

Can Implementation Intentions and Text Messages Promote Brisk Walking? A Randomized Trial

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Objective: To test the efficacy in promoting brisk walking of two theory-based interventions that incorporate implementation intentions and text message (Short Message Service; SMS) reminders directed at one's walking-related plans or goals. **Design:** Participants ($N = 149$) were randomized to one of three conditions (implementation intention + SMS plan reminder, implementation intention + SMS goal reminder, control) before completing measures at baseline and follow-up 4 weeks later. At follow-up, the experimental groups were given a surprise recall task concerning their plans. All participants completed an equivalent goal recall task. **Main Outcome Measures:** Validated self-report measures of physical activity and measures of implementation intention and goal recall, weight, and waist-to-hip ratio. **Results:** Both intervention groups increased their brisk walking relative to the control group, without reducing other physical activity. The goal reminder group lost the most weight. The SMS plan reminder group recalled more of their plans than the SMS goal reminder group, but the latter were more successful in goal recall. **Conclusion:** Both interventions can promote brisk walking in sedentary populations. Text messages aid the recall of, and could enhance interventions that target, implementation intentions and goals.

Keywords: United Kingdom, implementation intentions, text messages, randomized controlled trial, physical activity

Being physically active through behaviors that include brisk walking (Manson et al., 2002) is associated with potential health (e.g., Kohl, 2001) and psychological (e.g., Brownley et al., 2003) benefits. Consequently, guidelines across the world tend to recommend at least 30 min of moderate physical activity on most days of the week (e.g., U.K. Department of Health, 2004). However, many adults in Europe (Office for National Statistics, 2006b) and the United States (U.S. Department of Health and Human Services, 1996) have sedentary lifestyles and fail to meet these or similar guidelines. There is a need, therefore, to develop effective interventions that can be delivered efficiently across large populations. In this article, we present a test of two technology-based minimal interventions that attempt to promote brisk walking in individuals who were not meeting physical activity guidelines before intervention.

Theoretical Basis

Ample literature has shown the so-called “intention–behavior gap” whereby individuals fail to enact behaviors de-

spite holding positive intentions (e.g., Sheeran, 2002). Sheeran, Milne, Webb, and Gollwitzer (2005) argued that failing to supplement one's intentions (e.g., to walk briskly) along with details regarding when, where, and how the intention can be fulfilled (e.g., “Every weekday morning at 8:30 a.m., I will leave my house and walk briskly to work”) contributes to intention–behavior discrepancies. Gollwitzer's (1993) implementation intentions deal directly with this issue by requiring individuals to decide in advance of action when and where they will act. Implementation intentions have been proposed to influence behavior by first increasing the accessibility of the mental representation of the anticipated environmental cue (leaving the house on weekday mornings at 8:30 a.m.) so that fewer good opportunities to act pass by unnoticed (see Aarts, Dijksterhuis, & Midden, 1999). Second, implementation intentions strengthen the link between the planned situation (leaving the house) and the goal-directed response (walking to work) such that behavior is more likely to be initiated on encountering the planned situation (see Webb & Sheeran, 2007).

Because some studies have reported null effects of implementation intentions, strategies to enhance their efficacy need to be tested. Prestwich, Perugini, and Hurling (2009) have demonstrated that pairing implementation intentions with text messages strengthens their effects on physical activity; however, because the type of text message (plan vs. goal reminders) that participants received was not manipulated, which type of reminder would be the most effective is not clear. When paired with implementation intentions, reminders of one's plans or

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goals underlying the particular behavior are likely to be effective in changing behavior.

Plan reminders should further increase the accessibility of the environmental cue (because the individual is reminded of this cue), prompt an individual to implement his or her plan (because the individual is reminded of the association between the cue and the desired action), or both. This is consistent with the role of cues to action in the health belief model (e.g., Strecher & Rosenstock, 1997) as an important modifying factor influencing the likelihood of enacting health behaviors. Literature on automaticity (e.g., Aarts & Dijksterhuis, 2003) would suggest that text message reminders of one's goals can also facilitate action via environmental cues. In the Kruglanski et al. (2002, p. 333) theory of goal systems, "goal systems consist of mentally represented networks wherein goals may be cognitively associated to their corresponding means of attainment and to alternative goals" and "typically, facilitative links may exist . . . between goals and their corresponding means." Text message reminders of one's reasons (goals) for performing a behavior should strengthen the link between goals and behavioral intentions (and their associated plans) within a mental hierarchy (see Kruglanski et al., 2002; Prestwich, Perugini, & Hurling, 2008b). Thus, text reminders of one's goals, after implementation intention formation, should prompt intention activation and the associated plans via the cognitive hierarchical structure. When brought to mind at an opportune moment, intentions should be particularly predictive of behavior (e.g., Cooke & Sheeran, 2004). Moreover, activating one's goals in conjunction with an implementation intention has been shown to be useful in changing health behavior (Prestwich, Ayres, & Lawton, 2008). Recent evidence has shown that the mechanisms underlying the influence of implementation intentions and goal activation are separable and that both contribute additively to action execution (Miles & Proctor, 2008). In the context of this article, this might suggest that reminder cues of one's own plans and of one's underlying goals can both increase the likelihood of action execution and do so via relatively independent mechanisms.

