Pensieve: Supporting Everyday Reminiscence

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ABSTRACT

Reminiscing is a valuable activity that people of all ages spontaneously and informally partake in as part of their everyday lives. This paper discusses the design and use of Pensieve, a system that supports everyday reminiscence by emailing memory triggers to people that contain either social media content they previously created on third-party websites or text prompts about common life experiences. We discuss how the literature on reminiscence informed Pensieve's design, then analyze data from 91 users over five months. We find that people value spontaneous reminders to reminisce as well as the ability to write about their reminiscing. Shorter, more general triggers draw more responses, as do triggers containing people's own photos—although responses to photos tended to contain more metadata elements than storytelling elements. We compare these results to data from a second, Pensieve-like system developed for Facebook, and suggest a number of important aspects to consider for both designers and researchers around technology and reminiscence.

Author Keywords

Reminiscence, episodic memory, autobiographical memory, social media

ACM Classification Keywords

H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces.

General Terms

Design, Experimentation, Human Factors

INTRODUCTION

Do you remember your father's favorite pastime? The smell of a bonfire? A song you love to dance to?

There's a good chance that these questions prompted to you think, at least for a moment, about your past—in short, to reminisce. Reminiscence is a valuable activity that serves a number of purposes: maintaining relationships with people

near, far, and gone; working through past events and using them to help make sense of the present; and helping people tell consistent stories about their own lives and identities [19,33]. And, although reminiscing is often associated with the elderly, reminiscing is a lifelong activity [4] that people of all ages wish they did more often [9].

Much of the study of reminiscence treats it as a foreground activity. This is natural, given the focus in psychology on reminiscence as a potential "treatment" aimed at the elderly, to help people come to accept the past [6,20], to hopefully mitigate the effects of dementia [35], and frankly, just to give care home staff a structured activity to share with residents [27]. Technical support for reminiscence also often places it as a foreground activity, using purpose-built tools to help people capture, manage, and annotate media such as photographs [28] or physical mementos [30]—again, a natural consequence of the ways people generally interact with computers (and of the value the research community places on developing new technologies).

Although these perspectives are valid and useful in some ways for thinking about reminiscence, we prefer the lens of everyday computing [1]. That is, rather than being a task to be completed or managed, we see reminiscence as an *activity*: informal, unstructured, and woven into everyday life. People report that reminiscence is usually spontaneous, externally triggered, and often not consciously attended to [9]. We tell stories of our past experiences to make friends, while a newspaper photo depicting one's hometown sometimes brings back a flood of childhood memories.

Thus, we hope to support reminiscence using technologies that leverage and support people's current practices and fit gently into their lives. In this paper, we describe the design and deployment of Pensieve [9], a system that helps people remember to reminisce by sending them occasional emails containing "memory triggers". These include both generic prompts, such as those that started this paper, and the content that people already create in social media sites such as Flickr and Last.fm—content that often has personal significance. Pensieve's design supports spontaneity while providing some control; leverages personal content without requiring perfect capture or precise access to memory; and allows people to easily create a "diary" that helps them

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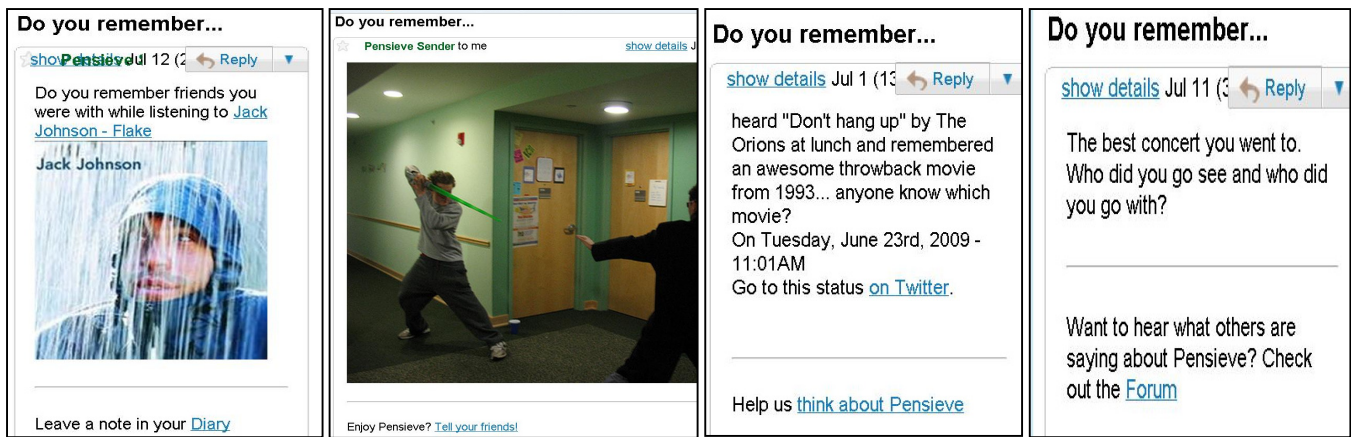[1] Peesapati and Schwanda are co-first authors.

Figure 1. Example memory trigger emails from last.fm, Flickr, Twitter, and a non-personalized text prompt. Emails contain both the trigger and link to other features, including the diary, ways to invite friends, and ways to give feedback about Pensieve.

write about the past at exactly the right time—when they are already reminiscing.

