Making regular exercise a habit that sticks

— PhD research proposal —

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The objective of my PhD research is to develop a better understanding of what helps people make regular exercise a habit and how long it takes to form such a habit. I plan to write three papers: one theory paper that integrates insights from the habit formation literature in psychology into existing habit formation models in economics, one paper presenting the results from a field experiment that aims to test the relevance of different components of habit formation, and one presenting findings from a field experiment that aims to uncover how long it takes for a habit for regular exercise to form. Ideally, my results will point to an intervention design that can eventually be employed to help people who want to exercise more (or form other healthy habits) to achieve their goal.

Background: We don't know what helps people make regular exercise a habit. Financial incentives make people exercise more as long as they are in place (Charness and Gneezy 2009, Acland and Levy 2015), financial commitment contracts help people commit to their exercise routine for some time (Royer et al. 2015), temptation bundling – rewarding yourself with a fun activity while you engage in an unpleasant one – helps people resist the temptation to skip workouts during the intervention period (Milkman et al. 2013), reminders help them remember workouts as long as they are sent (Calzolari and Nardotto 2016), having friends that exercise (or run) more seems to motivate people to workout (or run) more, too (Babcock and Hartman 2010, Aral and Nicolaides 2017), and while there are plenty of apps designed to help people exercise more regularly, we don't know how effective they are (Hingle and Patrick 2016, Vandelanotte et al. 2016, Stawarz 2017). Some of these papers, Charness and Gneezy (2009), Royer et al. (2015), and Calzolari and Nardotto (2016), do find post-treatment effects and interpret them as habit formation. But while these post-intervention effects are interesting, they are short-lived and small. The strongest effect

are in Royer et al. (2015), who find that commitment contracts increase the fraction of people who use the gym at least once a week by five percentage points in the first year after the intervention.

Contribution: Each of my three papers makes a contribution to our understanding of how to make regular exercise (and possibly other health behaviours) a habit. The first paper will provide a coherent conceptual framework that integrates insights from the habit formation literature in psychology and behavioural design into current habit formation models in economics, and thus merges insights from two largely independent bodies of research. The second paper, based on a field experiment that tests the efficacy of different (combinations of) components of the cue-behaviour-reward model will, to the best of my knowledge, be the first paper to provide large-scale evidence from the field. The third paper, based on a field experiment designed to investigate how long it takes for exercise to become a habit will, to the best of my knowledge, be the first paper that systematically addressed that question in any setting.

Why should we care?: Helping people exercise regularly has large potential benefits both for individuals themselves and for society as a whole. For individuals, regular exercise reduces body mass and obesity, is associated with lower rates of depression and anxiety, and tends to improve ones self-esteem and body image. Furthermore, circumstantial evidence and empirical evidence DellaVigna and Malmendier (2006) also suggest that many people would like to exercise more than they do. To society, the benefits come in the form of lower health care costs and higher economic output.[1]

The remainder of this proposal discussed in more detail each of the three papers, and ends with brief discussions on limitations, a timeline, and my proposed supervisor.

A theory of habit formation

There exist models of habit formation both in the economic and the psychology literature. In economics, there are two strands of literature on habit formation: one follows Becker and Murphy (1988) and argues that habits are formed if past behaviour builds up a capital stock that then increases the marginal value of the behaviour in the present[2]. This literature mainly focuses on explaining bad habits and addiction.[3] A more recent strand of literature sees inattention as the key for forming or not forming habits and

[1] Charness and Gneezy (2009) summarise the literature on physical and psychological benefits of regular exercising. Unhealthy eating, smoking, and alcohol consumption are estimated to cost $30.4 trillion in lost output and treatment cost over the next 20 years (D. Bloom et al. 2012, World Health Organization and others 2008).

[2] Read again!

