Short and Long-Term Benefits of Reflective Technologies

Artie Konrad
UC Santa Cruz
1156 High St
Santa Cruz, CA, 95064, USA
akonrad@ucsc.edu

Steve Whittaker
UC Santa Cruz
1156 High St
Santa Cruz, CA, 95064, USA
swhittak@ucsc.edu

Ellen Isaacs
PARC
3333 Coyote Hill Rd
Palo Alto, CA 94304, USA
Ellen.isaacs@parc.com

CHI 2013, April 27-May 2, 2013, Paris, France.
ACM 978-1-60558-930-5/10/04.

Abstract
New reflective systems are making it increasingly easier to make rich records of everyday activities and later reflect on these records. While these systems and other reflective tools such as Facebook Timeline are becoming more popular, few systematic studies have investigated their effects. Our work uses a combination of quantitative and qualitative methods to demonstrate short and long-term well-being benefits of reflection and identifies two different mechanisms that mediate these benefits. We also describe new work visualizing emotional habits. Our findings have important therapeutic implications, and suggest that reflective systems support natural adaptive memory processes.

Keywords
Reflection, emotion regulation, mobile technology, awareness.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
As social media and new reflective tools grow in popularity and ubiquity, people increasingly capture their daily activities, often **revisiting** these records at a

later time (e.g. Facebook Timeline). Posting photos and status updates gives people and their friends a simple method for accessing **veridical** information of the past. While Psychologists have extensively studied **memory** and **reflection**, few studies have considered how social media and reflective systems are fundamentally changing how we remember the past. Even less is known about whether these systems adaptively engender well-being benefits from reflection, or whether they interfere by potentially providing reminders of negative events that are best forgotten. We call this practice of using technology to create veridical records which are later reflected upon Technology-Mediated Reflection (**TMR**) [7]. In this paper, we describe our investigations into whether TMR benefits well-being, identifying **mechanisms** that drive these benefits. We describe long and short term evaluations.

Related Work

Physical Technology. There has been recent interest in technology that **monitors** and **records** physical information such as exercise, diet, and sleep patterns. These patient-centric systems provide awareness of habits and focused aspects of health with the aim of facilitating behavior change and goal achievement. By monitoring ones physical health, patients are given direct feedback about their progress in reaching goals and they are often connected to others for motivational support. While similar psychological systems are emerging, there is less research about systems that monitor emotional habits and well-being.

Recording Technology. Lifelogging systems [18] capture rich records of everyday activities. Such systems have been shown to improve memory and self-efficacy in Alzheimer's patients [2]. While lifelogging refers to the process of recording or logging life events as they are experienced, some commercial systems such as MemoLane, MorningPics, Timehop, and Everyday.me send back these records after time has passed. However, unlike TMR these tools only remind users of past events without facilitating **evaluation** and **repeated reflection** of one's changing reaction to those events.

Reminiscence Technology. Perhaps most similar to TMR, other memory tools have been designed to support **reminiscence**. Tools such as PosiPost Me [9] facilitate social reminiscence by sharing positive posts with friends to improve well-being. MobiMood [5] and eMoto [6] allow the sharing of emotional data with friends. Pensieve [12] supports reflection by providing users with past Facebook status posts and asks them to write their current reactions to these memories. Participants reported that they enjoyed this reflective process and that it improved their mood. Lastly, some systems have explored novel visualizations of emotional data to provide new insight on past events [5, 11].

Unmediated Reflection and Recording

Reflection. Reflecting on our past emotional experiences is beneficial for both physical and psychological health. For instance, reflection has been shown to reduce medical clinic visits [4], improve immune response [17], and increase subjective well-being [15]. Reflecting on **positive** events (e.g. thinking about past successes, friendships) has shown to be adaptive and increases perceived enjoyment of life [3] and positive affect [20]. Over 200 studies have shown that reflecting on **negative** events is also

adaptive for well-being [14] potentially because it allows people to **distance** themselves from traumas [13], and facilitates the construction of "redemption narratives" [20]. A **redemption narrative** is a shift in perception of a negative life event to a more positive, triumphant evaluation.

Recording. Recording involves **registering** and **evaluating** events in the present. Unlike reflection, it does not require events to be revisited after time has passed and can be done when events occur (or shortly after). Recording every day experiences has been shown to increase subjective well-being [10]. There are two ways that recording could succeed. Recording positive experiences increases subjective well-being because it enhances awareness and emotional intensity of positive aspects of life [1,8]. This type of recording is called **savoring**. Recording negative experiences also increases subjective well-being because labeling events and emotions imposes an organization of one's understanding of the trauma [16]. This structuring allows the event to be processed and better understood which reduces the emotional intensity of the painful experience [19]. This type of recording is called **emotional disclosure**.

