

## Effective Reminders

by

Giacomo Calzolari and Mattia Nardotto

# Online Appendix B

### B.1 Comparisons between controls of the 2008/09 cohort and those of the 2009/2010 cohort

Table 12 reports monthly attendance of the two groups of controls over the three treatment periods: pre-, during-, post- treatment. We do not find any significant difference in monthly attendance

Table 12: Attendance of controls

|                                      | Pre-treat. | During-treat. | Post-treat. | N   |
|--------------------------------------|------------|---------------|-------------|-----|
| Controls 2008/09                     | 8.89       | 7.41          | 8.18        | 142 |
| Controls 2009/10                     | 9.39       | 8.01          | 8.55        | 16  |
| Wilcoxon-Mann-Whitney test (p-value) | 0.34       | 0.72          | 0.99        |     |

between the two groups over time. Table 13 reports the average attendance, by treatment period, considering only low attendance users. Table 14 presents the estimates of an equation similar to

Table 13: Attendance of controls (low attendance users)

|                                      | Pre-treat. | During-treat. | Post-treat. | N  |
|--------------------------------------|------------|---------------|-------------|----|
| Controls 2008/09                     | 6.87       | 5.84          | 6.83        | 83 |
| Controls 2009/10                     | 7.83       | 6.83          | 5.92        | 8  |
| Wilcoxon-Mann-Whitney test (p-value) | 0.15       | 0.18          | 0.53        |    |

that in (1) but considering control users only and replacing the treatment variable  $Treated_u$  with a dummy variable  $\Delta_{2009/10}$  that takes value 1 if the user is a control from the 2009/10 cohort. Results show that the difference-in-difference change in monthly attendance is almost zero both if we consider all users and if we restrict the analysis to low attendance users.

Finally, Table 15 reports a placebo test on the immediate effect of reminders, using controls only and assigning the treatment to the cohort 2009/10. As expected we observe no effect of the treatment (also confirming the limited role of network or peer effects between contemporaneous users).

Table 14: Difference-in-difference estimation “of the effect of the treatment” on the number of monthly visits (pre-treatment vs. during-treatment) using control users only.

| <b>Dep. variable: <math>\Delta</math> monthly visits</b> |           |           |                      |           |
|--|-----------|-----------|----------------------|-----------|
|  | All users |           | Low attendance users |           |
|  | Coeff.    | Std. Err. | Coeff.               | Std. Err. |
| $\Delta$ 2009/10   | 0.095     | (0.818)   | 0.025                | (1.052)   |
| Constant   | -1.482*** | (0.260)   | -1.028***            | (0.312)   |
| $R^2$  | 0.000     |           | 0.000                |           |
| Observations   | 158       |           | 91                   |           |

Estimates of equation (1).  $\Delta$  2009/10 is a dummy equal to one for control users in the 2009/10 cohort. Standard error in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 15: Immediate effects of reminders, a placebo test

| <b>Dep. variable: probability to observe a visit on day <math>t</math></b> |           |           |                          |           |                      |           |                          |           |  |
|--|-----------|-----------|--------------------------|-----------|----------------------|-----------|--------------------------|-----------|--|
|  | All users |           |                          |           | Low Attendance users |           |                          |           |  |
|  | OLS FE    |           | OLS FE with AR(1) errors |           | OLS FE               |           | OLS FE with AR(1) errors |           |  |
|  | Coeff     | Std. err. | Coeff                    | Std. err. | Coeff                | Std. err. | Coeff                    | Std. err. |  |
| 1 day before $\times$ Treated  |           |           | 1.39                     | (5.08)    |                      |           | 4.62                     | (6.88)    |  |
| Reminder day $\times$ Treated  | -3.86     | (4.21)    | -1.60                    | (4.88)    | -4.78                | (4.77)    | -1.57                    | (6.56)    |  |
| 1 day after $\times$ Treated   |           |           | 8.77*                    | (5.01)    |                      |           | 3.07                     | (6.81)    |  |
| 2 days after $\times$ Treated  |           |           | 4.68                     | (4.70)    |                      |           | 1.02                     | (6.37)    |  |
| 1 day before   |           |           | 0.13                     | (2.77)    |                      |           | -3.62                    | (3.50)    |  |
| Reminder day   | 2.77      | (2.68)    | 1.15                     | (2.36)    | 1.57                 | (3.24)    | -0.45                    | (3.01)    |  |
| 1 day after  |           |           | -6.02**                  | (2.62)    |                      |           | -2.09                    | (3.27)    |  |
| 2 days after   |           |           | -2.78                    | (2.47)    |                      |           | -3.99                    | (3.08)    |  |
| Tuesday  | -6.16**   | (3.04)    | -5.87***                 | (1.10)    | -7.03                | (4.73)    | -6.97***                 | (1.46)    |  |
| Wednesday  | -3.90**   | (1.70)    | -3.94***                 | (1.15)    | -2.74                | (2.27)    | -2.60*                   | (1.53)    |  |
| Thursday   | -4.37*    | (2.44)    | -4.45***                 | (1.15)    | -5.09                | (3.71)    | -5.17***                 | (1.53)    |  |
| Friday   | -11.88*** | (2.28)    | -11.92***                | (1.16)    | -11.05***            | (3.14)    | -11.16***                | (1.55)    |  |
| Saturday   | -29.67*** | (2.76)    | -29.70***                | (1.14)    | -27.66***            | (3.53)    | -27.61***                | (1.52)    |  |
| Sunday   | -37.03*** | (3.13)    | -37.72***                | (1.88)    | -32.36***            | (3.45)    | -32.20***                | (2.50)    |  |
| Rain day   | -1.13*    | (0.63)    | -1.25*                   | (0.76)    | -0.86                | (0.83)    | -1.19                    | (1.01)    |  |
| Temperature  | 0.54**    | (0.24)    | 0.64**                   | (0.26)    | 0.50                 | (0.30)    | 0.56                     | (0.35)    |  |
| Temperature <sup>2</sup>   | -0.01     | (0.01)    | -0.01*                   | (0.01)    | -0.01                | (0.01)    | -0.01                    | (0.01)    |  |
| Exp  | -0.02***  | (0.01)    | -0.02***                 | (0.01)    | -0.01**              | (0.01)    | -0.01                    | (0.01)    |  |
| MD   | Yes       |           | Yes                      |           | Yes                  |           | Yes                      |           |  |
| $R^2$  | 0.130     |           |                          |           | 0.090                |           |                          |           |  |
| Observations   | 20101     |           | 19951                    |           | 10685                |           | 10604                    |           |  |