Technology and Health Behavior Change

Using technology such as the Internet or cell phones to deliver behavioral interventions has a number of benefits. The use of cell phones in young adults is widespread (Office for National Statistics, 2006a) and represents a means through which health behavior can be influenced at any time without the need for face-to-face interaction.

Recently, van den Berg, Schoones, and Vliet Vlieland (2007) identified 10 randomized controlled trials that used the Internet to try to change physical activity. Of these trials, three tested the efficacy of an Internet-based intervention against a waiting list or attention-control group, and two of these three studies achieved greater behavior change with the Internet-based strategy.

Further evidence has shown that a combined Internet and cell phone-based intervention, consisting of tailored feedback, tailored solutions to perceived barriers, motivational tips, self-monitoring, and implementation intentions with SMS text message reminders, significantly increased physical activity relative to a control group (Hurling et al., 2007). Although

effective, the number of techniques used in the intervention made it unclear which components are effective. A study by Prestwich et al. (2009) suggested that pairing implementation intentions with text messages represents a key intervention component and consequently that SMS text messages could be useful reminders when paired with plans.

Prestwich et al. (2009) randomly allocated participants to one of five conditions (implementation intention + SMS, implementation intention only, SMS only, or one of two control groups). The group in the implementation intention + SMS condition reported the greatest increases in exercise behavior, whereas neither implementation-intention-only nor SMS-only conditions were effective. In the SMS groups, participants were required to receive text messages, but they were free to choose their own message content. However, it was suggested that they might choose to be reminded of their plans. The participants who received these text reminders of their plans increased their exercise more than those who chose different messages. However, without a direct experimental manipulation of the type of message received by those forming implementation intentions, it is difficult to make firm conclusions. First, the participants who followed the request to have texts reminding them of their plans might have been different (e.g., more motivated) than those who did not. Second, text messages cuing implementation intentions were compared with any other type of text message, not just those cuing one's exercise goals. Therefore, whether text messages cuing one's plans are more effective than texts cuing one's goals is not clear. A third limitation, as with many of the studies included in Gollwitzer and Sheeran's (2006) review of implementation intentions, is that key study personnel were not made unaware of condition using mechanisms such as sealed envelopes. Methodological limitations regarding blinding, along with insufficient details regarding randomization and concealment methods, compromise any conclusions regarding implementation intention effectiveness, and some recent rigorous trials have reported null effects (e.g., Rutter, Steadman, & Quine, 2006). Further rigorous tests are needed. Here, we address these issues through a methodologically rigorous test of implementation intention-based interventions. In this trial, we compared interventions incorporating implementation intentions and either text message reminders of plans or brisk walking goals with simply asking a control group to try to meet governmental physical activity guidelines.

Summary and Objectives

Recent evidence has suggested that pairing an implementation intention with reminders delivered by means of text messages (SMS) is more effective than either implementation intentions or SMS alone or no intervention (Prestwich et al., 2009); however, whether the benefits of these interventions vary because of the specific content of the SMS (plans vs. goals) is unclear. Reminders of implementation intentions might make it more likely that the plan is mentally accessible and thus usable (Prestwich et al., 2009). Because of the fusion of goals and means within a mental represented network (Kruglanski et al., 2002), goal reminders should activate the means through which they can be achieved (i.e., behavioral intentions, implementation intentions, or both).

Our primary objective was to test whether interventions that paired implementation intentions with text messages cuing plans or goals increased brisk walking in a student-based sample. Effective strategies promoting physical activity in university students are important because at this stage of life, most students have often just moved from a period of structured and supervised exercise in the form of physical education classes at school. A secondary objective was to check whether any increase in walking arising from the manipulation had a negative compensatory effect on other physical activity. Additionally, we tested whether text reminders of plans and goals aided participants' recall in a surprise recall task at follow-up. If text reminders strengthen the mentally represented association between the stimulus and response, those receiving text reminders of one's plans should be more successful in their recall of plans.

Participants who formed implementation intentions and were reminded of either their plans or their goals should increase their brisk or fast walking (Hypothesis 1) and physical activity (of at least moderate intensity; Hypothesis 2), lose weight (Hypothesis 3a), and reduce their waist-to-hip ratio (Hypothesis 3b) significantly more than those in the control group. Moreover, those in the plan reminder condition should recall their plans significantly more than those in the goal reminder condition (Hypothesis 4), and those in the goal reminder condition should recall their goals significantly more than those in the plan reminder or control groups (Hypothesis 5). Although we did not hypothesize differences between the plan reminder and goal reminder conditions in brisk walking and physical activity, we explored such differences.

Method

Recruitment

Participants were recruited between January 15, 2007, and February 2, 2007, and completed follow-up measures 4 weeks after baseline. All participants were recruited using an e-mail distributed to a participant database that outlined the eligibility criteria and described the study as concerning attitudes and behavior relating to walking. Participants were required to exercise less than three times per week (including brisk walking), not have a medical condition that prevented them from walking briskly, own a cell phone, and be able to attend a second (follow-up) session exactly 4 weeks after their first session. Research Staff Member 4 screened the participants. The list of eligible participants was then forwarded to another research staff member (Research Staff Member 3). Participants received £15 (\$24.74) each or course credit.