[3] See, for instance, Bénabou and Tirole (2002), Bernheim and Rangel (2004), Fudenberg and Levine (2006), and Laibson (2001).

predicts that if inattention can be overcome, the behaviour occurs and, over time, a habit might be formed (Taubinsky 2013, Calzolari and Nardotto 2016, Karlan et al. 2016).[4]

Habit formation models in psychology (Lally and Gardner 2013, Fogg 2009, Cialdini 2007, Wood and Rünger 2016) and behavioural design (Eyal 2014, Stawarz et al. 2015) vary somewhat in their scope and focus, but the overall picture that emerges is that forming a habit requires multiple iterations through a cue-behaviour-reward cycle: a stable contextual cue that can be internal (a time of day, a place) or external (a reminder) and that triggers the the intended behaviour or the thought thereof; the behaviour itself, which needs to be consistently performed in the presence of the trigger, which requires sufficient levels of ability and motivation; and, finally, a reward.[5] Repeated iterations through the habit-formation cycle strengthen the cue-behaviour association in the brain until the behaviour is carried out automatically and without thought.

My aim in this paper is to incorporate additional insights of the cue-behaviour-reward model from psychology into an analytically rigorous model that can serve as a conceptual framework for my experimental work. The models of Calzolari and Nardotto (2016) and especially Taubinsky (2013) are ideal starting points for this, because by focusing on reminders (or cues) they already incorporate insights from psychology, and because they are fairly simple and yet elegant frameworks that lend themselves to be extended. One way to incorporate the ideas of the cue-behaviour-reward cycle into the framework would be to model them as complementary inputs into a habit production function. However, the main contribution of my dissertation will be empirical in the form of program evaluation, and not theoretical. So, the main aim of the model will be to serve as a conceptual framework for the experiments I conduct.

Elements of habit formation

Motivation: The papers cited in the background paragraph above account for at most one of the three components of the cue-behaviour-reward cycle. Financial incentives and commitment contracts provide monetary rewards (framed positively and negatively, respectively), temptation bundling provides non-pecuniary rewards, reminders an external cue, and more active friends might be a motivating force or a social reward or both.

The objective of this study to test the effectiveness of an intervention that incorporates more than

[4] The original theory on why people don't do investment behaviour: laibson, rabin, gul pesendorfer... from old proposal.

[5] Eyal (2014) and Cialdini (2007) argue that habit formation also requires an investment in the form of effort. Given that exercising is effortful, this component is automatically present whenever exercising takes place, and so I ignore this component.

one component of the cycle. The focus lies on program evaluation rather than mechanism analysis, and given that different treatments might affect different components of the habit-formation cycle, it will not be possible to isolate the importance of individual components for the overall habit formation process. An additional motivation is to test the effectiveness of interventions that do not rely on financial incentives, both because they are costly and thus hard to scale, and because they might have unintended consequences by crowding out intrinsic motivation (Frey and Jegen 2001, Gneezy and Rustichini 2000, Lepper and Greene 2015, Marteau et al. 2009).

Participant selection: In order of preference, both this experiment and the one described in the next section are run in large companies, commercial gyms, or on university campuses. The last option is a backup that should be feasible in any case and would allow me to produce results within the timeframe of my PhD. In any of these settings, participation will either be limited to past or active gym goers who would like to exercise more often, or also include people that have no experience with exercising. Including the latter group has the advantage of a larger overall population and sample size, as well as potentially large benefit in terms of health outcome, yet the disadvantage is that for the intervention to be useful, gym newcomers require a gym induction, which adds complexity to the project. The decision will depend on the experimental setting and on advise from my advisor(s). For the remainder of this proposal, I assume that both experiments take place in companies, that participation is limited to experienced gym-goers, and that all participants receive a Fitbit.[6]

To recruit participants, all employees will receive an invitation through company email. The invitation will state the purpose of the study (help experienced gym-goers exercise more or more regularly) and the institutional affiliations of my supervisor(s) and myself. Everyone who is interested to participate and meets the eligibility criteria (e.g. no serious health condition, not being an intern, etc. (Royer et al. 2015)) will be a participant.