Estimates of equation (3). Coefficients are percentage points. *Reminder day* is a dummy variable that takes value 1 if a reminder has been sent on that day (before 12:00), or if the reminder has been sent the day before (after 12:00). *Day before* is a dummy variable that takes value 1 in the day preceding that of dispatch. *One day after* and *Two days after* are dummy variables that take value 1, respectively one and two days after the day of dispatch. *Treated* is a dummy variable that takes value 1 for the treated users. *Rain day* is a dummy variable that takes value 1 if a daily rainfall of at least 0.2mm is recorded. *Temperature* is the average temperature (in Celsius degrees) recorded in the day between 10:00 and 22:00. *Tuesday to Sunday* are dummy variables for the days of the week (*Monday* being the baseline category). *Exp* is the total number of days since enrollment in the gym. *MD* is here the vector of monthly dummies. Cluster-robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## B.2 Replicating the main results using control users of the cohort 2009/2010 only

In this robustness analysis we make use of control users of the cohort 2009/10 only and replicate all the main results illustrated in the text. Table 16 reports monthly attendance by treatment period. None of these differences is statistically significant. The difference-in-the-difference of

Table 16: Attendance using the 2009/10 controls only

|          | Pre-treat. | During-treat. | Post-treat. | Difference<br>During-Pre | N controls<br>N |
|----------|------------|---------------|-------------|--------------------------|-----------------|
| Treated  | 9.23       | 8.07          | 8.53        | -1.16                    | 89              |
| Controls | 9.39       | 8.01          | 8.55        | -1.38                    | 16              |

treated and control users comparing during-treatment and pre-treatment is -0.22 (-1.38+1.16) which is very close to the -0.30 using all control users (see Table 1, -1.47+1.16).

A similar result is obtained in Table 17 where we consider the low-attendance users only. Al-

Table 17: Attendance using the 2009/10 controls only (low attendance users)

|          | Pre-treat. | During-treat. | Post-treat. | Difference<br>During-Pre | N controls<br>N |
|----------|------------|---------------|-------------|--------------------------|-----------------|
| Treated  | 6.79       | 7.38          | 7.61        | 0.59                     | 47              |
| Controls | 7.83       | 6.83          | 5.91        | -1.00                    | 8               |

though none of these differences is statistically significant because of the lower power, the difference-in-the-difference estimate is here -1.59, almost identical to the -1.61 using all control users (see Table 3).

Table 18 below is the equivalent of Table 3 in the paper. Treatment effects are very similar in magnitude although not statistically significant due to lower power.

Table 18: Difference-in-difference estimation of the effect of the treatment on the number of monthly visits (pre-treatment vs. during-treatment)

|                | <b>Dep. variable: <math>\Delta</math> monthly visits</b> |           |                      |           |
|----------------|--|-----------|----------------------|-----------|
|                | All users  |           | Low attendance users |           |
|                | Coeff.   | Std. Err. | Coeff.               | Std. Err. |
| Treated        | 0.223  | (1.046)   | 1.593                | (1.098)   |
| Constant       | -1.387   | (0.963)   | -1.004               | (1.015)   |
| R <sup>2</sup> | 0.000  |           | 0.038                |           |
| Observations   | 105  |           | 55                   |           |

Estimates of equation (1). *Treated* is a dummy equal to one for treated users. Standard error in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 19 reports the estimated coefficients of equation (3), i.e., the immediate effect of reminders and replicates results in Table 5.