Sample

We calculated required sample sizes a priori to detect a difference in activity between a group forming implementation intentions benefiting from SMS and a group forming implementation intentions not benefiting from SMS ($d = 0.59$; see Prestwich et al., 2009) at $p < .05$, with 80% power and, based on our experience with similar trials, allowing 5%–10% dropout. We thus recruited 149 volunteers (144 students, 4 nonstudents, 1 missing data; 54 men, 95 women; mean age = 23.44 years, $SD = 5.63$ years).

Randomization

Participants were randomized to one of three groups (implementation intention + SMS plan, implementation intention + SMS goal, control) and completed measures of walking at baseline and 4 weeks follow-up. An allocation sequence, based on complete randomization (nonblocked, nonstratified) with no restrictions, was prepared by Research Staff Member 1 using a computer-generated randomization program. On the basis of this allocation sequence, Research Staff Member 2 placed the relevant study materials in a series of numbered and sealed envelopes. These envelopes were passed to Research Staff Member 3, who met with the participants. Participants opened the envelopes in individual cubicles away from research staff. On completion of the study materials, participants sealed their completed measures in other envelopes. Consequently, Research Staff Member 3 was unaware of condition during the testing phase.

All participants were asked, in writing, to try to be active (as defined by governmental guidelines). Furthermore, to minimize the risk of contaminating the experimental manipulations, the need to refrain from communicating with other people about the study was stressed to all participants. Participants (by not discussing the trial with others), those entering the data (Research Staff Members 5 and 6, by receiving only the dependent measures), and the data analyst (Research Staff Member 7, by receiving information regarding the study groups coded by number rather than name) were unaware of condition.

Manipulations (Interventions)

Each manipulation (and the information given to the control group) was presented as written text after the baseline measures were completed. The control group received no text messages and was not required to form implementation intentions. However, as with all other participants, they provided their cell phone number and were informed of the current governmental guidelines for physical activity (30 min/day of at least moderate-intensity physical activity 5 or more days of the week) and the benefits of meeting these guidelines. Furthermore, they were told they did not meet these guidelines. Brisk walking was suggested as a good means to help them reach these targets, and they were then explicitly asked to try to walk for at least 30 min on 5 or more days per week (in bouts of at least 10 min).

Implementation Intention + Plan Reminder

Participants in this condition received the same text as the control group. Additionally, they were informed that it can be "helpful to *make very specific plans* regarding how you will walk briskly five times per week *and receive text message reminders of these plans.*" They were also told that they were free to choose the situations in which to walk that would be easy, convenient, or enjoyable for them, and they were able to decide when they would receive text message reminders of these plans.

Participants were then required to complete a task to help them form plans to help them to walk five times per week. They were required to think about when and where would be the most

convenient or enjoyable for them to walk 30 min per day for 5 days per week in bouts of at least 10 min, provided with suitable examples, and asked to write this plan in the form “When I’m in situation X, then I will do Y.” Participants were asked whether their plans identified enough situations to enable them to walk five times per week (30 min/day in bouts of at least 10 min). If they answered no, they were requested to formulate additional plans and were provided with space to do so. They then stated the day(s) and time(s) when they would like to receive text message reminders of these plans. They were required to receive at least one text message reminder of each plan. Finally, participants had to note down a username and password that would enable them, if they desired, to log onto a website to change the content of the text message reminders, the number of text message reminders they would receive, or when these text messages would be delivered. They also wrote down their username and password on a tear-off slip of paper that noted the website address and kept this sheet of paper. Unless the participants logged in to stop their text message reminders, they were sent text messages over each of the 4 weeks.

Implementation Intention + Goal Reminder

The manipulation received by this group was exactly the same as that presented to those in the implementation intention + plan reminder condition with the following difference. Although participants were requested to formulate implementation intentions, they did not receive reminders of these plans. Instead, they were informed that it would be helpful to receive reminders of their brisk walking goal. They were subsequently required to decide the days and times when they would receive these text message reminders. The participants in this condition could also log into the system to change the content of the text message reminders, the number of text message reminders they would receive, or when these text messages were delivered, and they received text messages for the full 4-week period.

Measurement of Outcomes

All self-report measures were completed in individual cubicles in the laboratory. Participants’ physiological measures were taken in the laboratory. Participants in each condition completed the behavior measure premanipulation and at the 4-week follow-up. The physiological measures were also taken at baseline and follow-up. Participants also completed a range of psychosocial measures from the extended model of goal-directed behavior (Perugini & Conner, 2000). On these measures, all participants were required to identify one goal that would best explain their walking briskly for 5 days per week over the next 4 weeks. These measures are not discussed further.