In both experiments, treatment status will be assigned using stratified random sampling, with the two strata being regular gym-goers (one or more visit a week) and irregular gym-goers (less than one visit a week). I will produce balance tables and regress participant covariates on treatment assignment to check that the degree of balance among treatment groups is reasonable given random assignment. Random treatment assignment is not only essential for estimating unbiased treatment effects, but also ensures that

[6]If my population does include people who require a gym induction, I'll follow Royer et al. (2015) and run the experiment in multiple cohorts in order to avoid the gym from being over-crowded and the gym staff being overrun. Having different cohorts would also provide a check for season specific effects (e.g. more exercise in spring/summer than in fall/winter).

a participant's number of peers that are assigned to a particular treatment (or the control) group is also random, and thus allows me to control for network effects.

Outcome variable: The main outcome variable is whether or not a habit for regular exercise has formed or how strong that habit is. In the literature, there does not presently exist a sharp measure for this. The papers in the economic literature cited above speak of habit formation whenever behaviour of the treatment group differs from the control group during the post-treatment period, while psychologists tend to rely on an index based on self-reported information. I intend to define a sharp measure of habit formation that does not rely on self-reporting.

One way or another, the measure will be based on the number of times a participant exercises for at least 30 minutes in a given week. In addition, I will also consider a binary measure of whether they achieves their exercise goal, a percentage measure of how close they come to achieving it, and possibly measure how regularly they exercise.

To measure exercise activity I will use gym access data and data from participants' Fitbits.[7] Using an automatic activity tracker has the advantage of providing richer and more reliable data than using gym access data only (which, in principle, allows for cheating in the form of accessing the gym without exercising). In addition, Fitbit's leaderboard feature (a ranking among friends based on their number of weekly steps) provides information about participants' social network within the company, which allows me to control for network effects. For the intervention to be easily scalable it needs to be cost-neutral, so using Fitbits is possible only if companies are willing to sponsor them for all participants. Companies increasingly invest in wellness programs so that sponsoring of Fitbits seems realistic (Gubler et al. 2017). In case this proves infeasible, however, I will follow other studies in the literature and use gym access data only.

Experimental design: I use a 2×2 factorial design that varies 1) whether participants are supported in forming an intention and a plan to exercise at specific times during the week and are reminded weekly of their intention and plan, and 2) whether they are supported in forming a personal exercise goal and are reminded weekly of that goal.

Intentions to exercise will be formulated as implementation intentions in the form of "if – then" statements following the implementation intention literature (Gollwitzer and Sheeran 2006). Following the

[7] I plan to work with Fitabase (https://www.fitabase.com), a platform that helps manage Fitbit data for research projects. Ideal Fitbit models are charge 2 or Alta HR. Alternatives to Fitbit include: Apple Watch, Jawbone, Garmin, Pebble, Polar.

results of Judah et al. (2013) and Stawarz (2017), participants will further be encouraged to form "event-based" cues, where the behaviour follows a sequence of already habitual behaviours. So, an example of an implementation intention could be: "When I finish work, I go to the gym right afterwards." A plan for exercising will consist of regularly scheduled slots (e.g. Mo, We, Fr evening) as well as one or two backup slots (e.g. Tu and Th evening) in case exercising has to be skipped. Together, intentions and plans can facilitate habit formation in at least three ways. First, the if-then statements help create an internal cue for exercising so that the impetus to exercise automatically occurs after some time. Building internal cues that do not rely on external reminders are a key component of habitual behaviour, especially if it should eventually be non-reliant on external reminders and technology (Stawarz 2017).[8] Second, intentions and plans also make exercising easier in that they eliminate the need to make a whether to exercise and the need to find time for exercise. This addresses the behaviour component of the habit-formation cycle, in that making behaviour easier to do increases the person's ability to do it. Finally, having scheduled appointments could also make people exercise more because not following the schedule might be dissatisfying and produce cognitive dissonance, which we tend to dislike (Cialdini 2007).

