University of Passau

Chair of Economic Theory

Seminar: Experimental Economics

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The impact of willpower-depletion on intertemporal choice, risk-preference and cognitive ability

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1. Introduction

Willpower depletion is a theoretical concept discussed by many psychologists for decades. Notations like *ego* / *willpower depletion* or restricted *self-control* / *self-regulation* are used to describe the concept that a restricted psychological resource regulates our mental processes. Especially the depletion of this regulatory resource has crucial effects on our lives. Cognitive resources facilitate economic deliberation and general decision-making and thus affect our economic lives. Therefore, an increasing number of economists have shown interest in this theory lately. Especially for poor individuals those biased decisions can perpetuate poverty further. For development economists the insights through willpower-depletion theories can help to understand how these psychological traps can be fought against. In this paper we describe a lab experiment conducted at the University of Passau to test the impact of willpower depletion on the areas of intertemporal choice, risk preferences and cognitive ability.

The paper is organized as follows: the first part describes the theory of willpower depletion we are testing for. The following parts describe the experiment and its design, the manipulation mechanism and the performance tasks for present-biasedness, risk preferences and cognitive ability. Subsequently, we will present our hypotheses and expectations and proceed to the results. Finally we will comment on the results, explore possible shortcomings and provide a conclusion.

2. Theoretical Background

Ego-depletion is a social psychology theory. It describes how our ability to execute self-control is limited. The *ego,* borrowed from Freud's psychoanalysis, is one part of our psyche (like the *id*, source of primitive needs and temptations; and the *super-ego,* source of higher moral standards). The ego is responsible for executive functions; the self's exertion of volition and psychic functions like control, judgement, intellectual functioning, memory, processing of information and taking responsibility. It solves conflicts between inner needs and the external reality. Exerting self-control depletes the same resources as other mental processes which are important to make valuable daily decisions. Willpower can be compared to a muscle: after usage it is tiered and has lowered power. But like a muscle, it can be trained and strengthened (compare to: Baumeister et al. 1998, Spears, 2010).

Baumeister et al. (1998) showed in a lab experiment how resisting freshly baked brownies affected test subjects' performance in consecutive independent tasks. Participants were assigned into two groups. The treatment group was not allowed to eat brownies but could eat radishes, whereas the control group could eat both. All participants entered the lab, filled with the smell of freshly baked chocolate brownies and some brownies on the tables. After a while all test subjects had to solve puzzles. Treatment subjects were less patient and quit faster when solving those puzzles compared to their control counterparts. Their self-regulatory resources were already depleted through the resistance of temptation, thus they could not force themselves through the puzzle solving part, as this is also cognitively demanding. Resisting temptation means exerting volition to control yourself: you crave for something, but in order to follow a reasonable goal, you are not allowed to indulge. The ego is depleted and following actions are affected. With our experiment we want to see how resisting temptation affects the subjects' performance, namely their intertemporal choices, risk-preferences and cognitive ability.

3. Experimental Design

The experiment is designed as a lab experiment. It was programmed with ZTree and conducted on computers within two execution days (Fischbacher 2007).

3.1. General Experiment Description

In the lab we had separated seats for each participant. Everyone sat in front of a computer with a piece of chocolate brownie on the right hand side and 2 slices of zucchini on the left hand side. Seats were randomly allocated and each seat was assigned to either treatment or control group. Hence assignment to treatment and control was also done randomly. The control group (Group 0) was allowed to eat both, brownie and zucchini, if wanted so. But treatment individuals (Group 1) were only allowed to eat zucchinis. This rule was introduced by the experimenters right in the beginning. The first part of the experiment comprised of a 5-minutes waiting time, where everyone was on their seats before continuing to following parts. Subsequently performance tasks started with the intertemporal decision, BART and Raven's test. At the end some control and demographic questions had to be answered by everyone.

3.2. Manipulation mechanism

The manipulation mechanism operated as follows: participants were sitting in front of the brownie and zucchinis for 5 minutes without doing anything and treatment individuals were not allowed to eat the brownie. The room was filled with baking aroma (vanilla and butter) to intensify the effect. Treatment individuals must control themselves and be patient until instructions followed. Control individuals, however, could eat the brownie and didn't have to exert self-control.

3.3. Performance tasks

A major part of the experiment is comprised of three different performance tasks. The purpose of those tasks is to test participants' behavior in terms of present-biasedness, risk-preferences and cognitive ability. The following sections outline the design and implementation of each performance task.

3.3.1. Intertemporal choice

As a measure for their present-biasedness, participants had to make an intertemporal choice. They had to decide for one of the two following options: 1) Obtain one chocolate bar today (earliest one hour after the experiment); or 2) Obtain two chocolate bars tomorrow. Participants had a "natural" incentive to choose option 2, since this would yield them a higher payoff (two instead of one chocolate bar). However, this payoff lies in the future and therefore needs to be discounted by the individual. Participants who chose option 1 seem to discount future earnings (chocolate bars) stronger than those who chose option 2. In other words, they are less patient or more present-biased. The chocolate bars were visible for participants to ensure a realistic decision-making process.

3.3.2. Balloon Analogue Risk Test (BART)

We used the Balloon Analogue Risk Test (BART) as a measure for risk-aversion (Lejuez et al. 2002, pp. 75-78). Participants were shown an image of a balloon on the computer screen. By clicking a "pump"-button, participants could inflate this virtual balloon and thereby earn tokens. Each "pump" yielded one token. The balloon could be inflated up to maximum eight times. However, each "pump" was associated with the risk of the balloon exploding. In case

of a balloon explosion, the participant lost all his tokens. The participants had no information at which pump number the balloon would explode. A random number between 1 and 8 was chosen by an algorithm prior to the first pump. As soon as the pump number reached this random number, the balloon would explode. The risk of explosion increases with each click, from 1/8 at the first pump to 1 at the eighth pump. As a consequence of this design, participants had on the one hand an incentive to inflate the balloon as much as possible to collect as many tokens as possible (seven times). On the other hand, participants had to include the increasing risk of explosion and loss of all tokens into their decision-making process. This task was played over 10 rounds to account for learning effects. Participants with a lower average pump number are classified as more risk-averse than participants with a higher average pump number.

3.3.3. Raven's progressive matrices

Cognitive ability of participants was measured using the so called Raven's progressive matrices (compare to: Raven 2008). Participants were shown incomplete rows of figures that they had to complete in a logical way. More precisely, in the upper part of the screen, the incomplete row of figures was shown. Underneath this row, participants could choose between four alternative figures to complete the row. However, only one figure was the right choice. The test comprised 18 different rows of figures and participants had three minutes time to complete as many rows as possible. Each correctly completed row yielded one token. A person's cognitive ability is measured according to the number of tokens / correctly completed rows. The more rows the persons completed correctly, the higher her cognitive ability.

4. Hypotheses and Expectations

Based on theory and the experimental design in mind, three main hypotheses could be framed. For each hypothesis we had an expected outcome in mind, according to the theoretical background. Those hypotheses and expected outcomes are presented below.

4.1. Hypotheses

First hypothesis: The treatment group will prefer the first option (one chocolate bar today) over the second option (two chocolate bars tomorrow). In other words they will be more present-biased and choose the smaller but sooner reward rather than the later but bigger reward.

Intertemporal decisions are cognitively costly. Deliberating about the value of a future reward is mentally hard, as many factors and risk influencing the net reward, have to be considered. Treatment participants had to exert self-control during the waiting time to not eat the brownie and will be cognitively *tired. O*nce the willpower is depleted/ tired the individual tries to mind cognitively costly actions. Thus treated individuals will behave in present-biased *(*compare to: Wang et al. (2010) and Baumeister et al. 1998).