Primary outcome measure. A self-report index of walking was taken from Prestwich, Perugini, and Hurling’s (2008a) validated Self-Report Walking and Exercise Tables (SWET) measure. The SWET demonstrated the best predictive validity (distance traveled, $r = .52$; number of steps recorded, $r = .48$), in relation to physical activity recorded by a validated pedometer (Yamax SW-200, Great Performance Limited, London), out of nine measures of physical activity such as the Godin scale (Godin & Shepherd, 1985; average $r = .42$ across the two criterion out-

comes), short-version International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003; average $r = .43$), and 7-day Physical Activity Recall (PAR) (Sallis et al., 1985; average $r = .07$). The Yamax pedometer range has consistently performed favorably against other available pedometers (e.g., Schneider, Crouter, & Bassett, 2004; Schneider, Crouter, Lukajic, & Bassett, 2003) and has been used to validate other pedometers (De Cocker, Cardon, & Bourdeaudhuij, 2006). The SWET was also less likely than some alternatives (e.g., Lifestyle Walking Questionnaire (LWQ); Stovitz, Van Wormer, Center, & Bremer, 2005) to produce missing data.

The walking subscale of the SWET requires participants to note in a table their walks during the past week; the days on which they took these walks, the duration of each walk, and the speed of each walk (categorized as a = slow pace [i.e., less than 3 mph], b = steady average pace, c = brisk pace, d = fast pace [i.e., more than 4 mph]). In line with the main aim of the research, the frequency of brisk walking was added to the frequency of fast walking to generate an index of walking frequency. In line with government guidelines and the aims of the study, from this table the number of days in a week on which a participant did brisk or fast walking for 30 min or more (in bouts of at least 10 min) was calculated and represented the primary outcome. In the same validation study described earlier (Prestwich et al., 2008a), the SWET’s walking subscale also demonstrated predictive validity (being significantly correlated with distance traveled, $r = .44$, and number of steps recorded, $r = .39$).

Secondary outcome measures. Total physical activity was assessed using the full version of the SWET. The full version involves both the walking submeasure and a second table pertaining to nonwalking physical activity. In this table, participants were required to note nonwalking physical exercise, the days on which they did this exercise, and the duration of each exercise session (in minutes) during the past week. Similar to the primary outcome, the secondary outcome reflected the number of days on which participants exercised (including brisk and fast walking) for at least 30 min (in bouts of at least 10 min). By measuring this, we could determine whether any increase in brisk or fast walking occurred at the expense of other exercise.

Physiological outcomes, although not necessarily indicative of physical activity, were recorded because of their association with health outcomes. Participants’ height, weight, waist size, and hip size were measured by Research Staff Member 3, who was unaware of condition. From these measures, body mass index (BMI) and waist-to-hip ratio (WHR) were calculated. When participants’ height was measured, participants removed their shoes and stood straight, feet together, flush against a wall chart. A pen was then placed horizontally on the participants’ head to obtain the height reading. Participants then emptied their pockets and removed any excess clothing (e.g., sweat-shirt), and their weight and waist and hip size were measured. With their shoes still removed, participants stood still on an electronic scale until a steady reading was shown to assess their weight. Their waist and hip size were then recorded using a tailor’s tape measure while the participants stood, feet together, with the readings taken at the narrowest (waist) and widest (hips) points. All measures were taken once by a researcher trained beforehand by another researcher experienced in taking these physiological measures. No steps were taken to verify the

accuracy of the measures (e.g., a percentage of measures taken by a second researcher and the results compared). However, the researcher was unaware of condition and thus any error in the measures should not have differed across the three conditions.

At 4-week follow-up, participants were given a surprise recall task. Participants in the implementation intention groups were required to list all of the implementation intentions that they had formed 4 weeks ago. Written instructions informed the participants that they should do this without looking at their phone. For each plan that they formed, up to 0.50 point was awarded for correctly recalling the planned situation and 0.50 points was awarded for correctly recalling the planned response (0.25 point was awarded when the response was partly correct; e.g., Monday morning in my house vs. Monday morning at work). Failing to recall the plan entirely or writing new plans at the 4-week follow-up (Time 2) were each scored as zero for that particular plan. These series of scores for each plan were then mean averaged to produce an index reflecting the degree of implementation intention recall. This ranged from 0 (*no recall of any plan*) to 1 (*full recall of all plans*). We chose this points system because it was more precise, and thus more powerful, than the alternatives (dropping the 0.25-point aspect or coding each plan simply in terms of whether the participants successfully recalled the full plan [situation and response or neither]). All participants were asked to try to recall their brisk walking goal. Each participant's goal recall was scored as 0 (*did not recall their goal*) or 1 (*did recall their goal*). Two independent raters showed almost perfect agreement on both measures (goal recall, $\kappa = .95$; plan recall, $r = .93$), and any discrepancies were resolved before analysis.

Statistical Methods

All of the analyses conducted are reported henceforth. We used analysis of variance and chi-square to examine differences between those completing the study and those who did not and baseline differences between the three conditions. We used analysis of covariance to test the effects of the interventions on increasing brisk or fast walking during the intervention period, using condition (implementation intention + plan reminder, implementation intention + goal reminder, control) as the between-subjects independent variable and brisk or fast walking at baseline as the covariate. This analysis was repeated with the secondary outcomes (number of days meeting physical activity guidelines, weight, WHR). We used *t* tests and chi-square to compare the groups on implementation intention and goal recall, respectively. Effect sizes (*d* or phi) are reported for significant primary and secondary outcomes. Within-groups *t* tests reflecting change in the outcomes between Time 1 (T1) and Time 2 (T2) are denoted in Table 1 (see Δt columns).