We start by describing the literature around reminiscence, both in psychology and in HCI, and how this work shaped Pensieve's design. We then present data collected from 91 people over five months, during which Pensieve sent over 11,000 memory triggers and people made over 700 diary entries. We analyze these entries, 20 people's responses to a questionnaire, and experiences with a Facebook application for reminiscing that, unlike Pensieve, requires people to consciously choose to reminisce. We find that people like using Pensieve and that it improves their mood; that reminding people to reminisce is important; and that both social media and generic prompts are useful triggers, although they lead people to write in different ways. The work shows the value of supporting reminiscing as an everyday activity and points to a number of fruitful directions for further study, particularly around exploring how technology might help people reminisce together.

RELATED WORK

Reminiscence is a type of remembering where we recall, interpret, and often share memories that are personally significant [3], using autobiographical memory [8] developed—and sometimes lost—throughout a person's life [12,14,23]. Autobiographical memories can range from specific, vivid detail of events to general impressions of life periods or themes that make up one's whole life story [3]. Further, they are to some extent constructed "on the fly"; how a given memory is experienced depends on people's current situation and mood.

That is, rather than a storehouse of information, autobiographical memory is a resource that is used for a variety of psychosocial purposes [33,34]. Reminiscence strengthens self-esteem [19,22] and provides pleasure and enjoyment [15,31]. Not all reminiscence is positive—people also reminisce to maintain grudges and to escape the present [33]—but on balance it is a positive activity [6,13]. It is often associated with the elderly [6,7], particularly as a systematic and organized kind of therapy [5,18,20]. Studies

have shown, however, that reminiscing is a valuable activity for people of all ages [4].

People use a number of media and methods to support reminiscing, most notably photos, which are used both to record memory and to share remembered experiences [12]. Mementoes are also important in reminiscing [26], and almost anything can serve as a memento if the person attaches personal significance to the item [25]. Other triggers are less intentional, ranging from smells to sounds to pictures of nostalgic cultural items [9]. Some people collect and organize these reminders though scrapbooking, a kind of self-narration or storytelling where memory objects are created by arranging objects on top of the normally linear life narrative [17].

The value of capturing and recalling information and the intentional facets of reminiscing have led to the creation of a number of systems to support it. SharePic [2] is a gesture based, multi-touch, multi-user collaborative tabletop device for photo sharing aimed at the elderly. CaraClock [32] supports sharing collective family memories through metadata-enhanced photo collections, allowing interesting views such as "everyone in the family at age 20" and supporting intelligent selection of photos to show based on the relationships in the group. The Personal Digital Historian Project [29] aims to help users to share and reflect on individual or collective experiences with others, while the Living Memory Box [30] helps families preserve their memories in a variety of media forms.

PENSIEVE

Pensieve leverages a number of ideas from the work described above. By reminding people to reminisce, we hope that Pensieve helps support the psychosocial goals of reminiscing. It uses a variety of media, including photos, text, and music, to trigger memories. It draws triggers from people's activity in social media sites in an attempt to provide reminders with personal significance, while generic triggers encourage reminiscing across the entire lifespan. And, like the other systems mentioned, it explicitly supports both remembering and capturing this personally significant
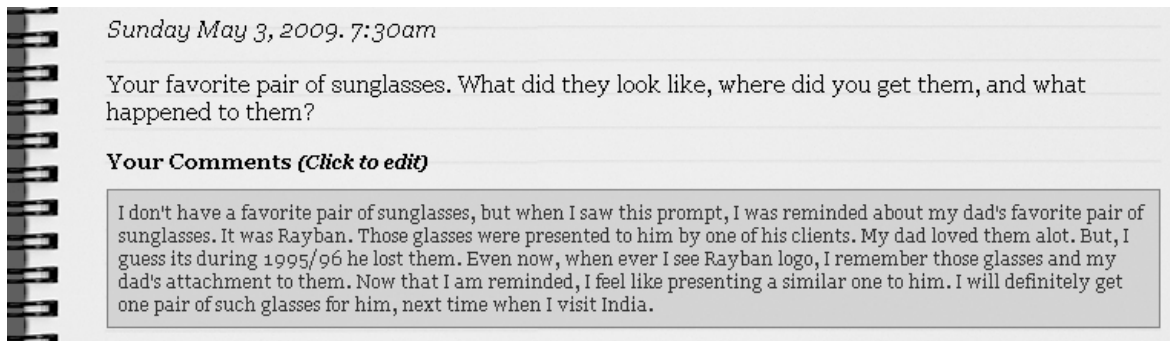
Figure 2. An example diary entry from Pensieve. A prompt about sunglasses led someone to write about their dad.

information, although with a more lightweight, everyday computing approach than most of these systems.

System Overview

In addition to the work above, Pensieve's design is based on a series of prototypes and interviews described in [9] that highlighted a number of themes and design goals based on the ways people reminisce, including the value of spontaneity, the importance of people in reminiscing, and the need to manage privacy, control, and intimacy.

Pensieve has two main functions: to remind people to reminisce, and to help people write in the course of reminiscing. People choose how often to be reminded to reminisce and can also link Pensieve to accounts on selected social media sites, including Flickr, twitter, Picasa, Blogger, and Last.fm. The Pensieve server uses these preferences to create memory triggers, emails that contain specific pieces of content either taken from a linked social media site or a set of non-personalized text prompts somewhat like those used in group reminiscence therapy[2]. Figure 1 shows examples of triggers from Last.fm, Flickr, twitter, and a non-personalized text prompt. Pensieve has no user model, so it chooses triggers randomly.

To help people write about their reminiscing, Pensieve provides a diary, which exploits the metaphor of a real diary (see Figure 2). People can see every trigger Pensieve has sent and write about reactions or stories the trigger elicited. People can also make diary entries by replying to an emailed memory trigger. People learned about the diary and the ability to reply to emails through tips included as a tagline with each email sent. These taglines also told people about other things they could do with Pensieve, including suggesting new non-personalized prompts and providing feedback about their experiences.