Second hypothesis: The treatment group will be more risk-averse than the control group and pump the balloon on average less often than the control individuals. The explanation for this hypothesis is that taking risk is again cognitively demanding and the already lowered will-power will be too exhausted to take risk and thus leading to more risk-averse behavior (compare to: Ainsworth et al. 2014 and Kool et al. 2010).

Lastly, the treatment group will solve less Raven's matrices correctly compared to their control counterparts. Solving problems demands self-control and mental resources, the person with the already depleted willpower will have less mental resources to solve these matrices (compare to: Baumeister et al. 1998).

4.2. Expectations

We expect to prove all three hypotheses with small but significant results. For risk behavior and intertemporal choice, we expect to find relatively strong impacts. But for the cognition task we expect smaller impacts, the manipulation might be too small. To affect the persons cognitive abilities, a bigger manipulation mechanism might be necessary, in this case a longer waiting period in the beginning. We are also aware of disturbances that appeared during implementation and the impact they might have on our results.

5. Results and discussion

After describing the experiment and presenting the theory, our hypothesis and expectations we will see the results in the following.

5.1. Sample description

A brief sample description is presented in table 1. The full sample consists of 195 participants, 98 individuals were assigned to the control and 97 to the treatment group. With 43 percent of male and 56 percent female participants, the gender distribution is balanced. In average participants are 22.3 years old, the biggest group is between 20 to 24 years old. Regarding the course of studies, we can see that many study programs are represented. Most participants are studying Business Administration, Kuwi/ European Studies or Teaching. Furthermore, a balance test shows that the sample is similar in all those characteristics, thus our treatment and controls are comparable regarding their observable characteristics.

Table 1: Sample characteristics

Sex	**N**	**%**
Male	84	43.1
Female	111	56.9

Age	**N**	**%**
17 - 19	34	17.4
20 - 24	121	62.1
25 - 29	37	19.0
30 - 34	3	1.5
		Average age: 22.3

Course of studies	**N**	**%**
Business Administration / Economics	76	39.0
Governance & Public Policy	16	8.2
KuWi / European Studies	39	20.0
MuK / SpruTe	9	4.6
Computer Science / Internet Computing	2	1.0
Teaching	21	10.8
Law	16	8.2
Other	16	8.2

Prior experiment participation	**N**	**%**
Yes	60	30.8
No	135	69.2

As we see in table 2, there is no significant difference in means for all four variables.

Table 2: Balance Test

Characteristic	*Mean control group*	*Mean treatment group*	*p-value*
sex	1.571	1.567	0.9506
age	22.67	21.89	0.0573
studies	3.327	3.206	0.7330
graduation	1.878	1.732	0.3545

5.2. Intertemporal choice

We analyzed the impact of willpower depletion on the intertemporal choice, thereby the impact of the manipulation on present-biasedness. The graphical analyses for the full sample shows no visible impact. Fisher's exact test proves this, as we do not have a significant difference between treatment and control group in their choice. We than continued with a regression analysis using a Probit model. Treatment dummy is still insignificant; the treatment has no influence on the choice whether to have one chocolate bare later today or two chocolate bars tomorrow. But the dummies *uni_tomorrow* and *studies* have a significant impact on the choice made. As shown in table 3, having class tomorrow increases the probability of choosing two chocolate bars tomorrow. This effect is highly significant on the 1% level. The impact of studies might also be due to the curriculum and if that person is later today or tomorrow at the university.

Table 3: Intertemporal choice

	Full sample	Brownie likers
	(1)	(2)
	dummy_intertemp_choice	dummy_intertemp_choice
treatment_dummy	-0.124	-0.178
	(0.195)	(0.209)
exertion_wait	0.020	-0.027
	(0.075)	(0.080)
uni_tomorrow	-1.042	-1.100
	(0.222)***	(0.243)***
sex	0.142	0.078

	(0.196)	(0.212)
age	-0.020	-0.007
	(0.034)	(0.036)
studies	-0.072	-0.090
	(0.042)*	(0.046)*
_cons	0.809	0.884
	(0.917)	(0.974)
N	195	170

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

However, one reason for the insignificance of the treatment dummy could be due to the fact that a substantial share of the sample might not like brownies. For such participants, the treatment can't have an effect since they don't experience the brownie as temptation. Thus restraining from eating it would not be willpower depleting for them. We therefore conducted the same analyses for a subsample – the so called brownie likers. This subsample excludes all participants who stated in the questionnaire that they don't like brownies. With now 170 observations, we tested the hypothesis with Fisher's exact test. Still we did not find significant difference between treatment and control. Also we did run a Probit regression. The effect of treatment on the choice is still not significant, but *uni_tomorrow* and *studies* are still significant. One difference is visible, the brownie likers found the waiting time exhausting. The treatment has no significant effect on intertemporal choice, neither for the whole sample nor for the restricted subsample.

However, having in mind that our sample comprises almost only university students, we can guess that they are not that sensitive to present-biasedness. And maybe chocolate bars are of minor value for these students, thus they choose according their timing but not their preference for present rewards. Also a university student's willpower is well-trained, as they have to control themselves often. For instance, investing in education itself shows high willpower, and also high value for future over present rewards. Also our treatment was not that strong to move these people into being present-biased after controlling themselves not to indulge.

5.3. Risk preferences

We analyzed the effect of willpower depletion on risk preference using both graphical and statistical (Mann–Whitney U test and OLS) analysis (see appendix for all graphs and tables).

For the full sample of participants, we only found a very small and statistically insignificant effect of the treatment on the average pump number. As visible in the regression results in column 1 of table 4 the only statistically significant difference is associated with the sex. Women pumped on average less often than men suggesting they are more risk-averse. This result might lead to the conclusion that willpower depletion does not alter risk preferences.

For the same reasons as explained in the previous chapter, we again run the regression for the subsample of brownie likers. Column 2 in table 4 shows these regression results. Women still seem to be more risk-averse in this subsample. More interesting, however, is the positive and statistically significant coefficient on the treatment dummy. It suggests that participants who had to resist the brownie, pumped the balloon on average 0.202 times more often than the control group. In relative terms this corresponds to an increase in the average pump number of 6.1 percent.

Another factor that could influence the average pump number and cause a downward bias of the results is the random number that determines the timing of the balloon explosion. For several observations it might be the case that the participant would have liked to continue pumping, but couldn't because the balloon exploded before he decided to stop pumping. For instance, the participant, after calculating his potential earnings and the explosion risk, would have opted for six pumps. However, the balloon exploded at pump number four. This exogenous pump restriction would yield data that depicts the participant as more risk-averse than he actually is. Due to this, we ran another regression for the brownie likers, with an explosion adjusted average pump number. The explosion adjusted average pump number is the average pump number over all ten rounds, yet only considering those rounds in which the balloon didn't explode. Since it excludes the exogenous pump restriction it only displays fully self-chosen pump numbers and therefore models risk-aversion more accurately. The results for this regression are shown in column 3 of table 4. Here, the treatment dummy (resisting the brownie) is the only statistically significant factor that explains differences in the explosion adjusted average pump number. Participants who had to resist the brownie pumped the balloon on average 0.361 times more often than the control group. In relative terms this corresponds to an increase in the explosion adjusted average pump number of 9.2 percent.