Personal goals can serve as reference points that motivate behaviour (Heath et al. 1999, Koch and Nafziger 2011, Koch and Nafziger 2016). The idea goes back to prospect theory (Kahneman and Tversky 1979): if people evaluate outcomes in terms of gains and losses relative to a reference point and are loss averse, then the aversion to falling short of ones personal exercise goal can act as a motivating force to exercise more often. Having a personal goal might also change participants' image of themselves and, if they reach their goal, serve as a reward for behaving in accordance with their invention (Cialdini 2007). Formulating a personal goal will include the number of times a participant wants to exercise per week, and their motivation for it ("e.g. I want to exercise four times per week because I want to feel more energetic"). The intervention differs from simply asking people about their goal in that people will be supported by formulating a goal. One possibility would be to simple provide people with information about goal setting and achievement rate of other participants, which led to promising results in Toussaert (2016). I will explore other ways before the beginning of the study.[9]

[8] The findings in Stawarz (2017) suggest that the ideal internal cue formation process contains a pre-event reminder of the "if-then" intention, a check whether the behaviour was performed, and, if the latter was not the case a few times in a row, and the capacity to help find people new cues is existing ones turn out not to work well (e.g. try exercising in the morning instead of after work). This process is ideally implemented with an app, and Stawartz and collaborators have developed an Android version of such an app. I'm currently exploring whether using that app or an extension thereof would be a feasible option for my PhD project.

[9] If the subject pool is large enough, I will use a 2×3 factorial design with the reference point dimensions consisting of "no reference point", "personal goal", and "social comparison", to test whether personal or external reference points are a stronger motivational force. Social reference points are not only commonly used in many health apps but have been successful in motivating people to be more energy efficient Schultz et al. (2007), Allcott and Rogers (2014), and Dolan and Metcalfe

One question I need to address before designing the interventions is to what degree to take into account participants' own goals and their scheduling constraints when helping them form intentions, plans, and goals. It is not a-priori clear what the optimal number of exercise sessions per week is. Habit research suggests that the higher the frequency of a behaviour, the faster it becomes habitual (Lally, Van Jaarsveld, et al. 2010) and there is some evidence that four sessions per week is the minimum for a habit to form at all (Kaushal and Rhodes 2015). At the same time, research summarised in Cialdini (2007) suggests that starting with small steps when pursuing a goal might ultimately be more effective, and for some people four sessions per week might simply seem infeasible and daunting at first. I will read more and seek feedback from my supervisor(s) on this before launching the experiments.

The timeline of the experiment will consist of a pre-treatment period (4 weeks), a treatment period (about 20 weeks), and a post-treatment period (up to 52 weeks). The exact durations will depend on the time constraints of my doctorate and feedback from my supervisor(s). During the intervention period, all participants receive free access to the company gym, a free Fitbit, and a weekly email, with the content varying depending on their treatment assignment. The 2×2 factorial design leads to four treatment conditions, which receive the following treatment:

Control group Participants in the control group receive a weekly email that reminds them of their free gym access. This is equivalent to the intervention in Calzolari and Nardotto (2016).[10]

Intention and no goal As part of the pre-treatment survey, participants are supported in forming if-then intentions and in making realistic plans for regular gym visits. In the weekly email, in addition to being reminded of their free gym access, participants are then also reminded of their if-then intention and their plan.

Goal and no intervention As part of the pre-treatment survey, participants are supported in formulating a personal exercise goal and required to stating their motivation for it. In the weekly email, in addition to being reminded of their free gym access, participants are then also reminded of their goal and motivation.

Intentions and goal Participants in this group form intentions and plans, and set a goal together with their motivation for it, and in the weekly email they are reminded of all these elements.

(2015). The reason that in I use personal goals in the 2×2 design is that I suspect that while social comparison can be exciting and motivating for a while, personal goals are more effective at changing long-term behaviour, especially in domains where people have a personal stake in succeeding. Eventually, I do want to test this intuition, however.

[10] Alternative: participants receive no email. But appeal of comparing my intervention to Calzolari and Nardotto (2016) is that it would nicely fit into the existing literature and build on it.

Hypotheses: The main objective of the study will be to test the following hypotheses based on the experimental results:

H1. *Participants who are supported in formulating intentions and plans to exercise and are reminded of them weekly exercise more often during the treatment period and are more likely to maintain their exercise routine post treatment than participants in the control group.*

H2. *Participants who are supported in formulating an exercise goal and are reminded of it weekly exercise more often during the treatment period and are more likely to maintain their exercise routine post treatment than participants in the control group.*

H3. *Participants who are supported in formulating intentions and plans as well as a personal goal, and who are reminded weekly of all of them exercise most often during the treatment period and are most likely to maintain their exercise routine post treatment.*

Data analysis: Besides running summary statistics, balance and robustness checks, test for heterogeneous effects, and visualising the main results, I will present two sets of main results.