Design decisions (and mistakes)

A primary goal was to support spontaneity and serendipity. One of the most interesting aspects of our interviews from [9] was that people found it hard to reflect on reminiscing

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[2] For example, "*Do you remember your father's favorite pastime?*" We chose prompts to be broadly applicable, inoffensive, and to suggest reminiscence rather than factual recall. See [9] for more details and example prompts.

because it's rarely planned; rather, it's generally triggered by an external stimulus, and often not consciously attended to. Systems that use special-purpose artifacts or software to support reminiscence (e.g., [2,28,30,32]) risk making reminiscing a conscious choice—easy to forget, and possibly changing its nature. Planned reminiscing has its place in care situations and in sharing memorabilia and photos. But in general, reminiscing is most like an everyday computing activity [1], woven into daily life, and our design tries to support that through irregularly timed emails and random selection of memory triggers.

Supporting privacy and control were also important. We chose not to link to social media sites where we would have to store passwords and we do not store data from those sites, protecting people's privacy. We also gave people a high degree of control, allowing them to choose whether to connect to social media and (roughly) how often to receive memory triggers. An early prototype delivered triggers through SMS but people worried about the cost and about being interrupted [9], so we switched to email. Making diary entries private also supports both privacy and control, as well as fitting with the metaphor of a real-world diary.

Privacy, however, had its costs, especially around potential social aspects of reminiscing. People often reminisce about and with other people [9], and as a team we fought hard over whether to make diaries fully private, fully public, or to allow people to share specific entries publicly. Public diary entries would have supported social goals; however, reminiscing is sometimes a very private and intimate activity, and although people are good at making privacy decisions, they're often bad at using computer interfaces to execute them [11]. Because of the real risk of emotional harm, we decided to forego explicitly social tools for reminiscing in this version of Pensieve.

Finally, the system suffered from occasional bugs that affected people's experience. For instance, the system broke when twitter's tweet ids exceeded $2^{31}-1$ because it used an outdated version of the PHP twitter API. It also sometimes sends repeated prompts (including, to one unfortunate person, the same picture of a mushroom five times). These bugs were occasionally annoying to users, but as we will see below, overall the system was well-liked and useful for reminiscing despite these flaws.

RESEARCH QUESTIONS

Our overarching research question was how Pensieve would affect people's reminiscing practices, and how its use might inform the design of similar systems. We presented a preliminary analysis of Pensieve use in [10]; here, we combine observations of people's use of the system, analysis of their responses to triggers, informal feedback, and questionnaire responses to ask a number of questions about how Pensieve might affect these practices.

- How do people use Pensieve to reminisce?

- Does it help them write more about reminiscing?

- Do people value Pensieve? What do they like? What don't they like? How could it be better?

- What kinds of things do they reminisce about?

- Are there temporal patterns in how people reminisce? Do they use it in an everyday way?

- What kinds of triggers are most evocative?

WEB PENSIEVE USAGE DATA

Pensieve became publicly available in late February 2009. As of July 24, 2009, 91 people had registered for Pensieve (41 female, 29 male, 21 unspecified). The prevalence of females aligns with studies suggesting that women report more enjoyment than men while reminiscing [15,17].

People using Pensieve span a range of ages: 42 are 18-25, 15 are 26-35, 13 are 36-55, and 21 are unspecified. Twelve of the young users are or were members of the research team. People primarily discover Pensieve from other Pensieve users and the development team, helping to explain the predominance of younger users. Still, the fact that young people use Pensieve suggests that reminiscing is something people want to do across their lifetime.

About 85% (77/91) of these people are currently receiving memory triggers, meaning that relatively few people turn the system off, suggesting that they value the reminders. Of active users, 42 use the default setting of one trigger per day; the rest are evenly spread among 1, 2, 3, and 5 times per week and 3 times per day. This points out both the power of default settings [31] and that the default of once per day seems reasonable.

Table 1. People registered with, triggers sent, and responses received for each type of trigger. Blogger, twitter and Last.fm were added in May, explaining their lower prevalence.

Trigger source	People	Triggers	Responses
Non-personalized	91	8,642	615
Picasa	13	714	65
Flickr	22	1,409	43
Blogger	2	22	0
twitter	15	277	3
Last.fm	9	104	4

After removing duplicate triggers and comments that were tests or reactions to repeats or bugs, our analysis dataset contains 11,168 memory triggers and 730 responses (a response rate of 6.5%). Table 1 shows the breakdown of activity by service. Non-personalized prompts dominate; 33 people have linked a total of 61 social media accounts to Pensieve. About 64% (58/91) of people have written at least one diary entry, and about 21% (19/91) of people have written 10 or more. We suspect the number of diary entries would have been higher had the interface for creating them by responding to emails been more visible.

Studying people's responses to triggers

Below we delve into the data to address the questions posed above. We focus on people's responses to memory triggers. This is partly pragmatic, as they are the main activity we can see, but responses also indicate that the trigger elicited a strong enough reaction to lead people to write, giving us access to reminiscence in the moment. We supplement our analyses of responses with data from a questionnaire we administered to people who were not directly associated with the researchers. It asked a number of questions about the ways Pensieve affected their reminiscing, whether they liked it, and how to improve it. Two people independently reviewed the responses, looking for common themes and interesting anomalies, then discussed their analysis and came to consensus on the portions reported below.

How do people reminisce using Pensieve?

We start with a high-level characterization of the tone and topics people reminisce about, based on linguistic analysis of the text of people's responses. We used Pennebaker et al.'s Linguistic Inquiry and Word Count Tool (LIWC), which counts the percentage of words in a corpus of text that fall into linguistic categories of interest, such as pronouns, positive expressions, or self-references [24].

