Testing the effect of text messaging cues to promote physical activity habits: A worksite-based exploratory intervention

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Testing the effect of text messaging cues to promote physical activity habits: a worksite-based exploratory intervention

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This study aims to test the efficacy of text messaging cues (SMS) to promote physical activity (PA) habit formation in the workplace. Employees (N = 49; 28 females and 21 males, Mage = 47.5 ± 8.29 years) were randomized into two parallel groups: a PA group enrolled in a 28-week supervised PA program and a PA+SMS group enrolled in the same PA program with text messaging cues received before their PA sessions. The exercise habit was assessed every week from self-reports on an online application. PA maintenance and several physical fitness measures were also assessed prior to and after the intervention to evaluate its general impact. Mixed model analysis of the 603 observations indicated a small but significant effect of the SMS cues on the speed at which participants engaged in PA behaviors, as the significant interaction effect revealed that the slope of the exercise habit over time was slightly steeper in the PA+SMS group (B = 0.0462, P = 0.0001) than in the PA group (B = 0.0216, P = 0.01). SMS delivery had a marginal effect on the maintenance of PA behaviors 1 year after the intervention. The results suggest that text messaging can help to form PA habits at the workplace and might facilitate long-term maintenance of PA behaviors.

A recent comprehensive literature search for studies on physical activity (PA) in the workplace suggested that this might be a suitable environment for encouraging changes in employees’ health behaviors (Hutchinson & Wilson, 2012), and the authors therefore encouraged further research to determine whether these changes can be maintained over time (Hutchinson & Wilson, 2012). Often, the effectiveness of behavior change interventions is limited because, once the active intervention ends, the short-term gains are lost over the long term (Jeffery et al., 2000). For example, a review of interventions promoting PA showed that only 50% of the participants continued their newly adopted PA behaviors 6 months after the end of intervention (Stiggelbout et al., 2006; Müller-Riemenschneider et al., 2008; Amireault et al., 2013). With this in mind, researchers have tried to determine the predictors of maintained behavior change (e.g., Rothman, 2000) and recent work has identified habits as the main predictor of the maintenance of health behaviors (Rothman et al., 2009; Gardner et al., 2012b).

Although the enactment of behaviors regulated by intention typically requires deliberate effort, habits are thought to be triggered automatically and may thus occur in the absence of awareness, conscious control, mental effort or deliberation (Wood & Neal, 2009). This may explain why habits are particularly adapted to guide behaviors in everyday life, where high cognitive demands (e.g., time pressure, distractions, stress, fatigue) reduce the capacity to act on deliberative processes. Habits are learned associations between responses and features of performance contexts (e.g., locations, preceding actions). Once habits are formed, perception of the contextual cues bring the response to mind (see Neal et al., 2006; Wood & Neal, 2009). Nevertheless, the process of habit formation is long and requires many repetitions of the same behaviors in the same context (Lally & Gardner, 2013). At the cognitive level, habits are procedural knowledge stored in a specific long-term memory system that contains the links between the contextual cues and a specific behavioral response (Dickinson & Balleine, 1995). It is assumed that the success of habit formation depends on the frequency and consistency of contextual cues associated with a behavioral response (Wood & Neal, 2009). A cue is a contextual event (e.g., time of the day, person) that, with repetition, become associated to the behavior. All kinds of contextual cues can trigger the behavioral response.

While many studies have demonstrated the predictive capacity of habit to determine health behaviors such as exercise and PA (Verplanken & Melkevik, 2016).
2008; de Bruin & Gardner, 2010; de Bruin & Rhodes, 2011), less attention has been paid to the process of habit formation itself. To observe habit formation in real-life situations, Lally and her colleagues (Lally et al., 2010) asked their participants to perform a new health-promoting behavior (e.g., eating fruit, drinking water, exercising) every day at the same time for 84 days. Every day, participants also had to report the degree of automaticity of the newly adopted behavior. After plotting automaticity over time, the researchers confirmed that automaticity increased with the number of repetitions but also showed that the automatization speed varied substantially, depending on the type of behavior. PA behaviors are rather complex behaviors because they can require preparation (e.g., changing clothes, bringing sport equipment), transport to a specific location, and effort. Such complex behaviors are thus more difficult to automatize than simpler behaviors. As habits can be understood as action sequences (Dezfouli et al., 2014), a part of the action sequence for complex behaviors may be automatic, while other parts can continue to require conscious monitoring. From this perspective, it may be helpful to focus on making the first step in the action sequence automatic, as this step initiates the behavior. For example, some authors (Verplanken & Melkevik, 2008) demonstrated that interventions to promote PA behavior should primarily focus on making the decision to exercise habitual. Phillips and Gardner (2016) confirmed this finding calling the decision-making exercise instigation. They demonstrated that exercise instigation habit strength was the only predictor of exercise frequency. Overall, this body of research underlines the importance of finding strategies for PA interventions that reduce reflective processes so that individuals can plan their PA sessions in a more automatic fashion.