Table 4: Average pump numbers

	Full sample	Brownie likers	Brownie likers & explosion adjusted
	(1)	(2)	(3)
	average_pump_number	average_pump_number	average_pump_number_adjusted
treatment_dummy	0.118	0.202	0.361
	(0.106)	(0.114)*	(0.185)*
exertion_wait	-0.004	-0.004	-0.060
	(0.040)	(0.043)	(0.070)
exertion_intertemp	-0.043	-0.049	-0.079
	(0.071)	(0.075)	(0.121)
Sex	-0.214	-0.255	-0.302
	(0.105)**	(0.115)**	(0.185)
Age	-0.001	0.002	0.014
	(0.018)	(0.020)	(0.032)
Studies	0.014	0.009	0.040
	(0.022)	(0.023)	(0.038)
_cons	3.838	3.816	4.347
	(0.554)***	(0.595)***	(0.966)***
R^2	0.03	0.05	0.05
N	195	170	169

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Overall, these results suggest that willpower depletion decreases risk aversion, contrary to our hypothesis. The temptation of the brownie during waiting time seems to have decreased participants' risk-aversion. One explanation could be that resisting temptation is frustrating and therefore leads to more impulsive (and riskier) decisions. Furthermore, resisting temptation consumes cognitive resources which are then no longer available for the calculation of risk. Hence, willpower depleted people might struggle to calculate risk and therefore not (or insufficiently) include it in their decision-making processes.

5.4. Cognitive ability

As for present-biasedness and risk-preferences we tested the impact of willpower depletion first for the full sample and then for the subsample brownie likers. As visible in column 1 of

table 5, there is no effect for the full sample. Both treatment and control group solved on average about 5.5 matrices correctly. Even when restricting the sample to the brownie likers the small effect is clearly insignificant, as presented in the regression results in column 2 of table 5. Accordingly, we did not find any effect of willpower depletion on cognitive ability.

However, the coefficient on the perceived exertion during the waiting time is negative, relatively sizable and highly significant for the full sample as well for the brownie likers. This suggests that participants, who perceived the waiting time as less exhausting, solved on average less matrices[1]. At the first sight, this result seems counterintuitive. One would think that less exhausted people should perform better. One explanation could be that those participants were exhausted because they didn't take the experiment seriously or used their smartphone for distraction during the waiting time. We can expect such participants also to be less committed to the performance tasks (especially to the raven's test since it is the last one) and therefore to perform worse.

Table 5: Correct answers in Raven's matrices

	Full sample	Brownie likers
	(1)	(2)
	Raven_correct	Raven_correct
treatment_dummy	0.047	0.255
	(0.409)	(0.440)
exertion_wait	-0.407	-0.390
	(0.155)***	(0.166)**
exertion_intertemp	0.085	0.161
	(0.280)	(0.293)
exertion_BART	0.171	0.120
	(0.200)	(0.217)
sex	-0.532	-0.565
	(0.410)	(0.444)
age	-0.093	-0.103
	(0.072)	(0.077)
studies	-0.099	-0.137
	(0.083)	(0.090)

[1] The variable exertion-wait is coded from 0 (very exhausting) to 4 (not exhausting at all).

_cons	8.853	9.062
	(2.144)***	(2.290)***
R^2	0.06	0.07
N	195	170

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

5.5. Manipulation test

The results of the previous sections show a modest effect of willpower depletion on risk-preferences, but no statistically significant effect, neither on present-biasedness nor on cognitive ability. Nevertheless, at this point, it is too soon to reject our hypotheses. One explanation for our (unexpected) results could be that the manipulation mechanism failed. If the participants in the treatment group (those who had to resist the brownie) did not perceive the waiting time as more exhausting than the control group (those who were allowed to eat the brownie), then we also can't expect them to be more willpower-depleted. Hence, we could not expect any differences in the performance tasks.

Using the Mann-Whitney U test, we did not find any statistically significant differences in the perceived exertion of the waiting time between control and treatment group. Could it be that the treatment group had a significantly weaker preference for brownies and therefore perceived the brownies as less tempting? A second Mann-Whitney U test rejected this hypothesis. Table 6 shows the most crucial result of our manipulation test. Even when restricting the sample to the brownie likers, we find no significant differences in the perceived exertion of the waiting time between control and treatment group. Although participants in both groups liked brownies, it was not particularly exhausting for participants in the treatment group to resist eating the brownie during the waiting time. Brownies seem to be an adequate proxy for temptation. However, resisting this temptation was not perceived as exhausting and therefore did not deplete participants' willpower. We conceive this shortcoming of the manipulation mechanism as a strong explanation for the missing/modest effects shown in the previous sections.

Table 6: Exertion of waiting time for brownie likers

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |      obs    rank sum    expected
-------------+---------------------------------
           0 |       83        6853      7096.5
           1 |       87        7682      7438.5
-------------+---------------------------------
    combined |      170       14535       14535

unadjusted variance   102899.25
adjustment for ties    -4777.72
                     ----------
adjusted variance      98121.53

