# Everyday Life Reflection: Exploring Media Interaction with Balance, Cogito & Dott

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## ABSTRACT

Reflection is of increasing interest in HCI as it has many potential benefits in design, education and everyday life. In this paper, we explore media-supported reflection through the design and deployment of three concepts. In contrast to prevalent reflective approaches that are based on system-collected data, we explore how user-created media can support personal reflection. Three interactive prototypes were developed, focusing on different modalities: Balance uses audio, Cogito uses text, and Dott uses visual media. We evaluate these concepts in an in-the-wild study that is both explorative and comparative. We found that the open-ended systems primarily supported reflection during the creation of media and that the use depended on opportunity and triggers. We conclude the paper with a discussion of our findings regarding the method and the implications of our findings for the broader area of design for reflection.

## CCS CONCEPTS

Human Computer Interaction (HCI); Field Studies; Empirical Studies in Interaction Design

## KEYWORDS

Reflection; Tangible Interaction; Media Interaction; Everyday Life; Design for Habits; Design Research

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## 1. Introduction

Present life is more fast-paced than ever, we are constantly distracted, struggle with maintaining attention and many people face stress or struggle with life choices. These trends have sparked a rise in the popularity of reflective practices. Living with a more reflective attitude can have many benefits such as gaining self-insight (Baumer et al., 2014), supporting life changes (Staudinger, 2001) and motivating behavior change (Li, Dey & Forlizzi, 2010). However, reflection can be challenging, as it requires attention, time and effort, which is why people often need support or encouragement (Fleck & Fitzpatrick, 2010). This creates a design opportunity for interactive systems to support reflection; a topic which attracts increasing interest within HCI, as can be seen by a number of recent overview papers (Baumer et al., 2014; Baumer, 2015; Mols, Van den Hoven & Eggen, 2016; Slovák, Frauenberger & Fitzpatrick, 2017).

Rather than focusing on a specific topic of reflection (such as movement [Consolvo et al., 2006], or energy usage [Valkanova et al., 2013]), we are interested in designing for open-ended everyday life reflection, which is less common (Baumer et al., 2014; Mols, Van den Hoven & Eggen, 2016). We scope everyday reflection as *"thinking about thoughts, feelings, actions and experiences concerning one's life"*. One direction to support open-ended reflection is to focus on user-created media rather than system-collected data. Supporting reflection through frequent media creation and review has been found to have a positive effect on well-being (Isaacs et al., 2013).

In this paper, we present the design and field exploration of three concepts to support everyday life reflection. With these concepts, we explore three different media types: visual media with Dott, textual media with Cogito and auditory media with Balance (see Figure 1). We conduct a comparative study, where the participants take part in co-reflecting on the designs and differences. In the following section, we discuss theory and practice of reflection and several related design-research projects. We discuss our approach to designing the concepts and their implementation in three prototypes. Our thematic findings focus on integrating reflection in everyday life, comparing creation and retrieval. We end this paper with a discussion of our method, the modalities, the context and the triggering of reflective creation.

**Figure 1: The three media concepts f.l.t.r. Dott, Cogito and Balance.**


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## 2. Related work

Much has been written on reflection. Theoretical views written by Dewey (1933), Schön (1983) and Mezirow (1990) have been analyzed and applied countless times to inform diverse domains ranging from health to education and design. Despite this large body of work, many publications in HCI lack a thorough grounding in theory or even lack a definition (Baumer, 2015).

### 2.1 Reflection theory

The life review model (Staudinger, 2001) describes reflection as "*remembering plus further analysis*". Such analysis can consist of evaluation or explanation through processes such as abstraction, comparison and categorization (Staudinger, 2001). We combine these process aspects with the type of insight we strive for, inspired by Mezirows theory (1990). Specifically, we build upon Mezirow's definition of critical self-reflection as "*reassessing our own orientation to perceiving, knowing, believing, feeling and acting*" (Mezirow, 1990; p.13). Together, these bring us to our detailed definition of everyday life reflection: "*Considering and analyzing past, present and future experiences in order to reassess our thoughts, beliefs, feelings and actions regarding our everyday life.*"

For a more specific view on what reflection is, scholars have suggested different models of reflection. Especially in education, reflection is often explained as a series of steps of looking back and looking ahead such as the ALACT-model (Korthagen & Kessels, 1999). Similar steps are described in Gibb's reflective cycle (1988) or Johns' (1999) model of structured reflection. Such process-models can provide direction on how to design for reflection. However, they might also hold a limitation, especially in more everyday context. We therefore adhere to Ekebergh's view that reflection closely relates to an attitude and should be supported in an *"open, flexible and sensitive way"* (Ekebergh, 2007, p. 338).

### 2.2 System-supported reflection

We are interested in exploring media-supported reflection, as media systems can take different roles in the process of supporting reflection: they can trigger, support as well as capture reflection (Mols, Van den Hoven & Eggen, 2016).

