

# Using reinforced implementation intentions to support habit formation

Wicaksono, Adhi; Hendley, Robert J.; Beale, Russell

DOI:

[10.1145/3290607.3312985](https://doi.org/10.1145/3290607.3312985)

*Document Version*

Peer reviewed version

*Citation for published version (Harvard):*

Wicaksono, A, Hendley, RJ & Beale, R 2019, Using reinforced implementation intentions to support habit formation. in *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI'19 Extended Abstracts)*. Association for Computing Machinery (ACM), ACM CHI Conference on Human Factors in Computing Systems (CHI 2019), Glasgow, United Kingdom, 4/05/19. <https://doi.org/10.1145/3290607.3312985>

[Link to publication on Research at Birmingham portal](#)

**Publisher Rights Statement:**

Checked for eligibility: 20/05/2019

© Owner/Author 2019. This is the author's version of the work. It is posted here for your personal use. Not for redistribution. The definitive Version of Record was published in CHI EA '19 Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems, 10.1145/3290607.3312985

**General rights**

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

**Take down policy**

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact [UBIRA@lists.bham.ac.uk](mailto:UBIRA@lists.bham.ac.uk) providing details and we will remove access to the work immediately and investigate.

---

# Using Reinforced Implementation Intentions to Support Habit Formation

**Adhi Wicaksono**

School of Computer Science, University of  
Birmingham  
Birmingham, UK  
axw412@cs.bham.ac.uk

**Robert J Hendley**

School of Computer Science, University of  
Birmingham  
Birmingham, UK  
r.j.hendley@cs.bham.ac.uk

**Russell Beale**

School of Computer Science, University of  
Birmingham  
Birmingham, UK  
r.beale@cs.bham.ac.uk

**ABSTRACT**

Despite promising results, the psychological approach of implementation intentions remain underused in 'in-the-wild' habit formation apps. The majority of existing apps focus on using self-tracking and reminders but these hinder the development of habit. This study proposes a new mechanism to support habit formation by using reinforced implementation intentions. Our findings suggest that adding reinforcement is indeed useful to maintain the level of compliance but it is not necessarily the same in terms of automaticity. We also discuss how the potential use of reinforcement can be improved in the future.

---

*CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland UK*

© 2019 Copyright held by the owner/author(s).

This is the author's version of the work. It is posted here for your personal use. Not for redistribution. The definitive Version of Record was published in *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI'19 Extended Abstracts), May 4–9, 2019, Glasgow, Scotland UK*, <https://doi.org/10.1145/3290607.3312985>.

Remember this situation:

If I arrive at home, then I will track my mood

OK, I understand



Figure 1: Reinforcement of implementation intention in Mood Journal app.

## KEYWORDS

Behaviour change; habit formation; implementation intentions

### ACM Reference Format:

Adhi Wicaksono, Robert J Hendley, and Russell Beale. 2019. Using Reinforced Implementation Intentions to Support Habit Formation. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI'19 Extended Abstracts)*, May 4–9, 2019, Glasgow, Scotland UK. ACM, New York, NY, USA, 6 pages. <https://doi.org/10.1145/3290607.3312985>

## INTRODUCTION

Despite the growing popularity of habit formation apps on the market, existing research has shown that the majority of those apps are not designed based on theory [12]. Self-tracking and reminders have been cited as the two features commonly available on the habit formation apps [10]. Those two features have been found to cause dependency, where people become dependent on the app rather than actually forming a new habit. Moreover, reminders can also hinder automaticity, i.e. the ability to perform a task unconsciously, which is essential during habit development. [12].

Designing an app to support habit formation is best when based on habit theory. A habit is defined as learned behaviour that will be performed automatically whenever a cue is encountered [15]. Habitual behaviour is often performed non-consciously without much cognitive effort [6–8, 16]. In order for a behaviour to become habitual, it needs to be performed repeatedly and consistently in a stable context. The problem with existing habit formation apps is that they usually send reminders at the same time every day, no matter what the current context of their users, and then the user performs the specified task immediately. The result is that users will rely on the availability of reminders to perform their intended behaviour, instead of relying on the cue that should trigger the behaviour.

To solve this issue, we propose a new mechanism of supporting habit formation by using reinforced implementation intentions. We aim to strengthen the implementation intention and allow the intended behaviour to eventually become habitual.

