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Nudging Self-Control: A Smartphone Intervention of Temptation Anticipation and Goal Resolution Improves Everyday Goal Progress

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Practitioners and researchers alike explore ways of increasing motivation. Whereas previous research mainly explores interventions that operate on people's goals (e.g., via goal setting), we explore an intervention that operates on overcoming interfering temptations and nudging self-control success. We report an experiment testing a 1-week smartphone field intervention. Self-control involves anticipating and battling temptation; hence, we encouraged participants in a treatment condition to anticipate temptation (i.e., obstacles) for daily goal pursuit and to envision resolutions. They generated these responses for half the goals they listed daily. Participants in the treatment (anticipation + resolution) condition reported more successful pursuit of the daily goals for which they listed obstacles and planned resolutions than for their other goals. We found no such difference between daily goals for participants in a control condition (no anticipation + and no resolution) and for participants in an anticipation-only condition. The beneficial effect of listing obstacles and resolutions was further limited to goals that require self-control and are stronger for people with an assessment self-regulatory mode. Finally, participants in the treatment condition reported increased general happiness during the period of the intervention. We conclude that a simple intervention can improve self-control.

Keywords: goal pursuit, counteractive self-control, goal progress, regulatory mode, experience sampling

A basic question in motivation research, with practical and theoretical implications, is how to design interventions to increase motivation. Previous research has explored interventions that operate on people's goals. Thus, research on goal setting finds that setting specific and ambitious goal targets increases motivation and, hence, performance (Locke & Latham, 1990, 2002, 2006; Mento, Locke, & Klein, 1992), and research on implementation intentions similarly demonstrates that having specific and concrete execution plans for goals is a powerful tool for increasing motivation (Gollwitzer, 1999). Other research on action control further offered descriptive and normative theories for improving motivation through better regulation of goals (Kuhl & Beckmann, 1985). These previously researched interventions increase people's commitment to pursuing a given goal by operating on that goal.

However, motivation deficits also arise from the presence of competing motives that pose obstacles and temptation for successful goal performance. How can one remove these barriers for successful performance? For example, a person may slack on a work or study assignment not because she is unmotivated to complete the assignment, but because she is equally tempted to engage in a competing activity of checking social media. To increase motivation, considering an intervention that removes barriers for goal progress rather than increasing the motivation to pursue the focal

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goal might be useful. Accordingly, this research proposes and tests a strategy of nudging self-control and demonstrates this strategy's consequences for improving performance.

The Processes of Self Control

Resolving goal conflicts through self-control is the key to achieving many important outcomes, including major life achievements such as career success, and more mundane, everyday tasks, such as completing one's daily assignments and avoiding interpersonal conflicts (Baumeister & Tierney, 2011; Duckworth & Seligman, 2005; Loewenstein, 1996; Mischel, Cantor, & Feldman, 1996; Thaler & Shefrin, 1981). Studies that sampled people's goal pursuits in the course of their daily life find that self-control involves a large proportion of these goals and enables adaptive response to the many obstacles and temptations people face as they pursue these goals (Hofmann, Baumeister, Förster, & Vohs, 2012).

We define self-control as the capacity to resist a temptation in order to protect a valued goal (e.g., resist social media to complete work assignment). Research on self-control has identified two distinct challenges to overcoming temptation: *identification* and *resolution* (Fishbach & Converse, 2010; Myrseth & Fishbach, 2009). Thus, to succeed at self-control, a person needs to first identify the conflict, for example, by considering multiple decisions to indulge in temptation together (vs. in isolation; Myrseth & Fishbach, 2009; Rachlin, 2000; Read, Loewenstein, & Rabin, 1999). Once a conflict has been identified, a person needs to resolve it, that is, protect the motivation to adhere to a valued goal. For example, anticipating the temptation to behave badly, a person may plan to protect her motivation to behave ethically and shield it against her desire to do otherwise (Sheldon & Fishbach, 2015).

Self-control theory states that identification and resolution are distinct challenges, though absent identification, resolution is rather unlikely (Fishbach & Converse, 2010). We define identification as the mental link between a specific action and the hindrance of an important goal. Research that explored conflict identification found that wide brackets (Rachlin, 2000; Read et al., 1999) and greater perceived connectedness to one's future self (Bartels & Rips, 2010; Ersner-Hershfield, Wimmer, & Knutson, 2009) increase identification of a self-control conflict. However, identification is only the first step, and for it to be effective, resolution must follow. We define resolution as the exercise of self-control in order to counteract the negative impact of temptation on goal pursuit (Trope & Fishbach, 2000). It typically involves selecting specific means for action (including social support) and forming concrete action plans that involve these means. Prior work that explored conflict resolution found, for example, that precommitments (Ariely & Wertenbroch, 2002) and cognitive construal of goals and temptations (Fujita, Trope, Liberman, & Levin-Sagi, 2006; Mischel, 1996) influence successful resolution, once the person has identified a problem.

The present research takes a different perspective by exploring *anticipation of obstacles* and *planned resolution* as an intervention, which should improve self-control in daily goal pursuits. We ask whether nudging people to identify obstacles to goal pursuit and envisioning overcoming these obstacles (the two parts of the self-control response) would facilitate goal pursuits and might increase general well-being.