Results

We did not exclude participants for withdrawal from treatment or poor adherence to trial protocol. Concerning the latter point, of the 99 participants required to form implementation intentions, six deviated from the protocol by incorrectly forming at least one implementation intention (i.e., identifying a situation and relevant action) but were still included in the main analyses. Of these, three failed to correctly form any implementation intention concerning their brisk walking (consequently, these three participants were omitted from analysis concern-

Table 1
Pre- and Postintervention Primary and Secondary Outcome Means (and Standard Deviations)

Condition	No. days per week walked briskly/fast for ≥ 30 min			No. days exercised (including brisk/fast walking for ≥ 30 min)			Weight (kg)			Waist-to-hip ratio			Recall		
	T1	T2	Δt	T1	T2	Δt	T1	T2	Δt	T1	T2	Δt	Plans	Goals	
Implementation intention + plan reminder (n = 40)	0.60 (0.96)	1.98 (1.75)	4.54**	1.18 (1.32)	3.13 (1.57)	5.91**	66.12 ^a (12.88)	66.22 ^a (12.81)	-0.51	.788 ^a (.050)	.775 ^a (.050)	2.70*	.72 (.25)	19/40 (48%)	
Implementation intention + goal reminder (n = 48)	0.56 (1.37)	1.98 (2.04)	3.94**	1.04 ^b (1.61)	2.81 ^b (1.96)	4.45**	67.66 ^c (14.09)	67.12 ^c (13.91)	2.65*	.795 ^c (.076)	.781 ^c (.069)	2.90*	.39 ^d (.33)	39/46 (85%)	
Control (n = 46)	0.70 (1.17)	1.17 (1.58)	1.96 [†]	1.34 ^b (1.52)	2.28 ^b (1.99)	4.06**	66.07 ^c (14.25)	65.93 ^c (14.10)	0.78	.792 ^c (.067)	.780 ^c (.069)	2.91*	—	30/45 (67%)	
Total	0.62 (1.18)	1.70 (1.83)		1.19 (1.49)	2.72 (1.88)		66.64 (13.72)	66.44 (13.57)		.792 (.065)	.779 (.064)		.54 (.34)	88/131 (67%)	

Note. T1 = Time 1; T2 = Time 2.
^a n = 42. ^b n = 47. ^c n = 49. ^d n = 46.
[†] p < .10. * p < .05. ** p < .001.

ing implementation intention recall but were included in all other analyses). Four participants failed to specify a day and time to receive their text message reminders but were still included in the analysis. On each dependent variable, six participants' responses could not be coded into the number of days on which they walked or exercised for at least 30 min because of incomplete data. Nine participants were lost to follow-up, reflecting a dropout rate of 6%. Two-tailed p values are reported throughout.

Those remaining in the study and those who dropped out did not differ in terms of their BMI, $F(1, 146) = 1.52, p = .22$, and WHR, $F(1, 146) = 1.57, p = .21$, nor was there differential dropout across sexes, $\chi^2(1) = 0.82, p = .37$. However, the participants who dropped out of the study walked marginally more, primary outcome: $F(1, 145) = 2.75, p = .099, M = 1.33$ versus $M = 0.63$, and exercised more, secondary outcome: $F(1, 145) = 4.40, p = .04, M = 2.33$ versus $M = 1.21$, at baseline, than those who remained in the study. Nonsmokers (7.9% drop out) were marginally more likely to drop out than smokers (0% dropout), $\chi^2(1) = 2.94, p = .09$.

The rate of drop out, $\chi^2(2) = 3.20, p = .20$, did not vary across the three conditions (implementation intention + plan reminder = 10.6%; implementation intention + goal reminder = 5.8%; control = 2.0%). The flow of the participants through each stage of the study is illustrated in Figure 1.

Baseline Characteristics of the Sample

The baseline characteristics of the participants are summarized in Table 2. Across the three conditions, there were no differences in the primary ($F = 0.05$) or secondary behavioral ($F = 0.55$) outcome variables, BMI ($F = 0.62$), WHR ($F = 0.15$), or age ($F = 1.94$) at baseline (all $ps > .14$), or in the proportion of men and women, $\chi^2(2) = 0.75, p = .69$; smokers, $\chi^2(2) = 3.19, p = .20$; and those receiving financial payment rather than course credit, $\chi^2(2) = 2.20, p = .33$.

On the basis of those who specified at least one day and time to receive their text message, 5.1 texts per week were requested on average. The average number of texts requested did not differ across the experimental groups, $t(93) = 1.30, p = .20$. Within implementation intention condition, 83% of the text messages were requested for the same time as the planned behavior (e.g., planned to walk on Monday morning and requested text message reminders on Mondays at 8:00 a.m.; planned to walk on Tuesdays at 9:00 p.m. and requested text message reminders on Tuesdays at 9:00 p.m.) and 91% of the text messages were requested within 1 hr of the planned walk (e.g., planned to walk on Mondays at 8:00 a.m. and requested reminders on Mondays at 7:30 a.m.).

