How scarcity affects borrowing decisions in groups*
Research Design Document

Kjell Arne Brekke† and Florian Diekert‡

November 16, 2017

1 Motivation and Objectives

Recent research has uncovered the important role that scarcity has on decision making. When the means to an end are scarce, decisions makers focus their attention (they "tunnel" in the language of Mullainathan and Shafir [1]), using available resources most effectively. For example, experimental subjects aim better in a target-hitting task when they have less shooting opportunities. Similarly, college students are significantly more productive when facing a close rather than a distant deadline. However, this increased focus comes at a cost. Decision makers lose oversight and neglect important but less pressing long-term projects. They borrow too much and overall performance decreases as a consequence.

Until now, this research has concentrated on individual decision makers. How does the effect of scarcity play out on the group level? Groups and teams form a basic unit of human organization. Team work has become indispensable in modern economies. Moreover, many resources are owned or used collectively, especially in developing countries. Thus, it is fundamental to understand how scarcity affects borrowing decisions in groups. Do groups also neglect long-term projects under scarcity? Do groups borrow to meet the needs of the present, and thereby compromise the ability to meet their needs in the future, to the same extent as individuals do?

*This research has been funded by the European Research Council Project NATCOOP (ERC StGr 678049). We would like to thank Anuj Shah for providing us with the source codes of the original experiment and Mikael Sundgren for the excellent programming work that made this project possible.

†Department of Economics, University of Oslo, PO-Box 1095 Blindern, 3017 Oslo, Norway. E-mail: k.a.brekke@econ.uio.no.

‡Department of Economics, Heidelberg University, Bergheimer Straße 20, 69115 Heidelberg, Germany. E-mail: florian.diekert@awi.uni-heidelberg.de.

On the one hand, research has shown that groups are better at self control than individuals, and neglect of long-term concerns may be seen as an issue of self control. If the mechanism is that scarcity affects the ability to self-control, we would expect less long-term neglect in the group setting than in an individual setting. On the other hand, groups must solve collective action problems. If scarcity increases selfishness, we would expect to see lower performance in the group than in an individual setting under scarcity.

Our objective is to study, by means of economic experiments, the effect of scarcity on decisions and performance when the borrowing decisions of subjects have (or don't have) consequences for the group.

2 Experimental setup

Our experimental design builds directly on the 4th experiment of Shah et al [2]. From the authors, we have received the corresponding instructions and source codes. We replicate their experiment and add three new treatments.

Subjects are recruited via Amazon's mechanical turk platform and perform an online task. We call the underlying task the "Guessing Game". The game is modeled after the TV-show "Family Feud": Subjects are faced with a question (for example, *name things that you take on a picnic*) and have to guess which answers were most popular among a random sample of 100 people. Subjects earn one point per correct answer, but they only have a limited amount of time per question. (Points are later exchanged into real money.) The key treatment is whether subjects have an abundant or a scarce time budget, that is, whether they have more (50 seconds) or less (15 seconds) time available per question. There are 12 questions in our version of the Guessing Game.[1]

In all treatments subjects are matched randomly and anonymously in pairs and play sequentially. In other words, one subject plays first and the other subject plays second. The payoff for each subject is their total group payoff. All subjects can borrow from their own future questions at a 100% rate, that is: if a subject spends 5 seconds more on one question, the time available for later questions is reduced by 10 seconds. As in Shah et al [2], time can be banked: When a subject goes to the next question before the available time for the current question is over, the remaining time is added to the time budget. This option is available after 40% of the per-period time has elapsed.

The fundamental distinction between treatments is whether the first subject can borrow time from the second subject. If this is possible, we say the group has a joint time

[1] In [2], there were 20 rounds so that players had 300 and 1000 seconds in total (but same amount per question).

budget. If this is not possible, we say that each subject has an individual time budget. As the individual payoff is always simply the group payoff, the individual time budget treatments neutralize all strategic effects on the borrowing decisions.[2] The difference between the abundance and scarcity treatments under individual time budgets can thus indeed be seen as single-player treatments and they can be used to replicate the effect of scarcity on borrowing decisions of Shah et al [2].

Finally, there is one treatment with a virtual second player, played by a computer, and only the first player receives a payoff. In contrast to [2], there is no "no borrowing" treatment.

