

# Personalized Routine Support for Tackling Medication Non-Adherence

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## ABSTRACT

Behavior change interventions addressing medication non-adherence tend to focus on intentional behavior and seem to ignore the fact that even motivated people can sometimes forget to take their medication. Behavior change often conjures up ideas of modifying or breaking bad habits; we argue that focusing on the development of good habits could be used to support memory and reduce unintentional non-adherence caused by forgetfulness. But the purposeful development of reliable habits is not easy. Our research shows that daily routines play an important role in supporting remembering of a medication regimen. We believe that, by facilitating the creation of good habits embedded into one's own personalized daily routine, technology could not only reduce unintentional medication non-adherence, but also provide a better support in other types of health-related behavior change interventions.

## Author Keywords

Forgetfulness; habits; routines; personalization

## ACM Classification Keywords

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

## INTRODUCTION

Behavior change interventions aim to alter a set of behavior patterns [12] and in many cases rely on creating, changing or breaking habits [11]. Even though behavior is facilitated by both intentions and habits [18], the majority of health-related behavior change interventions focus on intentional behavior [12], especially those targeting medication non-adherence [6]. And yet, even motivated people can sometimes forget and simple forgetfulness is the main cause of 30% of cases of unintentional non-adherence [19]. It affects both chronic health conditions and preventative therapies: for example, each year approximately one million unwanted pregnancies in the US are caused by medication non-adherence [15] and as many as 76% of women who conceived while using oral contraception did so because they had not taken their pills regularly [9].

Interventions explicitly addressing forgetfulness are few and far between, and they tend to neglect the habitual

nature of medication-taking and the fact that medication regimens can be easily incorporated into daily routines. Instead, these interventions and available technology focus on timer-based reminders and alerting patients to take medication at a specified time [6, 17, 20]. This approach requires patients to respond immediately so that the action is not forgotten [3], which can cause problems: interventions often use text messages [7, 20] that cannot be postponed and many reminder apps do not offer the snooze option [17].

We argue that habits play as important a role in supporting medication adherence as they do in other health-related behavior change interventions. Our investigation of medication-taking strategies shows that regardless of the type of regimen, daily routines are key in supporting remembering, even though they can be fragile. A technology guiding users and facilitating the creation of personalized, resilient routines that match their circumstances could not only support medication adherence, but would be beneficial to other areas of health-related behavior change.

## HABITS AND BEHAVIOUR CHANGE

Habits are an effect of the gradual learning of patterns of behavior and associations between the task or its features and the environment (e.g. physical location, preceding actions), especially when actions are regularly performed in a sequence in a stable context [21, 13]. Like implementation intentions [5], they are represented mentally as goal-action pairs controlled by contextual cues, and the strength of the association depends on the frequency of the behavior [1].

Many health goals such as maintaining healthy diet or taking medication often rely on repeating a specific behavior, and this repetition is key in supporting habit formation [10, 16]. Repetition leads to increased automaticity of behavior, which reduces cognitive load and allows people to efficiently complete their tasks without much deliberation [2]. At the same time, automatic behavior is characterized by unintentionality, uncontrollability and a lack of awareness [2], which can lead to repetition and omission errors [4]. Nevertheless, the automaticity of habitual behavior and the links between the task and the environment make habits a useful tool in supporting medication-taking.

## HABITS AND MEDICATION-TAKING

Many medication regimens are habitual in nature: medications need to be taken regularly and within a particular period of time, and just as with other habits, patients learn to associate their doses with a specific time of day, location or event. Associating medication with routine events such as meals is especially beneficial, as the presence of the routine guides the behavior and provides more contextual cues [14]. According to the Medication Adherence Model [8], such patterned behavior is an important part of medication-taking and supports patients' memory as it is personalized, unique for each individual and reflects their lifestyle and daily activities.

To understand to what degree daily routines support medication-taking and reflect patients' everyday lives, we conducted two surveys with populations representing two distinct medication regimens: long-term habitual preventative therapy and a short-term, strict regimen.

### Remembering Oral Contraception

Oral contraception was selected as an example of a long-term habitual regimen. 971 women (76% aged 18-25) responded to the survey [17]. At the time of the survey, 16% of women were taking the Pill for less than a year, 57% for 1-5 years and 27% for over 5 years. Their remembering strategies reflected the habitual nature of the regimen and were highly personalized. Taking the Pill was linked to routine events such as waking up (35%) or going to sleep (28%), and women kept their pills by the bed (52%), in a handbag or a purse (20%) or in the bathroom (9%). For 61% of survey respondents pill-taking was a part of their daily routine. However, while the presence of routines supported their memory, they still missed doses (41% completely forgot a pill at least once in the past month and 69% took it late), although less often compared to women for whom pill-taking was not a part of the routine (56% completely forgot and 86% took it late at least once in the past month).