Interestingly, the usefulness of considering obstacles/temptations for successful goal pursuit is not intuitive and the evidence so far is somewhat mixed. Identification of temptation can sometimes discourage goal pursuit by reminding people of the appeal of temptation (Coelho, Polivy, Herman, & Pliner, 2009; Papies, Stroebe, & Aarts, 2007) and by reducing their perceived self-efficacy (Bandura, 1997; Judge, Jackson, Shaw, Scott, & Rich, 2007). However, identification is also the first step in protecting the self against the impact of temptation by prompting the individual to resist the interference; therefore, identification is particularly useful when it occurs in advance. Indeed, research on counteractive control finds that anticipating temptation in advance facilitates goal adherence (Trope & Fishbach, 2000). When people anticipate a possible problem in executing their goals, they divert more resources toward ensuring that they can execute these plans. For example, cues for food temptations reminded people to take extra measures to endure healthy eating and increase responsible food consumption (Kroese, Evers, & De Ridder,

2009; Kroese, Adriaanse, Evers, & De Ridder, 2011). Similarly, anticipating the lure of leisure activities helped students study by increasing their planned time investment in academic pursuits (Zhang & Fishbach, 2010). In another line of research, studies on mental contrasting documented that identifying the discrepancy between one's present state and goal achievement is the first step in motivating goal pursuit (Oettingen et al., 2009).

Nudging Self Control

This research investigates the effectiveness of a seemingly simple way to boost successful goal pursuit by getting people to anticipate potential obstacles and temptations, and plan resolution. We compare this self-control intervention of "anticipation + resolution" to a mere "anticipation" intervention and to no intervention, and predict that the self-control intervention will result in greater goal progress than the latter conditions. We propose two types of comparisons. Our main comparison is between the subset of goals for which people engage in anticipation and resolution and the subset of goals for which they do not engage in anticipation and resolution (within-participants comparison). Our secondary comparison is between the treatment effect in this condition to that in the anticipation-only and no-intervention conditions: we predict that the difference between treatment goals and nontreatment goals will only appear in the anticipation + resolution condition and not in the anticipation-only and no-intervention conditions.

Our main hypothesis is that people will report greater progress on the goals for which they anticipate obstacles and plan resolutions as compared to their other goals (within participants, *Hypothesis 1a*). Our secondary hypothesis is that no such treatment differences in goal progress as expressed above will obtain for people who only anticipate obstacles and people with control intervention (between participants, *Hypothesis 1b*).

Everyday goals are quite manifold, and thus the domains of everyday goal pursuit may vary in the degree to which they pose a self-control challenge to people. For example, whereas work-related goals often conflict with low-order goals or temptations that pose a self-control conflict, pleasure or social goals (e.g., dining, partying) are less likely to uniformly require self-control and, if anything, they are the temptations that stand in the way of pursuing more important goals. We therefore predict that the effects of our treatment would be more pronounced for those goal domains that, by and large (as shown through literature), pose a higher self-control challenge, including work-related and academic goals, health and fitness goals, and financial goals. Specifically, we predict that the expected treatment effect of obstacle anticipation and goal resolution will only emerge for high-challenge goals but not for low-challenge goals (*Hypothesis 2*).

We further investigate individual differences in self-regulatory mode, specifically, the tendency to assess prior action (i.e., elaborate on "doing the right thing") and the tendency to act (or "just do it"; Kruglanski, Pierro, & Higgins, 2007; Kruglanski et al., 2000). Individuals vary by the degree to which they are predisposed to evaluate their actions ("assessors") as well as the degree to which they are predisposed to jump into action ("locomotors"; see also, Kuhl & Beckmann, 1985). We predict that individual differences in regulatory mode matter, and those high in assessment would profit most strongly from the self-control nudges we provide. Because assessors have the preorientation for planning, they, in particular, are likely to benefit from our intervention, which requires evaluating one's goals, temptations, and the response to temptation, which all occur during planning. We therefore hypothesize that high-assessment individuals should make more progress on those goals for which they anticipate obstacles and plan resolutions as compared to their other goals; however, this difference should be less pronounced for low-assessment individuals (*Hypothesis 3*).

Finally, because successful goal pursuit is associated with general well-being and happiness (Hofmann, Luhmann, Fisher, Vohs, & Baumeister, 2014), we predict that our self-control intervention can increase happiness over the course of the intervention. Specifically, people who anticipate obstacles and plan resolutions will experience higher levels of happiness at the end of the day compared to participants in the anticipation and control conditions (*Hypothesis 4*).

The Present Research

We designed a first smartphone field experiment to nudge people into better goal pursuit through the exercise of self-control. Our intervention consists of nudging people to anticipate temptation and plan resolution. To deliver nudges, we chose an innovative smartphone experience-sampling intervention to measure the impact of anticipation and resolution strategies on everyday goal pursuit. The decision to assess the effects of goal-specific mobile interventions was motivated by the desire to deliver our nudges as close as possible to where the action takes place (similarly to how a doctor would like to get the medicine as close as possible to where a given problem originates). Rather than having people come to a lab training session and think about their daily goals in a relatively artificial and removed setting, we wanted to "inject" our goal-specific nudges as people navigate their everyday environments as usual. To do so, we delivered text messages as signals/prompts to people's smartphones. Given the high availability of smartphones and online data plans in the general population (Miller, 2012), such an approach seemed highly feasible. Moreover, the present undertaking also has the potential to generate important "feasibility" information to practitioners as well as researchers who would likewise make use of smartphone nudges in motivating action.