Change in Brisk or Fast Walking (Primary Outcome)

There was a differential change across groups on the primary outcome, $F(2, 130) = 3.12, p = .048$.¹ Post hoc tests revealed that the implementation intention + plan reminder (vs. control: $p = .04, d = 0.49, 95\% \text{ CI } [0.05, 0.94]$) and the implementation intention + goal reminder (vs. control: $p = .03, d = 0.45, 95\% \text{ CI } [0.04, 0.88]$) conditions increased the number of days on which they met the physical activity daily guidelines, through brisk and fast walking, significantly more than did the control group. Hy-

pothesis 1 was thus supported. Forty-two percent in the goal reminder condition and 45% in the plan reminder condition benefited by at least an increase of 2 days per week (compared with 22% in the control group).

Change in Total Exercise (Secondary Outcome)

The benefits of the amount of brisk or fast walking accrued through implementation intentions paired with text messages did not particularly have a negative impact on other physical activity. Specifically, there was a marginal difference in total physical activity across the three conditions, $F(2, 130) = 2.63, p = .076$.² Post hoc tests indicated that the participants in the implementation intention + plan reminder condition exercised more than those in the control group ($p = .03, d = 0.55; 95\% \text{ CI } [0.12, 1.01]$). There were no differences between the other conditions (both $ps > .12$). There was, therefore, partial support for Hypothesis 2.

Change in Weight and WHR

There was a marginal difference in the change in weight from Time 1 to Time 2 across the three conditions, $F(2, 136) = 2.42, p = .09$. The implementation intention + goal reminder group lost more weight than the implementation intention + plan reminder group ($p = .03, d = .47, 95\% \text{ CI } [0.04, 0.91]$). The main effect was significant when the implementation intention + goal reminder group was compared with the implementation intention + plan reminder and control groups combined, $F(1, 137) = 4.07, p = .046, d = 0.37, 95\% \text{ CI } [0.03, 0.72]$. The implementation intention + goal reminder group lost most weight (on average, 0.53 kg) compared with those in the other conditions (the implementation intention + plan reminder group gained an average of 0.10 kg; the control group lost an average 0.14 kg). There was, therefore, partial support for Hypothesis 3a. There was no differential change across the three conditions in WHR, $F(2, 136) = 0.02, p = .98$. Hypothesis 3b was thus rejected.

Recall of Implementation Intentions and Goals

In a surprise recall task at Time 2, those in the implementation intention + plan reminder condition showed greater plan recall than those in the implementation intention + goal reminder condition, $t(84) = 5.09, p < .001, d = 1.10, 95\% \text{ CI } [0.63, 1.62]$,

¹ The primary outcome was also refined in a second measure on which participants were requested to complete the SWET table on the basis of a typical 7-day period over the past 4 weeks. The results were very similar, $F(2, 121) = 4.01, p = .02$. Both intervention groups reported more change in brisk walking than the control group (both $ps < .05$).

² When these analyses were repeated in regard to the typical 7-day period over the 4 weeks of the intervention period, the effects of the intervention were marginal, $F(2, 117) = 2.30, p = .10$ (implementation intention + plan reminder vs. control, $p = .11$; implementation intention + goal reminder vs. control, $p = .05$).

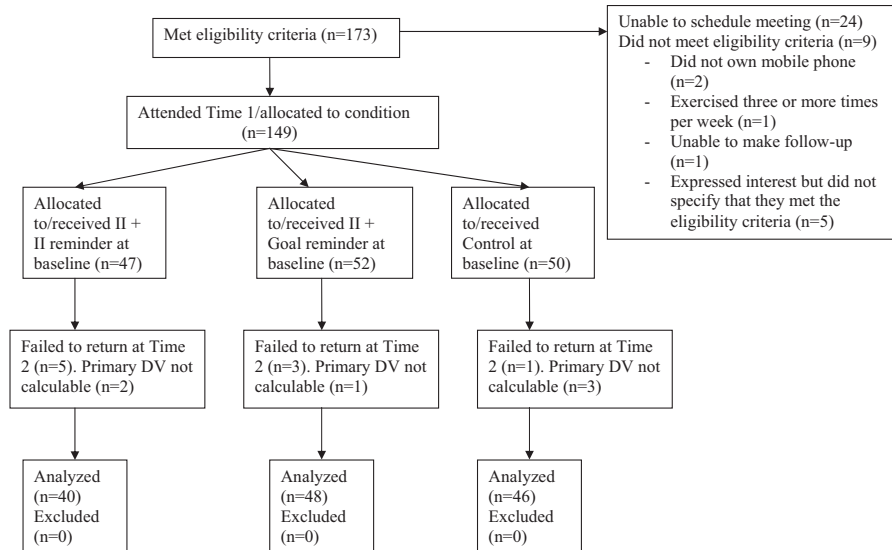


Figure 1. Participant flow chart. II = intention implementation.

