# Designing Reflective Dialogues on Self-Tracking Data

**Rafal Kocielnik**
University of Washington
Seattle, USA
rkoc@uw.edu

**Gary Hsieh**
University of Washington
Seattle, USA
garyhs@uw.edu



## Abstract
Despite recent interest in conversational assistants, relatively little of that revolution has affected the behavior change domain. Few applications on the market generally just repackage the already well-supported functionalities in a dialogue-based form. In this paper we explore the design of dialogues for scenario that can uniquely benefit from conversational interaction: A guided reflection on self-tracking data. Using a framework of reflection in learning, we define 3 unique reflective engagement scenarios: 1) discovering patterns in self-tracking data, 2) understanding past behaviors, and 3) forming future plans. For each scenario, we discuss the value of dialogue-based approach and propose a concrete interaction flow.

## Author Keywords
Behavior change; reflection; dialogues

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

## Introduction
Despite recent progress in dialogue-based interaction, relatively little has been done to bring these conversational capabilities to the behavior change domain [1]. Few attempts that have been made, such

**Identifying patterns in self-tracking data: example interaction**

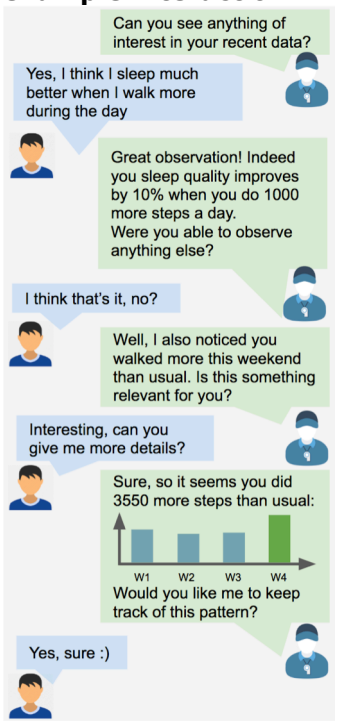



Figure 2: Example interaction for identifying patterns in self-tracking data. It is assumed here, that the dialogue is added on top of a personal-informatics tool with visualization dashboard (e.g. FitBit).

as Lark[1], HealthyBot[2], and CountIt[3], still leverage dialogue-based interaction to support user tasks that could already be done quite well, if not better, without conversational support. Specifically, HealthyBot and CountIt mainly provide motivational activity triggers through Slack. This is not different than SMS and email based reminders already in use [2]. Also the user input there is limited to querying information, a replacement for clicking a button. Lark interviews users for basic profile information and weaves in reports of activity into the chat, but such functionalities could be well realized using survey and visual dashboards.

We argue that these are not the best and most needed scenarios to be supported and not the best to benefit form dialogue based interaction. There are, however, areas for which dialogue-based interaction could be very helpful. One such area is reflection on behavior change [3]. Reflection is one of the goals of several effective non-technology based personal counseling techniques such as motivational interviewing [4].

In human-based counseling, the main focus is on helping people understand their own behavior and work towards effective solutions through thoughtful and constructive reflection [4]. This is contrary to many current technology-based systems, which focus mainly on prescribing actions, offering reminders, or supporting self-tracking [7]. Yet thorough reflective process user commitment to behavior change is not "forced", but emerges from the person herself and usually garners higher commitment [7]. Still, technology has struggled to support refection [3], [8]. As observed in [9] *"prior work carries an implicit assumption that [just] by providing access to data that has been 'prepared, combined, and transformed' for the purpose of reflection, reflection will occur."*

One principle of reflective techniques, such as motivational interviewing is to provide guidance [4]. That is positioned between just passively observing what the user does (e.g. tracking) and forcefully prescribing actions (e.g. persuading). In this work we define a number of guidance scenarios in which reflective dialogues make use of self-tracking data to help users better understand their own actions, form interpretations and hypotheses about behaviors, and define future goals. As reflection is a process rather than a single activity [10], we scaffold it using a reflection in learning framework [11].

## Identifying patterns in self-tracking data

Automated self-tracking offers objective information that can help users discover unknown behaviors, check on progress and help form realistic future goals. All these benefits are, however, only possible if the user can notice and understand the relevant patterns. Reflection framework describes it as **noticing** in which the person needs to, purely perceptually, notice the reflective material for any further steps to occur [11].

Most approaches in personal informatics rely on user's own curiosity and ability to systematically analyze visualizations of their data [3]. A noticeable attempt at supporting users in such task has been presented in HealthMashups [12], where system actively detects

[1] http://www.web.lark.com/

[2] https://healthybot.io/

[3] https://beta.countit.com/

**Understanding observed patterns: example interaction**


Figure 4: Example dialogue exchange for understanding patterns observed in the self-tracking data. It is assumed here, that the user already identified interesting patterns (e.g. though a different dialogue).

patterns and reports them in text. However, no support for any reflection on such patterns is attempted.