## RELATED WORK

According to existing studies, forming new habits can be used to support long-term behaviour change [15]; when behaviour has become habitual, it will persist over a prolonged period [6]. However, it is difficult to turn behaviour into a habit without a proper strategy. Intention alone is not enough to form a habit because the strength of the intention decreases over time [13]. In this case, external aid is needed to maintain the intention and keep an individual committed to the plan. Reminders act as an external prompt for prospective memory, helping someone to remember a particular action [14], and they are widely used by habit formation apps to keep their users engaged and to remember the

if  
this → Cue/situation  
then  
that → Behavioural response

**Figure 2: The structure of an implementation intention where 'this' refers to the cue/situation and 'that' refers to the associated behavioural response, i.e. "If I arrive at home, then I will track my mood". Implementation intention is effective in helping people to form a new habit as it has similar construct with habitual behaviours in which cue and response are strongly linked. Strengthening the mental link between the cue and its associated response should improve the chance of success in habit formation.**

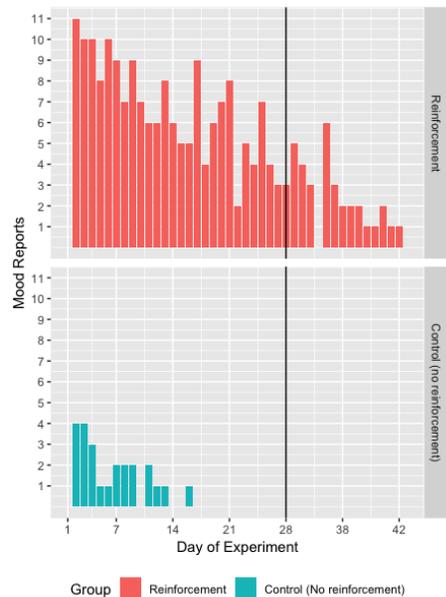
planned activity [10]. However, reminders are prone to dependency since they do not help the users to associate their habitual behaviour with the required cue. A behaviour is more likely to become habitual when there is a strong relationship between a cue and its associated response, but reminders do not support this type of relationship: they are more likely to become the trigger for the planned behaviour in the place of the desired cue.

Implementation intentions should provide an effective alternative strategy to help the formation of new habits. Implementation intentions are a specific action plan which follows a pattern "If situation X happens, then I will do Y" [3]. Implementation intentions have been found to be effective in supporting habit formation and to increase the automaticity of behaviour by heightening the accessibility of the cue and strengthening the mental link between the cue and its associated response [1, 4, 6]. In implementation intentions, users are encouraged to visualise an action associated with a contextual cue, and to try to act out that action. Despite the promising results, implementation intention approaches can suffer from a lack of motivation and are prone to forgetfulness [9, 11]. Adding reinforcement should improve the performance of implementation intentions: this paper aims to investigate how adding reinforcement of implementation intentions affects the early development of habit.

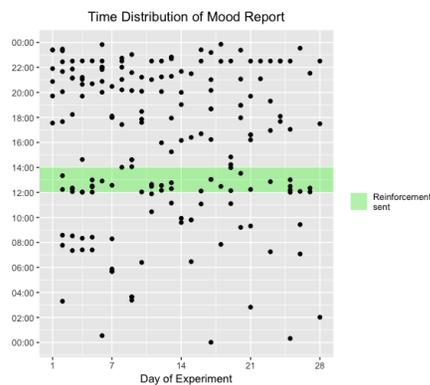
## METHOD

In this study, we asked participants to form an implementation intention of reporting their mood every day for 28 days. We used three dependent variables: compliance, automaticity, and time of the mood report. The variables were chosen as indicators of the development of new habits. In order for a behaviour to become habitual, it needs to be repeated consistently in a stable context and performed automatically. Compliance was used to measure the consistency, automaticity was used to measure the cognitive effort of reporting the mood, and time of the mood report was used to determine whether participants reported their mood consistently at the same time (stable context). Mood report was selected as the task because it is artificial, compliance is easy to measure, and mood reporting is very unlikely to be part of any of our participants' existing routines or ambitions. Because of this, we expect it to have equal salience for each of the participants, and so reduce bias. That is, people are unlikely to have a particularly different incentive to undertake the activity, compared to, say, losing weight or eating healthily, which may be of great interest to some and of none to others. We did not offer any financial incentive in this study.

At the beginning of the study, we asked participants to form an implementation intention and to complete a goal commitment questionnaire, measured using the HWK Scale [5]. We then allocated participants into one of two different groups: a control group and a reinforcement group, balanced by their goal commitment score. Participants in the reinforcement group received reinforcements for their implementation intention, whereas the control group got a reinforcement on the first day of the



**Figure 3: Compliance of mood reports throughout the study. The bold vertical line marks the end of the study (28 days).**



**Figure 4: Mood reports time. The green area marks the time in which reinforcements were sent.**

experiment only. Daily mood reports were recorded throughout the study. Every week, participants received a notification to complete the SRBAI questionnaire to measure their automaticity score.