Table 19: Immediate effect of reminders

| Dep. variable: probability to observe a visit on day $t$ | All users |           |                          |           | Low Attendance users |           |                          |           |
|--|-----------|-----------|--------------------------|-----------|----------------------|-----------|--------------------------|-----------|
|  | OLS FE    |           | OLS FE with AR(1) errors |           | OLS FE               |           | OLS FE with AR(1) errors |           |
|  | Coeff     | Std. err. | Coeff                    | Std. err. | Coeff                | Std. err. | Coeff                    | Std. err. |
| 1 day before $\times$ Treated                            |           |           | -2.61                    | (4.61)    |                      |           | -2.67                    | (6.28)    |
| Reminder day $\times$ Treated                            | 6.54**    | (2.96)    | 6.36**                   | (3.13)    | 7.31**               | (3.31)    | 7.87*                    | (4.03)    |
| 1 day after $\times$ Treated                             |           |           | -7.25                    | (4.53)    |                      |           | -3.50                    | (6.21)    |
| 2 days after $\times$ Treated                            |           |           | 1.44                     | (4.27)    |                      |           | 6.41                     | (5.85)    |
| 1 day before   |           |           | 1.50                     | (4.44)    |                      |           | 1.68                     | (6.05)    |
| Reminder day   | -2.89     | (2.37)    | -3.82                    | (2.88)    | -1.43                | (3.06)    | -2.37                    | (3.72)    |
| 1 day after  |           |           | 2.19                     | (4.33)    |                      |           | -1.15                    | (5.95)    |
| 2 days after   |           |           | 0.39                     | (4.05)    |                      |           | -2.23                    | (5.57)    |
| Tuesday  | -10.72*** | (3.57)    | -10.24***                | (1.23)    | -6.46                | (5.74)    | -5.63***                 | (1.61)    |
| Wednesday  | -6.29***  | (1.89)    | -7.21***                 | (1.30)    | -5.01*               | (2.80)    | -6.15***                 | (1.70)    |
| Thursday   | -8.56***  | (3.24)    | -8.82***                 | (1.28)    | -4.29                | (5.26)    | -4.41***                 | (1.68)    |
| Friday   | -15.68*** | (2.13)    | -15.82***                | (1.29)    | -15.88***            | (3.50)    | -15.76***                | (1.70)    |
| Saturday   | -36.41*** | (2.92)    | -36.61***                | (1.27)    | -32.24***            | (4.16)    | -32.22***                | (1.67)    |
| Sunday   | -43.20*** | (2.39)    | -43.16***                | (1.57)    | -36.37***            | (3.30)    | -36.29***                | (2.03)    |
| Rain day   | -1.92***  | (0.66)    | -1.85**                  | (0.81)    | -1.32                | (0.81)    | -0.98                    | (1.07)    |
| Temperature  | 0.16      | (0.22)    | 0.34                     | (0.26)    | 0.13                 | (0.31)    | 0.36                     | (0.35)    |
| Temperature <sup>2</sup>                                 | -0.00     | (0.01)    | -0.00                    | (0.01)    | -0.00                | (0.01)    | -0.01                    | (0.01)    |
| Exp  | -0.01**   | (0.01)    | -0.01**                  | (0.00)    | -0.01                | (0.01)    | -0.01                    | (0.01)    |
| MD   | Yes       |           | Yes                      |           | Yes                  |           | Yes                      |           |
| R <sup>2</sup>   | 0.142     |           |                          |           | 0.114                |           |                          |           |
| Observations   | 17361     |           | 17251                    |           | 9336                 |           | 9286                     |           |

Estimates of equation (3). Coefficients are percentage points. *Reminder day* is a dummy variable that takes value 1 if a reminder has been sent on that day (before 12:00), or if the reminder has been sent the day before (after 12:00). *Day before* is a dummy variable that takes value 1 in the day preceding that of dispatch. *One day after* and *Two days after* are dummy variables that take value 1, respectively one and two days after the day of dispatch. *Treated* is a dummy variable that takes value 1 for the treated users. *Rain day* is a dummy variable that takes value 1 if a daily rainfall of at least 0.2mm is recorded. *Temperature* is the average temperature (in Celsius degrees) recorded in the day between 10:00 and 22:00. *Tuesday to Sunday* are dummy variables for the days of the week (*Monday* being the baseline category). *Exp* is the total number of days since enrollment in the gym. *MD* is here the vector of monthly dummies. Cluster-robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Finally, Figure 5 replicates Figure 4 (right panel) and reports the treatment effect estimated using equation 5 (with a 95% cluster-robust standard error) and low attendance users.

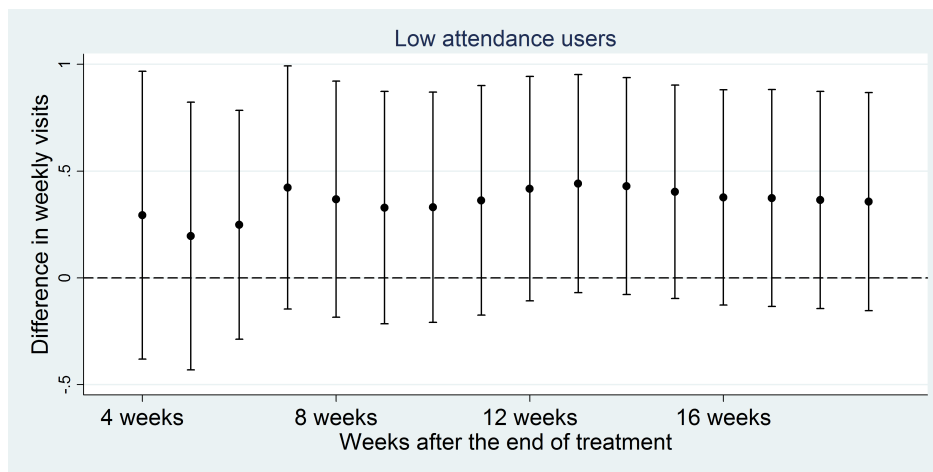


Figure 5: Estimated coefficient for the treatment effect in model (5) varying the time span in the post treatment. The figure reports the estimated coefficient and the 10% confidence interval, using low attendance users. The x-axis reports the number of weeks after the end of the treatment included in the regression. Table 11 in the Appendix reports point estimates, standard errors and p-values.