We propose a dialogue-based interaction that guides the user through identifying relevant patterns (Fig 1).

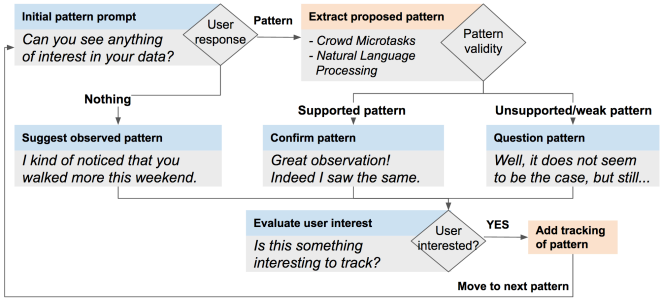



**Figure 1**: A conceptual dialogue structure for supporting reflection on patterns in self-tracking data.

Users are first prompted to actively think about the patterns themselves and offered support to guide such discovery if needed. Hence instead of starting with: *"You walked 20% more than this Friday."* the dialogue begins with *"Was there a day when you walked much more?"* There are two reasons for this. First, when user identifies pattern herself it is more likely to be remembered [13]. Second, automated techniques can identify thousands of irrelevant patterns [12] hence human cooperation helps keep track of the interesting ones. Going further the dialogue confronts the user observations with measured data and helps identify patterns interesting to track for the future. We see such dialogue as actually coupled with a visualization dashboard. To balance user tedium with manual pattern recognitions, different dialogue prompts (see Table 1) can be employed to offer different levels of guidance as needed. An example interaction is shown in Fig 2.

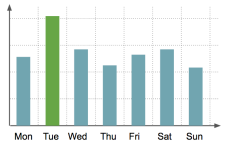
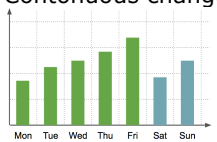
| Data patterns | Pattern specific prompts |
|---|---|
| One time outlier   | **Abstract:** *"Was there a day when you walked much more?"* **Directing:** *"Can you see anything specific about your behavior on Tuesday?"* |
| Contonuous change   | **Abstract:** *"Was there anything specific about your walking throughout the week?"* **Directing:** *"Can you see any change in your walking from Monday to Friday?"* |

**Table 1**: Example data patterns and associated two potential prompting approaches: 1) abstract – requires more work from the user, but can be beneficial for remembering, 2) directing – points directly to the pattern and lowers user effort.

## Understanding past behaviors

Even successfully identifying patterns in the data, does not necessarily lead to meaningful interpretation and actionable decisions [14]. An important step of making sense of the data is needed. Such step is described in the reflective framework as **making meaning [11]**. This is when a person revisits the past with an attempt to understand and form an explanation for the behavior. There are at least two challenges here. The person may not be able to recall the situation as the information needed for explaining the behavior may not be captured by self-tracking (e.g. the system "knows" the user did not sleep well, but not that she was drinking the night before) [15]. User may also be unable to connect the self-tracking data to the context in which pattern appeared in a meaningful way (e.g. not seeing the link between sleep and drinking). Many existing systems support such purpose by offering annotations for better recall [16].

## Reflecting on goals and future plans: example interaction

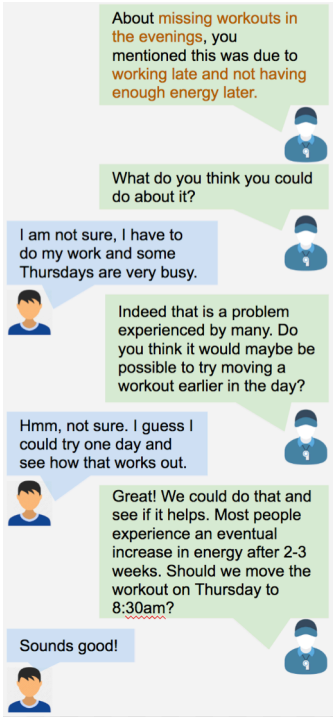



Figure 6: Example dialogue exchange for reflecting on goals and future behavior change plans. It is assumed here, that the user already identified interesting patterns (e.g. though a pattern identification dialogue) and provided some explanations for these patterns (e.g. through understanding the patterns dialogue)