Echo Technology. While we know from research on unmediated human memory that there are huge benefits for both **recording** events as they happen and later **reflecting** on these records, we know less about **how** TMR influences these benefits. To understand the nature of TMR and how it compares to recording without reflection, we designed a mobile smartphone application called "Echo." Echo allows participants to record events of their choosing. A record consists of a label and short description of the event, and an emotional reaction to that event (ranging from '1' for a highly negative event, to '9' for a highly positive experience).

Recording vs. Reflecting Study

To assess how TMR affects well-being and understand potential mechanisms, we deployed Echo to two groups: a **reflection** group who recorded and reflected on three or more past events per day, and a **recording** group who simply recorded three events per day. We compared these groups by assessing changes in subjective well-being across four different psychological survey measures over a period of working with Echo for 28 days. We predicted that both groups would improve on the well-being measures since recording and reflecting have demonstrated benefits [20,14,8,19]. However, we predicted that there would be greater benefits for reflection because it supports analysis and perspective-taking. Furthermore, reflection would allow for distancing from negative experiences and the formation of redemption narratives which may provide additional benefits [20,13]

Participants

We recruited 38 participants randomized into a recording group or a reflecting group. Two were removed because of technical issues with their phones and 3 withdrew, leaving us with 33 total participants. They were aged 20 to 60 (M= 28.79, SD= 9.90). The recording group consisted of 17 participants (9 male, 8 female), and the reflecting group consisted of 16 participants (9 female, 7 male).

Materials

Participants were assessed using four validated standard well-being scales at pretest and posttest. These scales were:

• *Subjective Happiness Scale* (SHS): 4 item survey that assesses happiness of self, and self relative to others.
• *Satisfaction with Life Scale* (SWLS): 5 item survey that assesses overall life satisfaction.
• *Psychological General Well-Being Index* (PGWBI): 22 item survey that measures self-representations of affective and emotional states.
• *Mindfulness Attention Awareness Scale* (MAAS): 15 item survey that measures attentiveness to what is occurring in the present.

Procedure

Both groups were asked to make at least three recordings per day and to record a broad range of events that were experienced as emotionally positive, negative, or neutral. Additionally, the reflection group was asked to reflect on previous recordings at least three times per day. A reflection involved revisiting a previously recorded event and re-evaluating it by writing a short textual description of how they now felt about that event along with a new emotional rating of their current feelings about that event. When opening up Echo to make a recording, Echo would present three prior entries from different time periods for reflection (e.g. one day ago, one week ago, two weeks ago etc.). Additionally, participants in the reflection group could view their past entries at any time and reflect on any that they chose. The recording group worked with a simplified version of Echo with reflection capabilities removed. They were not able to view or reflect on any previous recordings. Comparing the two versions of the application allowed us to isolate the effects of reflection.

Results and Discussion

Data were analyzed using a mixed-design multivariate analysis of variances (MANOVA) with one between factor (recording vs. reflecting group) and one within factor (pretest vs. posttest time). The dependent variables were the four scales measuring aspects of well-being. The main effect for time (pretest vs. posttest) was significant for both groups as a whole on the combined dependent variables, with a large effect size $V = .31$, $F(4,28) = 3.09$, $p=.03$, $\eta_p^2=.31$. The interaction effect of time by group on the well-being measures was not significant, $V = .11$, $F(4,28) = .90$, $p=.48$, suggesting that neither group improved significantly more than the other.

In support of our first hypothesis, we found both groups improved their well-being over a period of one month. However, we also predicted that reflecting would result in greater well-being benefits than recording alone. We did not find support for this hypothesis. Reflection offered no additional benefits to recording alone.

To better understand the mechanisms of these benefits, we ran LIWC, a text analysis program that calculates usage of word categories. By examining how the language used in posts was correlated with subjective happiness, we discovered that Reflectors benefited from talking about **actions** (verbs: $r(10)=.61$, $p=.036$, auxiliary verbs: $r(10)=.59$, $p=.045$). They also benefited from discussing the **present** and the **future** ($r(10)=.79$, p=.002, and $r(10)=.60$, $p=.038$ respectively). This suggests that Reflectors benefited from focusing on their actions (verb use) and prescribing future lessons from present understanding. This is illustrated in the following post and reflection.