In the last few years, many PA intervention designs have supplemented supervised PA sessions with technology-based supports (e.g., text messaging, mobile applications, websites). In comparison with supervised PA sessions only, these interventions have shown promising results in building compliance with PA recommendations (e.g., Hurling et al., 2007; Fjeldsoe et al., 2010) with, for example, a recent review indicating that text messaging had a generally positive effect on individuals’ level of physical fitness (Buchholz et al., 2013). However, the direct role of such interventions in exercise habit formation remains unexplored. We think that text messaging is likely to facilitate formation of PA habits in several ways. First, it can reduce the conscious and effortful processes that are normally needed to plan PA behaviors by reminding people to improve attendance (e.g., Leong et al., 2006). Although the effect size seemed limited (Gurol-Urganci et al., 2013), this factor could certainly be improved by better timing of the text messages. Text messaging can also have a priming effect that increases cognitive accessibility to PA behaviors without conscious effort (Shalev & Bargh, 2011). Last, text messaging can help the cueing process that is required to form habits. Habits depend on the binding of contextual cues and behavioral responses: habits are strengthened when they are linked to salient and consistent cues (Orbell & Verplanken, 2010). In theory, any salient feature of the context in which a behavior is consistently repeated can serve to cue habits (Verplanken, 2006; Wood & Neal, 2009). Provided that text messages always precede PA sessions, the saliency and consistency of these cues should thus facilitate habit formation. We hypothesized that PA habits should increase faster in a group receiving a PA intervention with text messaging cues than in a group receiving no text messaging cues.

Studies and meta-analysis showed that text messaging has an impact on PA frequency (Fjeldsoe et al., 2009; Fanning et al., 2012). The primary aim of this study was to directly test the efficacy of text messaging cues to promote PA habit formation in the workplace. A two-arm intervention was designed to compare a group attending supervised PA sessions (PA condition) and a group attending the same sessions plus receiving text messages before each session (PA+SMS condition). The repeated measurements approach developed by Lally and her colleagues (Lally et al., 2010) was used to assess the automaticity of the participants’ PA behaviors every week over the course of the PA intervention (28 weeks). By reducing reliance on conscious and effortful planning and decision-making and increasing salient cueing, we expected that participants in the PA+SMS condition would form PA habits faster than participants in the PA condition. The purpose of the study was to help people who intend to do PA to do so and to help to maintain it regularly. As a secondary objective, we also explored the effect of the intervention on the maintenance of PA behaviors and several physical measures of fitness: resting heart rate, 6-min walk distance (O’Keeffe et al., 1998), sit-to-stand test performance (Bohannon, 1995), and upper extremity strength.

**Method**

**Participants**

To determine the sample size, we performed a sample size calculation that adjusted for the correlated nature of the repeated measurements (see Liu & Liang, 1997). The power analysis was performed with PASS (PASS 14, NCSS, Kaysville, Utah, USA) using a simulation approach. The significance was fixed at $P = 0.05$ and the power was fixed at 0.80. Based on a review of text messaging effects by Leong et al. (2006), who reported a moderate effect size, and by Gurol-Urgonci and his
colleagues (Gurol-Urganci et al., 2013), who reported a smaller effect size, a small to moderate effect size was expected (Cohen’s $d = 0.30$). Based on another study in which we collected data on habit formation using the same weekly self-reported measure, the correlation among repeated measures was fixed at $r = 0.55$. We assumed that the participants would find the high frequency of measurements to be quite demanding, and we thus expected a response rate of 50% (14 measures out of the 28 weeks of intervention). Using these parameters and after 1000 simulations, the power analysis indicated that at least 42 participants were needed for this study.

