
If This, Then Habit: Exploring Context-Aware Implementation Intentions on Smartphones

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Abstract

Implementation intentions, 'if-then' plans where 'if's are contextual cues and 'then's are specific goal-related behaviours, hold much promise as an effective behaviour change technique to support habit formation. Nevertheless, they have been underused in digital behaviour change interventions. To address this gap, we outline a novel design of an implementation intention intervention that exploits the context-aware functionality of smartphones to extend the scope of these goal constructs. The results of a probe study and qualitative data from an elicitation survey are presented, from which we derive a set of key design recommendations and pointers for future research.

Author Keywords

Implementation Intentions; Nonconscious behaviour change technology; Context-aware smartphones.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Implementation intentions are a specialised form of goal intentions that explicitly set up contextual cues as triggers (e.g. time of day or a particular location) for a

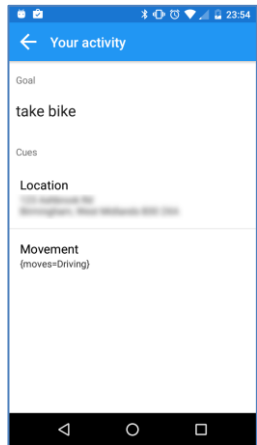


Figure 1 Example implementation intentions showing target 'then' goal-related behaviour and related context triggers

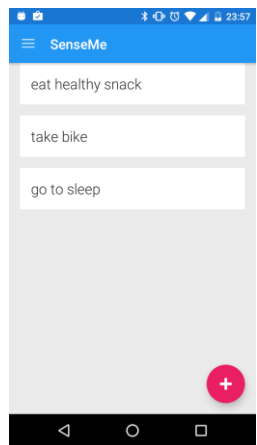


Figure 2 Example 'then' goal-related behaviour list

desired behaviour (e.g. to take the stairs) [10]. They are commonly expressed as 'if-then' constructs where the 'if' is a contextual cue and the 'then' is a specific goal-related behaviour, for example "if I go to the coffee shop, then I will buy an apple".

This paper presents a novel approach exploring implementation intentions using context-aware smartphones. We present the results of a design probe and an elicitation study that explore what sorts of if-then plans people would like to form using such technology. Finally, we outline the lessons learned and plans for future research.

Related work

Implementation intentions beyond the lab

Prestwich et al. noted that implementation intentions studies are overwhelmingly lab-based, with measures of behavioural impact mainly restricted to those within the immediate lab setting [18]. There is clearly a need to establish whether the success of lab-based implementation intentions can survive the jump into the wild. Our research lays the groundwork for such a jump.

Our novel approach is to use context-aware functionality in smartphones to support and broaden the 'if' (i.e. context trigger) component in implementation intentions 'if-then' plans. Although several SMS-based implementation intentions studies have been conducted [18] and broader digital behaviour change interventions using implementation intentions are starting to emerge, e.g. [22], to our knowledge this is the first research into exploring implementation intentions using context-aware smartphones.

Theory

Implementation intentions represent part of a growing focus on nonconscious behaviour change using technology to generate habits [1,17,20]. They aim to automate behaviour, i.e. to convert intentional behaviour into a nonconscious habit, by rehearsing cue-behaviour associations in memory such that the link achieves a "heightened accessibility" and becomes a candidate for automatic activation [9].

Sheeran et al. [19] further argue that implementation intentions may also protect people against adverse goal primes in the environment (e.g. advertising, items available for impulse purchase).

Empirical evidence

Gollwitzer & Sheeran's meta-analysis of 94 studies found that implementation intentions had a medium-to-large effect on goal achievement ($d = 0.65$), and found evidence supporting both the increased accessibility of goal plans and goal automation [11].

Implementation intentions design issues

Implementation intentions require both identification of appropriate contextual triggers and the ability to formulate these 'if's into if-then plans. Verhoeven et al. found that implementation intentions aimed at changing unwanted habits require the identification of the cues that trigger the unwanted behaviour [26]. Further, habit theory suggests that, in order for implementation intentions to be successful in automating behaviour, an 'if' trigger needs to be "sufficiently salient in daily life that it is encountered and detected frequently and consistently" [8]. Context-aware smartphones provide the opportunity not only to support additional trigger detection, even possibly

If ... <i>(context triggers)</i>	Then ... <i>(goal-related behaviours)</i>
Movement	Walking 30
Movement	Thin
Location	Sleep tight
Time	Jogging after
Time	Exercise for 10 minutes
Movement	Walking
Time	Drink water
Time	Jogging
Location, Time	Having a dinner
Movement	Walking

Table 1 Implementation intentions created during the probe from 'if' context trigger(s) and 'then' goal-related behaviours.