We can consider reflective media interaction in a contrast to data-supported reflection. Domains such as personal informatics (e.g. Li, 2010; Ohlin, Olsson & Davidsson, 2015) and the quantified-self (e.g. Choe et al., 2014) explore the use of quantitative data to support reflection. Most commonly, this data is (in part) automatically collected by systems and is focussed on a specific topic, e.g. movement pattern (Consolvo et al., 2006), energy consumption (Valkanova et al., 2013) or classroom performance (McNicol et al., 2014). Such media can concern photos (for example by Sensecam (Lindley et al., 2011), or be more number and sensor-based (Lin et al., 2006; Consolvo et al., 2008)). These systems present the data through visualisations, suggestions or overviews. Reflecting by looking at this data is useful as it shows things that cannot be directly perceived (e.g. steps taken in a day) and can show long-term trends or patterns. Despite these advantages, we believe data supported reflection has several limitations. First, it often focuses the reflection on a (single) specific dimension, which does not suit the diversity of everyday life reflection. Secondly, it often sees systems as having a certain 'authority' (Sengers & Gaver, 2006), which might make people trust the systems view more, rather than becoming truly self-conscious. We, therefore, prefer to support reflection using *human-generated media* because it is more holistic and personal.

#### Media in the home

Media interaction within the home is explored in a broader scope within HCI, for example to support remembering or for social bonding. Home is a shared place, in which objects of memory take a crucial role (Petrelli, Whittaker & Brockmeier, 2008). In this context, objects are used for comfort, as conversation starter and to display identity (Petrelli, Whittaker & Brockmeier, 2008). Several researchers have explored giving digital media a presence in the home and found instances of reflective conversation (Helmes et al., 2011; Odom et al., 2014), even though their primary aim was for other types of remembering such as reminiscence (Sellen & Whittaker, 2010). Petrelli, Whittaker & Brockmeier (2008) found that mementoes serving reflective purposes were more often found in private rooms, such as bedrooms or studies.

#### Media-supported reflection

For the design of media-supported reflection systems, we were inspired by different types of media interaction. Based on the extensive history of written accounts for reflection (O'Sullivan, 2005) we wanted to include textual media. Related text-based application to support reflection in an open-ended way include GoSlow (Cheng et al., 2011) and Echoes (Isaacs et al., 2013). Open-ended possibilities were also seen in the use of visual media, which is more often studied for remembering (Van den Hoven, Sas & Whittaker, 2012). To use visuals for reflection, we were inspired to use a higher level of abstraction, as such ambiguity could spark reflection (Gaver, Beaver & Benford, 2003). The design of Context Photography, for example, captures everyday experiences in an abstract way, (Håkansson et al., 2006; Ljungblad et al., 2004). This inspired us to look at visual abstraction as a form of reflective expressivity. Reviewing such abstract visuals creates room for interpretation (Gaver, Beaver & Benford, 2003). We saw similar possibilities in the use of audio recordings, as it has been found that hearing short recordings involves a process of "unravelling" to interpret their context and meaning (Oleksik & Brown, 2008).

### 2.3 Designs for a Comparative Explorative Study

This study uses a comparative explorative approach. By testing three concepts, we aim to explore the differences between the modalities and their use in everyday life. We take an in-the-wild approach, deploying the devices at the homes of people over a longer period of time (Rogers & Marshall, 2017). Rather than the comparison taking place post-hoc by the researchers, the participants are actively involved in the comparison during the final interview. Traditionally, comparative (lab) studies compare conditions or designs that differ on a single variable. Such a 'controlled' comparison is sometimes also implemented in a prototype and deployed in the wild. Isaacs et al. (2013), for

example, explored the difference between recording and reflective mode of the journaling app Echoes (Isaacs et al., 2013). Other examples include variations in algorithms and interfaces, without changing the concept in itself (e.g. the Smart thermostat in [Alan et al., 2016]) or varying multiple interaction characteristics (e.g. light interaction in [Werff et al., 2017]). In our case, the primary variable is media modality, but in contrast to traditional approaches, this difference is merely the starting point. Each variation is designed to be a valuable concept in its own right. To allow for comparison, several constraints were set but important differences evolved during the design process. Both the constraints and differences will be discussed in the following section.

## 3. Concepts & Prototypes

The designs of the three concepts play a crucial role in this study. Our design process is more elaborately described in (Mols, Van de Hoven & Eggen, 2017). Developing the three concepts started from their difference in media modality. We formulated a number of constraints in the design process to make the concepts more suitable for comparison. Firstly, we choose for all concepts to have a focal point in the *home* and incorporating elements of tangible interaction through dedicated devices. However, part of the creation can occur on mobile phones for easy access, with the potential for 'on-the-go'-use. The second constraint in concept development determines that each concept includes both media *creation* and media *retrieval* in an open-ended way. People are free to create media on any topic, thought or feeling and the systems provide no (steering) questions. Finally, the concepts are designed to have a *low threshold for interaction.* The interactions are intended to be light-weight, quick, and easily integrated in current daily habits and routines. In the following sections the three concepts will be described in more detail.