The game is played in 12 rounds. How does the time budget for a given player develop? Let X_t be total time left at the start of round t. Let x_t be the time spent in the round. Available time in round t before borrowing starts is $y_t = \max\left\{0, \frac{X_t}{13-t}\right\}$. At the beginning of each round, players get a "free second" to read the question. The game stop when $X_t \leq \bar{X} \leq 0$ or when all questions are answered. If $X_t > 0$ and $x_t > y_t$ the screen shows "you are borrowing time!". If $X_t < 0$ for the first player, the screen shows "you are borrowing time from your partner!" (for the second player, we always have $X_t \geq 0$). When $x_t > y_t$ (always true when $X_t < 0$) the time budget drops 2 units per second, otherwise one unit per second.

The list below gives an overview of our five treatments and the respective choice of parameters.

1) Individual-Scarce (IS) *Players are matched for payoffs but have an individual time budget. Borrowing at 100% rate starts after 15 seconds have been used on a given question. Game ends when total time budget of a subject is used up or he/she has answered all 12 questions.*

2) Individual-Abundant (IA) *Players are matched for payoffs but have an individual time budget. Borrowing at 100% rate starts after 50 seconds have been used on a given question.*

3) Joint-Scarce (JS) *Two-player group, joint time budget. Borrowing at 100% rate starts after 15 seconds have been used on a given question.*

4) Joint-Abundant (JA) *Two-player group, joint time budget. Borrowing at 100% rate starts after 50 seconds have been used on a given question.*

[2]Borrowing hurts the other player exactly the same as oneself. There are in fact also no free-riding incentives as increasing effort benefits the subject independent of the other player's performance. Of course, there may non-rational inter-dependencies that are introduced by coupling the payoff of the players, or player's effort cost may be so high that they do not exert any effort.

5) Virtual Second Player (VSP) *Single player with virtual second player. As third treatment (*JS*) but second player is virtual. A score for the second player is computed based on performance of second players in third and fourth treatment (*JS *and* JA*, respectively). Borrowing at 100% rate starts after 15 seconds have been used on a given question.*

Treatment	$X_1^{[1st]}$	$\bar{X}$	$X_1^{[2nd]}$
IS	180	0	180
IA	600	0	600
JS	180	120	$180 + (X_{12}^{[1st]} - x_{12}^{[1st]})$
JA	600	400	$600 + (X_{12}^{[1st]} - x_{12}^{[1st]})$
VSP	180	120	na

Table 1: Treatment parameters: $X_1^{[1st]}$ is the time budget of the first player in his/her round 1, $\bar{X}$ is the overdraft budget of the first player, and $X_1^{[2nd]}$ is the time budget of the second player in his/her round 1.

3 Hypotheses

If subjects "tunnel" under scarcity and focus extensively on the question at hand, they may neglect the time they have for future questions and borrow too much, which, in turn decreases performance (hypothesis 1).

Moreover, subjects may also neglect their collaborators' time. Sequential play means that "future time" is always also "the other player's time". Because individual payoff is the group payoff, reducing the other player's time by borrowing is as detrimental as using the own future time. Thus, there are no strategic incentives that encourage borrowing and overusing the common pool of time. Nevertheless, we expect that also players with joint time budgets are affected by scarcity (hypothesis 2), and that the first players will borrow so much under scacrcity that they use more than their share of the joint time budget (hypothesis 3).

Simply because a joint time budget means that the first player can borrow more, we expect that performance of groups with joint time budgets decreases under scarcity

(hypothesis 4). In order to isolate this effect of having a larger overdraft budget, we test whether subjects in the *VSP* treatment borrow too much (hypothesis 5).

Overall, however, we have no strong prior as to whether groups with joint scarce time budgets perform worse than single players that are matched with a virtual second player (hypothesis 6). The reason is that there may be several counteracting forces at work: On the one hand, when subjects have social preferences to not take from others, this should discipline borrowing, in spite of the fact that any direct effect of groups ability to self control are muted because the two players cannot communicate directly with each other (hypothesis 7). On the other hand, previous research has shown that "activating the concept of scarcity causes an underlying shift towards an agentic orientation, which then guides people's decision making towards advancing their own welfare, relative to that of others" [3]. This could drive the first players to overborrow in the scarcity treatment. Similarly, the first players could of course over-borrow because they think that they are better than the second player in scoring in the Guessing Game, such that a second used by them has a higher value than a second used by their counterpart (hypothesis 8). By testing hypotheses 7 and 8, we seek to shed light on the – potentially heterogenous – mechanisms that lead subjects to borrow more (or less) in the *JS* treatment than in the *VSP* treatment.