supporting Hypothesis 4.³ There were also differences across the three conditions in recall of the goals specified at Time 1, $\chi^2(2) = 13.50, p = .001, \phi = .32$. Goal recall was significantly greater in the implementation intention + goal condition group than in the control, $\chi^2(1) = 4.07, p = .04, \phi = .21$, and implementation intention + plan reminder, $\chi^2(1) = 13.54, p < .001, \phi = .40$, groups, supporting Hypothesis 5. The control group reported marginally greater recall of goals than those in the implementation intention + plan reminder condition, $\chi^2(1) = 3.19, p = .07, \phi = .19$. No adverse events were reported by any member of any of the three groups. There was a significant partial correlation between the implementation intention recall and brisk or fast walking at Time 2 ($r = .22, p = .047$; controlling for brisk or fast walking at Time 1), but no relationship between goal recall and the same outcome measure ($r = -.02, p = .83$) or any of the secondary outcomes.

Discussion

This study provides preliminary evidence that an intervention using physical activity-based text messages and implementation intentions can increase physical activity. Specifically, implementation intentions paired with SMS that either reminded the participants of their brisk walking plans or their reasons for brisk walking significantly increased, relative to a control group, the number of days that a participant self-reported brisk or fast walking for 30 min in bouts of at least 10 min (supporting Hypothesis 1). This was achieved without significant reductions in other types of physical activity of at least moderate intensity (supporting Hypothesis 2). Those receiving text message reminders of their plans did not lose more weight than those in the control group, but those receiving goal reminders did lose more weight (reflecting partial support for Hypothesis 3a). There were no differences across condition in WHR (thus Hypothesis 3b was rejected). Text messages targeting plans or goals aided the recall of plans and goals, respectively (supporting Hypotheses 4 and 5).

The study provides some suggestive evidence that implementation intentions might be incorporated within interventions that signifi-

cantly change health behavior (Gollwitzer & Sheeran, 2006). Moreover, by keeping the experimenter and data analyst unaware of participants' condition, the risk of experimenter or interpretational biases is minimized. The significant effect of an implementation intention-based intervention conflicts in some ways with recent studies, of similar methodological rigor, that conferred no benefit of implementation intentions for health behavior change (e.g., Rutter et al., 2006). However, we should note that the plans were paired with SMS and the primary outcome was based on a (validated) self-report measure. More research concerning efficacy and mechanisms is needed to build on these preliminary findings.

Implementation intention and relapse prevention interventions (Marlatt & Gordon, 1985), also shown to promote physical activity (Belisle, Roskies, & Levesque, 1987), are similar. Both establish action plans that are conditional on anticipated situational events. However, relapse prevention typically focuses on the maintenance of behavior change via action plans contingent on high-risk situations that could disrupt the desired behavior (problem-solving solutions). Implementation intentions typically focus on initiation of change via action plans contingent on critical situations that could enhance the likelihood of enacting the desired action. Future research could test whether combining these two approaches produces an additive change effect.

³ Three participants in the implementation intention + goal reminder condition mistakenly listed their goal instead of a plan and another six participants in this condition listed their goal and part of their plan during the surprise implementation intention recall task. This might have been because participants, in the written instructions for both implementation intention conditions, were requested to not use their cell phones during the recall tasks. Even when the first set of participants ($n = 3$) or the first and second set of participants were excluded ($n = 9$), the effect remained significant, $t(82) = 4.82, p < .001, d = 1.06, 95\% \text{ CI } [0.60 \text{ to } 1.57]$, and $t(76) = 4.23, p < .001, d = 0.97, 95\% \text{ CI } [0.49 \text{ to } 1.50]$, respectively. The effects of plan reminders were also significant on alternative indices of plan recall (see Secondary Outcome Measures section).

Table 2
Means (and Standard Deviations) of Baseline Characteristics Across Conditions

Condition	No. women (men)	Age	% smokers	No. days per week walked briskly/fast for ≥30 min	No. days exercised (including brisk/fast walking) for ≥30 min	Body mass index	Waist-to-hip ratio
Implementation intention + plan reminder (<i>n</i> = 47)	28 (19)	22.19 (5.01)	25.5	0.68 (0.96)	1.40 (1.51)	22.40 (3.60)	.79 (.05)
Implementation intention + goal reminder (<i>n</i> = 52)	33 (19)	24.38 (6.90)	15.4	0.63 (1.52)	1.10 (1.69)	23.23 (3.67)	.79 ^b (.07)
Control (<i>n</i> = 50)	34 (16)	23.62 (4.49)	30.0	0.71 ^a (1.17)	1.35 ^a (1.51)	23.06 (4.28)	.79 (.07)
Total	95 (54)	23.44 (5.63)	23.5	0.67 (1.24)	1.28 (1.57)	22.91 (3.86)	.79 (.07)

^a *n* = 48. ^b *n* = 51.