RF10 [3]: "*Parents left a note saying food in the fridge. They left me the smallest piece of meat. Fuck they make me angry. I know it my fault for not being present for dinner. But still my parents suck a little.*"
2 days later [5]: "*It's cool. I **shouldn't** act like such a spoiled brat. I knew that I'd feel this way later when I reflected on the anger I felt that night. Poop. This too shall pass.*"

Recorders, on the other hand, benefited more from discussing **relationships** (he/she: $r(15)=.54$, $p=.026$, talk about people: $r(15)=.49$, $p=.048$, sex: $r(15)=.53$, $p=.028$, and using quotes: $r(15)=.48$, $p=.049$). Rather than deriving behavioral lessons over time (as with reflection), Recorders experienced increased subjective happiness when their posts expressed interpersonal topics.

RC6 [7]: "*Just had the best most spiritually connected conversation with M after sitting in Sun in union square. So grateful that i can be so grateful with M about everything and feel so understood. Starting to just be me and do things despite what I think people will think.*"

Thus, while both groups received equivalent well-being benefits, a closer look suggests that these benefits are driven by **different mechanisms**. We have also conducted qualitative analyses of posts that support this, although we cannot present these here due to space constraints.

This unexpected finding has practical health implications. If recording alone brings equivalent benefits, then effective interventions could encourage simple event recording without needing additional reflection, improving patient compliance. Furthermore, an event can be written about and processed as it is happening, without needing to revisit painful experiences and dig up buried emotions. However, if the goal of the intervention is to help the patient understand their habits for health-related behavior change, reflective technologies might be a more promising solution.

Long Term Stability of Benefits

For a recording or reflecting intervention to be practical and worthwhile, it is important to **maintain** these well-being benefits for some time after the intervention has terminated. Since the posttest surveys were administered only a day after participants stopped using Echo, we have not yet established the stability of these well-being benefits. To assess whether the benefits seen after working with Echo for one month would be maintained, we re-administered the survey 4 months later. There were 17 long-term respondents, 8 female and 9 male. There were 9 in the recording group and 8 in the reflecting group. We compared well-being scores after 4 months with those obtained after one month using Echo

Results and Discussion

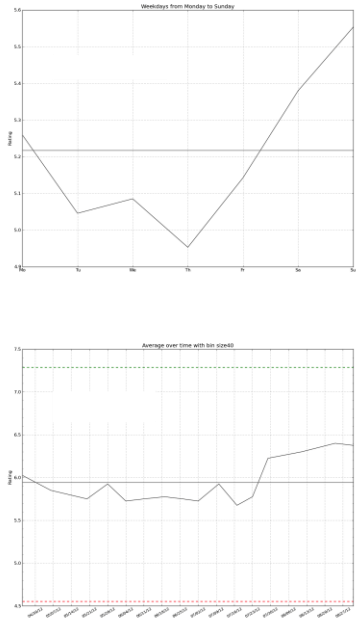
The main effect for time (pretest vs. posttest) was not significant for both groups as a whole on the combined dependent variables, $V = .35$, $F(4,12) = 1.59$, $p=.24$. The interaction of time by group on the well-being measures was also not significant, $V = .19$, $F(4,12) = .70$, $p=.61$, which suggests that neither group changed significantly more than the other.

The same results found after working with Echo for one-month were maintained four months afterwards. Both the recording group and the reflecting group had equivalent benefits and maintained these benefits even after the intervention had completed.

Visualizations

We are also exploring new techniques for **visualizing** previous records and reflections so that participants can become better aware of their emotional trajectories and triggers. We have interviewed participants who have used the system for 6 months to find what they can learn, for example, from reflecting on patterns showing long-term changes in their emotions.

Fig 1: Habitual emotion patterns showing moving average emotion rating each day for 4 months (bottom) and for different days of the week Mon-Sun (top), allowing participants to see long-term trends and recurrent emotional patterns.



Conclusions

This study gives us a better understanding of how new reflective technologies work and assist natural adaptive processes. We show that using Echo produced significant increases in well-being and we've begun to identify the underlying processes that drive these benefits. Both recording and reflecting contribute to well-being the same amount, but in different ways. By contributing to our knowledge of these differences, we are more efficiently able to design interventions.

Our new methodology for examining recording and reflection gives rise to new questions and exciting avenues for future research. Echo provides an opportunity for **lightweight**, **accurate** recording and reflection of a **rich variety** of everyday experiences. While not explicitly measured in our study, this methodology may provide an advantage over previous lab-settings and may contribute to improved intervention **compliance**. As a result of this methodology, we were able to work with 33 busy adults in a naturalistic setting as they recorded multiple times per day for a full month. This is promising for future research to use Echo as a new tool for answering fundamental questions about technology, memory and mental health.