Ho: exerti~t(treatm~y==0) = exerti~t(treatm~y==1)
             z =  -0.777
    Prob > |z| =   0.4370
```

6. Shortcomings

This chapter discusses possible short-comings in the design and implementation of the experiment. It will be shown that those shortcomings are likely to be the drivers behind the malfunction of the manipulation mechanism.

6.1. Experimental Design

Regarding the experimental design, we identified one crucial shortcoming. Willpower depletion should be caused by resisting the brownie during the waiting time. Due to exogenous restrictions like maximum experiment duration, we chose a relatively short waiting time of only five minutes. The execution of the experiment has shown that a longer waiting time wouldn't have been possible. However, five minutes of waiting time and resisting temptation is possibly too short to significantly deplete willpower. In reality, poor people have to resist several temptations every single day over a long period of time. It could well be that willpower depletion is rather a long-term phenomenon and therefore difficult to examine in a 20 minutes experiment.

6.2. Implementation

We further identified three possible shortcomings regarding the implementation of the experiment that could have interfered with the manipulation mechanism. First, we were not able to control for participants' eating behavior right before the experiment. A substantial share might have come to the experiment right after eating lunch or having a snack. Obviously, for those sated participants resisting a brownie shouldn't consume a lot of their willpower. The second problem refers to the experiment setting. To facilitate recruiting, participants were offered free coffee and snacks already before the start of the experiment. It is plausible, that when enjoying coffee and cookies during the waiting time, people won't find it too hard to resist one brownie. The last problem refers to the behavior of some of the participants. Although we asked participants not to use their smartphones during the experiment we observed several participants playing with their smartphone, especially during the waiting time. For those participants we expect the manipulation mechanism to fail, since this distraction possibly compensates for resisting the brownie. They reward themselves immediately for resisting one temptation (brownie) by giving in to the next temptation (smartphone).

7. Conclusion

Altogether, the results of our lab experiment do not provide any support for our hypotheses regarding the effect of willpower depletion. We expected the treatment group to be more present-biased, more risk-averse and of weaker cognitive performance. However, the experiment was not able to detect any of those expected results. Even with the restricted brownie likers sample, we did not find any significant effects neither for present-biasedness nor for cognitive performance, and only a small, but contrary effect on risk preferences. So, do we simply reject our hypotheses and the theoretical foundations behind them?

No, this would be naïve. The results of the manipulation test yield a reasonable explanation for the unexpected and rather disappointing findings. Although brownies have shown to be an adequate proxy for temptation, the experimental design (due to exogenous limitations) did not permit the temptation to take a significant effect. Temptation was simply not intense enough to deplete the willpower of the treated individuals. This shortcoming was further amplified by other uncontrollable factors (like eating behavior, free coffee before experiment etc.). Instead of simply rejecting our hypotheses we see these results as a basis to conduct further research in this area. In a future lab experiment we would put much effort in a well-functioning and

more intense manipulation mechanism. Increasing waiting time would be the first approach. Second, we would try to exert more control with regard to participants' behavior before and during the experiment (especially eating, or any kind of distractions) that could influence the degree of perceived temptation. We care to imagine that, under such circumstances, results confirming our hypotheses are much more likely to be found.

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Declaration of academic honesty

We hereby confirm that the present term paper on

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is solely our own work and that if any text passages or diagrams from books, papers, the web or other sources have been copied or in any other way used, all references – including those found in electronic media – have been acknowledged and fully cited. We further confirm that the present term paper, in this or similar form, hasn't been submitted to any other examination authority.

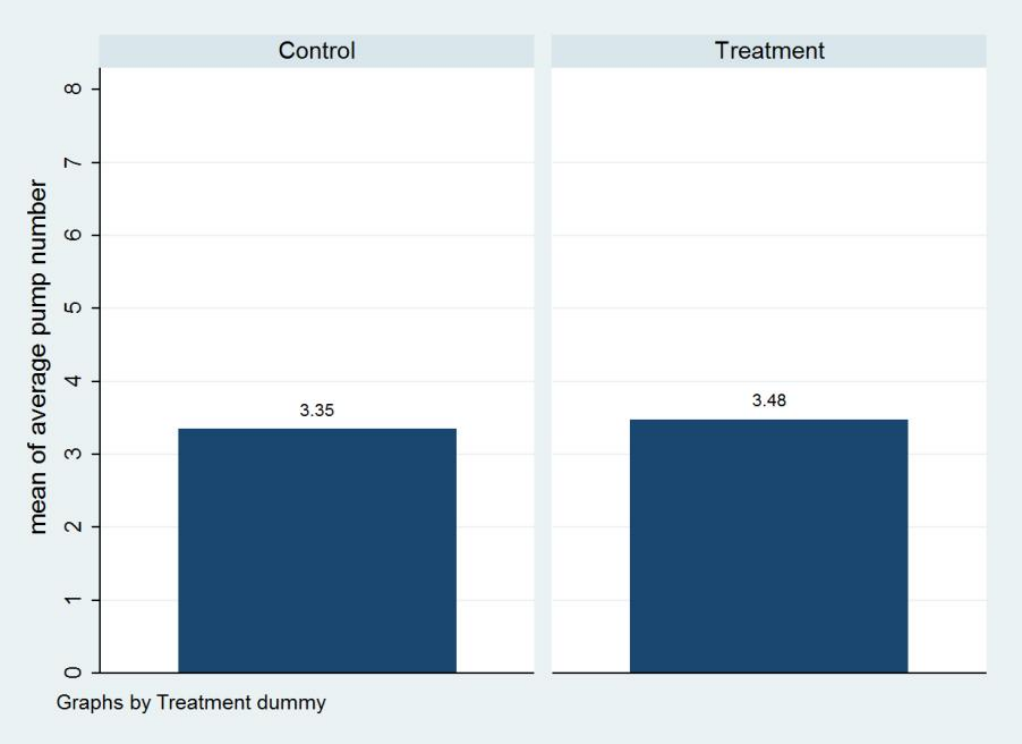
Passau, 15th of September, 2016

Nicolas Büttner Nadjia Mehraban

Appendix: Additional tables and graphs

BART – Full sample

Graphical comparison

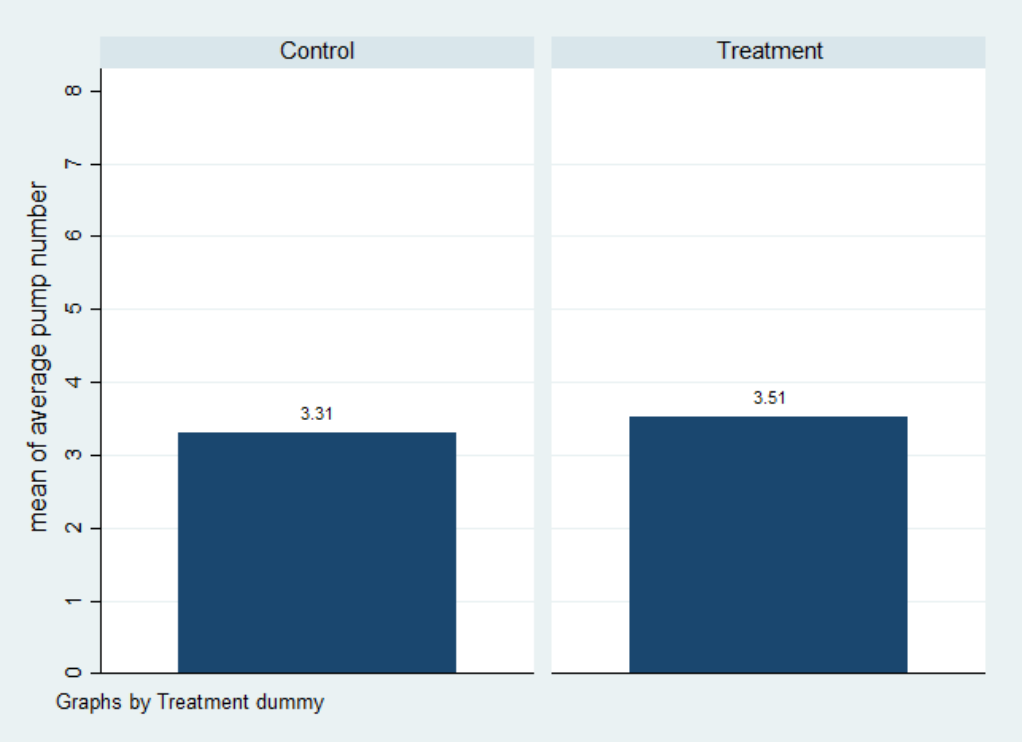


Mann-Whitney U test

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |       obs    rank sum    expected
-------------+---------------------------------
           0 |        98        9121        9604
           1 |        97        9989        9506
-------------+---------------------------------
    combined |       195       19110       19110

unadjusted variance   155264.67
adjustment for ties     -337.85
                     ----------
adjusted variance     154926.82

Ho: averag~r(treatm~y==0) = averag~r(treatm~y==1)
              z =  -1.227
    Prob > |z| =   0.2198
```

BART – Brownie likers

Graphical comparison

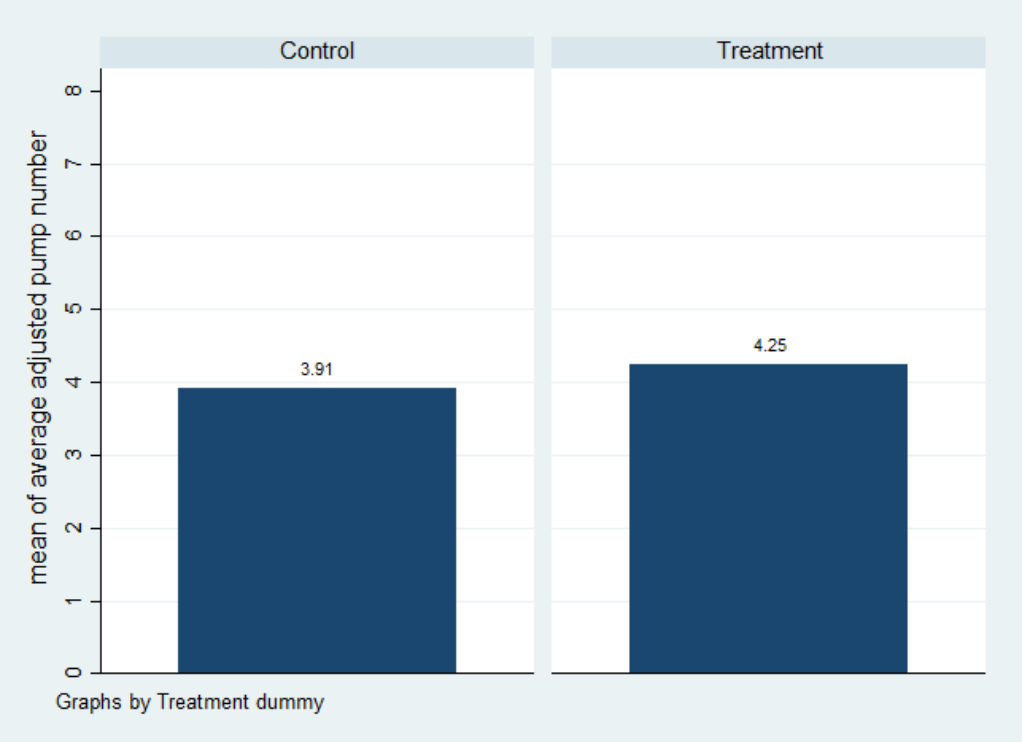


Mann-Whitney U test

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |      obs    rank sum    expected
-------------+---------------------------------
           0 |       83      6513.5      7096.5
           1 |       87      8021.5      7438.5
-------------+---------------------------------
    combined |      170       14535       14535

unadjusted variance    102899.25
adjustment for ties      -216.28
                       ----------
adjusted variance      102682.97