### 3.1 Balance

With the design of Balance (see Figure 2), we explore the *auditory* modality. Balance is a device in the home that uses tangible interaction to create personal voice memos. The object has the shape of a balance, allowing the recording of messages on two opposing sides. Initially Balance was focussed on recording positive and negative aspects about a day. However, this mapping is not integrated in the design but left open to the users' interpretation. When explaining the concept during the installation of the prototype, the idea of opposing meanings is introduced, as examples positive/negative or work/private life are used. The object is designed as a prominent object in the home to function as an embodied trigger.

By tapping either side of Balance a ten second audio segment is recorded. The more force is used when tapping, the more 'weight' is added to the message and to that side. As if it were a scale, Balance moves to a tilted position as a result of the weights added. As such, Balance represents the evaluative balance between two sides. One of our assumptions is that this movement or position can stimulate to record something on the other side, providing a more diverse view of one's day. Media can be replayed by touching one of the sides, a random recording from that side will then be played.

**Figure 2: Balance prototype in use, being tapped to record a message.**

### 3.2 Cogito

Cogito (see Figure 3) uses *text* to stimulate reflection. Using regular text-messaging services, a user can send short messages during the day, which the Cogito object receives and stores. This pyramid shape is positioned at home and can be opened up, displaying messages on three screens. As the screens are 16x2 character displays, longer messages use scrolling to be displayed, multiple lines move across the screen automatically. Above each screen is a touch sensor to browse messages. Messages on each screen can be browsed to look for interesting combinations of messages that spark new insight by comparing between or abstracting across messages. In the centre of the pyramid an additional note-pad is placed to allow for hand-written notes during more elaborate reflection.

In the bottom of the pyramid a rim of light is integrated to communicate Cogito's state. With this light, we aim to stimulate both regular sending and reviewing messages, for which three states are used. When the Cogito pyramid has not received messages in a long time (more than 24 hours) the device is considered 'empty' (light slowly glowing and fading). When Cogito has received many messages but these messages have not been reviewed yet, the device is considered 'full' (light pulsating actively). If the device is used regularly for both sending and reading, it does not need to attract extra attention, the light is

**Figure 3: Cogito prototype in use, a hand-written note being added after reading messages.**

simply on. To review messages, the closed pyramid can be opened up manually, by unfolding its sides. Internal screens show the most recent message and two random older messages.

### 3.3 Dott

Dott consists of a mobile phone application and a connected photo frame (see Figure 4). With the app, people can create abstract visualisations based on photos selected from the phone's gallery. Users can select one to three pictures, which form the basis of an abstract *visual* based on colours. A random selection of individual pixels is used to generate colourful dots. In the resulting abstract visualisation, specific elements of photos can no longer be recognised. With this transformation, we aim for the media to represent both the event and a personal perspective.

The app includes several parameters that can be adjusted to change the appearance of the visual. These parameters are: many/few, small/big and subtle/bright. Each time the user presses 'create', a visualisation with the selected parameters is generated. Figure 4 shows examples of different settings with the same source photo. Only when pressing 'save and upload' the current visualisation is uploaded to the photo frame. Splitting the creation and upload in two steps, allows for more creative exploration of different settings before a visual is uploaded.

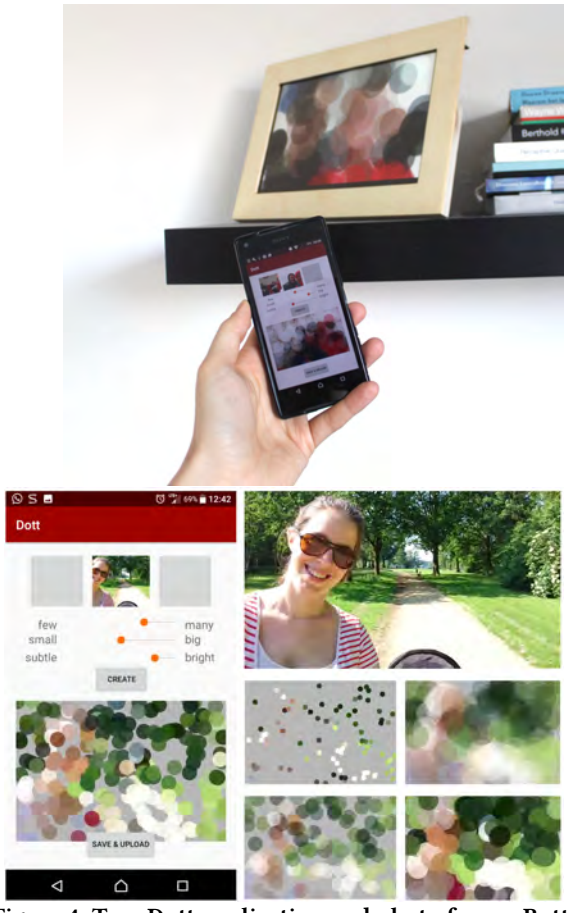



**Figure 4: Top: Dott application and photo frame. Bottom Left: Dott interface. Bottom Right: Four examples of Dott visuals with the same source image (top) but different parameter settings.**

The photo frame always displays the most recent visual and cannot be interacted with. Previous visuals can be browsed through in the app.