First, I will pool data from all treatments and test whether treatment (i.e. any of the three treatment conditions) increases the number of exercise sessions during the treatment period and post-treatment. For each participant p, I will define ΔE_p as the difference in average exercise sessions per week in the pre-treatment and the treatment or post-treatment period, and then estimate the empirical model

$$\Delta E_p = \alpha + \beta T_p + \epsilon_p, \tag{1}$$

where T_p is a dummy variable indicating whether participant p had been assigned to any of the three treatment groups. The coefficient β is the causal effect of interest. The main reason for using a difference-in-difference estimator is that it increases precision of the estimates if a participant's pre-treatment exercise frequency predicts their potential outcomes, which is highly likely. Following Bertrand et al. (2004), I will use cluster standard errors at the individual level to control for arbitrary serial correlation in ϵ_p.

Second, I will test the three hypotheses above by estimating a model of the form

$$\Delta E_p = \alpha + \beta_1 I_p + \beta_2 G_p + \beta_3 IG_p + \epsilon_p, \tag{2}$$

where I_p, G_p, and IG_p are dummy variables that indicate whether participant p was assigned to the

"Intention and no goal", the "Goal and no intention", or the "Intention and goal" treatment group. To provide evidence in favour of the three hypotheses above, the magnitudes of the coefficients need to follow $0 < \beta_1 < \beta_3$ and $0 < \beta_2 < \beta_3$.

A word on assumptions: Experimental results provide an unbiased estimator of the average treatment effect if assignment to treatment is random, each subjects' observed outcome depends on their own treatment assignment only (non-interference assumption), and treatment assignment affects observed outcome only through treatment status (exclusion restriction). In my experiment, assignment will be stratified random, Fitbit data allows me to control for network effects, and to bolster the exclusion-restriction, double-blindness in measurement is guaranteed given that measurement happens automatically. I am thus confident that my estimates will be unbiased.

Duration of habit formation

Motivation: Our understanding of what helps people form a habit for regular exercise is incomplete, but we know even less about how long it takes to form such a habit. Indicative evidence comes from Lally, Van Jaarsveld, et al. (2010), whose findings suggest that developing a habit for regular exercise takes more than 80 days. To address this question, I use an experimental design inspired by Allcott and Rogers (2014), who, among other things, use random discontinuation of treatment over time to test the incremental effect of longer treatment on participants energy conservation behaviour. In the domain of exercising, Calzolari and Nardotto (2016) test, among other things, whether sending gym-goers a weekly email to remind them of their free gym access increases their gym attendance on the days immediately following the email and find that it does.

The objective of my experiment is to test whether my intervention also leads participants to exercise more immediately after receiving the email, and whether the incremental effect of receiving email reminders for longer is positive but decreasing over time.

Outcome variables and participants selection are as described in the experiment above, and so I do not discuss them here.

Experimental design: The timeline of the experiment will consist of a pre-treatment period (4 weeks), a first treatment period (about 20 weeks) during which all no-control group participants will receive treatment, and a second treatment period (up to 52 weeks) during which at certain time intervals, treatment will be discontinued for random subsets of participants. The size and number of these subsets will depend

both on how long the second treatment period is, and on how many participants I have in my study. But if, for instance, the second treatment period were to run for one year, and I had a total of 300 participants in the treatment group, then I might discontinue treatment for a randomly chosen subset of 100 participants each at the beginning of the second treatment period, four months into the period, and eight months into the period. At the beginning of the second treatment period, I will also reduce the frequency of the emails to biweekly.

The experiment will have one control and one treatment condition:

Control group As in the experiment above, participants in the control group receive a weekly email that reminds them of their free gym access, just as in Calzolari and Nardotto (2016).