Ho: averag~r(treatm~y==0) = averag~r(treatm~y==1)
             z =  -1.819
    Prob > |z| =   0.0689
```

BART – Brownie likers – Explosion adjusted

Graphical comparison

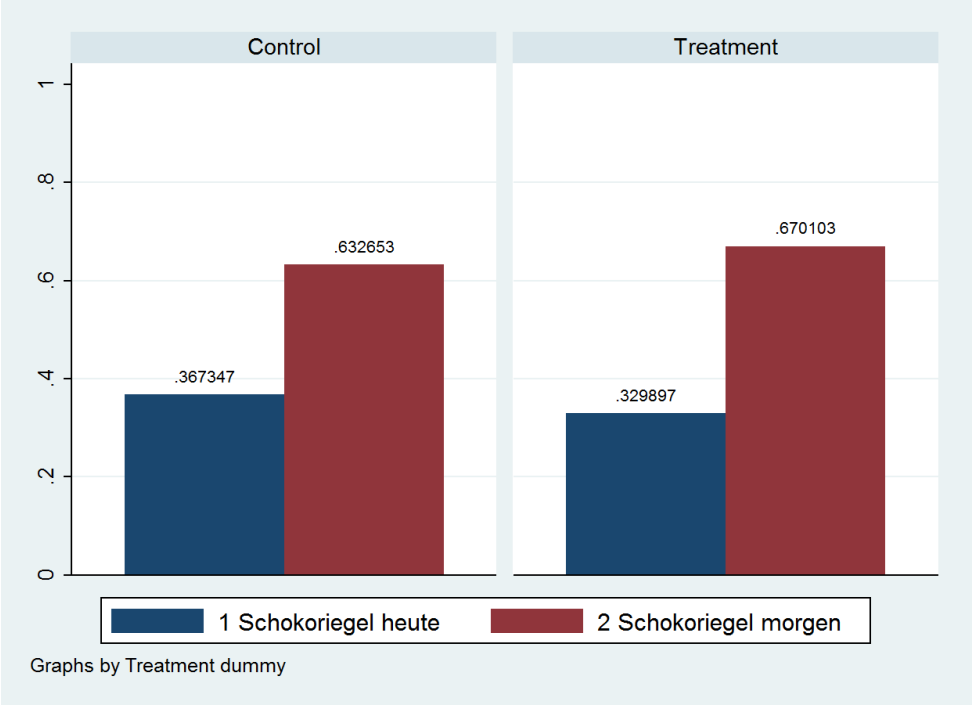


Mann-Whitney U test

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |      obs    rank sum    expected
-------------+---------------------------------
           0 |       83      6447.5        7055
           1 |       86      7917.5        7310
-------------+---------------------------------
    combined |      169       14365       14365

unadjusted variance    101121.67
adjustment for ties      -147.70
                       ----------
adjusted variance      100973.96

Ho: averag~d(treatm~y==0) = averag~d(treatm~y==1)
              z =  -1.912
    Prob > |z| =   0.0559
```

Intertemporal – Full sample

Graphical comparison



Fischer's exact test

```
Ho: Raven_~t(treatm~y==0) = Raven_~t(treatm~y==1)
              z =   0.160
    Prob > |z| =   0.8731
```

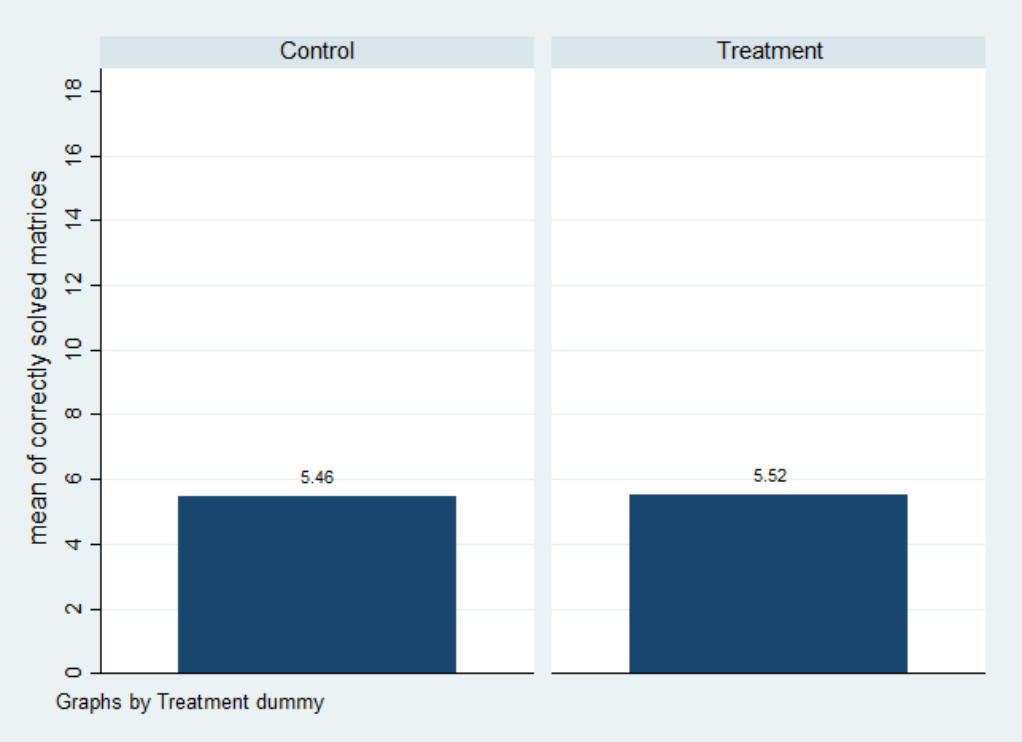
```
. tabulate dummy_intertemp_choice treatment_dummy, exact
```

Dummy intertempo ral choice	Treatment dummy 0	1	Total
1	36	32	68
2	62	65	127
Total	98	97	195

```
          Fisher's exact =                 0.653
  1-sided Fisher's exact =                 0.345
```