The reliance on routines had its price: changes in the daily routine (54%), being busy or distracted (47%) and travelling (23%) were the main reasons of forgetting. This illustrates the fragility of routines and dangers of automatic behavior, and presents an opportunity for a technology that could help to tailor more robust and personalized remembering strategies. However, only 25% of respondents reported using some sort of technology, mainly their cell-phone's alarm clocks (20%), which cannot support habit formation. Only 45 women (5%) used reminder apps to help them remember, including 14 women (1%) who used dedicated medication reminder apps. All remembering strategies are summarized in Figure 1.

### Remembering Antibiotics

The second survey investigated how parents remember their children's antibiotics. The aim was to compare and contrast remembering strategies developed by patients on a long-

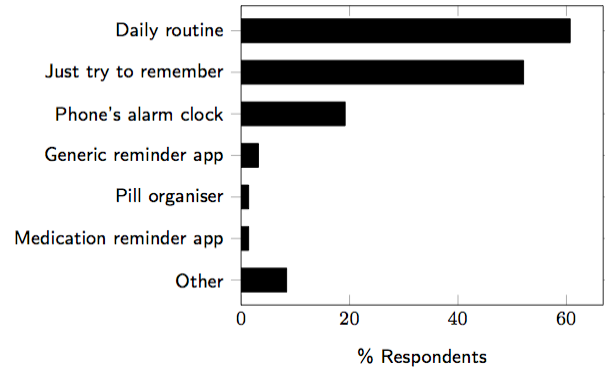


Figure 1. Remembering strategies developed by women taking oral contraception (N=971)

term single-dose habitual regimen with those developed by patients on a short-term multi-dose strict regimen, and to explore the role routines play in supporting both of them.

88 parents filled in the survey. They reported forgetting quite often: 59% missed 1-2 doses and 19% missed 3-4 doses last time their child was on antibiotics. Assuming an average of three daily doses need to be taken for a week, there are 21 opportunities to forget, which means that 59% of respondents reported missing 5-10% of doses and 19% reported forgetting 15-20% doses. Given that the majority of respondents admitted they did not use any specific strategies and "simply tried to remember" (61%), the high number of missed doses does not come as a surprise. However, even though it was assumed that technology could be more useful in supporting short-term strict regimens, only 24% of respondents used reminders. Remembering strategies are summarized in Figure 2.

Routines and a stable context were important in supporting remembering. 28% of respondents said that antibiotics were a part of their daily routine. To support their memory, 85% of respondents kept antibiotics in the kitchen and 75% in the fridge or a kitchen cabinet, which made taking the doses with meals easier.

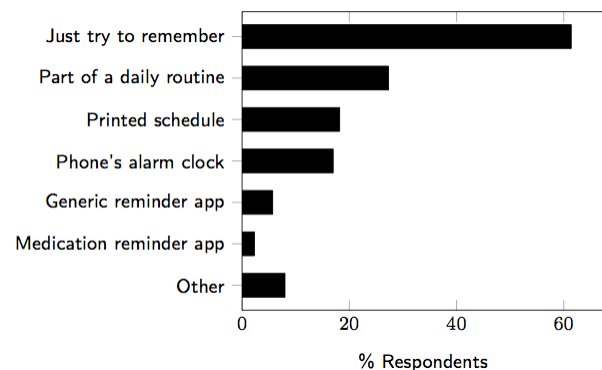


Figure 2. Strategies developed by parents to remember their children's antibiotics (N=88)

## Discussion

Remembering medication is a habitual action and as such relies on repetition and daily routines. Results of both surveys show that, regardless of the type of regimen, remembering strategies are similar and reflect personal circumstances. In both cases routines play an important role in supporting medication-taking, although that role differs between the two groups.

Among women taking oral contraception, pill-taking is often attached to a specific daily action or an existing routine. Because women tend to take their pills for years, with time they form a habit and can remember without using any external aids – the behavior becomes automatic.

Antibiotics, on the other hand, become temporarily attached to existing events and “ride” on existing routines (such as regular meals) until the end of the treatment. In this case there is not enough time to form a new independent habit, but existing routines and the location provide enough cues to support remembering.

## HOW CAN TECHNOLOGY SUPPORT DAILY ROUTINES?

These two studies show that contextual cues that are unique for each individual and their personalized routines are effective remembering strategies and can be used to support both long-term preventative therapies such as oral contraception and short-term strict regimens such as antibiotics. The presence of routines and stable context guide the behavior and reduce cognitive load, making remembering easier. However, at the same time the fact that routines depend on a specific context and cues makes them vulnerable to change. This vulnerability, however, opens up new opportunities for technology-based support.

Results of these studies also show that people tend not to use technology. To better understand why, we conducted a review of 229 medication reminder apps available for iPhone and Android smartphones [17]. We discovered that the apps not only focus on timer-based reminders and do not support habit formation, but also the majority of them do not provide a simple ‘snooze’ option, which makes it harder to respond to the reminder. However, despite these

limitations, we believe that current smartphones have capabilities to support the creation and maintenance of resilient strategies, especially if location tracking and accelerometer data that help to understand where the user is are taken into account. Smartphones could assist users in selecting the right routine or modifying the behavior so it better matches their circumstances and is more meaningful and memorable. They could also intervene in situations when the routine changes and provide relevant assistance. More detailed suggestions on how this could be done can be found in [17].