Method

Participants

Participants were 110 adults (mean age = 27.7, *SD* = 9.2; range 18–55; 53.6% female), 55.5% of which were undergraduate and graduate students. Regarding ethnic composition of the sample, 34.5% were Caucasian, 36.5% African American, 12.7% Hispanic, 13.6% Asian, and 2.7% other. We recruited participants via advertising in local newspapers in the larger Chicago metropolitan area and through the Chicago Research Lab email list. Recruitment ads pointed to an online screening survey for the study. Participants were eligible if they were 18 or older, proficient in English, and in possession of a smartphone including a touchscreen, texting capability, and a data plan. Participants received $5 as base compensation for coming to the orientation meeting and $1 for each completed daily or nightly survey. Thus, participants could earn an additional $35 for responding to all signals. One participant did not provide any goals at all and was therefore dropped from analyses. Further inclusion criteria, described in more detail below, resulted in a total of 95 participants for which we could conduct progress-related analyses.

Procedure

We assessed people's end-of-day progress on their daily goal pursuits over a period of one week, using experience-sampling methodology (Csikszentmihalyi & Larson, 1987). In each instance of experience sampling, participants were asked to report on a daily goal they were currently pursuing (four goals on each day). At the end of the day (nightly diary), they indicated the extent of the progress they had made on each goal. We manipulated, between participants, whether participants received no instructions (control, C), were asked to anticipate obstacles to their goal pursuits (anticipation, A), or were asked to both anticipate obstacles *and* to think about concrete means to achieve their goals (anticipation + resolution, A + R). We manipulated within participants whether participants received the treatment-specific instructions (for two of their daily goals). The remaining two daily goals were assigned to a within-participants control condition consisting of irrelevant questions.

Participants attended a laboratory-based session for an orientation meeting and intake assessment. At this session, a trained experimenter informed the participants about the general purpose of the study, providing both oral and written instructions and rules regarding the mobile phase of the study (including a short survey demonstration on participants' smartphones). Participants then registered their phone in the mobile phase of the survey via a web application (SurveySignal; Hofmann & Patel, 2015), and were assigned randomly to the control (n = 36), A (n = 36), or A + R (n = 38) condition. They then completed several surveys, among them locomotion and assessment scales tapping into individual differences in regulatory mode (locomotion and assessment; Kruglanski et al., 2000). The Locomotion scale includes items such as "I enjoy actively doing

things, more than just watching and observing," "I am a 'doer,'" and "By the time I accomplish a task, I already have the next one in mind." The Assessment scale includes items such as "I often compare myself with other people," "I often critique work done by myself or others," and "I am a critical person." Both 12-item scales had satisfactory reliabilities: $\alpha = .82$ and $\alpha = .80$, respectively. Two composite scores were computed by averaging across responses to each item. These scales were slightly negatively correlated, $r = -.22$, $p = .019$.

Experience-Sampling Records

In the experience-sampling phase, four daily signals were randomly distributed within four equally spaced time blocks (Hektner, Schmidt, & Csikszentmihalyi, 2006) via smartphone between 9 a.m. and 7 p.m.. These blocks were 9–11:30 a.m., 11:30 a.m.–2:00 p.m., 2:00–4:30 p.m., and 4:30–7:00 p.m., in order to spread out signals over the course of the day. Participants were asked to respond to these signals for one week. Therefore, each participant could provide up to 28 goal records throughout the experience-sampling period. Participants were instructed to respond to a brief goal survey as soon as possible after receiving each daily signal. In each survey, participants were asked to report on a daily goal using the below wording:

> Please tell us about something you plan to accomplish today (but that you have not yet started). (Note: this could be something you are trying to get started, complete, attain, achieve, or master, but it could also be something you are trying not to do, trying to avoid, or trying to resist from doing. If there is nothing you plan to accomplish, type "nothing").

If the participants indicated a goal, they briefly described what they were trying to accomplish via text entry and classified the goal according to goal domain with the help of 13 multiple-choice categories (academic/professional, relationship, social, health/fitness, financial, pleasure, leisure, hobby, spiritual, activism, emotion management, maintenance, other). This categorization was validated by Hofmann, Finkel, and Fitzsimons (2015). We screened responses for the category "other" and decided that we could reclassify a small number ($n = 11$) of text responses (e.g., "work," "maintaining family ties" into the existing categories). Notably, because participants listed their goals daily, it was possible that the same content (e.g., "I plan to exercise") appeared on multiple days, yet reflected different daily goals (and it was possible that some of these daily goals were met while others were dropped).

To be able to estimate treatment effects most appropriately, out of the four goal assessments during the day, we randomly assigned two to the treatment-specific instructions (i.e., anticipation instructions in the A condition; anticipation and resolution instructions in the A + R condition; no instructions in the control condition). These conditions varied between subjects. We assigned the remaining two goals to a within-participants control condition. See Table 1 for an overview of the experience-sampling intervention design.