People's overall tone in diary entries was positive: 2.8% of responses contained words classified as positive and 1.1% negative, compared to 2.7% positive and 2.6% negative in the LIWC personal writing corpus [24]. This suggests that, on balance, people reminisce more about pleasant than unpleasant memories. Questionnaire data also supported this finding; nearly all respondents said their mood was improved by reminiscence, either because the memory was pleasant or because it gave them a sense of closure.

People also frequently used pronouns: 13.17% of words were pronouns, versus 11.4% of the LIWC personal corpus [24]. This supports the idea that people are a dominant topic of reminiscence [9]:

> "Well I'd say it was usually about people. And it's also partially about places but the places are important probably because of the people."

People mention the past and present about equally (6.5% and 6.4% respectively, according to LIWC), but rarely the future (0.4%). This may suggest that people used Pensieve to make terms with their pasts and apply it to present day problems, as suggested by the literature [6,13]. Some questionnaire respondents mentioned this explicitly:
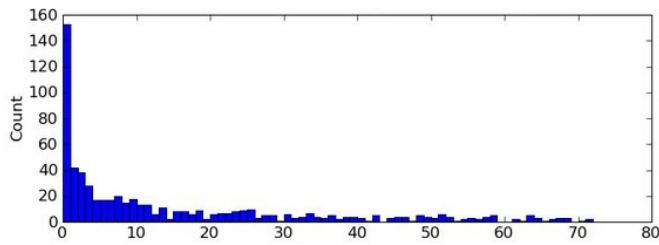
Figure 3. Hours between receiving and responding to a trigger. If a response comes, it usually comes quickly.

"I try to connect it to issues I am dealing with currently. I think, like therapy, this helps understand myself."

People were unwilling to respond to some prompts. Some triggers were simply disliked: *"This is a terrible trigger. I refuse to respond."* Other people had privacy concerns, while almost every questionnaire respondent reported receiving a prompt that elicited a negative reaction. Some prompts also led to memories that people said were too sad to want to dwell on or too strong to want to write about. On the other hand, some prompts elicited strong responses. The prompt *"Your favorite book as a child. Did you have your parents read to you or did you read on your own*?*"* led one person to write about his grandmother's storytelling:

"My grandmother used to read me a story about a dog named Hector who was too big for the pet shop. He kept knocking things over with his tail, but it wasn't his fault—he was just a Great Dane or something. The moral was that he just needed to get out into the country with a big house and a big yard. My grandmother is in the hospital right now—that was a really emotional trigger."

Are there temporal patterns in how people use Pensieve?
Our findings suggest that, like reminiscence itself, people's writing about reminiscence is spontaneous and immediate, and that it is important to capture it in the moment. Figure 3 shows, for each response, the time elapsed between Pensieve sending the trigger and the response. There is a large spike within an hour after the trigger is sent; that is, if someone is going to respond to a trigger, it is relatively likely they are going to respond shortly after they receive it. These results align with a number of questionnaire respondents who said they would respond to the prompt as soon as they saw it, or else not respond.

We also analyzed how much time elapses between responses by the same person. Few people go more than seven days between responding to triggers, suggesting that people either write regularly or not at all. Thus, systems that want to support writing must provide regular opportunities and reminders, as well as interfaces that make it easy to integrate writing into daily routines. We suspect, but cannot show, that a similar pattern happens in people's attention to the triggers as well—that once people fall out of the habit of paying attention to triggers, it is hard to start back up.

What kinds of triggers are most evocative?
Understanding what kinds of triggers are most likely to be evocative can help systems be more effective at supporting reminiscence. Below, we explore aspects of triggers that led to more frequent and longer responses. A trigger's response rate is defined as the number of times people respond to a trigger divided by the number of times the trigger was sent. A trigger's response length is defined as the average number of words in all responses to that trigger.

We first analyze the non-personalized text prompts, both because they allow us to compare reactions across users (unlike the social media, which are personalized), and because this analysis may inform the topics used in group reminiscence therapy [35] and in systems like Pensieve.

Length matters. We define prompt length in two ways: by the number of words in a prompt and the number of "parts" in a prompt. For example, the prompt "[*Your first job*]. [*How did you get it*], *and* [*who were your coworkers*]?*"* has three parts. Prompts with more parts tend to include specific questions related to the overall theme of the prompt.

Table 2. Responses for prompts by number of parts.

Parts	# of prompts	Avg. prompt length	Response rate	Avg. response length
1	45	8.8	7.2%	38.2
2	23	14.5	7.7%	41.4
3	21	17.5	6.6%	48.8
4+	16	25.6	6.7%	69.9

Table 2 shows descriptive statistics for non-personalized text prompts based on number of parts. Longer prompts have lower response rates (by prompt length, R^2=0.85; by parts R^2=0.44), but longer responses (by prompt length, R^2=0.75; by parts, R^2=0.86). This suggests that less specific prompts may be easier to respond to than longer, more specific prompts, but may not draw out as many details.

Emotional tone may matter. We also investigated whether a prompt's emotional tone affected people's responses. We classified prompts as positive, negative, both, or neither based on whether they contain words from LIWC's positive and negative categories. Positive prompts have on average 10.2% positive and 0.2% negative words, while negative prompts average 0.5% positive and 3.9% negative words.

Table 3. Responses for prompts by prompt emotional tone.

Type	#	Response rate	Avg. response length
Both	4	6.9%	68.3
Negative	17	7.2%	54.9
Positive	37	7.5%	43.3
Neither	47	6.8%	41.9

Table 3 shows prompts broken down by emotional tone. Response rates were not significantly different. Prompts containing negative words tended to elicit longer responses—but people did not like them:

"Why would you want to elicit bad memories?? My triggers have been very negative lately, and it makes me hate getting those emails."