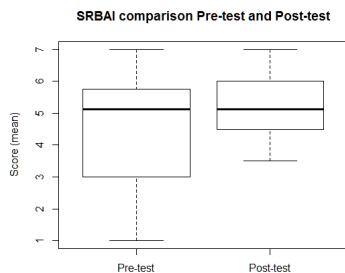


Figure 3 SRBAI means, pre- and post- test

predicting future contexts [16], but also to aid implementation intention rehearsal and reminders.

Ur et al., focusing on customising 'smart home' devices, demonstrated that even users unfamiliar with if-then programming can learn to generate plans with multiple 'if's and 'then's [24]. 'If-then' "recipes" have been implemented in the web & app service If This Then That (ITTT) [13] and in other smartphone-automation apps [28,29]. ITTT allows users to link together various device and social media services to automate tasks, with more than one million 'if-then' recipes created [12] and more than 100,000 users sharing recipes [25]. This indicates that if-then programming may be easily grasped, although these services are not targeted at behaviour change. Lucci & Paterno examined the application of if-then programming on smartphones [15], and noted that the UI needs to be able to graphically represent the if-then construct without imposing constraints on which is selected first, while presenting a manageable list of 'if' and 'then' options to the user.

Design probe

Intervention

We implemented a design probe on Android phones to explore how users would interact with a context-aware implementation intentions app. The app enabled users to combine 'if' context triggers with 'then' goal-related behaviours to generate implementation intentions. When the relevant 'if's were detected for each implementation intention, the app notified users with an alert and text to remind them of their related 'then' goal-related behaviour.

The 'if' context triggers available within our probe were: location, movement, time, calendar, device battery and orientation. Figure 1 shows an example implementation intention with two combined cues, while Figure 2 shows an example list of goal-related behaviours that have been added to cues to generate implementation intentions.

10 participants installed the app and received instructions on generating their own implementation intentions from 'if' context triggers and 'then' goal-related behaviours. Participants completed a Self-Report Behavioural Automaticity Index (SRBAI, [7]) to measure the automaticity of their selected goal-related behaviours. We selected this instrument because it is specifically designed to capture behavioural automaticity, and is a subset of the Self-Report Habit Index (SRHI, [27]). After one week, users filled in a post-test SRBAI and a System Usability Scale (SUS,[5]) questionnaire as an indication of ease of use of the app.

Results & Discussion

During the probe, among 10 users, the app was launched 49 times with a total duration of use across all participants of 2 hours and 39 minutes. The mean SUS score was 71.75, indicating that the app has no major usability problems [2].

Internal consistency of the SRBAI for the 10 participants at both pre- and post- test SRBAI measures (pre-test $\alpha = 0.9$, post-test $\alpha = 0.84$). The mean pre- and post- SRBAI values are shown in Figure 3, although note that our small sample size makes inferential statistics inappropriate.

Location	Mentions
kitchen	38
entrance/exit	12
lounge	12
bedroom	9
bathroom	5
study	3
stairs	2
lift	1
drive	1

Object	Mentions
fridge	30
food storage	23
TV	21
desk	10
sofa	9
bed	9
computer	8
phone	7
car	5
exercise equipment	4
freezer	4
kettle	4

Table 2 Top 10 categorised home locations/objects mentioned

Table 1 shows the implementation intentions created by users during the probe. 'Then' goal-related behaviours all focused on health, with 7/10 related to exercise and movement, 2/10 relating to food and water intake and the remaining goal going to sleep. In terms of 'if' context triggers, 4 goals used movement as a cue, 4 goals used time as a cue, 1 goal used location as a cue, and 1 goal combined location and time as the cues. Most users (9/10) only specified one goal using one cue; there is therefore room for improvement within the implementation intentions definition stage to make it clear to users that multiple cues can be combined, and that multiple implementation intentions may be expressed if required.

Elicitation survey

To further explore how potential users might benefit from a context-aware implementation intentions system, particularly one with location-aware resources, we surveyed 137 people (mean age 30.7 years, SD 11.97, 100 female), recruited via social networks. Our broad aim was to determine how they might wish to use technology to support habit changes. We asked people to think about both any repetitive behaviours they wanted to change (creating new habits or breaking old ones) and where they performed them, both at home and at work. Then we asked where they might place 'proximity triggers', i.e. technology to detect when they were close to a particular place or object to support them to change their behaviour, and why. We gave examples of a proximity trigger on a water cooler to remind them to drink more water, and one by the lift to remind them to take the stairs. We analysed the survey responses using a line-by-line iterative coding technique using the WEFT qualitative analysis tool [30].