In the A condition, the treatment-specific instructions were to "Please think for a minute about what might be going to make it difficult to achieve the reported goal today." A text-entry window was provided below the instruction and participants were asked to "briefly note any such difficulties in the field below." This instruction was intended to have people anticipate potential obstacles to their goal pursuit. We provided participants in the A + R condition with the same instruction

Table 1
Study Design

	Control condition (C)	Anticipation condition (A)	Anticipation + resolution condition (A + R)
4 daily goal assessments	2 goal assessments: no instructions	2 goal assessments: anticipation instructions	2 goal assessments: anticipation and resolution instructions
	2 control goal assessments: irrelevant questions	2 control goal assessments: irrelevant questions	2 control goal assessments: irrelevant questions
Nightly diary	Goal progress for all daily goals	Goal progress for all daily goals	Goal progress for all daily goals

Note. The four daily goal assessments were assigned randomly without replacement to the goal-assessment and control-goal-assessment within-participant conditions.

as those in the A condition; in addition and subsequently, however, the treatment-specific instructions were to "Please think for a minute about what or who might be going to help you achieve this today" and to "Please think for a minute about how exactly you will be going to accomplish this today." These instructions were intended to nudge participants to come up with a resolution, that is, a plan to overcome the obstacle or temptation previously listed.[1] In the control condition, we provided no instructions.

In each condition, we presented the above treatment-specific questions only for a subset (two) of the daily goals. For the other (two) reported goals, we asked participants two irrelevant (treatment-unspecific) questions that were similar across conditions ("Please describe some aspects of your current surroundings (e.g., place you are in, people around) while you were writing this [the reported goal]"; "Please think for a minute about what reminded you of this [the reported goal]"). Note that with this design, the control condition received two different types of control instructions (no instruction; irrelevant instruction). Using this paradigm, the difference in goal progress between the treatment-specific goals and the within-control goals allowed us to estimate treatment effects most precisely within each condition, because it controlled for possible main effects between the three different conditions of participants.

Each day, at 9 p.m., participants also received a nightly diary on their smartphone. The nightly diary asked them to indicate, for each goal listed earlier that day, the rate of progress they had made on the goal on a slider scale from −3 (*much less than usual*) to +3 (*much more than usual*). We used relative (less or more than usual) assessment of subjective goal progress because it is comparable across domains. Had we sampled only one domain (e.g., eating healthy), healthiness of food eaten would have served as the progress dependent variable, but because we sampled goals so broadly, we needed to rely on people's ability to judge whether they did better or worse than usual on a given day regarding that goal's reference value.

After the goal-specific assessment, participants also provided a daily summary measure of their happiness ("Taken together, how happy do you feel with yourself today?" on a scale from −3 to +3), level of stress ("Taken together, how stressful was your day?" on a scale from 0 to 6), and exhaustion ("Taken together, how mentally exhausting was your day?" on a scale from 0 to 6). The means and intercorrelations of our main experience-sampling and dispositional measures can be seen in Table 2.

Results

Data Analytic Procedure

Because experience-sampling data are nested (observations within persons), we conducted all analyses—except descriptive raw data calculations—through multilevel modeling (Hox, 2012) using the MIXED command in SPSS (Peugh, 2010). The Level 1 unit of analysis was goals; hence, we treated within-participants goal assignment to type of instruction (treatment-specific vs. irrelevant) as a Level 1 factor. The Level 2 unit of analysis was persons; hence, we treated between-participants condition assignment as a Level 2 factor. For the moderator analyses involving locomotion and assessment, we grand-mean-centered the two personality variables for interpretation purposes and added them as Level 2 continuous predictors.

Response Rate, Response Delay, Completion Rate

Overall, participants reported on a total of 2,426 goals during the daily part of the experience-sampling phase. This number corresponds to a response rate of 80%. On 6.8% (165) of occasions, participants indicated they did not plan to accomplish anything at all. These occasions were dropped from further analyses.

Participants completed a total of 719 nightly diary surveys (response rate: 94%). With this high compliance, information on actual daily goal progress could be collected for a total of 1,945

[1] Examples of the responses of participants in the A + R condition include (in the order of [a] goal, [b] obstacle, [c] who or what might help, and [d] resolution): Participant A: (a) apply for a job out of state, (b) possible other plans, (c) my girlfriend, and (d) sit down away from distractions and get it done. Participants B: (a) avoid chocolate, (b) I like chocolate, (c) eating mango, and (d) eat other food and fruits. Participant C: (a) clean my house, (b) tired, (c) my son, and (d) get a couple of hours sleep. Participant D: (a) give a good speech to my class, (b) being stressed, (c) breathe, and (d) try my best to relax. Participant E: (a) I'm looking to reach my sales goal at work today, (b) people won't come in today, (c) just myself, and (d) by going out of my way to engage potential customers.