Raven – Full sample

Graphical comparison

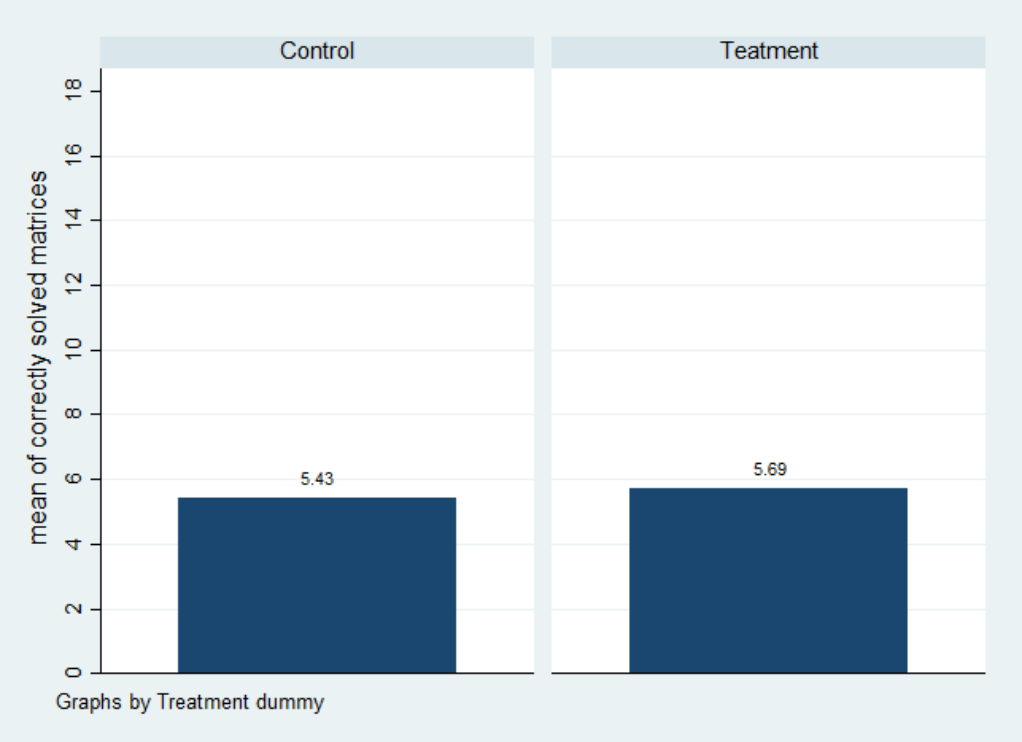


Mann-Whitney U test

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |      obs    rank sum    expected
-------------+---------------------------------
           0 |       98      9666.5        9604
           1 |       97      9443.5        9506
-------------+---------------------------------
    combined |      195       19110       19110

unadjusted variance   155264.67
adjustment for ties    -2123.96
                     ----------
adjusted variance     153140.71

Ho: Raven_~t(treatm~y==0) = Raven_~t(treatm~y==1)
              z =   0.160
    Prob > |z| =   0.8731
```

Raven – Brownie likers

Graphical comparison



Mann-Whitney U test

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |      obs    rank sum    expected
-------------+---------------------------------
           0 |       83      6966.5      7096.5
           1 |       87      7568.5      7438.5
-------------+---------------------------------
    combined |      170       14535       14535

unadjusted variance    102899.25
adjustment for ties     -1312.37
                       ----------
adjusted variance      101586.88

Ho: Raven_~t(treatm~y==0) = Raven_~t(treatm~y==1)
              z =  -0.408
    Prob > |z| =   0.6834
```

Manipulation test

Manipulation test – exertion waiting time

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |       obs    rank sum    expected
-------------+---------------------------------
           0 |        98      9324.5        9604
           1 |        97      9785.5        9506
-------------+---------------------------------
    combined |       195       19110       19110

unadjusted variance   155264.67
adjustment for ties    -7068.31
                     ----------
adjusted variance     148196.35