## 4. Method: Explorative Comparative Study

As described in the introduction, we developed these concepts to conduct a comparative and explorative study. This method was chosen as we were broadly interested in how different media types could be used for reflection. Table 1 shows an overview of the most important characteristics of the three concepts. By evaluating three concepts, in the wild, we explored how the concepts can be integrated in everyday life. Rather than comparing the concepts post-hoc by the researchers, the participants were involved in the comparison through co-reflection.

During the home study, each participant used all three concepts consecutively, each for approximately two weeks. The order of the concepts was counter balanced, see Table 2 for the order. We visited each participant four times. Consent was asked for the recording of all interviews and the temporary storage of created media. During the first visit, we interviewed the participant on his/her attitude towards reflection and current practices. After this interview, the first concept was installed and explained.

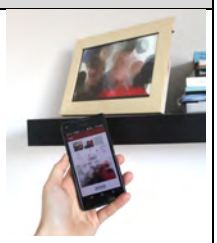
| **Balance - Audio** | **Cogito - Text** | **Dott - Visual** |
|---|---|---|
|  |  |  |
| Media Creation | | |
| Personal voice messages recorded on one of two opposing sides, adding weight to that side. | Short messages sent from a mobile phone are stored and displayed in the Cogito pyramid. | Abstract visualisations generated based on photos and several parameters |
| Mode of Retrieval | | |
| If one of the sides is tapped, a random message from that side is played back. | Media is retrieved by opening Cogito, three messages are then displayed. | Media is retrieved by looking at the Dott frame, which always displays the most recent visual. |
| Triggering Behaviour | | |
| When not used, Balance slowly returns to the central position, in balance. | A rim of light in the bottom of the pyramid indicates if the object is 'empty' or 'full'. | The Dott frame always displays the most recent visual, previous visuals can be seen in the app. |

**Table 1. Overview of the three designs with important characteristics concerning the media creation, media retrieval and triggering behaviour.**

During the second, third and fourth visit we started with a concept interview and installed the next concept. During the use of the concepts, media was primarily stored locally (with the exception of Dott, which used cloud storage). During the interviews, all media was transferred to a laptop for discussion. To ensure privacy, the media was not browsed by the researcher directly, at any moment in the process. During the interviews, participants were asked to browse the media and show specific examples to discuss. For these examples, additional consent was asked for saving and publication. During the fourth visit, the study was concluded with a comparative interview about the differences in use, reflection support and user experience using a number of comparative scales. Additionally, we discussed advantages and disadvantages of each concept.

## 4.1 Participants

For this explorative study, we choose to recruit six participants to explore each concept in depth with each person. This number also allows us to counter-balance the order of concepts. Participants were recruited in two ways. Participants from an earlier study (Mols, Van den Hoven & Eggen, 2016b) who had indicated interest in future concepts were invited. Secondly, open calls on social media platforms were used to attract new participants. With all interested people a short intake interview over the phone was conducted, to see if participation is possible. As the Dott concept is prototyped as an Android application, participants with an Android phone were preferred. In two cases an Android phone was lent to a participant, for this concept specifically. All participants received a €15 gift voucher as compensation for potential costs of mobile services.

## 4.2 Analysis

By visiting the users multiple times and interviewing them on each concept individually as well as comparatively, we gathered rich descriptions of their experiences. Together, the interviews accumulated 16.5 hours of recordings, which were transcribed for analysis. We adopted thematic analysis with a primary open-coding approach (Braun & Clarke, 2006). We started from the data and our coding scheme evolved over several iterations. In total, this resulted in 2151 applied codes. Most segments had several codes associated to them, including to which concept it referred. Codes were clustered into several themes (e.g. General Use, Reflection Characteristics, Integration in Everyday Life) and with an iterative approach, some of these themes were then split into sub-categories. For example, 69 segments were coded as relating to a 'trigger', this was further analysed and split into multiple types of triggers. In this paper, we discuss the largest clusters relating to reflection, modalities and the integration into everyday life.

# 5. Findings

In this section, we will first present the general experience of using the concepts. We describe more in detail how *creation* was integrated in everyday life habits, discussing the role of opportunity and triggers. We continue with our findings on media *retrieval*.

## 5.1 General Use

During the period of use, participants created an average of 16 media instances with each concept. Averages for each concept are close (Balance 17, Cogito 15 and Dott 14) but there are large individual differences (see Table 2). Overall, participants reported engaging more in media *creation* and less in media *retrieval*. Specific numbers for retrieval cannot be given, as this was not tracked.