Table 2
Means, Standard Deviations, and Intercorrelations for Main Study Variables at the Person Level

Variable	1	2	3	4	5	6	7	8
1. Progress (person-level average)								
2. Stress (person-level average)	−.100							
3. Exhaustion (person-level average)	−.135	**.886**						
4. Happiness (person-level average)	**.512**	**−.327**	**−.374**					
5. Assessment tendency	.009	**.282**	**.245**	**−.312**				
6. Locomotion tendency	**.222**	−.138	−.148	**.242**	−.124			
7. Condition dummy 1 (C,A + R[0]; A[1])	−.048	.031	.055	−.005	−.090	−.080		
8. Condition dummy 2 (C,A[0]; A + R[1])	−.028	−.016	−.083	.165	.007	.043	**−.462**	
Mean	.78	2.40	2.42	1.10	3.93	4.39	.32	.32
SD	.82	1.27	1.21	1.10	.78	.69	.47	.47

Note. Correlation analyses were conducted at the person level (i.e., aggregating lower-level measurements of progress, stress, exhaustion, and happiness), including only those participants for whom valid progress data were available ($n = 95$). Significant correlations at $p < .05$ are printed in bold.

goals (86% of all goals). The overall number of participants for which goal progress information was available was 99. In terms of response delay, the median response time to signals was 9.0 min. In other words, participants responded to more than 50% of all answered signals within just 10 min of us dispatching those signals. Also, 99% of all surveys that had been started were actually completed. Together, these technical validation parameters indicate a very satisfactory participant adherence to the smartphone intervention.

Goal Domains

What types of everyday goals did people report? Participants mentioned goal domains with the following frequency in descending order: pleasure (32.8%), academic/work (28.8%), leisure (24.2%), maintenance (26.4%), social (25.4%), health/fitness (25.2%), emotion management (19.0%), financial (17.1%), relationships (12.8%), hobby (11.0%), spiritual (5.7%), activism (3.3%), and other (2.2%). (Because participants were able to check more than one category per goal, these percentages add up to more than 100%.) According to our reasoning above, we classified goals tagged with at least one of the following six dimensions as high in self-regulatory challenge: academic/work, maintenance, health/fitness, emotion management, financial, activism.[2] We found that 80.2% of reported goals (with progress data) fell into that category, whereas the remaining 19.8% were not associated with any of the high self-regulatory challenge domains.

Manipulation Check and Data Preparation

To eliminate from analysis occasions for which participants may not have been able to come up with a response or may not have been following instructions correctly, we checked the responses to the obstacle and the two resolution items for obvious signs of noncompliance with instructions (e.g., responses such as "nothing;" "don't know"). As a result of this compliance check, a total of 8.1% of responses was excluded from further analyses, leaving 1,787 goals with progress data for the final analysis (the overall number of participants with valid goal progress data after this exclusion criteria had been applied was reduced from 99 to 95).

Treatment Effects

Because we assumed that the effects of our nudging intervention (H_1) would depend on self-regulatory challenge (H_2), we ran an overall analysis first that involved the three treatment conditions (C, A, A + R conditions) as a between

[2] Even though our initial classification was only based on common sense and prior themes in the literature, a sample of 40 independent raters on mturk rated each goal domain as to how challenging it is for the average person to pursue their goals in this domain on a scale from 0 (*not challenging*) to 6 (*very challenging*), and confirmed that the six goal domains assigned to the high challenge cluster were judged to be significantly more challenging ($M = 3.77$, $SD = .78$) than those assigned to the low challenge cluster ($M = 2.56$, $SD = 1.04$), dependent samples $t(39) = 8.10$, $p < .001$, $d = 1.3$.

factor, the type of goal instruction (treatment-specific vs. irrelevant) as a within-participants factor, and self-regulatory challenge of the goal domain (high vs. low) as a within-participants factor (Table 3). This analysis yielded only a three-way interaction, $F(2, 1748) = 3.43$, $p = .033$, all other ps $> .102$, indicating different treatment effects for the three conditions, that depend on self-regulatory challenge.

Decomposing the three-way interaction revealed a different pattern for high- and low-challenge goal domains (Figure 1). Beginning with high-challenge goal domains, we found a marginally significant Treatment Condition × Goal Instruction interaction, $F(2, 1373) = 2.78$, $p = .062$. Further analysis of the simple effects revealed a significant treatment effect in the A + R condition, $b = .43$, $p = .026$, indicating that participants made significantly more progress on highly challenging goals for which they had anticipated obstacles and planned resolution as compared to highly challenging goals for which they received irrelevant control instructions (see Figure 1, upper panel). This finding confirms H_{1a}. We obtained no such treatment effect (i.e., the within-participants difference between treatment-specific and control instructions) for the anticipation condition, $b = .01$, $p = .962$, or the control condition, $b = -.16$, $p = .327$, confirming H_{1b}. As a supplementary analysis to H_{1a}, we investigated whether the treatment effect obtained in the A + R condition depended on the specific goal-content-domain reported. To this end, we included an effects-coded variable for each of the six specific challenging domains (academic/work, maintenance, health/fitness, emotion management, financial, activism) as a main-level predictor, and its interaction with the goal-instruction effect in a multilevel regression of goal progress for the A + R condition only. Results showed that none of the six content domains significantly moderated the average progress effect, all ps $> .191$. The absence of moderation suggests that the treatment effect we obtained can indeed be generalized well across these goal domains.