Definition of variables / Measurements:

In order to test our hypotheses, we derive the following set of measurements that are either directly based on the observed behavior in the Guessing Game, or on the post-experiment survey that is described below.

- *Performance* is measured by the total number of points that a given player scores. Performance in treatment x is measured as the average performance of the players in the treatment and denoted by P_x.

- *Borrowing* is measured by the number of seconds that a given player exceeds the time-limit per question. Borrowing in treatment x is measured as the average borrowing of the players in the treatment and denoted by B_x.

- We record the amount of time that subjects spend on each question. In order to additionally distinguish the borrowing of the first-movers in the group treatment, we denote their *time use* by T_{1x}. Their time-use is measured as the number of seconds that the first-movers uses either directly or as payment of the interest rate.

- To obtain a measure of the strength of a subject's *social preference* to not take from others, we use a post-experiment question with a Likert-scale (see section 4 below). We set this measure M_s equal to 0 when a subject's score is lower than the average, and equal to 1 otherwise.

- To measure their *confidence*, we ask subjects about their belief about their own performance and the performance of an average subject. We set M_c equal to 1 if a subject believes that he or she performs better than the average and equal to 0 otherwise.

Hypothesis Testing:

- Hypothesis 1 (replication): In the single-player treatments, scarcity implies more borrowing and lower performance.

$$B_{\text{IS}} > B_{\text{IA}} \qquad \text{and} \qquad P_{\text{IS}} < P_{\text{IA}}$$

- Hypothesis 2 (scarcity affects groups): Scarcity implies more borrowing and lower performance also in the group treatments.

$$B_{\text{JS}} > B_{\text{JA}} \qquad \text{and} \qquad P_{\text{JS}} < P_{\text{JA}}$$

- Hypothesis 3 (will borrow from others): The first player will borrow from the second player under scarcity.

$$T_{1\text{JS}} > 180 \text{ seconds}$$

- Hypothesis 4 (groups perform worse): Groups will perform worse with a joint time budget than two subjects with individual time budgets under scarcity.

$$P_{\text{JS}} < P_{\text{IS}}$$

- Hypothesis 5 (will overdraw): Single players will borrow also from their virtual partner.

$$T_{\text{VSP}} > 180 \text{ seconds}$$

- Hypothesis 6 (overdrawing harmful): First player behave similarly with

virtual and real second player.

$$P_{\text{VSP}} = P_{\text{JS}}$$

- Hypothesis 7 (social preferences): First players that hold social preferences to not take from others will borrow less.

$$\mathsf{E}[T_{1\text{JS}}|M_s = 1] < \mathsf{E}[T_{1\text{JS}}|M_s = 0]$$

- Hypothesis 8 (confidence): First players that believe that their performance in the Guessing Game are above average will borrow more.

$$\mathsf{E}[T_{1\text{JS}}|M_c = 1] > \mathsf{E}[T_{1\text{JS}}|M_c = 0]$$

Power:

The original study reported a standard deviation of 10 for "poor" subjects. In our design we score pairs of subjects, thus we expect the standard deviation for a pair to be $\sqrt{2} \cdot 10$. We will compare the score of pairs with and without borrowing from the partner. The statistics will be the difference, so the standard deviation for the difference between two pairs with and without borrowing will increase by another $\sqrt{2}$, to 20. With 40 observations we get a standard error for the mean difference of $20/\sqrt{40} = 3.16$.

The original study found an effect size of 11 between borrowing and no borrowing for the individual, with an average score of 20 for the poor. All individuals in our case will borrow from their own future time budget, the difference is only the borrowing from the partner, we should thus expect a smaller effect size. On the other hand, we consider the score for pairs, so the average score should be twice as large, around 40. This should also increase the effect size, so an effect size of 10 is reasonable. To conclude that the difference is significantly positive we thus need that the difference is $1.96 \cdot 3.16 = 6.19$.