### B.3 Treatment effect over time and as a function of the frequency of dispatches

In Table 20 we report the estimated coefficient of a model analogous to (3) where we split the treated days by membership within the during treatment period, as reported in the following equation (7):

$$\begin{aligned} \Pr(Visit_{u,t}) = & \delta_1 \textit{Reminder day FS}_{u,t} \times \textit{Treated}_u + \delta_2 \textit{Reminder day TF}_{u,t} \times \textit{Treated}_u + \\ & + \gamma_1 \textit{Reminder day FS}_{u,t} + \gamma_2 \textit{Reminder day TF}_{u,t} + \beta_1 MD_t + \beta_2 W_t + \beta_3 Exp_{u,t} + a_u + \varepsilon_{u,t} \end{aligned} \quad (7)$$

where *Reminder day FS*<sub>u,t</sub> is a dummy variable that takes value 1 for the users receiving a reminder and this being within the first or second membership in the during-treatment period, *Reminder day TF*<sub>u,t</sub> is a dummy variable that takes value 1 for the users receiving a reminder and this being within the third, fourth or later membership in the during-treatment period. *Treated*<sub>u</sub> is a dummy variable for the user being a treated user. *MD*<sub>t</sub> is a vector containing monthly dummies and dummies for the various days of the week and a within-membership linear trend, while *W*<sub>t</sub> is a vector of daily local weather conditions: a dummy variable for a rainy day and a (continuous) variable for the average temperature during the day. Users' experience in the gym is measured with *Exp*<sub>u,t</sub>, which is the number of days since enrollment, and it is introduced to model the declining trend in attendance documented in the previous section. Finally, we perform the regression using individual fixed effects *a*<sub>u</sub>.

Table 20: Effects of reminders over time, during treatment

| Dep. variable: probability to observe a visit on day $t$ | All users           |                          | Low Attendance users |                          |
|--|---------------------|--------------------------|----------------------|--------------------------|
|  | OLS FE              | OLS FE with AR(1) errors | OLS FE               | OLS FE with AR(1) errors |
|  | Coeff               | Coeff                    | Coeff                | Coeff                    |
|  |                     |                          |                      |                          |
| Reminder day TF $\times$ Treated                         | 7.84**<br>(3.48)    | 8.16<br>(5.23)           | 8.61***<br>(3.13)    | 8.59<br>(7.13)           |
| Reminder day TF $\times$ Treated                         | 6.12*<br>(3.60)     | 6.68**<br>(3.05)         | 8.07<br>(4.88)       | 8.57**<br>(3.91)         |
| Reminder day FS  | -4.97*<br>(2.68)    | -5.58<br>(4.95)          | -2.85**<br>(1.32)    | -3.48<br>(6.77)          |
| Reminder day TF  | 1.57<br>(2.52)      | 1.57<br>(2.12)           | -0.55<br>(3.02)      | -0.06<br>(2.64)          |
| Tuesday  | -8.22***<br>(2.43)  | -8.25***<br>(0.83)       | -6.84*<br>(3.79)     | -6.75***<br>(1.09)       |
| Wednesday  | -4.59***<br>(1.33)  | -4.77***<br>(0.87)       | -3.45*<br>(1.83)     | -3.60***<br>(1.14)       |
| Thursday   | -6.04***<br>(2.08)  | -6.06***<br>(0.88)       | -4.69<br>(3.21)      | -4.69***<br>(1.15)       |
| Friday   | -13.34***<br>(1.66) | -13.36***<br>(0.88)      | -12.71***<br>(2.40)  | -12.63***<br>(1.16)      |
| Saturday   | -32.33***<br>(2.06) | -32.20***<br>(0.87)      | -29.55***<br>(2.75)  | -29.34***<br>(1.14)      |
| Sunday   | -40.15***<br>(1.92) | -40.65***<br>(1.16)      | -34.46***<br>(2.40)  | -34.92***<br>(1.51)      |
| Rain day   | -1.39***<br>(0.48)  | -1.44**<br>(0.57)        | -0.92<br>(0.60)      | -0.96<br>(0.75)          |
| Temperature  | 0.35**<br>(0.17)    | 0.50***<br>(0.19)        | 0.25<br>(0.23)       | 0.42*<br>(0.25)          |
| Temperature <sup>2</sup>                                 | -0.01<br>(0.01)     | -0.01<br>(0.01)          | -0.01<br>(0.01)      | -0.01<br>(0.01)          |
| Exp  | -0.02***<br>(0.00)  | -0.02***<br>(0.00)       | -0.01**<br>(0.00)    | -0.01**<br>(0.00)        |
| MD   | Yes                 | Yes                      | Yes                  | Yes                      |
| R <sup>2</sup>   | 0.133               |                          | 0.099                |                          |
| Observations   | 35453               | 35196                    | 19216                | 19090                    |

Estimates of equation (7). Coefficients are percentage points. *Reminder day FS* is a dummy variable that takes value 1 if the Reminder day is within the first or the second membership in the during-treatment period. *Reminder day TF* is a dummy variable that takes value 1 if the Reminder day is within the third, fourth or later membership in the during-treatment period. *Treated* is a dummy variable that takes value 1 for treated users. *Rain day* is a dummy variable that takes value 1 if a daily rainfall of at least 0.2mm is recorded. *Temperature* is the average temperature (in Celsius degrees) recorded in the day between 10:00 and 22:00. *Tuesday to Sunday* are dummy variables for the days of the week (*Monday* being the baseline category). *Exp* is the total number of days since enrollment in the gym. *MD* is here the vector of monthly dummies and a within-membership linear trend. Cluster-robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