Regarding goals from low-challenge domains (relatively small number; 19.8% of all goals), we obtained a different pattern, which confirms H_2. Specifically, we found a marginally significant Treatment Condition × Goal Instruction interaction, $F(2, 349) = 2.85$, $p = .059$. This interaction was mostly driven by an unexpected effect in the control condition, such that control participants reported significantly more progress for goals from low-challenge domains on

Table 3
Multilevel Regression Results Predicting Goal Progress as a Function of Treatment Condition (A + R Condition = Base), Type of Goal Instruction (0 = Irrelevant; 1 = Treatment-Specific), and Goal Domain Challenge (0 = Low; 1 = High)

Effect		Numerator (*df*)	Denominator (*df*)	*F*	*p*
Intercept		1	146.7	113.35	<.001
Treatment condition		2	145.2	.04	.961
Type of goal instruction		1	1748.8	.41	.521
Goal domain (high vs. low challenge)		1	1785.1	2.67	.102
Type of Goal Instruction × Treatment Condition		2	1749.7	.41	.666
Type of Goal Instruction × Goal Domain		1	1748.5	.01	.922
Treatment Condition × Goal Domain		2	1783.5	.39	.679
Type of Goal Instruction × Treatment Condition × Goal Domain		2	1748.9	3.43	.033
Regression parameter	*B*	*SE*	*df*	*T*	*p*
Intercept	.58	.17	173.1	3.51	<.001
Control condition dummy (A + R = base)	.35	.23	167.6	1.50	.135
Anticipation condition dummy (A + R = base)	.13	.23	163.4	.55	.584
Type of goal instruction dummy (irrel. = base)	.43	.19	1388.8	2.23	.026
Type of Goal Instruction × Control Condition	−.59	.25	1386.8	−2.33	.020
Type of Goal Instruction × Anticipation Condition	−.42	.26	1369.6	−1.63	.104

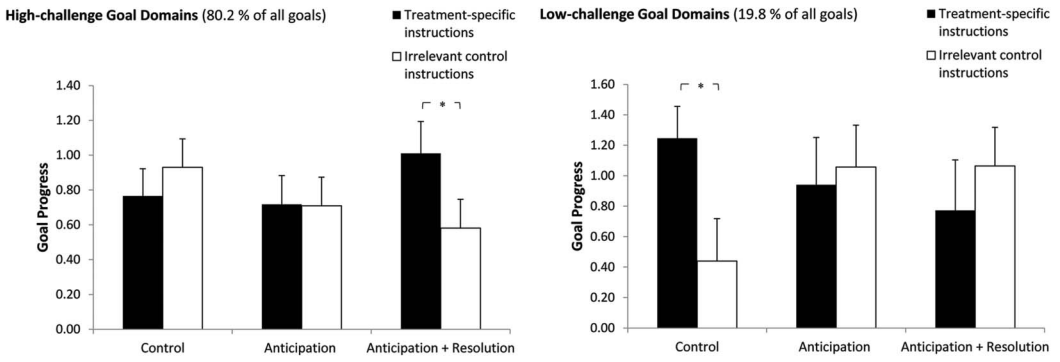

Figure 1. Daily goal progress for high-challenge goal domains (left panel) and low-challenge goal domains (right panel) by treatment condition and instruction type.

which they received no instructions as compared to irrelevant goal questions, $b = .81$, $p = .013$ (see Figure 1, lower panel). No significant such effect emerged for the A condition, $b = -.12$, $p = .766$, or for the A + R condition, $b = -.29$, $p = .461$.[3]

The Role of Regulatory Mode

To study whether regulatory mode moderates how much progress people in the A + R condition actually made when facing challenging goal domains (H_3), we ran a multilevel regression analysis of progress within the subset of high-challenge goal domains, entering type of goal instruction as a within factor, locomotion and assessment tendency as grand-centered predictors, and all interactions among these as predictor variables. As Table 4 shows, locomotion tendency showed a significant main effect only, $B = 0.90$, $p < .001$, such that people higher in locomotion tendency made more progress overall. By contrast, assessment tendency had a marginally (though not fully significant) negative main effect, indicating somewhat lower rates of progress overall for those high in assessment tendency, $B = -0.26$, $p = .096$.

In support of H_3, assessment moderated the magnitude of the treatment effect, $B = 0.50$, $p = .045$ (see Table 4).[4] As Figure 2 shows, whereas low-assessment individuals did not profit from the treatment-specific instructions to anticipate obstacles and think about how to resolve them, high-assessment individuals made far more progress on those goals for which A + R instructions were provided as compared w goals for which they were not provided. This finding is important because it indicates the effects of our (overall successful) treatment may be more pronounced among those individuals who have a tendency to deliberate on their goal pursuit rather than jump into action.

Downstream Effects on Daily Happiness, Stress, and Exhaustion

In support of H_4, a multilevel analysis of happiness, assessed with the nightly diary, showed a significant overall treatment effect, $F(2, 103) = 3.28$, $p = .042$. The means are displayed in Figure 3. More focused comparisons revealed that participants in the A + R condition reported significantly higher levels of

[3] Although we did not predict asking irrelevant questions would decrease the tendency to act on low-challenge goals relative to asking no questions (we did not have any prediction for low-challenge goals), we note that asking irrelevant questions about some of participants' goals (e.g., "What made you think of this goal?") but not about others was sufficient to lower progress on the former goals. In response to questions about the context that reminded participants of the goal (vs. no questions), participants might have construed these low-priority goal as externally imposed, and therefore, they were more likely to reject them. For example, participants in the control condition who listed social media as a low-challenge goal may have concluded (in response to our questions on context) that contextual cues impose that goal, which reduced their motivation. We note, however, that the low number of observations in low-challenging goal domains makes us cautious in over-interpreting this effect.

[4] Supplementary analyses showed that neither locomotion nor assessment reliably moderated the effect of instruction type in the anticipation or control conditions.