With an expected difference of 10 and standard error of 3.16, we should get a difference of at least 6.19 with 88,5% probability. The power is above 80% if the effect size is at least 8.9.

4 Post-experiment questionnaire

With the post-experiment questionnaire we seek to obtain a number of demographic variables to get more precise estimates as well as the measures of social preferences and confidence used in hypothesis 7 and 8. Specifically, we ask these questions (response

options are in *italic*.

1. Highest level of education: *not completed Highschool / Highschool / Some College / Bachelor or equivalent / Master or equivalent / PhD or equivalent.*
2. Which is your mother tongue: *English / Spanish / Chinese / French / Hindi / other*
3. Gender: *male / female*
4. Age: *Open field to fill in values from 18-99*
5. How many points did you score (on average) per question? *Open field to fill in values from 0-99*
6. How many points did an average subject score per question? You get an additional 5 points if your answer is correct. *Open field to fill in values from 0-99*
7. Life sometimes confronts us with difficult/uneasy choices. Imagine that you are hungry in a supermarket in a foreign city, but you are out of cash. Is it OK to take food without paying? Answer on this scale from 1 (it is never OK) to 5 (it is usually OK). *1 / 2 / 3 / 4 / 5*
8. In case you have borrowed from the second player, why did you do so (choose one of the options):
9. In case you have transferred time to the second player, why did you do so (choose one of the options):
10. Do you like to watch game shows? *yes / no*
11. Did you know "Family Feud"? *yes / no*

5 Technical implementation

Assignment of subjects to treatments is done in the following way: Upon opening of the task in AMT we first assign each arriving new subject with equal probability to one of the five groups IA, IS, JA(first), JS(first), or VSP and we "close" a group when we reach a set number (we aim for N=100). Once JA(first) is closed we open up JA(second) and similar for JS.

To incentivise the players, each point earned by the player herself or by her partner translates into an entry for a lottery to win a \$25 bonus. We calibrate the winning chances such that players, in expectation, earn an hourly wage of at least \$12. To this end, we set the chance of winning the \$25 bonus to 2/1000 per point (that is, each point has an expected value of 5 cent). Based on the data from [2], we expect players in the scarcity treatments to earn 20 points and players in the abundance treatments to earn 50 points. We pay a fixed participation fee of 50 cent, so that each member of a group in the scarcity treatment can expect to earn \$0.50+2·20·\$0.05=\$2.50. When we suppose that subjects spend 10 minutes for reading the instructions, the test round, and answering the survey, players in the scarcity treatment spend in total 13 minutes for the experiment, which is equivalent to an hourly wage of \$11.53. Each member of a group in the abundance treatment has a time budget of 10 minutes so that they spend in total 20 minutes in the experiment and earn \$0.50+2·50·\$0.05=\$5.50, which is equivalent to an hourly wage of \$16.66. Ex ante, players are allocated with equal chances to the scarcity or the abundance treatment and one seventh of our sample is allocated to the VSP treatment, so that the expected hourly wage is above \$12.

Payment is implemented by assigning each subject an entry into the lottery for each point that his/her group scores. Entry in the lotteries are given by six digit code of the format `123.456`, where the last three digits serve to identify the lottery tickets. We use random.org as randomisation device and publicly announce two randomly drawn numbers between 0 and 999.

References

[1] Sendhil Mullainathan and Eldar Shafir. *Scarcity: the true cost of not having enough*. Penguin, New York, 2013.

[2] Anuj K. Shah, Sendhil Mullainathan, and Eldar Shafir. Some consequences of having too little. *Science*, 338(6107):682–685, 2012.

[3] Caroline Roux, Kelly Goldsmith, and Andrea Bonezzi. On the psychology of scarcity: When reminders of resource scarcity promote selfish (and generous) behavior. *Journal of Consumer Research*, 2015.

Appendix

Instructions practice round

Thank you for participating. In what follows, you will play rounds from the game show Family Feud. In each round, you will guess the most popular responses to survey questions (e.g., "Name things to take on a picnic").

For each correct response, you earn a point. Each point provides an entry into a lottery for a $25 bonus. The more points you earn, the better your chances of winning.