Location and object cues

For both home and work, responses were of two types: specific locations and particular objects within those locations. Table 2 shows categorised number of mentions for home-specific locations and objects, and Table 5 shows the same for workplaces. Food issues feature strongly in both: the kitchen is the top home location, while food outlets topped the work location list. The top objects at home are fridge and food storage (e.g. biscuit tin), while food storage, vending machines and workplace fridges all feature in the top 10 work objects.

Target behaviours

Target behaviours people mentioned also fell into two categories: *positive behaviours* where the goal is to perform a desired behaviour; and *negative behaviours* where the goal is to stop performing an undesired behaviour. Target behaviours for the home and for work are shown in Table 3 and Table 4 respectively.

Positive behaviour	Mentions	Negative behaviour	Mentions
exercise/ breaks	21	stop snacks	18
eat healthily	15	Procrastination/ distraction	7
drink water	10	stop being sedentary	3
floss / clean teeth	3	don't smoke	1
read more	3		
tidy/wash up	3		
lock up / remember keys	3		

Table 3 Target behaviour category mentions (home)

Location	Mentions
food outlet	19
lift	13
kitchen	11
entrance/exit	7
office	4
bathroom	3
bus stop	3
stairs	2
car park	2
pub/bar	2

Object	Mentions
water cooler	20
computer	15
desk	14
fridge	11
food storage	8
vending machine	5
phone	5
mirror	2
light switches	2
chair	2
coffee machine	2
bag	2

Table 5 Top 10 categorised workplace locations/objects mentioned

Positive behaviour	Mentions	Negative behaviour	Mentions
exercise/ breaks	17	procrastination/ distraction	6
eat healthily	17	stop snacks	3
drink water	17	drink less coffee	2
take stairs	5	don't smoke	1
energy saving	3	drink too much	1
		spend too much	1

Table 4 Target behaviour category mentions (workplace)

As with our design probe, health-related behaviours dominate: the top four positive home behaviours, 3 of the 4 negative home behaviours, the top 4 positive workplace behaviours and half of the four negative workplace behaviours are all related to health. The data also shows other convergent requirements: implementation intentions to guard against procrastination and distraction feature as negative behaviours in both locations, while the top 3 positive behaviours are the same across locations.

Given that we effectively cued watercooler/drink more, lift/take stairs implementation intentions with our survey questions, the popularity of these need to be validated in a future behavioural study.

Notifications: when and how

We also asked how such an app should alert people, and what it would say. There was a wide variety of suggested modes of interruption, from specifically unobtrusive vibration ("*vibrate to be discreet*", "*silent vibrate*") to deliberately annoying ("*In the most*

annoying way possible so that it can't be ignored"), via loud noises and alarms. One user suggested a solution: "*You should be able to choose the alert sound or vibrate that suits you. The alert should self destruct if not responded to within a particular time frame*".

Although we implied that the reminders would always appear when the given trigger was detected, several people suggested regular reminders might lose impact over time: "*I tend to start ignoring them after a bit*"; "*if you have something reminding you at set times of day then you'll just get used to it*", supporting research by Tobias [23]. Additionally, two people suggested random reminders, reflecting the evidence that a variable reinforcement schedule is the most effective schedule for instilling habits [3]. Reactance [4] was also identified as a potential issue if the app is triggered at an inconvenient time: "*If I got too many notifications when I'm not able to go through with the task I'd probably get a bit annoyed and turn them off entirely or delete the app*". Others wanted an "*alert when it is appropriate*", wanting the app to be aware of their activities and/or calendar.

Responses to the content question demonstrated the importance of allowing users to configure notification content, since simple goal reminders were only a minority of suggestions (40%). Other notification categories are shown in Table 6.

This suggests that implementation intentions apps should allow users to configure their own notifications, both in terms of interrupt mode (vibration, noise, lights etc.) and in terms of notification content (a default of simple implementation intentions goal reminders, with options to add implementation intentions-relevant

Type	%	Examples
simple goal reminder	40%	
outcomes reminder	13%	"show me an image of rotten teeth"
context-aware reminder	9%	"linked to the pedometer"
generic reminder	9%	"stop!", "think"
tailored reminder	9%	users can "set [their] own phrases"
sound or vibration only	8%	

Table 6 Reminder type categories mentioned by % of users

images and/or words or simply play a sound). Our results also indicate that user expectations may need to be managed, since it is not trivial for context-aware apps to reliably detect behaviour [17].