In a few cases, participants stopped using a device after a few days, this was seen with Balance (P02, P03 and P05) and with Cogito (P02). This was due to technical difficulties (two cases with Balance (either unstable sensor or annoying continuous buzz sound)) or due to strongly disliking the concept (one case with both Balance and Cogito). Most interactions occurred during the late afternoon or evening and for most participants a moment of interaction meant creating a single media item. Figure 5 shows examples of how each concept was used.

| | Concept order | # of media | | |
|---|---|---|---|---|
| | | B | C | D |
| **P01 Female 78** | D-C-B | 29 | 28 | 33 |
| **P02 Female 45** | C-D-B | 9 | 6 | 14 |
| **P03 Female 23** | B-D-C | 6 | 9 | 15 |
| **P04 Male 62** | B-C-D | 16 | 11 | 13 |
| **P05 Male 58** | C-B-D | 4 | 18 | 8 |
| **P06 Male 32** | D-B-C | 40 | 18 | 6 |

**Table 2: Overview of participants, with gender and age. Concept order indicates in which order the prototypes were used (B = Balance, C = Cogito, D = Dott). Final columns indicate the number of media that person created with each prototype.**

## 5.2 Comparing Modalities

Overall, creation with both Cogito and with Dott was considered to be simple. Most participants considered the Dott frame and visualisations an aesthetically pleasing addition to their interior. Most people used Dott to create visuals with existing recent photos, looking for a combination of pictures and settings that still contained some recognisable elements (Figure 5, example bottom-left). Most participants preferred to use a single photo rather than blending multiple, to make it easier to recognize elements. P01 used Dott in an exceptionally expressive way (example Figure 5, bottom-right). She created visuals to represent her feelings and goals, using both existing photos and creating new compositions as source material.

For most, recording spoken messages on Balance felt somewhat awkward, either because it felt unnatural to talk to an inanimate object (P05) or because they didn't want to hear back their own voice (P04). Sending written messages to Cogito was a more familiar interaction. There was some variation in how the messages were sent, due to technical differences between phones and operators. As a result, some participants could easily read


**Figure 5: Examples of how each concept was used. Top to bottom: recordings on Balance, messages with Cogito and visuals with Dott.**

back messages on their phone, which they preferred over reading on the Cogito object, which was often considered to be somewhat cumbersome and impractical.

### Depth in Reflection

We asked participants to compare the three concepts based on the depth reached in their reflections. When discussing these rankings with the participants, it became clear that most of them primarily reflected during the *creation* of media. Secondly, it showed that the extent to which depth is reached is strongly influenced by personal preference. Some participants feel more comfortable to express thoughts in spoken word and others in text. With Balance, P04 and P05 had a clear aversion to record more deeper thoughts, as to them, it felt awkward to speak something like that towards an object. In contrast, P03 and P06 reached more depth with Balance, each in a different way: P06 reached more depth because he could use the split between a positive and a negative aspect in a very useful way. P03 reached depth because she experienced a threshold that required what she recorded to be more important or significant.

> "If you are going to say something, out loud, then it really makes you think [about] what you are going to say, at least in my opinion. We are so used to typing, but recording [...] your voice, you don't do that so often, [...] That was a bigger deal for me than writing and sending [...]. Especially: do I think it's worthwhile to record? Typing a message is not that "valuable" but recording something is more of a hassle, so..." [P03 on Balance]

For most participants, creating messages with Cogito reached some level of depth. We expected the concept to reach more depth when reading multiple messages and looking for connections, but this was rarely done. The interview was now in some cases a stimulant to reflect across multiple messages, for example for P06, who even made connections between reflections made with Balance and Cogito:

> "Well, now that I talk about it with you, [something] really stands out. I send [to Balance] at the start that I was annoyed because [my partner]. didn't respond as I had expected when I put up a lamp [...]. And now my last message to Cogito is "Annoyed that I don't get more attention from [partner], do I give her enough attention?". Yes, Yes, maybe something like that, that it can surface over time, do you give each other enough attention." [P06]

By most participants Dott was considered to be the most light-hearted and even superficial. The visuals were mainly made on an aesthetic level, with little expressivity. Recall usually remained on a superficial level ('oh yeah that happened'). In all concepts, the 'light-heartedness' is also seen as an advantage. Participants thought it made it easier to do in short moments and is useful if a person has a tendency to make reflections very deep and emotional.

### Individual and Social Use

All concepts were designed to be primarily used individually. Yet, as they were position in a shared space (most often the living room), the objects evoked responses from partners, family members and visitors. Inspired by the frequent occurrence of reflective conversations (Mols, Van den Hoven & Eggen, 2016b), we expected the direct visibility of the media in Dott to trigger such talk. It surprised us that instead, the closed design of both Balance and Cogito, in which media is hidden, sparked more conversation. Partners were curious of what was captured and even a little suspicious. Some participants also indicated that using these devices sparked conversation more indirectly. For example, P6 wanted to record something, but did not know exactly what he wanted to say about a topic. He later had a conversation about the subject, to figure it out, but the media was not a direct trigger for such a conversation.

## 5.3 Integrating Creation into Everyday Life

For most participants, the creation of media did not have a fixed moment in the day. This was seen strongest with two participants who had no fixed day-time activities such as work.