IA and IS treatment: You will be matched with a partner for the game. You and your partner will answer separately, but you will have a joint pool of lottery tickets. This means that each point that you, or your partner, earns increases the number of tickets that both of you have for the $25 bonus.

JA and JS treatment: You will be matched with a partner for the game. You and your partner will answer separately, but you will have a joint pool of lottery tickets. This means that each point that you, or your partner, earns increases the number of tickets that both of you have for the $25 bonus. You will also have a joint time budget.

VSP treatment: You will be matched with a virtual player (a computer) for the game, with whom you share a joint time budget. The number of lottery tickets you get will depend on the points you earn, plus the points from the virtual player. How many points you get from the virtual player depends on how much time you leave behind. Each second that you leave behind increases your points according to the average performance of 100 human players that have played this game before.

On the panel to the right, there will be an indication of the round number you are on and of how many points you have earned so far. You will also see the time remaining for the current round. (As you can see, this information is already listed for the first practice round.)

Before you begin the game sessions, you will complete a practice session of 4 rounds for which you will have 30 seconds. The practice session will end when you finish all 4 rounds or exhaust the total time given, whichever comes first. **The practice points will not count towards lottery entries.**

The amount of time that each round starts with depends on how much total time you have left. The total time will be divided evenly among the remaining rounds in the practice session. For example, since you currently have 120 seconds and 4 rounds to complete, the first round will start with 30 seconds. No round will ever start with more than 30 seconds, but rounds can start with less.

IA and IS treatment (both players): After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time. In the lower right of the panel, you can see a counter of your total time remaining.

After the initial 20 [6] seconds of each round, the 'Next Round' button will become active and you can click that button to move on whenever you like. Following each round, you will be shown the answers. You can take longer or move on to rounds as you see fit, within the constraints mentioned above. Note that if you spend less than the time allocated to this round, the remaining time is forwarded to the next question. To begin the practice session, please **click here**.

JA and JS treatment (first player): After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time. In the lower right of the panel, you can see a counter of your total time remaining. Once your time budget has been used up, you begin to borrow time from your partner. Each second that you then spend on a round will subtract two seconds from the time budget of your partner.

After the initial 20 [6] seconds of each round, the 'Next Round' button will become active and you can click that button to move on whenever you like. Following each round, you will be shown the answers. You can take longer or move on to rounds as you see fit, within the constraints mentioned above. Note that if you spend less than the time allocated to this round, the remaining time is forwarded to the next question. Time remaining after the last question is transferred to your partner. To begin the practice session, please **click here**.

JA and JS treatment (second player): After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time. In the lower right of the panel, you can see a counter of your total time remaining. Your initial time budget depends on how much your partner has borrowed from you or transferred to you.

After the initial 20 [6][3] seconds of each round, the 'Next Round' button will become active and you can click that button to move on whenever you like. Following each round, you will be shown the answers. You can take longer or move on to rounds as you see fit, within the constraints mentioned above. Note that if you spend less than the time allocated to this round, the remaining time is forwarded to the next question. To begin the practice session, please **click here**.

VSP treatment: After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time. In the lower right of the panel, you can see a counter of the total time remaining. Once your time budget has been used up, you begin to borrow time from the virtual second player. Each second that you then spend on a round will subtract two seconds from the time budget of the virtual second player.

After the initial 6 seconds of each round, the 'Next Round' button will become active and you can click that button to move on whenever you like. Following each round, you will be shown the answers. You can take longer or move on to rounds as you see fit, within the constraints mentioned above. Note that if you spend less than the time allocated to this round, the remaining time is forwarded to the next question. To begin the practice session, please **click here**.

Instructions game session

In a moment you will begin the game session where points will earn you actual entries into the lottery for the bonus. For the most part, this game will follow the same rules as in the practice

[3]The reader should note that these fields are "dynamic" in the orginal HTML text that the subjects will see: The time after which it is possible to move to the next round depends on the overall remaining time budget. For example, when the second player starts the game with 120 seconds because the first player has borrowed, then the second player will have 10 seconds per round at the outset and the option to move on will appear after 0.4*10 sec = 4 seconds.

session. **Unlike the practice session, the game will consist of 12 rounds.** The game will end when you finish all 12 rounds or exhaust the total time given, whichever comes first.