People were able to suggest non-personalized text prompts for everyone; their submissions support our above findings. Five users submitted 16 prompts. Of these, ten had 10 or fewer words, while nine had one part, six had two parts, and one had three. This supports our finding that users prefer shorter prompts. Nine of these prompts were positive and seven were neither positive nor negative, also suggesting a preference for positivity.

Table 4. Responses for prompts by category. The table displays hierarchical nesting of categories, and prompts can belong to more than one category.

Category	#	Response rate		Avg. resp. length
Things	35	7.2%	(213/2953)	42.7
Entertainment	15	6.5%	(78/1209)	49.4
Music	3	8.1%	(21/259)	65.9
Books	2	2.8%	(5/181)	40.0
TV/movies	5	6.4%	(22/343)	24.0
Games	3	6.7%	(17/255)	48.8
Technology	1	4.9%	(4/82)	33.5
Appearance	9	7.8%	(61/783)	44.8
Food	12	7.2%	(77/1065)	34.1
Events	7	7.7%	(47/610)	57.1
Sports	1	3.3%	(3/92)	27.0
Parties	4	8.9%	(31/347)	54.6
Places	25	6.7%	(144/2136)	56.0
Homes	8	5.7%	(41/718)	40.5
Outdoors	8	7.8%	(51/655)	68.4
School/Work	10	7.3%	(63/862)	55.5
People	29	6.9%	(162/2331)	44.5
Family	13	6.0%	(66/1096)	41.9
Parents	9	5.7%	(44/770)	43.0
Siblings	4	7.0%	(24/342)	36.5
Ext. Family	1	2.2%	(2/89)	21.0
Pets	1	1.6%	(1/62)	3.0
Loved Ones	4	8.7%	(28/327)	49.1
Friends	4	7.1%	(24/337)	50.2
Experiences	23	7.2%	(132/1828)	57.4
Medical	2	7.7%	(12/155)	35.6
School	13	6.1%	(62/1022)	47.6
Work	4	6.1%	(21/342)	64.7
Travel	5	9.6%	(38/394)	76.1

Not all topics are created equal. We were also interested in whether the topic a prompt referred to would affect people's response patterns. We developed a codebook for prompt topics over five iterations in which people ranging in age from 16 to 52, some associated with the project and some not, coded a random sampling of the prompts. Two members of the Pensieve team coded the full set of prompts using the final codebook. Disagreements were settled by the two coders coming to a consensus on whether or not the disputed category should be applied to the prompt[3]. The categories are hierarchical, with parent categories of things, people, places, and experiences, and up to two levels of subcategories; prompts can belong to multiple categories.

Table 4 shows how people responded to prompts broken down by category. The highest number of responses, 17, was received for the prompt *"Meeting someone famous."* Among the 10 prompts that received the most responses, 6 were coded as things and 4 were coded as experiences. There was little difference in how people responded based on category. At the level of parent categories, prompts had roughly equal response rates, and there were few differences at the level of subcategories.

We also looked at the topics people choose to write about. Two coders used the category codebook to code a random sample of 93 responses; again, prompts could belong to multiple categories. Intercoder agreement on high-level categories ranged from 79% to 91% and Krippendorff's Alpha from 0.52 to 0.81. People were more likely to reminisce about people or things (46% and 36%, respectively) than places (24%) or experiences (20%) ($\chi^2(372,3)=18.319$, $p<0.001$), no matter the topic of the prompt. For instance, the prompt in Figure 2 asks about sunglasses, while the response is about the person's father. This suggests that the prompts themselves may not be as important as the way people interpret them.

Media, personalization, and response rate
Finally, we looked at the effects of media type and personalization on users' responses. Table 1 shows the number of triggers sent and responded to from the different social media; here, we focus on activity in Picasa (65 responses to 714 triggers) and the non-personalized text prompts (615 responses to 8,642 triggers). We do not consider Blogger, twitter, or Last.fm in our analysis because these services had relatively few triggers sent. We also exclude Flickr because it was plagued with a bug that generated malformed triggers that contained no pictures.

People responded more often to Picasa triggers than to non-personalized text prompts (9.1%, 65/714 versus 7.1%, 615/8642; $\chi^2(9356,1)=3.864$, $p<0.05$). However, the tone of the responses was different. The average length for a Picasa response was about 37 words, versus about 46 for text prompts; an informal analysis of response content suggests

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[3] Intercoder agreement ranged from 67% to 91% with a mean of 85% for parent categories and from 80% to 100% with a mean of 97% for child categories. Krippendorf's Alpha ranged from 0.29 to 0.81 with a mean of 0.64 and 0.0 to 1.0 with a mean of 0.67 respectively. "Places" was the most difficult category (67% agreement, 0.29 Krippendorf's Alpha); coders found it hard to separate events from places (for example, weddings made one coder think of "places" because that coder often went to outdoor weddings). We report intercoder agreement by category based on [21].

that Picasa responses often contained metadata such as the people, event, and place in the photo, while responses to non-personalized text prompts were more story-like. Contrast the story about the grandmother or the diary entry about sunglasses to this response to a Picasa trigger:

> *"I guess this is from the Ithaca Festival. The guy on the left is Hilby the Skinny German Juggler Boy. Not too exciting."*

People noticed the tendency to record metadata as well; one person suggested that showing data already collected by the sites hosting the pictures might encourage responses with less metadata and more emotional content.

In this analysis, personalization and medium are confounded since Picasa sends personalized pictures while the prompts are non-personalized text. We will return to this in our discussion of a second system for supporting reminiscence, developed in Facebook.