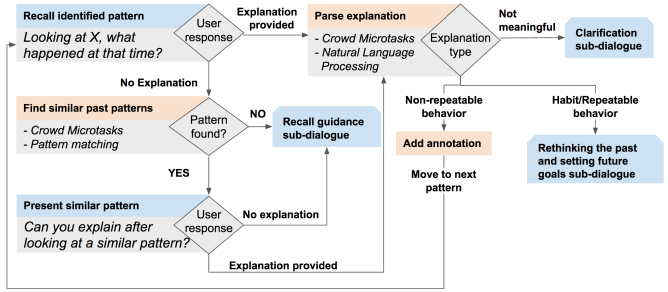



**Figure 3**: A conceptual dialogue structure for supporting forming understanding of past behaviors.

We propose a dialogue-based interaction that can guide the user thorough forming understanding and explanations of behavior patterns (Fig 3). We first trigger the user to think about the explanations of observed patterns. Such trigger itself may lead the person to successful reflection. In case of difficulties the dialogue assists by presenting similar patterns from the past or offering guidance in retracing steps of an activity. An example interaction is shown in Fig 4.

### Thinking about future actions

A crucial step in behavior change is helping people set their own goals for achieving their desired behaviors [17]. This can be paralleled with **transformative learning** step in the reflective framework [11]. The power of reflective approach here is that through working together with the users, the goals are formulated by the users themselves and hence have stronger fit and motivational support that when a goal is given a priori [4]. Dialogue based interaction lends itself well to supporting such reflection as arriving at meaningful and measurable goals is oftentimes an iterative process [18].

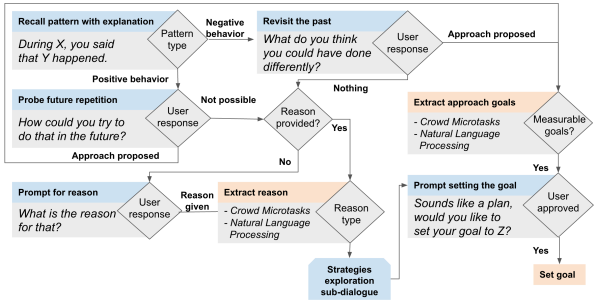



**Figure 5**: A conceptual dialogue structure for supporting reflection on future actions.

We propose a dialogue-based guidance presented in Fig 5. It essentially prompts the user to think about what could have been done differently in case of negative behavior pattern. In case of positive pattern, it directly asks the user to think about how such pattern can be repeated in the future. Depending on user reply, the dialogue tries to guide user towards formulating goals or explores the barriers user has for trying the change in the future. Ideally the dialogue results in a new set of goals. An example interaction is shown in Fig 6.

### User experience design challenges

Two particularly important aspects of design for reflective conversation is empathy and trusts towards the agent. Refection is a continuous process and agent's status as a guide requires a long-term relationship with the user. Design for empathy can potentially leverage motivational interviewing techniques for empathy building, such as use of open-ended questions to avoid interrogation style of conversation, as well as use of affirmations [19]. The design for trust is equally, if not more, important. Trust has been decomposed into aspects of competence and

likeability in past work [20]. While credibility relies on agent not making mistakes, which is a technical challenge, the trustworthiness can be designed for by making the agent likeable e.g. through physically attractive appearance [21]. Another design approach that has been shown to reduce user frustration from agent mistakes relies on tailoring the dialogue structure itself, e.g. towards a specific culture of the user [22].

Another important design aspect is integration with self-tracking data. Closely coupling the reflective dialogue with the data visualization can be beneficial in many ways. First of all, it gives more concrete information for users to reflect on and increases the agent's transparency [23]. It can also help the user create a mixed conversation-visual narrative along the lines of visual storytelling [24]. Nevertheless, such close integration can be realized in many ways: e.g. by placing one chat box on a self-tracking dashboard; by creating multiple separate mini-dialogues around specific data pieces or by injecting the visualizations into the dialogue itself.

## Discussion and Future directions

We plan to implement these dialogues and test their effectiveness in triggering reflection. Dealing with open user input can be challenging, but tools such as Louis[4] or Watson Conversation[5] seem well suited for the task.

## Acknowledgments

This work was supported by National Science Foundation grant #1348543.

[4] https://www.luis.ai/

[5] https://www.ibm.com/blogs/watson/2016/12/build-chat-bot/

## References

[1] V. Götzmann, "Towards a Persuasive Dialog System Supporting Personal Health Management," National Research Center, 2015.

[2] R. Kocielnik and G. Hsieh, "Send Me a Different Message: Utilizing Cognitive Space to Create Engaging Message Triggers," *Proc. 20th ACM Conf. Comput.-Support. Coop. Work Soc. Comput.*, p. 2017.