## FINDING & PRELIMINARY RESULTS

Over a period of 28 days, we recruited 35 participants for our study. We allocated our participants into two different groups: 18 participants in the reinforcement group and 17 in the control group.

### Compliance

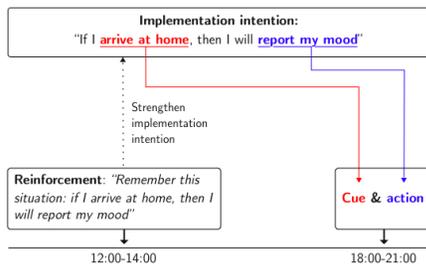
Compliance was used to measure the consistency of participants in reporting their mood every day. We measure compliance by counting the daily mood reports sent by our participants. Our findings suggest that the compliance level of participants in the reinforcement group ( $M=6.61$ ,  $SD=2.39$ ) was significantly higher than the compliance of participants in the control group ( $M=1.11$ ,  $SD=1.68$ ),  $t(48.49) = 9.94$ ,  $p < .001$ ,  $d = 2.66$ . However, participants in both groups failed to stay committed to their intention as their compliance decreased over time, as shown in Figure 3. The data shows that adding reinforcements slowed the decay. In the reinforcement group, compliance went down from 61% to 17% in four weeks, whereas in the control group, compliance was down from 23% to 0% in only 16 days. Participants in the control group stopped reporting their mood completely after 16 days of the study. Interestingly, two weeks after the study ended, seven participants from the reinforcement group were still reporting their mood.

### Mood Report Time

We used mood report time as an indication of whether participants were committed to their implementation intention or not. Our findings show that the majority of participants (56%) were consistent with their implementation intention of reporting mood later in the evening although they received reinforcements at lunchtime. However, some of them reported their mood at different times, i.e. early in the morning or around the time reinforcements were sent. At the moment, we cannot draw a firm conclusion on why some participants chose to report their mood at different times as we did not have any supporting data to answer this question. A more rigorous investigation is needed to understand this finding.

### Automaticity

We used the SRBAI questionnaire [2] to measure the automaticity of reporting mood every day. SRBAI questionnaires were triggered automatically every week. Unfortunately, the number of responses that we received was insufficient for further analysis. Only 6 participants from the reinforcement group and 2 from the control group answered the SRBAI questionnaire. Due to the small sample size, we cannot run an inferential statistical analysis on SRBAI.



**Figure 5: Reinforcement should strengthen implementation intentions by heightening the accessibility of the cue and its behavioural response.**

## DISCUSSION

Our findings suggest that forming an implementation intention alone is not enough without any external aids. In our study, we used reinforcement to strengthen the implementation intention. Compared to the more common approach of sending reminders at around the time when the intended action is supposed to happen, our reinforcements were sent way in advance to avoid dependency. The reinforcement aimed to help participants commit to their plan and perform their intended task consistently in a stable context, even when their intention is weak.

Despite the encouraging results that show compliance is much improved, the reinforcements we used in our study were passive. They only contained an instruction to remember the implementation intention and had the potential to be dismissed quickly. The effect of reinforcements can potentially be improved by making them active: an active reinforcement would demand participants to perform a specific task when the reinforcement arrives. For example, in our case, an active reinforcement could ask participants to take an action of sitting down and vividly imagining themselves in the situation that they have specified in their implementation intention, as well as to vocalise their implementation intention explicitly. Using active reinforcements should increase participants' cognitive effort around their implementation intention and, as a result, heighten the accessibility of the cue and its associated response.

However, there is a trade-off from making the reinforcement active since it requires more attention. Thus, active reinforcement should only be delivered at opportune moments: in this case, making the reinforcement context-aware becomes important because it will allow the reinforcement to be sent at moments where participants are available and able to pay appropriate attention to it.

## CONCLUSION & FUTURE WORK

In this paper, we present a study to investigate how using reinforced implementation intentions can be used in early habit development. We found that adding reinforcements led to better compliance which is important for a behaviour to become habitual. Further, the majority of participants committed to their plan by reporting their mood consistently in the evening. However, the reinforcements used in our study were passive. The effect could be stronger if the reinforcement is made active, prompting participants to rehearse their implementation intention. Nevertheless, preliminary findings suggest that using reinforcement of implementation intentions is indeed useful in habit formation by allowing the behaviour to be consistently repeated. Further work should investigate how the reinforcement can be designed better, i.e. by making it more active and context-aware to make it unobtrusive. More research is also needed to investigate the effect of reinforcement in the long-term to ensure that participants do not rely on the reinforcement to execute their intended plan.