As a reminder: The amount of time that each round starts with depends on how much total time you have left. The total time will be divided evenly among the remaining rounds in the game. For example, since you currently have 600 [180] seconds and 12 rounds to complete, the first round will start with 50 [15] seconds. No round will ever start with more than 50 [15] seconds, but rounds can start with less.

IA and IS treatment (both players): After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time.

In the lower right, you can see a counter of your total time remaining.

JA and JS treatment (first player): After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time.

In the lower right, you can see a counter of your total time remaining. Once your time budget has been used up, you begin to borrow time from your partner. Each second that you then spend on a round will subtract two seconds from the time budget of your partner.

JA and JS treatment (second player): After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time.

In the lower right, you can see a counter of your total time remaining. Your initial time budget depends on how much your partner has borrowed from you or transferred to you.

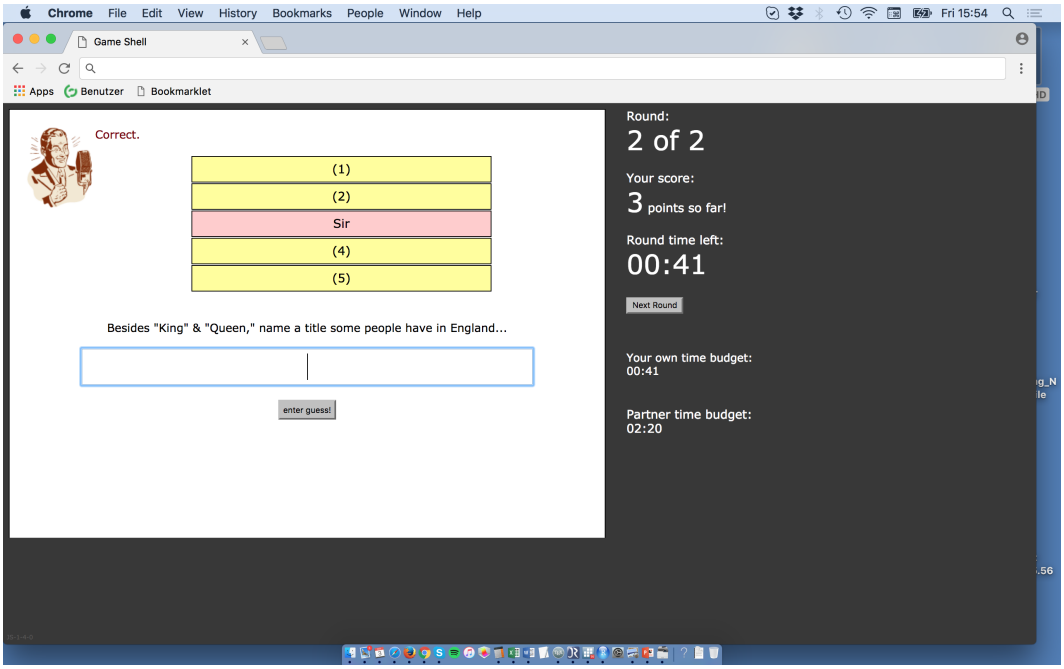
VSP treatment: After the initial time for a round elapses, you will begin to borrow time from future rounds. Each second (beyond the initial time given) spent on a round will subtract two seconds from your remaining total time.

In the lower right, you can see a counter of the total time remaining. Once your time budget has been used up, you begin to borrow time from the virtual second player. Each second that you then spend on a round will subtract two seconds from the time budget of the virtual second player.