[3] R. Fleck and G. Fitzpatrick, "Reflecting on reflection: framing a design landscape," in *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction*, 2010, pp. 216–223.

[4] C. for S. A. Treatment, *Chapter 3—Motivational Interviewing as a Counseling Style*. Substance Abuse and Mental Health Services Administration (US), 1999.

[5] C. Abraham and S. Michie, "A taxonomy of behavior change techniques used in interventions.," *Health Psychol.*, vol. 27, no. 3, p. 379, 2008.

[6] D. E. Conroy, C.-H. Yang, and J. P. Maher, "Behavior change techniques in top-ranked mobile apps for physical activity," *Am. J. Prev. Med.*, vol. 46, no. 6, pp. 649–652, 2014.

[7] F.-E. Kinnafick, C. Thøgersen-Ntoumani, and J. L. Duda, "Physical Activity Adoption to Adherence, Lapse, and Dropout A Self-Determination Theory Perspective," *Qual. Health Res.*, vol. 24, no. 5, pp. 706–718, 2014.

[8] V. Rivera-Pelayo, V. Zacharias, L. Müller, and S. Braun, "Applying quantified self approaches to support reflective learning," in *Proceedings of the*

*2nd international conference on learning analytics and knowledge*, 2012, pp. 111–114.

[9] E. P. Baumer, V. Khovanskaya, M. Matthews, L. Reynolds, V. Schwanda Sosik, and G. Gay, "Reviewing reflection: on the use of reflection in interactive system design," in *Proceedings of the 2014 conference on Designing interactive systems*, 2014, pp. 93–102.

[10] D. A. Epstein, A. Ping, J. Fogarty, and S. A. Munson, "A lived informatics model of personal informatics," in *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, 2015, pp. 731–742.

[11] J. A. Moon, *Reflection in Learning and Professional Development: Theory and Practice*. Routledge, 2013.

[12] K. Tollmar, F. Bentley, and C. Viedma, "Mobile Health Mashups: Making sense of multiple streams of wellbeing and contextual data for presentation on a mobile device," in *2012 6th International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth) and Workshops*, 2012, pp. 65–72.

[13] Y.-S. Kim and J. Hullman, "User-driven Expectation Visualization: Opportunities for Personalized Feedback," 2015.

[14] I. Li, A. K. Dey, and J. Forlizzi, "Understanding my data, myself: supporting self-reflection with ubicomp technologies," in *Proceedings of the 13th international conference on Ubiquitous computing*, 2011, pp. 405–414.

[15] I. Li, "Personal Informatics and Context: Using Context to Reveal Factors that Affect Behavior," *Dissertations*, Aug. 2011.

[16] A. Pirzadeh, L. He, and E. Stolterman, "Personal informatics and reflection: a critical examination of the nature of reflection," in *CHI'13 Extended Abstracts on Human Factors in Computing Systems*, 2013, pp. 1979–1988.

[17] E. A. Locke and G. P. Latham, "New Directions in Goal-Setting Theory," *Curr. Dir. Psychol. Sci.*, vol. 15, no. 5, pp. 265–268, Oct. 2006.

[18] T. J. Bovend'Eerdt, R. E. Botell, and D. T. Wade, "Writing SMART rehabilitation goals and achieving goal attainment scaling: a practical guide," *Clin. Rehabil.*, vol. 23, no. 4, pp. 352–361, 2009.

[19] L. Sobell and M. Sobell, "Motivational interviewing strategies and techniques: Rationales and examples," *Retrieved April*, vol. 24, p. 2015, 2008.

[20] L. C. Young and G. S. Albaum, *Developing a Measure of Trust in Retail Relationships: A Direct Selling Application*. School of Marketing, University of Technology, Sydney, 2002.

[21] B. F. Yuksel, P. Collisson, and M. Czerwinski, "Brains or Beauty: How to Engender Trust in User-Agent Interactions," *ACM Trans. Internet Technol. TOIT*, vol. 17, no. 1, p. 2, 2017.

[22] B. Dhillon, R. Kocielnik, I. Politis, M. Swerts, and D. Szostak, "Culture and facial expressions: A case study with a speech interface," in *IFIP Conference on Human-Computer Interaction*, 2011, pp. 392–404.

[23] P. C. Shih, K. Han, E. S. Poole, M. B. Rosson, and J. M. Carroll, "Use and Adoption Challenges of Wearable Activity Trackers," Mar. 2015.

[24] R. Kosara and J. Mackinlay, "Storytelling: The Next Step for Visualization," *Computer*, vol. 46, no. 5, pp. 44–50, May 2013.