We are interested here in testing for a difference in the effect of reminders depending on the frequency of dispatch. We split reminders in two groups: those sent in weeks with low frequency of dispatches (1 reminder sent in the week) and those sent in week with high frequency of dispatches (2 or 3 reminders sent in the week). We estimate the following regression model:

$$\begin{aligned} \Pr(\text{Visit}_{u,t}) = & \gamma_1 \text{Reminder day}_{u,t} + \gamma_2 \text{Low Freq week}_{u,t} + \gamma_3 \text{High Freq week}_{u,t} \\ & + \gamma_4 \text{Low Freq week}_{u,t} \times \text{Treated}_u + \gamma_2 \text{High Freq week}_{u,t} \times \text{Treated}_u + \\ & + \beta_1 MD_t + \beta_2 W_t + \beta_3 \text{Exp}_{u,t} + a_u + \varepsilon_{u,t} \end{aligned} \quad (8)$$

where *Reminder day*, as discussed in section 4, is a dummy variable that takes value 1 if a reminder has been sent on that day (before 12:00), or if the reminder has been sent the day before (after 12:00); *Low freq week* is a dummy variable that takes value 1 if one reminder has been sent during the week. *High freq week* is a dummy variable that takes value 1 if two or three reminders have been sent during the week. *Treated<sub>u</sub>* is a dummy variable for the user being a treated user, *MD* includes a vector of dummy variables for the months, a vector of dummy variables for the days of the week and a within-membership linear trend. *Exp* captures the experience of user *u* in the gym. *W* includes a variable for the number of days in which a daily rainfall of at least 0.2mm is recorded, and two variables for the average temperature in the week and its square. Estimated coefficients are reported in Table 21.

Table 21: Weekly visits and frequency of dispatches (low attendance users)

| Dep. variable: probability to observe a visit on day $t$ | All users |           |                          |           | Low Attendance users |           |                          |           |
|--|-----------|-----------|--------------------------|-----------|----------------------|-----------|--------------------------|-----------|
|  | OLS FE    |           | OLS FE with AR(1) errors |           | OLS FE               |           | OLS FE with AR(1) errors |           |
|  | Coeff     | Std. err. | Coeff                    | Std. err. | Coeff                | Std. err. | Coeff                    | Std. err. |
| Low Freq week $\times$ Treated                           | 4.02      | (4.47)    | 4.73                     | (3.24)    | 4.64                 | (5.33)    | 4.74                     | (4.29)    |
| High Freq week $\times$ Treated                          | 5.90**    | (2.68)    | 5.80**                   | (2.42)    | 8.21**               | (3.25)    | 8.08***                  | (3.10)    |
| Reminder day   | -0.58     | (1.92)    | -0.03                    | (1.81)    | -1.40                | (2.46)    | -0.60                    | (2.29)    |
| Low Freq week  | 2.43      | (1.57)    | -0.22                    | (1.32)    | 4.57**               | (1.97)    | 2.11                     | (1.70)    |
| High Freq week   | 1.24      | (1.55)    | -0.30                    | (1.33)    | 1.76                 | (1.82)    | 0.45                     | (1.73)    |
| Tuesday  | -8.26***  | (2.45)    | -8.18***                 | (0.83)    | -7.04*               | (3.82)    | -6.83***                 | (1.09)    |
| Wednesday  | -4.63***  | (1.34)    | -4.70***                 | (0.88)    | -3.64*               | (1.86)    | -3.67***                 | (1.15)    |
| Thursday   | -6.07***  | (2.08)    | -6.00***                 | (0.88)    | -4.83                | (3.23)    | -4.74***                 | (1.16)    |
| Friday   | -13.35*** | (1.67)    | -13.29***                | (0.89)    | -12.87***            | (2.41)    | -12.69***                | (1.17)    |
| Saturday   | -32.33*** | (2.07)    | -32.13***                | (0.87)    | -29.68***            | (2.79)    | -29.40***                | (1.15)    |
| Sunday   | -40.35*** | (1.94)    | -40.63***                | (1.17)    | -34.81***            | (2.44)    | -35.04***                | (1.53)    |
| Rain day   | -1.33***  | (0.49)    | -1.44**                  | (0.57)    | -0.79                | (0.61)    | -0.90                    | (0.75)    |
| Temperature  | 0.38**    | (0.17)    | 0.48**                   | (0.19)    | 0.31                 | (0.23)    | 0.44*                    | (0.25)    |
| Temperature <sup>2</sup>                                 | -0.01     | (0.01)    | -0.01                    | (0.01)    | -0.01                | (0.01)    | -0.01                    | (0.01)    |
| Exp  | -0.02***  | (0.00)    | -0.02***                 | (0.00)    | -0.01**              | (0.01)    | -0.01**                  | (0.00)    |
| MD   | Yes       |           | Yes                      |           | Yes                  |           | Yes                      |           |
| t-test $H_0 : \gamma_2 = \gamma_3$ (p-value)             | 0.678     |           | 0.752                    |           | 0.536                |           | 0.454                    |           |
| R <sup>2</sup>   | 0.133     |           |                          |           | 0.100                |           |                          |           |
| Observations   | 35453     |           | 35196                    |           | 19216                |           | 19090                    |           |

Estimates of equation (8). Coefficients are percentage points. Coefficients are percentage points. *Reminder day* is a dummy variable that takes value 1 if a reminder has been sent on that day (before 12:00), or if the reminder has been sent the day before (after 12:00). *Low freq week* is a dummy variable that takes value 1 if one reminder has been sent during the week. *High freq week* is a dummy variable that takes value 1 if two or three reminders have been sent during the week. *Treated* is a dummy variable that takes value 1 for the treated users. *Rain day* is a dummy variable that takes value 1 if a daily rainfall of at least 0.2mm is recorded. *Temperature* is the average temperature (in Celsius degrees) recorded in the day between 10:00 and 22:00. *Tuesday* to *Sunday* are dummy variables for the days of the week (*Monday* being the baseline category). *Exp* is the total number of days since enrollment in the gym. *MD* is here the vector of monthly dummies and a within-membership linear trend. Cluster-robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

#### B.4 Alternative empirical approach for users without active membership in the post-treatment period

We report in Figure 6 below the estimated coefficients of model (5) with  $k \in [4, 19]$ , attributing zero visits to the gym when users do not renew their membership. Results are very similar in size with those reported in Figure 4 and in Table 6.