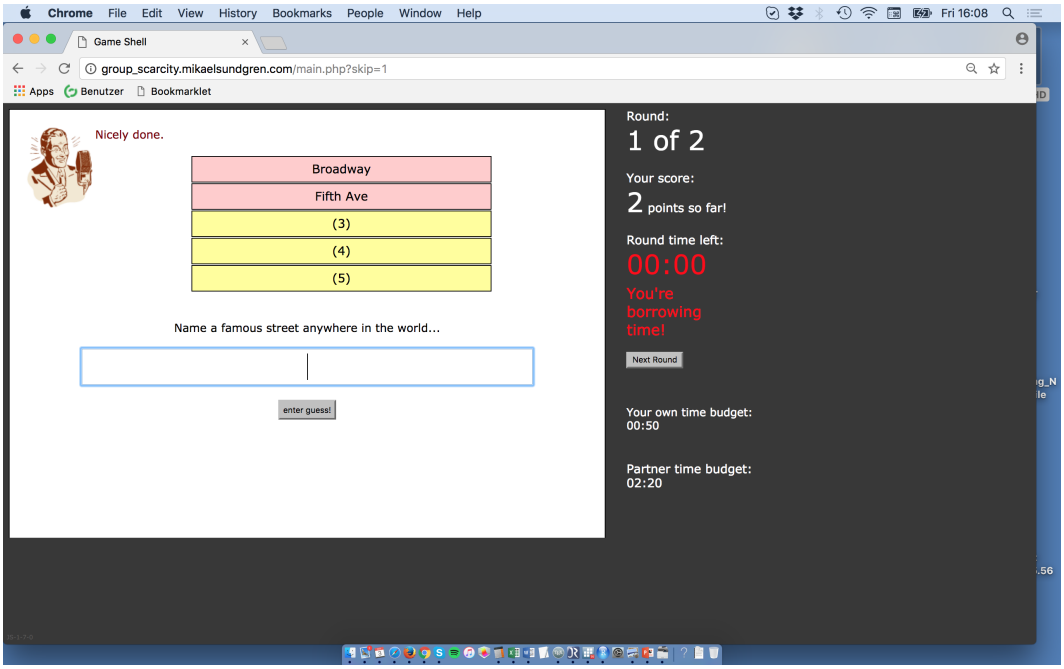
After the initial 20 [6] seconds of each round, the 'Next Round' button will become active and you can click that button to move on whenever you like. Following each round, you will be shown the answers.

Remember, your goal is to earn as many points as you can (which will give you a better chance of winning the bonus). You can take longer or move on to rounds as you see fit, within the constraints mentioned above. Good luck! To begin the game, please **click here**.

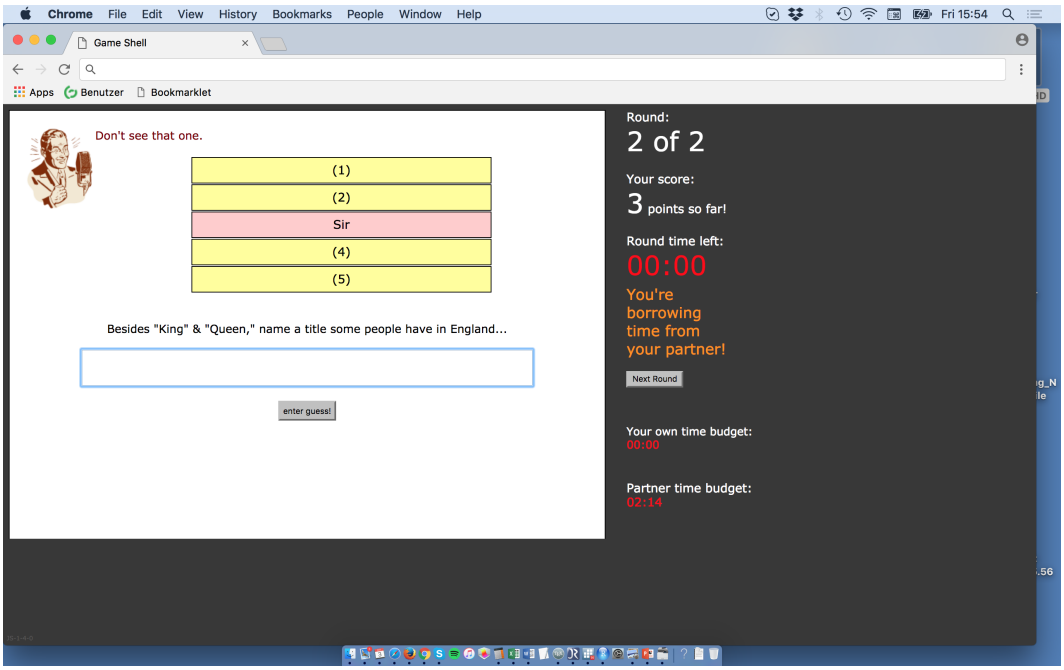
Screenshots



A-1: Screenshot; correct guess



A-2: Screenshot; borrowing time



A-3: Screenshot; borrowing time from partner