This interventional study was a two-arm (1:1), parallel intervention. It was approved by the scientific board of the University of Nice Sophia Antipolis and registered in a public registry (ISRCTN10276604). The study took place in a French service company in the south of France, from May 2013 to June 2015. First, all employees were approached through seminars, emails, and a special event promoting the research project from May 2013 to October 2013. All ($N = 352$, 124 females and 228 males) received a detailed description of the project including subject requirements, a timetable, and the testing and training facilities. To be eligible for the study, the employees could not be involved in any exercise training. Further eligibility criteria included the following: (a) medical clearance to start an exercise program and (b) the ability to attend 60-min sessions at a fitness center twice a week. The final sample comprised 49 employees (28 females and 21 males, $M_{age} = 47.5 \pm 8.29$ years from 23 to 60 years) recruited on a voluntary basis. Interested participants signed the consent form before being randomized. Figure 1 illustrates the pathway through the trial.

**Randomization**

To allocate the participants, the investigators randomized them using a minimization algorithm (Qminim software, see Saghaei & Saghaei, 2011) with sex and age as blocked factors to ensure the balance between the intervention groups over these factors. Figure 1 shows the composition of each group.

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**Fig. 1.** Progress of screening and recruiting participants and the follow-up stages of the trial after the randomization intervention.
The strength of the PA habit was measured using the Self-Report Behavioural Automaticity Index (SRBAI) (Gardner et al., 2012a), which is the automaticity subscale of the Self-Report Habit Index (SRHI) (Verplanken & Orbell, 2003). The SRBAI removes frequency and thus may permit a truer estimation of the relationship between the cue-response association strength and behavioral performance (Gardner et al., 2012a). It is a 4-item questionnaire (“I do automatically”; “I do without thinking”; “I do without having to consciously remember”; and “I start doing before I realize I’m doing it”). We used a French adaptation of these items that was validated by Boiché (2014). Participants provided their answers using a 10-point Likert scale, with higher scores indicating stronger habit strength. They received an email every Thursday at 14:00 h from the communication service of their company to ask them to complete the SRBAI for physical exercise using an online survey-managing website. If they failed to send a report, they received another email to remind them on the following Monday at 14:00 h.

The PA level was measured using the International Physical Activity Questionnaire (IPAQ, Craig et al., 2003). The communication service of their company also sent the participants an invitation to complete the IPAQ using an online survey-managing website 12 months after the end of the intervention. Resting heart rate was measured three times upon awakening when the participants were still in bed, using the Polar FT1 heart rate monitor watch. Fitness variables were assessed with the 6-min walk test (O’Keefe et al., 1998), a handgrip strength test (Schlüssel et al., 2008), and the sit-to-stand test (Bohannon, 1995).

**Blinding**

Effort was made to maintain blinding. The participants were not informed that SMS delivery was being manipulated between their groups. Although contamination among participants was possible, it should be noted that they were not aware of the study hypotheses. The investigators who assigned them to an intervention and the PA coaches were kept blind to the exact participant assignments. The trial adhered to established procedures to maintain a separation between the staff responsible for the outcome measurements and the staff delivering the intervention. Staff members who made the outcome measurements were not informed of the group assignment. Statisticians who analyzed the data were not aware of the meaning of the coding scheme representing the two arms of the trial.

**Statistical analyses**

We first checked the normality of the distribution by a graphical method (frequency histogram and quantile-quantile plot) and a Shapiro-Wilk test (Ghasemi & Zahediasl, 2012). In order to account for the non-independence of the repeated measures that were grouped within participants, the main hypothesis was tested using a mixed model approach. This approach was particularly useful for our study as the repeated measures were unbalanced due to missing measures from most of the participants (Cnaan et al., 1997). Concerning the analysis of PA automaticity (i.e., SRBAI score), the time of measurement, the experimental condition and the interaction between these two variables were defined as fixed factors. The intercept was defined as a random factor that could vary for each participant.

To analyze the effects of the intervention on PA maintenance (IPAQ score), resting heart rate, 6-min walk distance, sit-to-stand test performance and muscle strength, a general linear model (GLM) was used, including the time of measurement (within-subject factor), the experimental condition (between-subject factor) and the interaction between these two factors.

All results were considered significant at a P-value below 0.05 or the 95% confidence interval.

**Results**

The mean participation in the PA session was 47.43%, and this was similar in the two conditions (46.67 ± 23.84% in the PA condition and 48.32 ± 23.93% in the PA+SMS condition), \(t(37) = 0.210, P = 0.834\). Eight participants quit before the end of the intervention: four in the PA condition (two due to health problems and two for professional reasons) and four in the PA+SMS condition (one for health problems and three for professional reasons because they often had to work abroad or they had some difficulties to deal with their professional obligation during lunch time). Although these participants were not present for the physical evaluation at the end of the program, their scores for PA automaticity were retained in the analysis as the mixed model can deal with missing data. In all, the participants provided 603 measures of PA
experimental condition did not produce any main or interaction effects. Only a marginal main effect of the condition was found for the resting heart rate, indicating that, in general, participants of the PA+SMS condition tended to have lower resting heart rates.