COMPARING TO AN ALTERNATE DESIGN

Our findings from Pensieve suggest that people valued receiving spontaneous emails reminding them to reminisce about random topics. Prompts that are short and that are on general topics received more responses, while people responded more often but perhaps less thoughtfully to personalized picture prompts than to non-personalized text prompts. People tended to use the emailed memory triggers to reminisce spontaneously; if they were to write about their reminiscing, they were most likely to do so shortly after receiving a trigger and if they were regular writers.

To investigate the generality of our findings, we wrote a sister application in Facebook ("Facebook Pensieve", or FP, shown in Figure 4). FP is similar to Pensieve but with design differences to help test our claims. Like Pensieve, FP's goal is to help people reminisce and to allow people to write about the past. Each day someone visits FP, it selects a photo they were tagged in and a status they had written in the past and presents them with textboxes that allow people to respond. Like Pensieve, FP is aimed at individuals; because of privacy and IRB concerns, it has no explicit social features—although we think adding social features is an important next step for supporting reminiscing.

FP differs from Pensieve in three important ways. First, whereas Pensieve automatically sends emails, people must make a conscious decision to visit FP every day in order to reminisce. FP does use Facebook's notification mechanism to remind people to visit; by default, once every three days. Second, all content in FP is personalized. Unlike the generic text prompts in Pensieve, text in FP is drawn from a user's own status updates. Finally, Pensieve's primary interface is email, while FP's is within Facebook itself.

These differences mattered. FP was released in March 2009, and as of July 24, 2009, 75 people had used FP at least once. However, people received many fewer triggers than in Pensieve. Only 17 people received 50 or more, while most received less than 10. We think this is because

Figure 4. An example page from the Facebook application.

FP requires people to consciously reminisce, while Pensieve's push model requires no special effort.

Some aspects of users' response patterns were also different. After eliminating test and repeated triggers, our analysis dataset contained a total of 120 responses (72 to photos, 48 to statuses) to 2,698 triggers. This led to a significantly lower response rate in FP (4.4%) than in Pensieve (6.5%) (χ^2 (2698, 1)=14.75, p<0.01). Only 21 of 75 FP users ever responded, and only 5 responded more than 5 times. Responses in FP were also much shorter than those in Pensieve on average (12.8 vs. 43.6 words). We suspect this is because of the norm in Facebook to write short pieces of text for status messages, comments on photos, and wall posts.

However, there were similarities in terms of positive emotion and the ways people responded to different media. LIWC analysis showed that, as with Pensieve, people's overall emotional tone was positive (3.9% positive, 1.4% negative) compared to the personal writing corpus. Also like Pensieve, people tended to refer about equally to the past (8.2%) and the present (7.8%), but rarely the future.

Pensieve users respond more frequently to photos than to text prompts, and FP data shows a trend consistent with this finding (5.2%, 72/1392 for photos vs. 3.7%, 48/1306 for statuses (χ^2(2698,1)=3.25, p=0.071). Because all FP content

is personalized, this suggests that the medium, rather than the personalization, explains the difference we saw in response rates in Pensieve.

Finally, like Pensieve, responses to photos in FP contained more metadata than responses to text prompts (28.4%, 21/72 for photos vs. 8.3%, 4/48 for statuses; $\chi^2(120,1)=5.18$, p=0.023). Here we define metadata as the who, what, where, and when of an item. Unlike Pensieve, there was no significant difference in response length to photos and text triggers (14.3 and 10.6 words respectively).

DISCUSSION

Overall we consider Pensieve to be a successful prototype for supporting everyday reminiscence. People continue to sign up and, once registered, they continue to receive the memory triggers. They like the emails and being able to respond:

> *"I really like coming to the website and having this personal space to write whatever I want about long-forgotten things."*

> *"Although I don't necessarily respond to the triggers that often, it would feel weird not having prompts being sent anymore."*

This shows that even when users do not respond to triggers, they still value the spontaneous reminder to reminisce, and report that it generally improves their mood and supports other positive effects of reminiscing such as reviving pleasant memories, working through one's past, and using the past to address current issues:

> *"When I really think about the message and the memories related to it I typically feel better even if the memory itself is bittersweet. I guess it is a sort of perspective taking process."*

> *"I try to connect…to issues I am dealing with currently. I think, like therapy, this helps understand myself."*

Below, we discuss how our main findings bear on the design of systems that support reminiscence, suggest ways that common design issues such as cultural differences and the appropriation of systems may apply in this domain, and suggest future directions for both designs and research in reminiscence.

Design suggestions and implications

Couple capture with reminiscence. People responded to a number of triggers, helping meet the desire expressed in [9] to write more about reminiscence. Allowing people to make diary entries by responding directly to the emails that contained the triggers was effective, reducing the effort required to write an entry and placing writing "in the moment" of reminiscing. More generally, we suspect that embedding much of the interface into the everyday tool of email was an important aspect of Pensieve's success.

Design the email interface. We could have done a better job with this. Most of our design effort focused on the website,

making it attractive and organizing its features. However, people's primary interaction with Pensieve was via email. Just over half of diary entries were created through emails, and had we made this feature more obvious, we suspect it would have been even higher. Further, had we made the ability to create diary entries by reply to emails more salient, we think people would have written more responses overall. Likewise, the website allows people to request a trigger at any time. Emails should also have offered this option, for times when a prompt was repeated or blank because of a bug, or for prompts that were not evocative. We failed to focus our design work where it really mattered, a mistake we hope other designers can learn from.