Table 4
Multilevel Regression Results Predicting Goal Progress in High-Challenge Domains in the Focal A + R Treatment Condition From Type of Instruction (0 = Irrelevant; 1 = Treatment-Specific), and Grand-Centered Individual Differences in Locomotion and Assessment Tendencies

Effect	Numerator (*df*)	Denominator (*df*)	*F*	*p*
Intercept	1	412	45.75	<.001
Type of instruction	1	412	4.27	.039
Locomotion	1	412	25.79	<.001
Assessment	1	412	.01	.939
Locomotion × Assessment	1	412	1.83	.177
Locomotion × Type of Instruction	1	412	.07	.786
Assessment × Type of Instruction	1	412	4.05	.045
Locomotion × Assessment × Type of Instruction	1	412	.24	.622

Regression parameter	*B*	*SE*	*df*	*t*	*p*
Intercept	.47	.13	412	3.66	<.001
Type of instruction	.41	.20	412	2.07	.039
Locomotion	.90	.20	412	4.49	<.001
Assessment	−.26	.16	412	−1.67	.096
Locomotion × Assessment	−.14	.19	412	−.74	.460
Locomotion × Type of Instruction	−.09	.34	412	−.27	.786
Assessment × Type of Instruction	.50	.25	412	2.01	.045
Locomotion × Assessment × Type of Instruction	−.16	.32	412	−.49	.622

happiness at the end of the day than those in the control condition, $b = .63$, $p = .018$, and in the A condition, $b = .53$, $p = .049$, whereas participants in the control and A conditions did not differ in daily happiness, $b = .09$, $p = .712$.[5] We found no effect of treatment condition on daily levels of stress, $F(2, 98) = 1.45$, $p = .240$, or exhaustion, $F(2, 102) = 0.97$, $p = .384$.

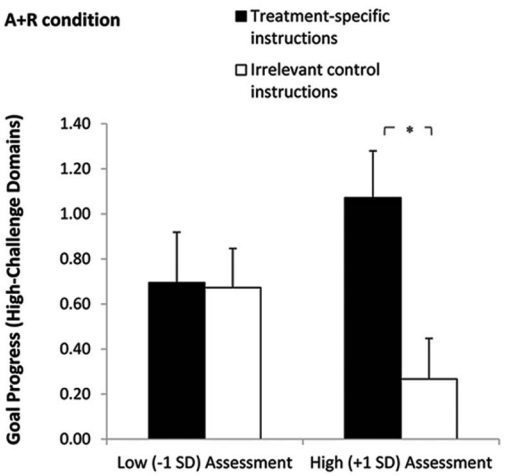

Figure 2. Moderator effect regulatory mode. The graph shows mean progress levels on challenging goal domains for individuals low (−1 *SD*) versus high (+1 *SD*) in assessment tendency in the A + R condition. Those high in assessment profited particularly from treatment-specific instructions to anticipate obstacles to daily goal pursuits and to think about how to resolve them.

General Discussion

Applying a basic psychological theory of self-control to field settings, we reported the results of a smartphone intervention designed to nudge people into better goal progress in their daily lives. Self-control theory posits that both identifying temptation and responding to it are necessary phases for success at goal pursuit (Fishbach & Converse, 2010; Hofmann et al.,

[5] A supplementary multilevel analysis showed that including daily aggregated goal progress for treatment-specific goals and treatment-unspecific goals and their interaction with treatment group reduced the overall group effect to nonsignificance, $F(2, 98) = .1.90$, $p = .156$. Visual inspection of the regression effects revealed that the effect of treatment-specific goal progress on happiness ($B = .30$, $p = .001$) in the A + R group was larger than the effect of treatment-unspecific goal progress on happiness ($B = .10$, $p = .299$). Whereas these results should not be over-interpreted due to the aggregated nature of analyses and loss of data (for days on which both progress scores could not be computed), this supplementary analysis may suggest that goal progress on those goals that were in the focus of the intervention may partly mediate the above treatment effect on daily happiness.

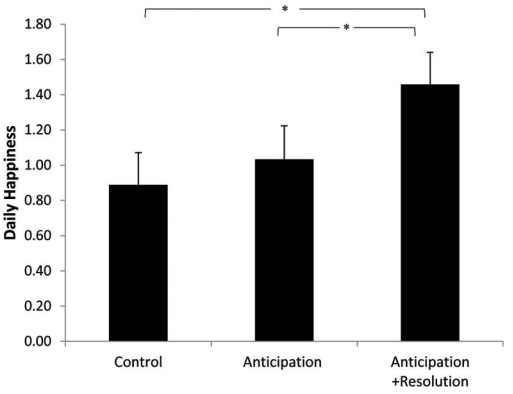

Figure 3. Average daily happiness, assessed at the end of the day, in the three treatment conditions. Errors indicate standard errors.

2012). Accordingly, our intervention encourages people to list their goals, anticipate obstacle/temptation, and plan resolution. Results showed that the "A + R" treatment condition reported better success on those goals for which we nudged them to "anticipate and resolve" compared to other (control) goals (H_{1a}). We found no such treatment effect on goal progress in the anticipation-only condition or in the control condition (H_{1b}). This finding suggests that both elements (anticipating obstacles *and* planning their resolution) need to come together if beneficial effects on goal progress are to be expected.