> *I don't really have fixed times [to use the concepts], but then again, I don't work, my grandchildren are a bit older, so I have a lot of time on my hands [...] So I did it at many different moments and that suits me. I'm not the kind of person to say 'in the morning it has to be so and so' [with a fixed routine].* [P01 on Dott]

Although to a lesser extent, such variation was seen for almost all participants, both in terms of timing during the day and in terms of amount on each day (e.g., much was created on one day then nothing for several days). Dott had the most varied timing, several participants expressed that this was the easiest concept to use "in between" other things as it was both mobile and light-hearted. Balance was used on a more regular moment by half of the participants.

*In my case just in the evening, then it's quieter here, than I have nothing around me for a moment, then I can do those things. During the day, that's not for me, because I constantly have the kids asking questions and such.* [P02 on Cogito]

We expected sending messages with Cogito would be so quick and easy that it could be done in between activities. However, for most people, this required more attention and time then we had thought, resulting in mainly sending a (number of) message(s) at the end of a day. This also relates to the fact that more elaborate reflection occurred at the moment of creation with all concepts, including Cogito.

### Opportunity

Even when creation happened on similar moments on most days, this was not because it was planned as such. Use happened on a regular moment because *opportunity* for creation arose on similar times each day, usually in the evening. 73 segments from the interviews were coded in this category, including the quote by P02 above. But what constitutes an opportunity?

*That's when you have time to yourself, start of the evening as well, especially if I'm alone, not if other people are at home. I really consider this something to use when you are alone.* [P05 on Cogito]

*It takes time, to put [thoughts] into words, what you considered good or bad. And to do that, that's often end of the day. Then you can sit down and think: what went well, what went bad, and usually I would [use Balance] then.* [P06 on Balance]

These quotes include several themes that were mentioned by most participants. This includes a state of *calmness* (13 codes, 5 out of 6 participants,). Additionally, most considered creation easiest when *alone* (6 codes, 3 out of 6 participants) and when there was some *time* (5 codes, 3/6p). For most participants, opportunity arose most when they were at *home* (5 codes, 4 out of 6 participants). Within the home, the devices were mostly located within a shared space, such as the living room, which created some challenges for the preferred solidarity. The creation with Cogito and Dott was appreciated for being more mobile, even though in practice the mobile use was often limited to within the house. In most cases, because of these characteristics, opportunity did not arise *during* an experience or activity. Opportunity arose more when *looking back* at an experience (or the day as a whole). As such, moments included coming home (looking back at the day) or Saturday morning (looking back at the week), or for example lunch break at work (looking back at events of that morning).

### Trigger

As timing was not fixed, we are also interested in what triggered people to create something.

The *physical presence* (13 segments, 4 out of 6 participants) of the different concepts was an important trigger to create something. People saw the device, which triggered them to make something. Sometimes the making started from a thought that was already in their mind, other times the presence of the object triggered to start thinking. However, not in all cases people had something to record when they were triggered by the presence of the device.

*If I would come home I would see it and think, I could record something, but often I didn't have anything specific (on my mind) that I wanted to record.* [P03 on Balance]

As the quote shows, the trigger of physical presence connects to the routine of 'coming home' as the device was often noticed when entering the room. However, the quote also shows that there needs to be an internal motivation as well. In several cases, people were primarily internally triggered to reflect and create. This was sparked by an *emotion* (9 segments, 5 out of 6 participants) or an *insight* (6 segments 3 out of 6 participants).

*I came home happily, that time, I think, the time is not included, is it? [I think] it was beginning of the evening, after dinner, that you look back at the day with a lot of fulfilment.* [P05 on Cogito]

Both for emotions and insights, it was expressed that this had to be 'worthwhile', significantly emotional or a significant insight.

In other cases, *external triggers* (9 codes, 2 out of 6 participants) lead to reflection and creation. For one participant, conversations with others triggered creation several times, with different concepts (P03). P01 was frequently triggered by external inspiration such as art or books. Finally, an important trigger was seen in people's desire to comply with the *research participation* (14 codes, 4 out of 6 participants). Often, this coincided with seeing the device or with being reminded of the research by an upcoming appointment.

For the different concepts, more specific triggers were observed. In the case of Dott people were frequently triggered by receiving new photos (from others) or by making a photo explicitly for Dott (triggered by the situation). With Dott, use was also frequently triggered by curiosity: how would this photo turn out on the frame, rather than more reflective intentions. Additionally, creation was sometimes triggered by seeing the old visual and wanting something different.

The design of Cogito used a rim of lights as trigger by indicating if the device had not received anything in a long time (thus inviting to create) or was filled with unread messaged (thus inviting to retrieve). Several participants mentioned the lights, but only for one participant this was a real trigger to create. Others expressed that the lights were not clearly visible enough (as it was summer, and usually light inside) or the different states were too difficult to distinguish. Balance used dynamic behaviour as well to serve as trigger, the position of Balance restored to the centre over time. However, the position of the Balance had little meaning to the participants. The addition of symbolic 'weight' to the messages was not used because the force sensor was not sufficiently stable to use in an expressive way. This system behaviour did therefore not provide the trigger to create as expected.