People also identified potential downfalls in the design of the 'then' goal-related behaviour construct: one person indicated awareness of the possibility of ironic effects [6] "I think encouraging me to do something rather than to not do something is more likely to work". Nevertheless, several people specifically requested such 'negative' reminders ("near coffee shops, to not go in", "alerted when I see a cake on TC - that I do not want one"), and see Table 3 and Table 4. This emphasises the importance of the training phase to support users in creating appropriate implementation intentions. These should be specific, in line with implementation intentions literature [10] and Goal Setting Theory [14], positive to avoid ironic effects [6], and configurable because our elicitation study has demonstrated that users value this quality highly.

Other tensions highlighted by survey respondents include the tension involved in distracting people with reminders to not be distracted ("remind me not to be so distracted and carry on with work"). This is a particular problem if the implementation intentions alert is on a smartphone that in itself can serve as a procrastination tool: one person wanted a reminder "to stop me from looking a[t] my phone", with others suggesting desktop- and watch-based reminders.

Finally, we note that this approach would not appeal to everyone: 11 people (8%) rejected the idea of proximity triggers at work, one because they are retired, while 10% (14%) rejected the idea of proximity

triggers in the home. One person commented, "I would HATE this and avoid these places"; another noted that "this would feel like nagging".

Design recommendations

Our analysis provides new insights into the augmentation of implementation intentions using context-aware smartphones. We suggest apps should:

1. Support strong configurability for 'if' proximity triggers to include room-level locations and particular objects;
2. Guide users during the implementation intentions formation phase to avoid negative behaviours and form goals with appropriate specificity;
3. Support user tailoring for notification timings, mode and content, integrating with user calendars where possible;
4. Manage context-aware expectations;
5. Expect some users to be resistant to the app, and test for reactance as a possible confounding factor.

Future work

Our next step is to conduct a large-scale study to implement some of the lessons learned from our design probe and elicitation study. In particular, we have designed an experimental app combining smartphones and Bluetooth Low-Energy (BLE) beacons in the form of Estimote Stickers [31] to broaden the range of contextual triggers available. Such beacons can broadcast their orientation, temperature and motion. Using the stickers addresses design recommendation (1) by having configurable levels of proximity (e.g. room- and object- level triggering, while repositionable

stickers add flexibility to if-then plans), and addresses recommendation (4) by enriching the user's potential if's more in line with their expectations.

BLE beacons and similar nearables have been used in context-aware mobile apps [21], but have yet to be deployed in the implementation intentions behaviour change context. Together with our qualitative analysis demonstrating a focus on fridge-aware technology, there is a clear opportunity to test implementation intentions triggered by motion-aware beacons. For example, "if I open the fridge, then I will choose X as a healthy snack", which could be tailored to present alternative X items at different times of the day.

References

- [1] Adams, A.T., Costa, J., Jung, M.F., and Choudhury, T. Mindless Computing: Designing Technologies to Subtly Influence Behavior. *UbiComp '15*, ACM (2015), 719–730.
- [2] Bangor, A., Kortum, P.T., and Miller, J.T. An empirical evaluation of the system usability scale. *Intl. Journal of Human-Computer Interaction* 24, 6 (2008), 574–594.
- [3] Bijou, S.W. Patterns of reinforcement and resistance to extinction in young children. *Child Development*, (1957), 47–54.
- [4] Brehm, J.W. A theory of psychological reactance. In W. Burke, D.G. Lake and J.W. Paine, eds., *Organization Change: A Comprehensive Reader*. John Wiley & Sons, Ltd, San Francisco, CA, 2009, 377–390.
- [5] Brooke, J. SUS-A quick and dirty usability scale. *Usability evaluation in industry* 189, 194 (1996), 4–7.
- [6] Earp, B.D., Dill, B., Harris, J.L., Ackerman, J.M., and Bargh, J.A. No sign of quitting: Incidental exposure to no-smoking signs ironically boosts cigarette-approach tendencies in smokers. *Journal of Applied Social Psychology* 43, 10 (2013), 2158–2162.
- [7] Gardner, B., Abraham, C., Lally, P., and de Bruijn, G.-J. Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioral Nutrition and Physical Activity* 9, 1 (2012), 102.
- [8] Gardner, B., Lally, P., and Wardle, J. Making health habitual: the psychology of 'habit-formation' and general practice. *The British Journal of General Practice* 62, 605 (2012), 664–6.
- [9] Gollwitzer, P.M. Goal achievement: The role of intentions. *European review of social psychology* 4, 1 (1993), 141–185.
- [10] Gollwitzer, P.M. Implementation intentions: strong effects of simple plans. *American psychologist* 54, 7 (1999), 493.
- [11] Gollwitzer, P.M. and Sheeran, P. Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in experimental social psychology* 38, (2006), 69–119.
- [12] If This Then That. IFTTT Blog - One million tasks created. 2012. <http://blog.ifttt.com/post/22129854971/one-million-tasks-created>.
- [13] If This Then That. IFTTT homepage. 2015. <https://ifttt.com/>.
- [14] Locke, E.A. and Latham, G.P. New Directions in Goal-Setting Theory. *Current Directions in Psychological Science* 15, 5 (2006), 265–268.