We further identified several boundary conditions. First, our intervention helps in the pursuit of challenging goals, which, by definition, rely more on the exercise of self-control than do low-challenge goals (H_2). For example, our intervention can assist people in finishing a project at work, but it makes little difference in the execution of leisure plans. Second, our intervention most helps those who are predisposed to assess their actions prior to executing them ("assessors"; Kruglanski et al., 2000), and has a lower impact on those who are low on assessment (H_3). We attribute this result to the timing of our intervention, which operates in the planning process that is most involving for high assessors. Alternatively, it is also possible that high assessors are most in need of a specific plan for action. Although planning is essential for effective self-regulation, high assessors are higher in anxiety and a tendency to ruminate, and are more likely to get "stuck" in goal pursuit or fail to commit, hence they can benefit from our intervention.

Moreover, our intervention has the potential to improve well-being. Participants in the A + R condition reported the highest levels of happiness among all three conditions, and their happiness was predicted by the progress on high challenging goals. This suggests that our manipulation not only affected goal progress, but also had positive downstream affective consequences (H_4). We further do not find that our strategy saps more resources or imposes substantially higher levels of stress on people (absent a depletion effect), which suggests minimal costs. By using subjective and generic goal-progress measures, we were able to assess progress on a broad spectrum of everyday goals, including work-related, health, and financial goals, and we did not find substantial differences among these high-challenge goal domains. On the downside, self-report measures of progress may only partially reflect actual progress. We nonetheless find the self-report measures appropriate for evaluating our intervention, because participants could not intuit when to expect greater progress and thus when to be more likely to report progress on these goals to confirm their expectations. Specifically, we predicted greater progress on goals for which participants listed temptation/obstacles and resolutions, as long as these were high-challenging goals, and this is not an intuitive prediction for participants.

Of further note, our treatment effects appeared to be goal-specific: Manipulating the instructions within participants, we found a positive impact only on those goals for which people listed obstacles plus resolutions compared with their other goals (H_1), which suggests that people were not generalizing the instructions to their other goals. It is possible that people may have even been balancing goals (Fishbach & Dhar, 2005) or licensing themselves (Monin & Miller, 2001; Mullen & Monin, 2015). That is, they may have focused on some goals while taking resources away from others, based on our instructions. The specific effect on treatment goals leads us to consider implications of this research to the transfer-of-training problem—the problem of transferring learning and practice into one's everyday context. Whereas we do not find generalization within the 1-week

experiment to noninstructed goals, people may still transfer their learning to other goals after the intervention is over. We believe our intervention has high transfer potential because it occurs in a naturalistic context—the same context in which people pursue their personal goals. Future research could test this potential implication for transferring learning beyond the immediate intervention context.

Naturally, this study is not without limitations. Beyond our use of subjective progress measures, we chose to test people over a period of one week and assess their daily goals, and thus we cannot evaluate the effectiveness of our intervention beyond this 1-week period and for broader and more major goals. For example, whereas our intervention helped people finish their daily tasks at work, we cannot evaluate its impact on completion of quarterly projects at work. In addition, we have some evidence that our questions may alter the ways people think about their goals beyond exercising self-control. In particular, we find that asking irrelevant questions discouraged pursuit of low-challenge goals in the control condition compared to asking no questions, most likely because these questions acknowledge potential social pressure to indulge in temptation.

Relationship With Existing Research

Our results validate previous work on self-control, suggesting that identification and resolution are two stages in the self-control process (Fishbach & Converse, 2010; Myrseth & Fishbach, 2009). In addition, these results are consistent with previous research on mental contrasting and implementation intentions (MCII; Duckworth, Kirby, Gollwitzer, & Oettingen, 2013; Stadler, Oettingen, & Gollwitzer, 2010), which developed an intervention to improve self-regulation by having people contrast their current state with an ideal state and to generate implementation intentions in the form of if-then plans for how to achieve a goal (i.e., "If situation XX is encountered, then I will perform the goal-directed response YY").

Beyond the similarities, it is worth noting that MCII research is prescriptive; it offers a specific training to achieve success. Our self-control research, in contrast, explores more broadly whether anticipating an obstacle and planning a resolution (the two stages of self-control) can be prompted externally to nudge people to exercise self-control. Thus, we do not offer a specific prescription for how to generate obstacles and resolutions. Indeed, because we did not direct people to generate implementation intentions, we did not see much evidence for spontaneous generation of implementation intentions (in an "if-then" format). Hence, absent of specific training, people do not appear to spontaneously generate such intentions. Instead, our intervention nudges people to exercise self-control in a broad sense and without telling them exactly how to do it. We conclude that nudging people to exercise self-control can be effective, even if they do not engage in a specific prescribed self-regulatory intervention.

Conclusion

Our results demonstrate how basic self-control theory can be applied to assist people's daily goal pursuits, with particular implications for the regulation of challenging goals. Our intervention is highly feasible; we obtained very satisfactory technical validation parameters including a satisfactory response rate, a short median response delay, and very high survey-completion rates. Together, these data give rise to cautious optimism about the relatively high degree of adherence to smartphone interventions of this sort. We therefore hope the present results may open the door for similar theory-driven smartphone interventions that gauge the effects of basic motivational mechanisms on everyday behavior.

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