## 5.4 Reflection in Retrieval

With retrieval, we refer to the moment of 'using' the media that has been created earlier. This relates to reading messages (Cogito), listening to messages (Balance) and looking at the current or earlier visuals (Dott). This does not actually require actively browsing or retrieving files with these concepts, but is done by opening Cogito, tapping Balance or simply looking at Dott. This topic was covered by 99 coded segments.

As mentioned in the section on general use, most participants focused on creating media and retrieved media less frequently.

*As I said, I wasn't really focussed on it, so I think I might have read it back four or five times. But I haven't used it that often.* [P06 on Cogito]

From the coded segments on media retrieval, the largest amount related to Dott (45 out of 99 codes, 6 out of 6 participants). It can be assumed that retrieval with Dott occurred more frequently, as it requires no active interaction; the visual is simply always present in the room, making retrieval easy or even implicit.

#### Depth in retrieval

When reading, listening or looking back at a media item, the "success" of retrieving some media depended on whether they would remember the context of creation, or what the media represented for them. With Cogito and Balance, the brief messages were often sufficient to cue rich recall:

*[Just] to keep it brief. And then I hear by the tone of voice [what I mean] and I can immediately recall the whole situation.* [P01 on Balance]

For Dott, responses were diverse. Some people considered it easy to recall what the visual represented, for others it became more or less meaningless. This seems to partially depend on the effort invested in creating the visual and the significance of the represented experience. If the experience was very unique, it was easier to recall, even from an abstract representation.

*Then it has to be something that is stored in your memory very well, this I will remember, but with other photos, maybe I couldn't remember so well.* [P04 on Dott]

If the user invested a lot of effort in creating an appealing visual, the connection between experience and visual was also more actively made, making it easier to remember. During the interview, several visuals were also seen of which participants could no longer tell what it was or why it had been created, even though the visual was a maximum of six weeks old.

As these examples show, when looking at the visuals most people recalled the past experience that it represented. Often, these recalls were not very reflective, but focussed on the facts with potentially some level of introspection concerning the experienced emotions. Rather than focussing on the past experience, P06, instead used the photo that was on display as a trigger to think about his current day, even if it was unrelated to the visual.

*I do think about it, because I have put up that visual, so you think about the photo and go back to that moment. But I try specially to think back about the current day. It is not [a trigger to] reflect about what happened at [the moment of] the shot. I try to [reflect] about today.* [P06 on Dott]

For him, the photo frame was a trigger to reflect on the day, more than an actual representation of an experience.

## 6. Discussion

The research-through-design study comparing Balance, Cogito and Dott gave rich insights in the potential of media based reflection technology. In this section, we first discuss our results regarding our study design. Secondly, we discuss the modalities that we explored and their differences. Following, we propose considering the context of reflection in a more nuanced way. We end the discussion with an overview of the important design aspects that supported reflection in creation.

## 6.1 Explorative Comparative Study

Comparing multiple designs, in-the-wild, and involving participants in this comparison, is a rarely seen approach. Here, we share some of the insights we gained regarding this combination of exploration, comparison and evaluation.

In the design and development, we experienced that it is challenging to develop three concepts that are simultaneously sufficiently similar and interestingly different. In hindsight, Cogito and Balance were too similar, the reliance of both concepts on words (and thus on verbalising thoughts) made them more similar to each other and very different from Dott. Focussing the audio concept on soundscapes or environmental recordings could have made the concepts more equally spread across the 'design space' (Gaver & Martin, 2000).

To allow participants to experience the concepts first-hand, they were all implemented in interactive prototypes. We aimed to integrate role, implementation and look-and-feel into each prototype (Houde & Hill, 1997). However, the technical implementations created some obstacles that inhibited evaluating the concepts to their full potential. For example, the force sensors in Balance were unstable, which made recording more difficult. Secondly, the design features that were intended to serve as peripheral reminders (restoring position of Balance over time or fading lights in Cogito) were too subtle in most home environments. Some participants could easily use the prototypes as a starting point (moving beyond technical challenges), not judging it by its actuality but by its potential (Odom et al., 2016), but for others this created an unsurmountable obstacle.

In the final interview, we emphasized the differences between the concepts by using comparative scales (similar to Werff et al., 2017). This was a useful way to stimulate people to view the concepts from different perspectives. However, the strong emphasis on differences, made it more challenging for us to analyse the similarities between the concepts. The systems share many characteristics as well, such as individual home use, combining media creation and retrieval, and having a low threshold. Prompting the participants to discuss the similarities more explicitly would have strengthened our insights in this area.

## 6.2 Modalities for reflection

The study set-up relied heavily on comparing the different concepts and their modalities. In the following sections of the discussion, these differences will continuously be mentioned. Here, we briefly discuss the some of the major findings and future directions regarding each modality.