**Discussion**

Given the problem of PA maintenance and the suggested crucial role of habit in behavior maintenance (Rothman et al., 2009), the objective of this study was to examine the conditions that facilitate the formation of PA habits in a PA intervention. We designed an intervention to test the efficacy of text messaging cues in habit formation during a workplace PA intervention. For both conditions (i.e., with and without the delivery of text messages), automaticity increased linearly over the weeks of the study. This confirms the general idea that repeating a behavior in a consistent setting increases automaticity (e.g., Wood & Neal, 2009). Concerning the test of our specific hypothesis on the effect of text messaging cues, our finding of a steeper slope showed that the automaticity score increased more in the PA+SMS condition than in the PA condition, suggesting that the PA+SMS participants formed PA habits slightly faster. The size of this effect was small but comparable to the general effect of similar text messaging interventions on the engagement in PA (see Buchholz et al., 2013). Moreover, the time and condition interaction had a marginally significant effect on PA behavior, suggesting that the PA intervention had a positive effect on the long-term maintenance of PA behaviors only for the participants in the PA+SMS condition.

As to the mechanisms underlying this effect, we speculate that the text messages affected habit formation in several ways. First, the text messages might have helped the participants to plan for their PA sessions by providing specific cues, our finding of a steeper slope showed that the automaticity score increased more in the PA+SMS condition than in the PA condition, suggesting that the PA+SMS participants formed PA habits slightly faster. The size of this effect was small but comparable to the general effect of similar text messaging interventions on the engagement in PA (see Buchholz et al., 2013). Moreover, the time and condition interaction had a marginally significant effect on PA behavior, suggesting that the PA intervention had a positive effect on the long-term maintenance of PA behaviors only for the participants in the PA+SMS condition.

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**Table 1.** Output of the mixed model analysis showing the effect of each fixed factor: the linear effect of time (across the 28 weeks of the physical activity intervention), the effect of the experimental condition (PA vs PA+SMS), and the effect of the time × condition interaction; SE stands for standard errors.

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Estimates</th>
<th>SE</th>
<th>t</th>
<th>P</th>
<th>Confidence interval 95% Lower limit</th>
<th>Upper limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>5.827692</td>
<td>0.313927</td>
<td>18.564</td>
<td>0.000</td>
<td>5.192728</td>
<td>6.462657</td>
</tr>
<tr>
<td>Condition</td>
<td>0.363171</td>
<td>0.627854</td>
<td>0.578</td>
<td>0.566</td>
<td>-0.906758</td>
<td>1.633101</td>
</tr>
<tr>
<td>Time</td>
<td>0.033882</td>
<td>0.005585</td>
<td>6.067</td>
<td>0.000</td>
<td>0.022913</td>
<td>0.044852</td>
</tr>
<tr>
<td>Condition × Time</td>
<td>0.024978</td>
<td>0.011170</td>
<td>2.236</td>
<td>0.026</td>
<td>0.003039</td>
<td>0.046917</td>
</tr>
</tbody>
</table>
reminders and prompting individuals to think about and anticipate their upcoming session. The contents of the text messages were specifically designed to facilitate planning by detailing the actions that had to be taken before going to the PA session (e.g., preparing sports clothes, finishing ongoing tasks). In other words, the text messages may have diminished reliance on conscious planning, which in turn would have facilitated habit formation as habits typically arise when conscious planning is minimal (Neal et al., 2006). Another process that might explain the faster development of habits in the systematic text messaging condition is the cueing effect. It has been suggested that behavioral habits are formed when the behavioral response is repeatedly produced in reaction to a systematic cue (Wood & Neal, 2009). As the text messages were systematically received at the same time and on the same day before the PA session, this likely served the habit formation process. Specifically, the systematic occurrence of the same cue might have facilitated the creation of an associative link in long-term procedural memory between contextual events and the decision to go to the PA session (Wood & Neal, 2009). The cue may have initiated an action sequence of planning behavior. As highlighted by Tobias (2009), the impact of reminders may have diminished as habits developed and could explain why the SMS group maintained the PA behavior 18 months after the beginning of the intervention.