The medium affects the message. Behavior was different between FP and Pensieve, and much of this was because of the medium. FP had less use and fewer responses than Pensieve, probably because of the need to consciously intend to reminisce in FP. Responses in FP were also much shorter, suggesting that when you use Facebook as a delivery platform you may get Facebook-style responses. We believe in supporting everyday reminiscing by leveraging people's current activity and practices; thinking carefully about the norms and implications of those practices (e.g., [25,26]) will inform designs. The medium of the prompt itself also mattered, affecting response rates, lengths, and characteristics. Careful attention to the characteristics of triggers used to support reminiscence will be important to successful systems.

Create value through aggregation. People valued the idea of revisiting responses they had previously created. Logs showed that several people went back through their diary, presumably to reflect on their previous responses. We could better support this kind of reflection through intelligent aggregation. For example, we could send prompts that asked people to reminisce about specific years and use the responses to create timeline views of a person's past. We could also use either manual tagging or automatic tag extraction to give people access to topic- or person-focused views of their diary. People wanted to use Pensieve to think about their past; such views might encourage people to reflect, reminisce, and write more, in a virtuous circle.

Consider cultural differences. One user gave the following feedback:

> *"I also find the triggers extremely US white middle class centric and as such, often irrelevant to me. This just means that my past is culturally too different to fit well within these."*

Designers should already be attending to cultural factors, but it might be fruitful to explore how reminiscence differs in cultures where extended families interact more closely or in contexts where the creation and sharing of memory-laden content such as photos is more difficult or less common.

Support the unexpected. In addition to our expected use of Pensieve to support and record reminiscence, we found

unexpected uses of the system. One person reported linking Pensieve to multiple photo streams with the goal of finding creative inspiration. Another linked multiple accounts from the same social media service in order to receive photos that family and friends had created. As with culture, designers should be aware that people appropriate systems in unexpected ways—and should build features that support this kind of appropriation.

Exploit context to personalize reminiscence. Although serendipity and random selection worked well enough, we think using context to intelligently choose triggers might be helpful. Learning features of prompts individuals respond to would further support personalized reminiscing. Other aspects of context might be useful as well. For instance, a mobile system that supports reminiscence might try to send prompts related to a person's current location, activities, or nearby friends.

Support social aspects. Several people reported that Pensieve helped them to reconnect with others when prompts incited them to contact old friends:

> *"Thank you. This prompted me to email Debbie. The last time I talked to her was on a video chat at Christmas."*

This, plus the tendency of responses to focus on people, suggests that Pensieve supports another positive purpose of reminiscence, maintaining social connections.

Explicitly supporting social aspects of reminiscence is a fruitful next direction to explore. Such a system might leverage existing social network platforms, as one person suggested: *"It seems likely that fully integrating into social sites and using the relationships people express in them to form groups will be helpful."* This aligns with findings from [9] about the key role of people as sources and objects of reminiscence. Supporting social reminiscence also opens new questions around using context, such as choosing triggers for a group of people reminiscing or triggers about, e.g., a friend whose birthday is today and who you haven't spoken with in a while.

However, for some people reminiscence is a private experience:

> *"The most important reminiscing for me is private, usually about my family or very close friends. I wouldn't share it with others."*

This suggests that social features would be good to include, but that they should not be forced on people.

Limitations

Our analysis focused primarily on people's responses because this is the main data we had access to. It would have been wonderful to explore people's beliefs about and experiences of reminiscing more directly, since writing about the past is only a small part of the larger activity of reminiscing. We collected some data about the experience of reminiscing in our interviews, reported in [9], but it would be nice to learn more about how Pensieve changed that experience. Here, we considered including probing questions about people's experiences along with memory triggers, somewhat like a diary study. However, we feared that sending questions along with prompts would confuse people and that sending questions instead of prompts might lead people to stop using the system. So, we punted.

Using social media to support reminiscing may also bias people toward reminiscing about recent or easily captured events. In Pensieve, we hope that including non-personalized prompts that address all periods of a person's life mitigates this bias. More generally, this may be hard to study in the short term: a well-studied phenomenon known as the "reminiscence bump" [16] says that people remember more from the period between the ages of 10 and 30, and since so many heavy social media users are in this age group, it may be hard to tease those effects apart. Still, the general question of how systems like Pensieve and SenseCam affect the things we remember and the ways we remember them is an interesting issue for future work.

CONCLUSION

We hope to have made a number of contributions through this work. We show that people value even a simple system designed to support everyday reminiscence. People's use of the system supports existing findings about the nature of reminiscing in a new context that includes computer support. By deploying two separate but related systems with somewhat different design characteristics, we offer a number of observations, design ideas, and future directions for work around the study and support of reminiscence with some claim to generality.

Generality matters, because supporting reminiscence is an area where HCI can make a valuable contribution to society. Reminiscing to know ourselves, to think about the present, to maintain our relationships, and to construct our identities has value for everyone, every day, while the traces of our lives that are recorded and made accessible through technology pose privacy risks and technical challenges but also provide designers and researchers with new opportunities. We should make the most of them.

REFERENCES
1. G.D. Abowd, E.D. Mynatt. (2000). Charting past, present, and future research in ubiquitous computing. *ACM Trans. Comput.-Hum. Interact.* 7(1):29–58.

2. T. Apted, J. Kay, A. Quigley. (2006). Tabletop sharing of digital photographs for the elderly. In *Proc. CHI 2006*, ACM Press, 781–790.

3. S. Bluck, N. Alea. (2002). Exploring the functions of autobiographical memory: Why do I remember the autumn? In J.D. Webster, B.K. Haight (Eds.), *Critical advances in reminiscence work: From theory to application* (pp. 61–75). Springer Publishing Company.

4. F. Bryant, C. Smart, S. King. (2005). Using the past to enhance the present: Boosting happiness through positive reminiscence. *J. Happiness Studies*, 6:227–260.