Without the inclusion of conditions in which participants received only SMS text messages or were asked only to form implementation intentions, it is not possible to determine, solely on the basis of this study, the components of the intervention that caused the significant increase in physical activity. This is a common problem with randomized controlled trials. Health behavior change studies often include multiple techniques and are compared with interventions that lack at least two of the intervention techniques (see Michie, Abraham, Whittington, McAteer, & Gupta, in press). However, previous research has already suggested that both implementation intention and SMS components contribute to experimental effects (Prestwich et al., 2009). This study reinforces the finding that this combined intervention is effective relative to a control using more methodologically robust controls. Moreover, benefits from combining SMS and planning manipulations can be achieved equally by reminding the individual of his or her specific plans or the goals underlying the behavior.

Prestwich et al. (2009) suggested, but did not provide evidence, that text message reminders of implementation intentions might enhance the mechanisms through which implementation intentions change behavior (i.e., the accessibility of the mental representation of the planned situation and the association between the planned situation and response). In the study presented here, text messages aided the recall of implementation intentions, which might reflect that text messages strengthened implementation intentions by improving the accessibility of the plan, strengthening the stimulus–response link, or both. The results are also compatible with additional theoretical mechanisms. Text reminders might act by increasing the likelihood of self-generated thoughts concerning the individual plans or goals (Petty, Ostrom, & Brock, 1981) that in turn could make them more salient and consequently cognitively accessible.

It is important to note that the level of plan recall was significantly correlated with changes in self-reported brisk or fast walking, suggesting that being able to recall one's plan has some importance for behavior change. In this sense, the relatively low rate of recall in the implementation intention + goal condition (i.e., the group without plan reminders) might explain why implementation intentions sometimes do not work. It could also undermine, somewhat, the mechanisms through which implementation intentions change behavior in real-life settings. The studies that have focused on implementation intention mechanisms have been conducted in the laboratory (e.g., Aarts et al., 1999; Webb & Sheeran, 2007), and thus their generalizability to more real-life settings is not clear. If implementation intentions do increase the accessibility of the planned situation and the link between stimulus

and response to the point that it reflects features of automaticity such as immediacy and efficiency (e.g., Brandstätter, Lengfelder, & Gollwitzer, 1997), then people should consistently respond in the same way when encountering the same situational cues. Consequently, recall of their plans should be sound. This does not necessarily appear to be the case. The association between the planned stimulus and response can be strengthened, as indexed by superior recall following relevant reminders.

The effects of pairing implementation intentions with goal reminders also warrant discussion. Participants in this condition reported walking more than the control group and reduced their weight significantly more than the implementation intention + plan reminder group. In light of the latter finding, the consequences of the interventions are unlikely to be determined purely by the formation of implementation intentions. Studies have suggested that goals and intentions are linked (e.g., Kruglanski et al., 2002) and that goals can moderate intention–behavior relations (Prestwich et al., 2008b). Sending text reminders of one's goals at opportune moments should ensure the activation of behavioral intentions and also consequently moderate the likelihood of action (cf. Cooke & Sheeran, 2004). As well as activating intentions to walk briskly, by reminding individuals of their goals text messages might also have activated other behavioral intentions (e.g., to do vigorous activity, to avoid snacks) that promote actions that indirectly influence weight. Moreover, activating behavioral intentions can also have an impact on implementation intentions because research has shown that for them to effect behavior change, they should be supplemented by positive intentions (e.g., Prestwich, Lawton, & Conner, 2003; Sheeran, Webb, & Gollwitzer, 2005).

We should note some limitations. The study primarily used self-reports. However, to reduce the risk of social desirability or demand effects, all participants were asked to meet physical activity guidelines. Furthermore, the behavioral measure has been validated against an objective behavioral measure (i.e., pedometer) in a largely inactive sample that was comparable to the sample recruited in this study. Moreover, Gollwitzer and Sheeran (2006) reported that the effects of implementation intentions are similar when self-report or objective measures are used. We also incorporated physiological measures and achieved significant change in weight although the effect sizes were only small to moderate. The data should be viewed as providing only preliminary evidence for the efficacy of this strategy in changing objectively measured behavior. Although the study was appropriately powered to detect significant differences between groups, the sample size was quite

small and consequently the 95% confidence intervals were quite broad. However, the effect size was similar to that obtained in previous research (Prestwich et al., 2009), and we used a rigorous methodology. The study was powered to detect significant effects rather than to make strong conclusions regarding null effects. Consequently, the nonsignificant difference between the two types of text messages should be considered in light of how the study was powered. The sample consisted mainly of students, thus the generalizability of findings to the general population is unknown.

Promoting brisk walking produces important physiological benefits (e.g., Manson et al., 2002), thus identifying effective interventions, delivered on a wide scale to increase brisk walking, is important. Some of the behavioral changes achieved through our interventions might require further maintenance to accrue measurable physiological change. However, they require fairly minimal intervention and are potentially deliverable without face-to-face interaction.

To summarize, we present a methodologically rigorous test of whether combining implementation intentions with text messages cuing plans or goals can significantly increase brisk walking. This study provides preliminary data supporting the efficacy of both strategies as indexed by a validated, self-report measure, relative to a control group. These interventions were quick to administer. These factors, in combination with the widespread use of cell phones, suggest that this approach could be effective and efficiently administered to a wider population of inactive adults.

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