We are interested in discussing the potential of personalized routines in the context of health behavior change, relevant personalization strategies, technical solutions that could be adapted from broader behavior change interventions to medication-adherence and vice versa, and the underpinning theories.

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## BIOS

**Katarzyna Stawarz** is a PhD candidate at UCL Interaction Centre and her research focuses on understanding how technology could facilitate the creation of resilient daily routines that support medication-taking habits.

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**Professor Ann Blandford** is Professor of HCI in the Department of Computer Science at UCL, and a member of UCL Interaction Centre. She has experience of evaluating complex systems “in the wild”, whether in relation to human error or the use of information; her research now focuses on Digital Healthcare.

## REFERENCES

1. Aarts, H., Dijksterhuis, A. Habits as knowledge structures: Automaticity in goal-directed behaviour, *Journal of Personality and Social Psychology*, 18, 1 (2000), 53–63.
2. Bargh, J. A. The four horsemen of automaticity: awareness, intention, efficiency, and control in social cognition. In R. S. Wyer & T. K. Srull (Eds.), *Handbook of social cognition: Vol I basic processes*. Lawrence Erlbaum Associates (1994), 1–40.
3. Cramer, J. A. Overview of Methods to Measure and Enhance Patient Compliance. In Cramer, J. A. & Spilker, B. (eds.) *Patient compliance in medical practice and clinical trials*, Raven Press, 3–10.
4. Einstein, G. O., McDaniel, M. A., Smith, R. E., & Shaw, P. Habitual Prospective Memory and Aging: Remembering Intentions and Forgetting Actions. *Psychological Science*, 9, 4 (1998), 284–288.
5. Gollwitzer, P. Implementation Intentions: Strong Effects of Simple Plans. *American Psychologist*, 54, 7 (1999), 493–503.
6. Haynes, R. B., Ackloo, E., Sahota, N., McDonald, H. P., Yao, X. Interventions for enhancing medication

- adherence. *Cochrane database of systematic reviews*, CD000011 (2008).
7. Hou, M., Murwitz, S., Kavanagh, E., Fortin, J., Goldberg, A. Using Daily Text-Message Reminders to Improve Adherence with Oral Contraceptives: A Randomized Controlled Trial, *Obstetrics & Gynecology*, 3, 116 (2010), 633–640.
  8. Johnson, M. J. The Medication Adherence Model: A Guide for Assessing Medication Taking. *Research and Theory for Nursing Practice*, 16, 3 (2002), 179–192.
  9. Jones, R. K., Darroch, J. E., Henshaw, S. K. Contraceptive Use Among U.S. Women Having Abortions in 2000-2001. *Perspectives on Sexual and Reproductive Health*, 34, 6 (2002), 294–303.
  10. Lally, P., Chipperfield, A., Wardle, J. Healthy habits: Efficacy of simple advice on weight control based on a habit formation. *International Journal of Obesity*, 32 (2008), 700–707.
  11. Lally, P. & Gardner, B. Promoting habit formation. *Health Psychology Review*, 7, Suppl. 1 (2011), 1-22.
  12. Michie, S., van Stralen, M. M., West, R. The behavior change wheel: A new method for characterizing and designing behavior change interventions, *Implementation Science*, 6, 1 (2011), 42.
  13. Neal, D. T., Wood, W., Labrecque, J. S., Lally, P. How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology*, 48, 2 (2012), 492-498.
  14. Park, D. C., Kidder, D. P. Prospective memory and medication adherence. In Brandimonte, M., Einstein G. O., McDaniel, M. A. (eds) *Prospective memory: Theory and applications*, Lawrence Earlbaum Associates, 369–390.
  15. Rosenberg, M. J., Waugh, M. S. Causes and consequences of oral contraceptive noncompliance. *American Journal of Obstetrics and Gynecology*, 180, 2 Pt 2 (1999), 276–279.
  16. Rothman, A. J. Toward a theory-based analysis of behavioral maintenance. *Health Psychology*, 19, Suppl. 1 (2000), 4-17.
  17. Stawarz, K., Cox A., Blandford, A. Don't forget your pill! Designing effective medication reminder apps that support users' daily routines, In. *Proc. CHI 2014*, ACM Press (2014), in press.
  18. Triandis, H. C. *Interpersonal behavior*. Brooks/Cole Publishing Company (1977).
  19. Unni, E. J., & Farris, K. B. Unintentional non-adherence and belief in medicines in older adults. *Patient education and counseling*, 83, 2 (2011), 265–268.
  20. Vervloet, M., Linn, A. J., van Weert, J. C. M., de Bakker, D. H., Bouvy, M. L., and van Dijk, L., The effectiveness of interventions using electronic reminders to improve adherence to chronic medication: a systematic review of the literature, *JAMIA*, 19, 5 (2012), 696–704.
  21. Wood, W., & Neal, D. T. A new look at habits and the habit-goal interface. *Psychological Review*, 114, 4 (2007), 843–8.