5. R.N. Butler, M.I. Lewis. (1982). *Aging and Mental Health*. St. Louis, MO: C. V. Mosby.

6. R.N. Butler. (1963). The life review: An interpretation of reminiscence in the aged. *Psychiatry*, 26:65–76.

7. P.G. Coleman. (1974). Measuring reminiscence characteristics from conversation as adaptive features of old age. *Int. J. Aging Human Dev.*, 5:281–294.

8. M.A. Conway, C.W. Pleydell-Pearce. (2000). The Construction of Autobiographical Memories in the Self-Memory System. *Psychol. Rev.*, 107(2): 261–288.

9. D. Cosley, K. Akey, B. Alson, J. Baxter, M. Broomfield, S. Lee, C. Sarabu. (2009). Using Technologies to Support Reminiscence. *BCS HCI 2009*.

10. D. Cosley, V. Schwanda, S.T. Peesapati, J. Schultz, J. Baxter. (2009). Experiences with a Publicly Deployed Tool for Reminiscing. In *Proc. First Int'l Workshop on Reminiscence Systems*, 31–36.

11. L.F. Cranor, P. Guduru, M. Arjula. (2006). User interfaces for privacy agents. *TOCHI*. 13(2), 135–178.

12. D. Frohlich, A. Kuchinsky, C. Pering, A. Don, S. Ariss. (2002). Requirements for photoware. In *Proc. CSCW 2002*. ACM, New York, NY, 166–175.

13. R.J. Havighurst. (1959). *Human Development and Education*. New York, NY: Longman.

14. M.L. Howe, M.L. Courage. (1997). The emergence and early development of autobiographical memory. *Psychol. Rev.*, 104:499–523.

15. G.A. Hughston, S.B. Merriam. (1982). Reminiscence: A nonformal technique for improving cognitive functioning in the aged. *Int. J. Aging Human Dev.*, 15:139–149.

16. S.M. Janssen, J.M.J. Murre. (2008). Reminiscence bump in autobiographical memory: Unexplained by novelty, emotionality, violence, or importance of personal events. *Q. J. Exp. Psychol.*, 61(12):1847–1860.

17. T. Katriel, T. Farrell. (1991). Scrapbooks as cultural texts: An American art of memory. *Text Perform. Q.*, 11(1):1–17.

18. L.M. Kelly, P.M. Mosher-Ashley. (2002). Combining reminiscence with journal writing to promote greater life satisfaction in an assisted-living community. *Activities, Adaptation, & Aging*, 26:35–46.

19. C.N. Lewis. (1971). Reminiscing and self-concept in old age. *J. Gerontol.*, 26: 240–243.

20. M.I. Lewis, R.N. Butler. (1974). Life review therapy: Putting memories to work in individual and group psychotherapy. *Geriatrics*, 29:165–169, 172–173.

21. M. Lombard, J. Snyder-Duch, C.C. Bracken. (2002). Content Analysis in Mass Communication: Assessment and Reporting of Intercoder Reliability. *Hum. Commun. Res.*, 28(4):587–604.

22. A.W. McMahon, Jr., P.J. Rhudick. (1967). Reminiscing in the aged: An adaptational response, in S. Levin and R.J. Kahana (Eds.), *Psychodynamic Studies on Aging: Creativity, Reminiscing, and Dying* (pp. 64–78).

23. K. Nelson. (1993). The psychological and social origins of autobiographical memory. *Psychol. Sci.*, 4:7–14.

24. J.W. Pennebaker, M.E. Francis, R.J. Booth. (2001). *Linguistic Inquiry and Word Count LIWC 2001*.

25. D. Petrelli, E. Hoven, S. Whittaker. (2009). Making History: Intentional Capture of Future Memories. In *Proc. CHI 2009*. ACM Press, 1723–1732.

26. D. Petrelli, S. Whittaker, J. Brockmeier. (2008). Autotopography: what can physical mementos tell us about digital memories? In *Proc. CHI 2008*, 53–62.

27. S. Reed. (2009). My Stories Are My Identity. In *Proc. First Int'l Workshop on Reminiscence Systems*, 28–30.

28. A. Sellen, A. Fogg, S. Hodges, K. Wood. (2007). Do life-logging technologies support memory for the past? An experimental study using SenseCam. *CHI 07,* 81–90.

29. C. Shen, N.B. Lesh, F. Vernier, C. Forlines, J. Frost. (2002). Sharing and building digital group histories. In *Proc. CSCW 2002*, ACM Press, 324–333.

30. M.M. Stevens, G.D. Abowd, K.N. Truong, F. Vollmer. (2003). Getting into the Living Memory Box: Family archives & holistic design. *Pers. Ubiquitous Comput.*, 7(3-4):210–216.

31. R.H. Thaler, C.R. Sunstein. (2008) *Nudge: improving decisions about health, wealth, and happiness.* Yale.

32. D. Uriu, N. Shiratori, S. Hashimoto, S. Ishibashi, N. Okude. (2009). CaraClock: an interactive photo viewer designed for family memories. *CHI 2009*, 3205–3210.

33. J.D. Webster, M.E. McCall. (1999). Reminiscence functions across adulthood: A replication and extension. *J. Adult Dev.*, 6(1):73–85.

34. P.T.B. Wong. (1995). The process of adaptive reminiscence. In B.K. Haight, J.D. Webster (Eds.), *The art and science of reminiscing: Theory, research, methods and application* (pp. 23–35). Taylor & Francis.

35. B. Woods, A. Spector, C. Jones, M. Orrell, S. Davies. (2005). Reminiscence therapy for dementia. *Cochrane Database of Systematic Reviews*.