Finally, it is also possible that the intrinsic goal content in the text message helped to form habits (i.e., “Don’t forget your PA session in an hour. You’ll feel good after!”). In addition to repetition and cueing, reinforcers also help habit formation (Dickinson & Balleine, 1995; Neal et al., 2006). Intrinsic goal contents provide intrinsic reinforcement in the text message by satisfying psychological needs (Ryan & Deci, 2000; Vansteenkiste et al., 2006) and previous studies have shown that such intrinsic motivation can have a positive impact on the formation of habits (e.g., Gardner & Lally, 2012).

The present study does not identify the exact process mediating the effect of the text messaging intervention on the formation of PA habits. Future studies might manipulate the various factors of a text messaging intervention independently to answer this question. Another issue not addressed by this research is the acceptance of text messaging by the participants. Although text messaging interventions
are usually well accepted, this still varies considerably among individuals (Wei et al., 2011). Some cues may be better suited to support habits than others and the ease of identifying the appropriate cue to action can influence habit formation (Lally & Gardner, 2013). Text messaging cues may therefore not be appropriate for all participants, and one implication of this is that text messages could be used in such a way that the participants are able to schedule their own messages and timing. One of the reasons for the disruption in habit formation and habits is a disruption or change in the individual’s routines (e.g., holidays, changes in work schedule). Building a degree of flexibility in anticipation of these disruptions by permitting participants to schedule their own messages might be good way to circumvent the problem.

The limits of the SRBAI need to be considered, as well, as recently noted by Hagger et al. (2014), Labrecque and Wood (2015) and Orbell and Verplanken (2015) in answer to Gardner (2015a). The SRBAI is a self-report measure of experienced automaticity, and these authors discussed the validity of using such a declarative measure to capture an automatic response. Nevertheless, there are no alternatives at the moment (Gardner, 2015b) and the short format for the SRBAI is particularly useful for repeated measures to study habit formation.

Last, although a relatively small number of volunteers participated in this intervention, the design was appropriate and sufficient power was ensured by taking into account a high number of repeated measures as the main unit in the mixed model analysis. However, our small sample size was not adequate to evaluate our secondary objective. In addition, we had a high quantity of missing data due to the relatively long duration of our study and the lack of availability of our working participants.

Finally, it is important to note that this intervention operate by reminding participants who are strongly inclined to do PA. Participants included in the study presumably have been highly motivated to regularly engage in PA for 28 weeks. Nevertheless, reminders as instigation habit of deciding to exercise might (Phillips & Gardner, 2016) also depend on initial exercise stage of change of participants which was not controlled in the present study. Also long time of measurement is lacking from many PA studies. The study could be tested with larger sample with a cost-effectiveness analysis done in order to be more convincing for real-life transferability. Given the small sample size and high attrition rate, findings are not definitive or conclusive, but rather tentative.

**Perspectives**

To conclude, the present findings suggest that the effect of a text messaging intervention on PA

| Table 2. Results for the physical health-related variables assessed before and after the 28-week PA program for each arm of the trial |
|---|---|---|---|---|
| | Pre- | Post- | Time × Condition |
| **PA** | **PA** | **PA** | **PA** |
| **IPAQ (MET per week)** | 1985 | 1576 | 0.29-0.05 |
| | 1142 | 8.12 | |
| **HR rest (BPM)** | 57 | 56.14 | 0.59-0.01 |
| | 8.48 | 5.11 | |
| **6-min walking test (m)** | 673.7 | 734.11 | 0.00-0.16 |
| | 68.4 | 5.5 | |
| **The sit-to-stand test (n)** | 23.7 | 27.64 | 0.00-0.16 |
| | 5.52 | 5.11 | |
| **Handgrip strength test (N)** | 241.5 | 274.90 | 0.00-0.16 |
| | 85.69 | 5.5 | |

Notes: MET = metabolic equivalent of task. BPM = beats per minute. n = number of repetitions. N = Newton. N = sample size.
adherence and maintenance might be explained by the formation of PA habits. Nevertheless, given the small sample size and high attrition rate, findings are not definitive or conclusive, but rather tentative. This study showed that using environmental cues like text messages helped to establish and maintain PA behavior. This type of intervention should be adopted in the workplace to encourage active lifestyles among employees. In addition, this type of intervention can easily be transferred to real-life situations in companies with ready access to sports facilities, as text messaging is a low-cost service that can be quickly implemented.

**Key words:** Habits, text messaging, physical activity, cues, automaticity.
Text messaging cues to promote physical activity habits