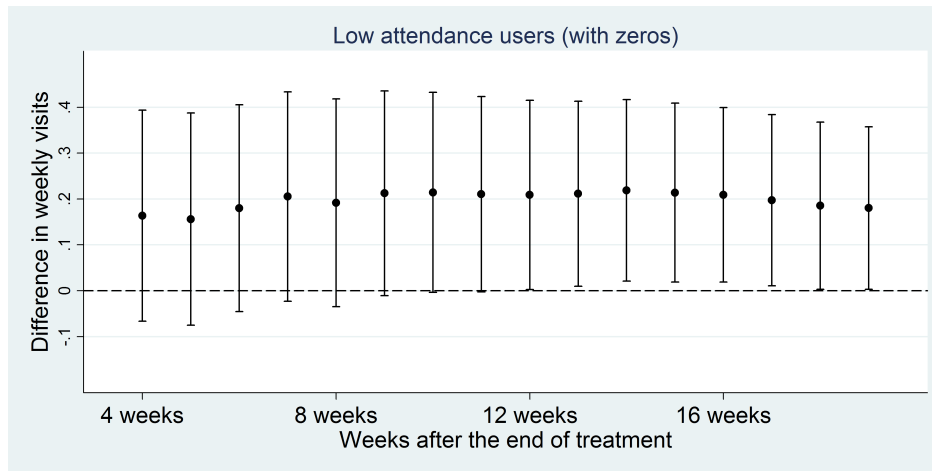


Figure 6: Estimated coefficient for the treatment effect in model (5) varying the time span in the post treatment. The figure reports the estimated coefficient and the 10% confidence interval, using low attendance users and considering the days without an active membership as days with zero attendance. The x-axis reports the number of weeks after the end of the treatment included in the regression.

## Online Appendix C

### A model of investment with limited attention and habit formation

This section sets up a simple model of inattentive individuals who can take an investment and habit-forming action. The analysis formally derives the Hypotheses discussed in Section 2 of the paper.

In any period  $t$  an individual may invest in an activity involving “attending” (a gym), characterized by an immediate cost and by a benefit (better health and fitness) that is delayed by one-period. The decision to attend in  $t$ , or otherwise, is indicated, respectively, by  $d_t = 1$  and  $d_t = 0$ . The cost  $c_t$  is stochastic, IID, with distribution  $F(\cdot)$  and strictly positive density  $f(\cdot)$  over the support  $[0, \bar{c}]$ .<sup>29</sup> The benefit  $b(D_t)$  is delayed to  $t + 1$  and may positively depend on (some) past attendance  $D_t = \sum_{i=0}^{\tilde{t}} d_{t-i}$  (possibly up to some past date  $\tilde{t} \leq t$ ). This is the case when past attendance induces habituation,  $b'(\cdot) \geq 0$ , although at a decreasing rate,  $b''(\cdot) \leq 0$  and with a certain degree of decay so that “remote” attendance, i.e. preceding date  $\tilde{t}$ , is ineffective on the benefit. For the sake of simplicity, we assume that  $\bar{c} \leq b(0)$  so that, regardless of past activity, it would always be optimal to attend. The individual is forward looking so that, whenever past attendance increases the benefits, he/she anticipates that the decision to attend today also affects future decisions through greater benefits in the future.

To perform the activity, the individual subscribed a flat-rate membership at  $t = 0$ , paying up-front for the right to freely attend in any of the following periods (for simplicity we do not explicitly consider the decision to renew a membership). We assume risk neutrality and no cash constraints. The (standard exponential) discount factor will be denoted by  $\delta$ .

The individual may be subject to certain behavioral biases. He/she may be *present-biased*, in which case all future payoffs are discounted by the same factor  $\beta \leq 1$ .<sup>30</sup> He/she may also be *inattentive*, so that with probability  $1 - \lambda_t$  the possibility of attending at  $t$  is not salient compared with available alternative activities, and thus, necessarily,  $d_t = 0$ .

Let  $U(D_t)$  and  $\bar{U}(D_t)$  indicate the continuation payoffs that are expected at date  $t$  when the individual is, and is not attentive at date (respectively)  $t + 1$ , given a certain level of attendance in the past,  $D_t$ . Then, at  $t > 0$ , with probability  $\lambda_t$ , the individual will be attentive and will decide to attend if:<sup>31</sup>

$$\beta\delta b(D_{t-1}+1) - c_t + \beta\delta [\lambda_t U(D_{t-1} + 1) + (1 - \lambda_t)\bar{U}(D_{t-1} + 1)] \geq \beta\delta [\lambda_t U(D_{t-1}) + (1 - \lambda_t)\bar{U}(D_{t-1})]$$

<sup>29</sup>The independence assumption is made here for the sake of simplicity. In our econometric analysis we deal with the possibility of shocks being correlated over time.

<sup>30</sup>Simplifying, but without affecting our analysis, we assume full sophistication (O’Donoghue and Rabin, 1999).

<sup>31</sup>We assume that at  $t$  the individual’s expectation of the probability of being attentive in the future is  $\lambda_t$ .