Ho: exerti~t(treatm~y==0) = exerti~t(treatm~y==1)
              z =  -0.726
    Prob > |z| =   0.4678
```

Manipulation test – brownie liking

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

treatment_~y |       obs    rank sum    expected
-------------+---------------------------------
           0 |        98      9913.5        9604
           1 |        97      9196.5        9506
-------------+---------------------------------
    combined |       195       19110       19110

unadjusted variance   155264.67
adjustment for ties   -13500.13
                     ----------
adjusted variance     141764.54

Ho: browni~g(treatm~y==0) = browni~g(treatm~y==1)
              z =   0.822
    Prob > |z| =   0.4111
```

```
1
2   set more off
3   clear
4   matrix drop _all
5   set matsize 5000
6   cap log close
7   cap log using "C:\Users\Nico\Documents\Studium Uni Passau\Unterlagen Master DevSt\02
    SS16\Experimental Economics\Auswertung\STATA\Data_Editing.log", replace
8   cd "C:\Users\Nico\Documents\Studium Uni Passau\Unterlagen Master DevSt\02
    SS16\Experimental Economics\Auswertung\STATA"
9
10  #d ;
11
12
13  * Append sessions (raw datasets) * ;
14
15  clear ;
16  use Wednesday_0950_raw.dta ;
17  append using Wednesday_1050_raw.dta ;
18  append using Wednesday_1150_raw.dta ;
19  append using Wednesday_1350_raw.dta ;
20  append using Wednesday_1450_raw.dta ;
21  append using Wednesday_1550_raw.dta ;
22  append using Thursday_0950_raw.dta ;
23  append using Thursday_1050_raw.dta ;
24  append using Thursday_1150_raw.dta ;
25  append using Thursday_1350_raw.dta ;
26  append using Thursday_1450_raw.dta ;
27
28  save Masterfile_raw.dta, replace ;
29
30
31  * Rename and label variables * ;
32
33  rename subject subject_number ;
34  label variable subject_number "Subject number" ;
35  rename platznummer seat_number ;
36  label variable seat_number "Seat number" ;
37  rename gruppe_auswahl treatment_dummy ;
38  label variable treatment dummy "Treatment dummy" ;
39  rename timealternative1einschokoriegelh time_alternative1 ;
40  label variable time_alternative1 "Time alternative 1" ;
41  rename timealternative2zweischokoriegel time_alternative2 ;
42  label variable time_alternative2 "Time alternative 2" ;
43  rename pumpzahl pump_number_1 ;
44  label variable pump_number_1 "Number of pumps in first round" ;
45  rename var7 pump_number_2 ;
46  label variable pump_number_2 "Number of pumps in second round" ;
47  rename var8 pump_number_3 ;
48  label variable pump_number_3 "Number of pumps in third round" ;
49  rename var9 pump_number_4 ;
50  label variable pump_number_4 "Number of pumps in fourth round" ;
51  rename var10 pump_number_5 ;
52  label variable pump_number_5 "Number of pumps in fifth round" ;
53  rename var11 pump_number_6 ;
54  label variable pump_number_6 "Number of pumps in sixth round" ;
55  rename var12 pump_number_7 ;
56  label variable pump_number_7 "Number of pumps in seventh round" ;
57  rename var13 pump_number_8 ;
58  label variable pump_number_8 "Number of pumps in eighth round" ;
59  rename var14 pump_number_9 ;
60  label variable pump_number_9 "Number of pumps in nineth round" ;
61  rename var15 pump number 10;
62  label variable pump_number_10 "Number of pumps in tenth round" ;
63  rename bart_aktuell BART_payoff_1 ;
64  label variable BART_payoff_1 "BART Payoff in first round" ;
65  rename var30 BART_payoff_2 ;
66  label variable BART_payoff_2 "BART Payoff in second round" ;
67  rename var31 BART payoff 3 ;
68  label variable BART_payoff_3 "BART Payoff in third round" ;
69  rename var32 BART_payoff_4 ;
70  label variable BART_payoff_4 "BART Payoff in fourth round" ;
71  rename var33 BART_payoff_5 ;
72  label variable BART_payoff_5 "BART Payoff in fifth round" ;
73  rename var34 BART_payoff_6 ;
```

```
label variable BART_payoff_6 "BART Payoff in sixth round" ;
rename var35 BART_payoff_7 ;
label variable BART_payoff_7 "BART Payoff in seventh round" ;
rename var36 BART_payoff_8 ;
label variable BART_payoff_8 "BART Payoff in eighth round" ;
rename var37 BART_payoff_9 ;
label variable BART_payoff_9 "BART Payoff in ninetch round" ;
rename var38 BART_payoff_10 ;
label variable BART_payoff_10 "BART Payoff in tenth round" ;
rename bart_gesamt BART_payoff ;
label variable BART_payoff "BART Payoff total" ;
rename richtige Raven_correct ;
label variable Raven_correct "Correct answers in Raven test" ;
rename f1w exertion_wait ;
label variable exertion_wait "How exhausting was the waiting time?" ;
rename f1a1 exertion_intertemp ;
label variable exertion_intertemp "How exhausting was the intertemporal choice task?" ;
rename f1a2 exertion_BART ;
label variable exertion_BART "How exhausting was the BART task?" ;
rename f1a3 exertion_Raven ;
label variable exertion_Raven "How exhausting was the Raven's task?" ;
rename f2a uni_tomorrow ;
label variable uni_tomorrow "Are you at university tomorrow?" ;
rename f3a brownie_liking ;
label variable brownie_liking "How much do you like brownies?" ;
label variable sex "Sex" ;
label variable age "Age" ;
rename studiengang studies ;
label variable studies "Course of studies" ;
rename abschluss graduation ;
label variable graduation "Graduation" ;
rename teilnahme dummy_participation ;
label variable dummy_participation "Dummy for past experiment participation" ;


* Create new variables * ;

gen dummy_alternative1=0 ;
replace dummy_alternative1=1 if time_alternative1!=0 ;
label variable dummy_alternative1 "Dummy alternative 1" ;
gen dummy_alternative2=0 ;
replace dummy_alternative2=1 if time_alternative2!=0 ;
label variable dummy_alternative2 "Dummy alternative 2" ;
gen dummy_intertemp_choice=1 if dummy_alternative1==1 ;
replace dummy_intertemp_choice=0 if dummy_alternative2==1 ;
label variable dummy_intertemp_choice "Dummy intertemporal choice" ;

gen average_pump_number=(pump_number_1+pump_number_2+pump_number_3+pump_number_4+
pump_number_5
+pump_number_6+pump_number_7+pump_number_8+pump_number_9+pump_number_10)/10 ;
label variable average_pump_number "Average pump number in BART" ;

gen pump_number_1_adjusted=pump_number_1 ;
label variable pump_number_1_adjusted "Number of pumps in first round - adjusted" ;
gen pump_number_2_adjusted=pump_number_2 ;
label variable pump_number_2_adjusted "Number of pumps in second round - adjusted" ;
gen pump_number_3_adjusted=pump_number_3 ;
label variable pump_number_3_adjusted "Number of pumps in third round - adjusted" ;
gen pump_number_4_adjusted=pump_number_4 ;
label variable pump_number_4_adjusted "Number of pumps in fourth round - adjusted" ;
gen pump_number_5_adjusted=pump_number_5 ;
label variable pump_number_5_adjusted "Number of pumps in fifth round - adjusted" ;
gen pump number 6 adjusted=pump number 6 ;
label variable pump_number_6_adjusted "Number of pumps in sixth round - adjusted" ;
gen pump_number_7_adjusted=pump_number_7 ;
label variable pump_number_7_adjusted "Number of pumps in seventh round - adjusted" ;
gen pump_number_8_adjusted=pump_number_8 ;
label variable pump_number_8_adjusted "Number of pumps in eighth round - adjusted" ;
gen pump number 9 adjusted=pump number 9 ;
label variable pump_number_9_adjusted "Number of pumps in nineth round - adjusted" ;
gen pump_number_10_adjusted=pump_number_10 ;
label variable pump_number_10_adjusted "Number of pumps in tenth round - adjusted" ;

replace pump_number_1_adjusted=. if BART_payoff_1==0 ;
replace pump_number_2_adjusted=. if BART_payoff_2==0 ;
```

```
148   replace pump_number_3_adjusted=. if BART_payoff_3==0 ;
149   replace pump_number_4_adjusted=. if BART_payoff_4==0 ;
150   replace pump_number_5_adjusted=. if BART_payoff_5==0 ;
151   replace pump_number_6_adjusted=. if BART_payoff_6==0 ;
152   replace pump_number_7_adjusted=. if BART_payoff_7==0 ;
153   replace pump_number_8_adjusted=. if BART_payoff_8==0 ;
154   replace pump_number_9_adjusted=. if BART_payoff_9==0 ;
155   replace pump_number_10_adjusted=. if BART_payoff_10==0 ;
156
157   egen average_pump_number_adjusted=rmean(pump_number_1_adjusted pump_number_2_adjusted
      pump_number_3_adjusted pump_number_4_adjusted pump_number_5_adjusted
158   pump_number_6_adjusted pump_number_7_adjusted pump_number_8_adjusted
      pump_number_9_adjusted pump_number_10_adjusted) ;
159   label variable average_pump_number_adjusted "Average pump number in BART - adjusted" ;
160
161   replace uni_tomorrow=. if uni_tomorrow==1 ;
162   replace uni_tomorrow=1 if uni_tomorrow==0 ;
163   replace uni_tomorrow=0 if uni_tomorrow==. ;
164
165
166   * Order variables * ;
167
168   order subject_number seat_number treatment_dummy time_alternative1 time_alternative2
      dummy_alternative1 dummy_alternative2 dummy_intertemp_choice
169   pump_number_1 pump_number_2 pump_number_3 pump_number_4 pump_number_5 pump_number_6
      pump_number_7 pump_number_8 pump_number_9 pump_number_10
170   pump_number_1_adjusted pump_number_2_adjusted pump_number_3_adjusted