- [15]Lucci, G. and Paternò, F. Analysing How Users Prefer to Model Contextual Event-Action Behaviours in Their Smartphones. In P. Díaz, V. Pipek, C. Ardito, C. Jensen, I. Aedo and A. Boden, eds., *IS-EUD 2015*. Springer, Madrid, Spain, 2015, 186–191.
- [16]Pejovic, V. and Musolesi, M. Anticipatory mobile computing: A survey of the state of the art and research challenges. *ACM Computing Surveys (CSUR)* 47, 3 (2015), 47.
- [17]Pinder, C., Vermeulen, J., Beale, R., and Hendley, R. Exploring Nonconscious Behaviour Change Interventions on Mobile Devices. *MobileHCI'15 Adjunct*, ACM Press (2015).
- [18]Prestwich, A., Perugini, M., and Hurling, R. Can implementation intentions and text messages promote brisk walking? A randomized trial. *Health Psychology* 29, 1 (2010), 40.
- [19]Sheeran, P., Milne, S., Webb, T.L., and Gollwitzer, P.M. *Implementation intentions and health behaviour*. Bibliothek der Universität Konstanz, 2005.
- [20]Stawarz, K., Cox, A.L., and Blandford, A. Beyond Self-Tracking and Reminders: Designing Smartphone Apps That Support Habit Formation. *CHI '15*, (2015).
- [21]Sykes, E.R., Pentland, S., and Nardi, S. Context-aware mobile apps using iBeacons: towards smarter interactions. *CASCON '15*, IBM Corp. (2015), 120–129.
- [22]Thompson, D., Bhatt, R., Lazarus, M., Cullen, K., Baranowski, J., and Baranowski, T. A serious video game to increase fruit and vegetable consumption among elementary aged youth (Squire's Quest! II): Rationale, design, and methods. *JMIR research protocols* 1, 2 (2012).
- [23]Tobias, R. Changing behavior by memory aids: a social psychological model of prospective memory and habit development tested with dynamic field data. *Psychological review* 116, 2 (2009), 408.
- [24]Ur, B., McManus, E., Pak Yong Ho, M., and Littman, M.L. Practical trigger-action programming in the smart home. *CHI '14*, ACM (2014), 803–812.
- [25]Ur, B., Pak Yong Ho, M., Brawner, S., et al. Trigger-Action Programming in the Wild: An Analysis of 200,000 IFTTT Recipes. *CHI '16*, ACM (2016), 3227–3231.
- [26]Verhoeven, A.A., Adriaanse, M.A., de Vet, E., Fennis, B.M., and de Ridder, D.T. Identifying the 'if'for 'if-then'plans: Combining implementation intentions with cue-monitoring targeting unhealthy snacking behaviour. *Psychology & health* 29, 12 (2014), 1476–1492.
- [27]Verplanken, B. and Orbell, S. Reflections on Past Behavior: A Self-Report Index of Habit Strength1. *Journal of Applied Social Psychology* 33, 6 (2003), 1313–1330.
- [28]Tasker for Android. <http://tasker.dinglich.net/>.
- [29]Locale for Android. <http://www.twofortyfouram.com/>.
- [30]Alex Fenton » Weft QDA - a free, open-source tool for qualitative data analysis. <http://www.pressure.to/qda/>.
- [31]What are Estimote Stickers? – Estimote Community Portal. <https://community.estimote.com/hc/en-us/articles/203323543-What-are-Estimote-Stickers->.