## REFERENCES

- [1] Marieke A. Adriaanse, Charlotte D.W. Vinkers, Denise T.D. De Ridder, Joop J. Hox, and John B.F. De Wit. 2011. Do implementation intentions help to eat a healthy diet? A systematic review and meta-analysis of the empirical evidence. *Appetite* 56, 1 (2011), 183–193. <https://doi.org/10.1016/j.appet.2010.10.012>
- [2] Benjamin Gardner, Charles Abraham, Phillippa Lally, and Gert-Jan de Bruijn. 2012. Towards Parsimony in Habit Measurement: Testing the Convergent and Predictive Validity of an Automaticity Subscale of the Self-Report Habit Index. *The International Journal of Behavioral Nutrition and Physical Activity* 9 (2012), 102. <https://doi.org/10.1186/1479-5868-9-102>
- [3] Peter M. Gollwitzer. 1999. Implementation intentions: Strong effects of simple plans. *American Psychologist* 54, 7 (1999), 493–503. <https://doi.org/10.1037/0003-066X.54.7.493>
- [4] Rob W. Holland, Henk Aarts, and Daan Langendam. 2006. Breaking and creating habits on the working floor: A field-experiment on the power of implementation intentions. *Journal of Experimental Social Psychology* 42, 6 (nov 2006), 776–783. <https://doi.org/10.1016/j.jesp.2005.11.006>
- [5] Howard J. Klein, Michael J. Wesson, John R. Hollenbeck, Patrick M. Wright, and Richard P. DeShon. 2001. The Assessment of Goal Commitment: A Measurement Model Meta-Analysis. *Organizational Behavior and Human Decision Processes* 85, 1 (may 2001), 32–55. <https://doi.org/10.1006/obhd.2000.2931>
- [6] Phillippa Lally and Benjamin Gardner. 2013. Promoting habit formation. *Health Psychology Review* 7, sup1 (may 2013), S137–S158. <https://doi.org/10.1080/17437199.2011.603640>
- [7] Phillippa Lally, Cornelia H M Van Jaarsveld, Henry W W Potts, and Jane Wardle. 2010. How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology* 40, 6 (2010), 998–1009.
- [8] Sheina Orbell and Bas Verplanken. 2010. The automatic component of habit in health behavior: habit as cue-contingent automaticity. *Health Psychology* 29, 4 (2010), 374.
- [9] Andrew Prestwich, Rebecca Lawton, and Mark Conner. 2003. The use of implementation intentions and the decision balance sheet in promoting exercise behaviour. *Psychology & Health* 18, 6 (dec 2003), 707–721. <https://doi.org/10.1080/08870440310001594493>
- [10] Ian Renfree, Daniel Harrison, Paul Marshall, Katarzyna Stawarz, and Anna L. Cox. 2016. Don't Kick the Habit: The Role of Dependency in Habit Formation Apps. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '16*. 2932–2939. <https://doi.org/10.1093/ajae/aaq155>
- [11] Paschal Sheeran, Thomas L Webb, and Peter M Gollwitzer. 2005. The Interplay Between Goal Intentions and Implementation Intentions. *Personality and Social Psychology Bulletin* 31, 1 (jan 2005), 87–98. <https://doi.org/10.1177/0146167204271308>
- [12] Katarzyna Stawarz, Anna L Cox, and Ann Blandford. 2015. Beyond Self-Tracking and Reminders: Designing Smartphone Apps That Support Habit Formation. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 2653–2662. <https://doi.org/10.1145/2702123.2702230>
- [13] Stephen Sutton. 1998. Predicting and explaining intentions and behavior: How well are we doing? *Journal of Applied Social Psychology* 28, 15 (1998), 1317–1338. <https://doi.org/10.1111/j.1559-1816.1998.tb01679.x>
- [14] Robert Tobias. 2009. Changing behavior by memory aids: A social psychological model of prospective memory and habit development tested with dynamic field data. *Psychological Review* 116, August (2009), 408–438. <https://doi.org/10.1037/a0015512>
- [15] Bas Verplanken and Henk Aarts. 1999. Habit, Attitude, and Planned Behaviour: Is Habit an Empty Construct or an Interesting Case of Goal-directed Automaticity? *European Review of Social Psychology* 10, September (1999), 101–134. <https://doi.org/10.1080/14792779943000035>
- [16] Wendy Wood and David T Neal. 2007. A new look at habits and the habit-goal interface. *Psychological review* 114, 4 (2007), 843.