      pump_number_4_adjusted pump_number_5_adjusted pump_number_6_adjusted
      pump_number_7_adjusted
171   pump_number_8_adjusted pump_number_9_adjusted pump_number_10_adjusted average_pump_number
      average_pump_number_adjusted BART_payoff_1 BART_payoff_2 BART_payoff_3
172   BART_payoff_4 BART_payoff_5 BART_payoff_6 BART_payoff_7 BART_payoff_8 BART_payoff_9
      BART_payoff_10 BART_payoff Raven_correct exertion_wait exertion_intertemp
173   exertion BART exertion Raven uni tomorrow brownie liking sex age studies graduation
      dummy_participation ;
174
175   save Masterfile.dta, replace ;
176
177   * Correct typing errors of participants * ;
178
179   replace treatment_dummy = 0 in 17 ;
180   replace treatment_dummy = 1 in 48 ;
181   replace seat_number = 11 in 180 ;
182
183   save Masterfile_corr.dta, replace ;
184
185
186
187
```

```
 1
 2  set more off
 3  clear
 4  matrix drop _all
 5  set matsize 5000
 6  cap log close
 7  cap log using "C:\Users\Nico\Documents\Studium Uni Passau\Unterlagen Master DevSt\02
    SS16\Experimental Economics\Auswertung\STATA\Analysis.log", replace
 8  cd "C:\Users\Nico\Documents\Studium Uni Passau\Unterlagen Master DevSt\02
    SS16\Experimental Economics\Auswertung\STATA"
 9
10  #d ;
11
12
13  ************
14  * Analysis *
15  ************;
16
17  use Masterfile_corr.dta ;
18
19  /* sample characteristics */ ;
20
21  tab sex ;
22  tab age ;
23  sum age ;
24  tab studies ;
25  tab dummy_participation ;
26
27  *balance test
28
29  global allvar "sex age studies graduation"
30
31  tabstat $allvar if  treatment_dummy==0, stats(count mean sd) columns(statistics)
32  tabstat $allvar if  treatment_dummy==1, stats(count mean sd) columns(statistics)
33
34  foreach v of varlist $allvar {
35  quietly ttest `v', by (treatment_dummy)
36  di "`v'" _col(18) %8.4g r(mu_1) " " %8.4g r(mu_2) %8.4f r(p)
37  }
38
39  cap log close
40
41  ************************************
42  * Intertemporal choice  - full sample *
43  ************************************
44
45  /* Graphical Analysis */ ;
46
47  graph bar dummy_alternative1 dummy_alternative2 , by(treatment_dummy) blabel(total) ylabel
    (0(0.2)1.0) ;
48  graph export intertemp.png, replace ;
49  /* --> no strong effect visible */ ;
50
51  /* Hypothesis tests: Fisher's exact test */ ;
52  tab dummy_intertemp_choice treatment_dummy, exact ;
53  /* treatment insignificant */ ;
54
55  /* Regression: Probit */ ;
56  probit dummy_intertemp_choice treatment_dummy exertion_wait uni_tomorrow sex age studies ;
57  outreg using Intertemp, se starlevels (10 5 1) sigsymbols(*, **, ***) replace ;
58  /* treatment insignificant, uni_tomorrow and studies, significant */ ;
59
60
61  ****************************************
62  * Intertemporal choice  - brownie likers *
63  ****************************************
64
65  /* Graphical Analysis */ ;
66
67  graph bar dummy_alternative1 dummy_alternative2 if brownie_liking<=2, by(treatment_dummy)
    blabel(total) ylabel(0(0.2)1.0) ;
68  graph export intertemp_bl.png, replace ;
69  /* --> no strong effect visible */ ;
70
```

```
  71  /* Hypothesis tests: Fisher's exact test */ ;
  72  tab dummy_intertemp_choice treatment_dummy if brownie_liking<=2, exact ;
  73  /* treatment insignificant */ ;
  74
  75  /* Regression: Probit */ ;
  76  probit dummy_intertemp_choice treatment_dummy exertion_wait uni_tomorrow sex age studies
      if brownie_liking<=2 ;
  77  outreg using Intertemp_bl, se starlevels (10 5 1) sigsymbols(*, **, ***) merge replace  ;
  78  /* treatment insignificant, uni_tomorrow and studies, significant */
  79
  80  /* Conclusion: treatment has no effect on intertemporal choice: not for whole sample,
      also not for restricted sample */ ;
  81
  82
  83
  84  **********************
  85  * BART - full sample *
  86  **********************
  87
  88  /* Graphical Analysis */ ;
  89  graph bar average_pump_number , by(treatment_dummy) blabel(total) ylabel(0(1)8) ;
  90  graph export BART.png, replace ;
  91  /* --> no strong effect visible */ ;
  92
  93  /* Hypothesis tests: Mann-Whitney test */ ;
  94  ranksum average_pump_number,by(treatment) ;
  95  /* treatment insignificant */ ;
  96
  97  /* Regression: OLS */ ;
  98  reg average_pump_number treatment_dummy exertion_wait exertion_intertemp sex age studies ;
  99  outreg using BART, se starlevels (10 5 1) sigsymbols(*, **, ***) replace  ;
 100  /* treatment insignificant, but women more riskaverse */ ;
 101
 102  ************************
 103  * BART - brownie likers *
 104  ************************
 105
 106  /* Graphical Analysis */ ;
 107  graph bar average_pump_number if brownie_liking<=2, by(treatment_dummy) blabel(total)
      ylabel(0(1)8) ;
 108  graph export BART_bl.png, replace ;
 109  /* --> no strong effect visible */ ;
 110
 111  /* Hypothesis tests: Mann-Whitney test */ ;
 112  ranksum average_pump_number if brownie_liking<=2,by(treatment) ;
 113  /* treatment significant (10%) --> treatment has more pumps --> less risk averse */ ;
 114
 115  /* Regression: OLS */ ;
 116  reg average_pump_number treatment_dummy exertion_wait exertion_intertemp sex age studies
      if brownie_liking<=2 ;
 117  outreg using BART_bl, se starlevels (10 5 1) sigsymbols(*, **, ***) merge replace  ;
 118  /* treatment significant (10%) --> treatment has more pumps --> less risk averse, women
      more riskaverse */ ;
 119
 120
 121  *******************************************
 122  * BART - brownie likers - explosion adjusted *
 123  *******************************************
 124
 125  /* Graphical Analysis */ ;
 126  graph bar average_pump_number_adjusted if brownie_liking<=2, by(treatment_dummy) blabel(
      total) ylabel(0(1)8) ;
 127  graph export BART_bl_adj.png, replace ;
 128  /* --> no strong effect visible */ ;
 129
 130  /* Hypothesis tests: Mann-Whitney test */ ;
 131  ranksum average_pump_number_adjusted if brownie_liking<=2,by(treatment) ;
 132  /* treatment significant (10%) --> treatment has more pumps --> less risk averse */ ;
 133
 134  /* Regression: OLS */ ;
 135  reg average_pump_number_adjusted treatment_dummy exertion_wait exertion_intertemp sex age
      studies if brownie_liking<=2 ;
 136  outreg using BART_bl_adj, se starlevels (10 5 1) sigsymbols(*, **, ***) merge replace  ;
 137
```

```
138   /* treatment significant (alsmost 5%) --> treatment has more pumps --> less risk averse */
       ;
139
140   *********
141   * Raven *
142   *********
143
144   /* Graphical Analysis */ ;
145
146   graph bar Raven_correct , by(treatment_dummy) blabel(total) ylabel(0(2)18) ;
147   graph export Raven.png, replace ;
148   /* --> no strong effect visible */ ;
149
150   /* Hypothesis tests: Mann-Whitney test */ ;
151   ranksum Raven_correct , by(treatment_dummy) ;
152   /* treatment insignificant */ ;
153
154   /* Regression: OLS */ ;
155   reg Raven_correct treatment_dummy exertion_wait exertion_intertemp exertion_BART sex age
      studies ;
156   outreg using Raven, se starlevels (10 5 1) sigsymbols(*, **, ***) replace  ;
157   /* treatment insignificant, exercion_wait: the less exhausting, the worse Raven:
      explanation: distraction during waiting and raven (clowns) */ ;
158
159   *************************
160   * Raven - brownie likers *
161   *************************
162
163   /* Graphical Analysis */ ;
164
165   graph bar Raven_correct if brownie_liking<=2, by(treatment_dummy) blabel(total) ylabel(0(2
      )18) ;
166   graph export Raven_bl.png, replace ;
167   /* --> no strong effect visible */ ;
168
169   /* Hypothesis tests: Mann-Whitney test */ ;
170   ranksum Raven_correct if brownie_liking<=2, by(treatment_dummy) ;
171   /* treatment insignificant */ ;
172
173   /* Regression: OLS */ ;
174   reg Raven_correct treatment_dummy exertion_wait exertion_intertemp exertion_BART sex age
      studies if brownie_liking<=2 ;
175   outreg using Raven_bl, se starlevels (10 5 1) sigsymbols(*, **, ***) merge replace  ;
176   /* treatment insignificant, exercion_wait: the less exhausting, the worse Raven:
      explanation: distraction during waiting and raven (clowns) */ ;
177
178
179   **********************
180   * Manipulation test *
181   **********************
182
183   ranksum exertion_wait, by(treatment_dummy) ;
184   /* no sign. difference in exertion_waiting time --> manipulation failed */ ;
185
186   ranksum brownie_liking, by(treatment_dummy) ;
187   /* no sign. difference in taste for brownies --> manipulation failed */ ;
188
189   ranksum exertion_wait if brownie_liking<=2, by(treatment_dummy) ;
190   /* also no sign. difference for brownie likers in exertion_waiting time --> manipulation
      failed */ ;
191   /* gründe: zu wenig Wartezeit, kaffe/kuchen vor und während Experiment, Menaessen,
      Cafete, Verständnisprobleme
192
193
194
195
196
197
198
```

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