Treatment Participants in the treatment group will receive the "Intention and goal" intervention of the above experiment, which means that they will form intentions and plans as well as goals and motivations during the pre-treatment survey, and are reminded of all of them in their weekly email.

Hypotheses: The main objective of the study will be to test the following hypotheses based on the experimental results:

H1. *Participants in the treatment group are more likely to exercise on the days immediately after receiving the weekly email.*

H2. *The incremental effect of receiving the intervention for longer is positive but decreasing over time.*

Data analysis: Besides running summary statistics, balance and robustness checks, test for heterogeneous effects, and visualising the main results, I will present two sets of main results.

First, I test the effect of the remainder emails on the probability of exercising at the day of receiving the email and on the following two days. The dummy variable E_{pt} is equal to one if participant p exercises on day t, R_{pt}^{-1} is equal to one if day t is the day before the reminder email, R_{pt}^{0} is equal to one if day t is the day of the email, R_{pt}^{+1} if t is one day after the email has arrived, and R_{pt}^{+2} is equal to one if t is two days after the email has arrived. I then estimate a linear probability model of the form

$$\begin{aligned} E_{pt} = {} & \gamma_1 R_{pt}^{-1} + \gamma_2 R_{pt}^{0} + \gamma_3 R_{pt}^{+1} + \gamma_4 R_{pt}^{+2} \\ & + \beta_1 R_{pt}^{-1} T_p + \beta_2 R_{pt}^{0} T_p + \beta_3 R_{pt}^{+1} T_p + \beta_4 R_{pt}^{+2} T_p + controls + \epsilon_{ip}. \end{aligned} \tag{3}$$

The βs and in particular $\beta_2, \beta_3,$ and β_4 are the coefficients of interest. They tell us whether receiving the

treatment email rather than the simple reminder email makes it more likely that participants exercise on the same day or on one of the two following days.

Second, I test the effect of treatment on post-treatment exercise frequency. As discussed above, I will split the experimental period into four periods: a pre-treatment period, the first treatment period during which all participants in the treatment group receive a weekly email, a second treatment period during which a random subset of participants in the treatment group will stop receiving emails, and a post treatment period. Let ΔE_p be the difference in average weekly exercise sessions in the pre-treatment and post-treatment periods, and let $\mathbf{T}_p$ be a vector of dummies with typical element T_p^d indicating whether participant p received the treatment for a duration of d months. The typical element in vector $\boldsymbol{\beta}$ is β_d, which measures the causal effect of receiving the treatment for d periods.

$$\Delta E_p = \alpha + \boldsymbol{\beta}\mathbf{T}_p + \epsilon_p.$$

Hypothesis 1 predicts that $\boldsymbol{\beta} > 0$. If treatment was administered for four different durations indexed by 1 (shortest) to 4 (longest), then hypothesis 2 predicts that $\beta_1 > (\beta_2 - \beta_1) > (\beta_3 - \beta_2) > (\beta_4 - \beta_3) > 0$.

Limitations

The main limitation of my results will be that I only see the effect of the interventions on exercise behaviour (and, if I can use Fitbits, on overall physical activity). While this is the scope of my PhD project, ultimately the goal is to help people live healthier lives. In the presence of spillovers (Dolan and Galizzi 2015), it is not clear whether more exercise achieves this, because all else is not necessarily equal: it could be that exercising more makes people eat less healthy as a reward to themselves, or that it promotes a healthier diet to be more in line with their exercise routine. Neither theory not empirical evidence on this are conclusive, and controlling for spillover effects is one of the directions I intend to pursue after my PhD.

Timeline

In year 1, besides coursework, I will develop a more detailed research proposal, develop an outline of the conceptual framework for the theory paper, and launch pilot studies for my two experiments on campus. In year 2, I finish the theory paper, complete the experimental designs, and plan the experiments. In year 3, I run the experiments, draft the non-result parts of the two experiment papers, and prepare code for

data analysis. In year 4, I analyse the data and the two experiment papers.

Supervision

I have discussed my proposal with ... and think he/she/they would be an ideal supervisor for my project because ...

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