References

[1] Boehm, J. K., & Lyubomirsky, S. (2009). The promise of sustainable happiness. In S. Lopez, & C. Snyder (Eds.), *Oxford handbook of positive psychology* (pp. 667-677). Oxford, England: Oxford University Press.

[2] Browne, G., Berry, E., Kapur, N., Hodges, S., Smyth, G., Watson, P., & Wood, K. (2011). SenseCam improves memory for recent events and quality of life

in a patient with memory retrieval difficulties. *Memory*, 19(7), 713-722.

[3] Bryant, F. B., Smart, C. M., & King, S. P. (2005). Using the past to enhance the present: Boosting happiness through positive reminiscence. *J. of Happiness Studies, 6*(3), 227-260.

[4] Cameron, L. D., & Nicholls, G. (1998). Expression of stressful experiences through writing: Effects of a self-regulation manipulation for pessimists and optimists. *Health Psychology, 17*(1), 84-92.

[5] Church, K., Hoggan, E., & Oliver, N. (2010). A study of mobile mood awareness and communication through MobiMood. *Proc NordiCHI '10*, ACM Press, 128-137.

[6] Fagerberg, P., Ståhl, A., & Höök, K. (2004). eMoto: Emotionally engaging interaction. *Personal Ubiquitous Computing,* 8(5), 377-381.

[7] Isaacs, E., Konrad, A., Walendowski, A., Lennig, T., Hollis, V., & Whittaker, S. (2013). Echoes from the past: How technology mediated reflection improves well-being. In *Proceedings of the 2013 Conference on Human factors in computing systems* (CHI '13). ACM, New York, NY, USA.

[8] Jose, P. E., Lim, B. T., & Bryant, F. B. (2012). Does savoring increase happiness? A daily diary study. *The Journal of Positive Psychology, 7*(3), 176-187.

[9] Kanis, M., & Brinkman, W. P. (2010). Making mundane pleasures visible: Mediating daily likings with lightweight technology. *Personal and Ubiquitous Computing,* 14(3), 261-269.

[10] Ko, H. C., & Kuo, F. Y. (2009). Can blogging enhance subjective well-being through self-disclosure? *CyberPsychology & Behavior, 12*(1), 75-79.

[11] McDuff, D., Karlson, A., Kapoor, A., Roseway, A., & Czerwinski, M. (2012). AffectAura: An intelligent system for emotional memory, *Proc. CHI '12*, ACM Press, 849-858.

[12] Peesapati, S. T., Schwanda, V., Schultz, J., Lepage, M., Jeong, S., & Cosley, D. (2010). Pensieve: Supporting everyday reminiscence. *Proc. CHI '10*, ACM Press. 2027-2036.

[13] Pennebaker, J. W. (2004). Writing to heal: A guided journal for recovering from trauma and emotional upheaval. Oakland, CA: New Harbinger Publisher.

[14] Pennebaker, J. W., & Chung, C. K. (2011). Expressive writing: Connections to physical and mental health. In H.S. Friedman (Eds.), *Oxford handbook of health psychology* (pp. 417-437). Oxford, England: Oxford University Press.

[15] Pennebaker, J. W., & Graybeal, A. (2001). Patterns of natural language use: Disclosure, personality, and social integration. *Current Directions in Psychological Science, 10*(3), 90-93.

[16] Pennebaker, J. W., Mayne, T. J., & Francis, M. E. (1997). Linguistic predictors of adaptive bereavement. *Journal of personality and social psychology, 72*(4), 863-871.

[17] Petrie, K. J., Booth, R. J., Pennebaker, J. W., Davison, K. P., & Thomas, M. G. (1995). Disclosure of trauma and immune response to a hepatitis B vaccination program. *Journal of Consulting and Clinical Psychology, 63*(5), 787-792.

[18] Sellen, A. & Whittaker, S. (2010). Beyond total capture: a constructive critique of lifelogging. *CACM*, 53, 5, 70-77.

[19] Smyth, J. M., True, N., & Souto, J. (2001). Effects of writing about traumatic experiences: The necessity for narrative structuring. *Journal of Social and Clinical Psychology, 20*(2), 161-172.

[20] Wildschut, T., Sedikides, C., Arndt, J., & Routledge, C. (2006). Nostalgia: Content, triggers, functions. *Journal of Personality & Social Psychology, 91*(5), 975-993.