Since the individual does not attend when he/she is inattentive,

$$\bar{U}(D_t) = \lambda_t \delta U(D_t) + (1 - \lambda_t) \delta \bar{U}(D_t),$$

and the previous inequality can be rewritten as follows,

$$\beta \delta \times b(D_{t-1} + 1) - c_t + \frac{\beta \delta \lambda_t}{1 - \delta + \lambda_t \delta} \Delta U(D_{t-1}) \geq 0 \quad (9)$$

where  $\Delta U(D) = U(D+1) - U(D)$ , is the change in (the present value of) future payoffs associated with an increase of the stock of past attendance  $D$  by one additional unit.

The first term in (9) is the short-run net discounted benefit of attending, and the second is the future payoff increase, which is nil if there is no habituation ( $b'(\cdot) = 0$  implies  $\Delta U(\cdot) = 0$ ). On the other hand, when expecting increased future benefits, i.e.  $b'(\cdot) > 0$ , then  $\Delta U(\cdot) \geq 0$  which increases an individual's current incentive to attend. We notice that this effect is smaller the more inattentive an individual is (the ratio  $\frac{\beta \delta \lambda_t}{1 - \delta + \lambda_t \delta}$  is increasing in the level of attention  $\lambda_t$ ).

At date  $\tau$ , the individual may receive a reminder, i.e. a stimulus, indicated by  $r_\tau = 1$ . The probability of being attentive at date  $t = \tau + \Delta t$  before another reminder arrives then becomes  $\lambda_t = \lambda \rho(\Delta t)$  where  $\lambda \in [0, 1]$ ,  $\rho'(\cdot) \leq 0$ ,  $\rho''(\cdot) \leq 0$ , and  $\rho(0) = 1/\lambda$ ,  $\rho(\infty) = 1$ . At the date of a reminder (i.e.  $\Delta t = 0$ ),  $\lambda_t$  jumps to one before decaying towards  $\lambda$ , unless another reminder arrives in the meantime.<sup>32</sup>

Upon receiving a reminder at date  $\tau$ , the probability of attendance at a future date  $t = \tau + \Delta t$  (and before the next reminder) for an individual with a stock  $D_{t-1}$  of past visits is thus,<sup>33</sup>

$$\Pr(d_t = 1 | r_\tau = 1) = \lambda \rho(\Delta t) \times F \left[ \beta \delta b(D_{t-1} + 1) + \frac{\beta \delta \lambda \rho(\Delta t)}{1 - \delta + \lambda \rho(\Delta t) \delta} \Delta U(D_{t-1}) \right]. \quad (10)$$

We shall now consider the effect that reminders have, by comparing the probabilities of attending in  $t > 0$  of two individuals, one of whom receives a reminder in period  $\tau$  (the probability being  $\Pr(d_t = 1 | r_\tau = 1)$ ), while the other does not (with a probability  $\Pr(d_t = 1)$ ). For the individual who receives the reminder, the time span between date  $t$  and the date  $\tau$  of the reminder is  $\Delta t$ , so that  $t = \tau + \Delta t$ . For the second individual it is simply  $t$  (the stimulus being just the membership subscription at date  $t = 0$  in this case).<sup>34</sup> The stock of attendance of the latter individual is  $\tilde{D}_{t-1}$ , and  $D_{t-1} \geq \tilde{D}_{t-1}$  is the one of the former. The difference in probabilities of the two individuals

<sup>32</sup>The probability of being attentive  $\lambda_t$  may be higher if the individual recently attended, i.e.  $d_{t-1} = 1$  as compared with  $d_{t-1} = 0$ . This possibility may be relevant in environments with low frequency of reminders, but definitely less so in the case of gym attendance and our weekly (or biweekly) reminders.

<sup>33</sup>Depending on the environment, it may be unfeasible to attend two periods in a row. Although we do not explicitly consider this possibility, it could be accommodated in the model with some additional complication in the notation.

<sup>34</sup>To simplify the exposition we abstract from the possibility that attendance acts as a reminder.

can be written as

$$\Pr(d_t = 1 | r_\tau = 1, D_{t-1}) - \Pr(d_t = 1 | \tilde{D}_{t-1}) = \lambda [\rho(\Delta t) - \rho(t)] \times F[\underline{c}_t] + \lambda \rho(\Delta t) \int_{\underline{c}_t}^{\bar{c}_t} dF(c) \quad (11)$$

where  $\underline{c}_t$  is the maximal realization of cost  $c_t$  compatible with the decision to attend of the individual who does not receive the reminder, and  $\bar{c}_t$  is the equivalent for the other individual (receiving the reminder), provided that  $\bar{c}_t \geq \underline{c}_t$  (this is discussed below).

The first term in (11) is the immediate effect of the reminder on limited attention, while the second term is its delayed effect. As regards the former, given the underlying probability of attending of an attentive individual receiving no reminders, a reminder increases the current probability of being attentive, and then deciding to attend, by the term  $\lambda [\rho(\Delta t) - \rho(t)] \geq 0$ . If an individual is fully attentive, then  $\rho(\Delta t) = \rho(t) = 1$  and this term vanishes.

The second term in (11) instead exists uniquely if individuals are habit-forming. With simple algebra, we obtain

$$\begin{aligned} \bar{c}_t - \underline{c}_t = & [\rho(\Delta t) - \rho(t)] \frac{(1-\delta)\beta\delta\lambda}{[1-\delta+\lambda\rho(\Delta t)\delta][1-\delta+\lambda\rho(t)\delta]} \Delta U(\tilde{D}_{t-1}) + \\ & \beta\delta \times \left[ \Delta b(D_{t-1}, \tilde{D}_{t-1}) + \frac{\lambda\rho(\Delta t)}{1-\delta+\lambda\rho(\Delta t)\delta} \Delta U(D_{t-1}, \tilde{D}_{t-1}) \right] \end{aligned} \quad (12)$$

where we used the following definitions,

$$\begin{aligned} \Delta b(D_{t-1}, \tilde{D}_{t-1}) &= b(D_{t-1} + 1) - b(\tilde{D}_{t-1} + 1) \geq 0 \\ \Delta U(D_{t-1}, \tilde{D}_{t-1}) &= \Delta U(D_{t-1}) - \Delta U(\tilde{D}_{t-1}) \leq 0. \end{aligned}$$

The integral in (11) is well defined as long as  $\bar{c}_t - \underline{c}_t$  is positive and this difference, in (12), is made up of the two lines with different interpretations.

The first is positive and is again related to the different level of attention guaranteed by reminders, interacted now with habit formation: the individual receiving the reminder also anticipates that attendance in the current period increases future benefits because of habit formation. When there is no habituation,  $b'(\cdot) = 0$  we have  $\Delta U(\tilde{D}_{t-1}) = 0$  and this term vanishes, as well as when the individual is habit-forming but fully attentive (i.e.  $\rho(\Delta t) = \rho(t)$ ).

The second line in the r.h.s. of (12) is due to the fact that we are considering two habit-forming individuals with possibly different levels of attendance  $D_{t-1}$  and  $\tilde{D}_{t-1}$ . It would be nil when  $D_{t-1} = \tilde{D}_{t-1}$  and/or  $b'(\cdot) = 0$ .<sup>35</sup>

This decomposition of probabilities in (11) implies the Hypotheses of Section 2.

Hypothesis 1 is immediate because with fully attentive individuals the expression in (11) is nil and it is instead positive when they are inattentive (independently of the stocks of past attendance).

<sup>35</sup>The (positive) first prevails since  $\frac{\lambda\rho(\Delta t)}{1-\delta+\lambda\rho(\Delta t)\delta} \leq 1$  and the larger stock  $D_{t-1}$ , as compared with  $\tilde{D}_{t-1}$ , has a stronger (first order) effect on  $\Delta b$  than on the (double) difference  $\Delta U(D_{t-1}, \tilde{D}_{t-1})$ , which shows that  $\bar{c}_t \geq \underline{c}_t$ .

Hypothesis 2 follows from the fact that the difference in (11) is positive even if  $\Delta t > 0$  but is decreasing in  $\Delta t$ .

These two Hypotheses on the effects of reminders on reminder and non-reminder days can be depicted in Figure 7. The solid lines represent the probability of being attentive at any point in time, respectively, of control (in bold) and treated users (saw-shape line). Treated users receive reminders periodically, at a time interval  $\tau$ , so that at dates  $\tau, 2\tau, 3\tau \dots$  the probability of being attentive is temporarily restored to one. Although the probability then declines until the next reminder, it is still higher than that of controls, which leads to the following.

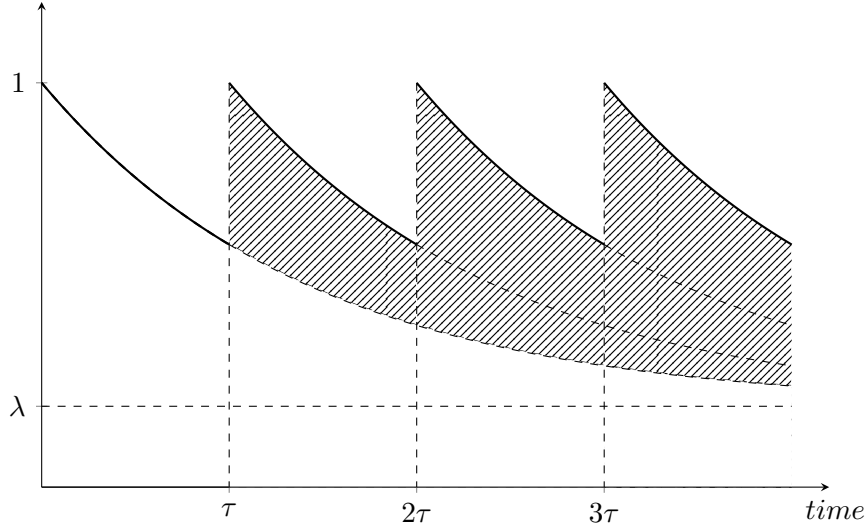


Figure 7: Probabilities of being attentive at any date  $t$  of a user who receives reminders (saw shape line) and another user who does not receive any reminders (solid bold line).

We also notice an interesting interaction between inattention and habit formation. Indeed, the attention-related effect of reminders (the terms multiplied by the difference  $[\rho(\Delta t) - \rho(t)]$  in (11) and (12)) is increasing in  $\Delta U(\tilde{D}_{t-1})$  (specifically the first line in (12)). This implies that we may have an effect of reminders that increases with the stock of past attendance, or likewise, with time, although at a decreasing rate since  $\Delta U(\tilde{D}_{t-1})$  is itself decreasing in the stock  $\tilde{D}_{t-1}$ . This is at least in part consistent with the findings in the Online Appendix B.3.

As for Hypothesis 3, imagine a case in which  $\Delta t$  is very large (as it would be in the post-treatment period of our experiments) so that  $\rho(\Delta t) \simeq \rho(t)$  and the only relevant component in (11) is the second line in (12). If the individuals are not habit forming also that part would be nil. If instead, they are characterized by habit formation, then it is positive and the individual who has the larger stock of past attendance (due to previous reminders) has a larger probability to attend.