First, the visual media was most different from both other forms. Based on our findings we conclude that abstract visuals *can* be supportive for reflection by allowing for expressivity. However, most people have the tendency to look for the 'hidden' objects or people in the photo 'behind' the visual. Rather than looking at the visual as an expression in itself it was seen as a representation of the photo (which in turn is a representation of the actual event). This might not necessarily be a bad thing, as recalling the original photo and event can support reflection as well, but it creates a different process of interpretation. In future research, it would be interesting to explore abstraction in the moment of creation itself (such as Context Photography Ljungblad et al., 2004), rather than as an alternation applied afterwards. Additionally, more abstract expressivity could be used, without using photos as a source. In the use of Dott, it became clear that color-pallets are well suited to express emotion as most participants also expressed feelings such as happy, sad, chaotic or calm. In its most minimal form, colors as expression are explored in GoSlow (Cheng et al., 2011), using just a single color to represent a day (although this was combined with text entry). Findings novel ways to create color compositions of a certain experience or timeframe could be a valuable concept for reflection.

As mentioned above, the text and audio modalities were more similar than we had expected. Their reliance on words and briefness made them more similar in the way they supported reflection. The biggest difference was that speaking to a device is experienced as more awkward, whereas typing is very familiar. Additionally, audio is inherently hidden when stored, but at the same time it is the most 'public' media during both recording and retrieval. Anyone present in the room can hear a message being recorded or played. This might have been one of the factors that made the Balance device more awkward to use, especially because the home is such a shared context (see next section). It could be an argument against using voice recordings as a private reflective tool, however it might be very suitable for more social forms of reflection in conversation.

The advantage of the text messages in that sense, was that they were hidden and even the creation could be done 'hidden' as it was just on a regular phone. Exploring multiple messages by opening up the device was appreciated on a conceptual level by the participants. However, in practice the orientation and types of screens used made it difficult to compare the messages. Using a word-cloud or collage style could provide different perspectives on written message. Additionally, it would be interesting in future research to explore depth in written language by providing different interactions for different lengths of texts: a single word, a sentence or a complete (diary like) story.

## 6.3 Context of Reflection

In both the pre-interviews and the evaluation it became clear that 'home' is an important place for reflection. It was seen as one of the core characteristics of good 'opportunity' for reflection and even mobile creation was often done at home. In the literature on reflection, few examples are seen of such 'domestic reflection', which is influenced by the dominant focus on educational or professional aims. Others focus more on the interaction with (mobile) systems, with little reference to the context in which such interactions take place (Li, Dey & Forlizzi, 2010). We conclude that for reflection to be integrated in everyday life, considering its context is crucial.

Such nuanced view for example means that even the home cannot be seen as a singular context. For example Petrelli, Whittaker & Brockmeier (2008) found that mementoes serving reflective purposes were more often found in private rooms, such as bedrooms or studies. In more public or shared rooms, digital media with a presence in the home can create reflective conversation (Helmes et al., 2011; Odom et al., 2014). In our case, we were surprised to see that it was not the most visible media that triggered questions from others, but rather the designs that would 'hide' media (insight Balance and Cogito). Our objects were currently used in a single location for the duration of the study, but it would be interesting to allow people to try out different places and rooms, differing in private, shared or public status. Exploring different locations within the home, changes how systems are perceived and integrated in family routines (Helmes et al., 2011).

A nuanced view of the context for reflection could be take in other areas as well. For example, systems for reflection in work or education rarely take into account *where* the reflection will occur, but instead focus on platforms that can be used anytime and anywhere. Based on our study, aspects such as a quiet context or being alone could be beneficial. We see a future research opportunity in exploring the contextual characteristics for reflection in other areas.

#### Use over time

The open-ended designs were not used in a pre-scribed way, in terms of timing, process or otherwise. Thus, the reflective interactions can be seen as a flexible habit, rather than a fixed routine. From day-to-day the desire for reflection and the opportunity to use a system changes. On a larger scale, the need for reflection is similarly flexible (Mols, Van den Hoven & Eggen, 2016b), changing with certain periods and across the life span (see also Staudinger, 2001). Rather than aiming for establishing habits "from now on and until forever" (Fogg, 2009), it would be valuable to consider designing reflective technology for flexible, temporal or cyclic use. This requires a perspective in which periods of non-use (or 'lapses', see Epstein et al., 2016) are accepted and integrated in the design.

An approach that focusses on flexible or cyclic use would benefit from designing dynamic systems. A combination of active and reactive behaviour stimulates exploration in open-ended systems (De Valk, Bekker & Eggen, 2013) and can provide peripheral triggers in the home. Cogito, for example, used light patterns to

achieve this, which could be even more dynamic. Allowing users to adjust dynamic behaviour of the concepts to specific (family) situation is beneficial, as it allows the system and its 'agency' to take a suitable role within the home. Although same dynamics were included in our designs, we believe these were too subtle to stimulate such exploration.

### 6.4 Triggering Reflective Creation

The use of Balance, Cogito and Dott showed that many participants reflected during the *creation* of media. This differentiates these systems from many other designs for reflection (with media), as these most often focus on media retrieval. In some cases, this media is primarily system collected (for example by Sensecam (Lindley et al., 2011), or sensor-based (Lin et al., 2006; Consolvo et al., 2008)). If the users are involved, media creation is often focussed on creating 'logs of events for future retrieval' (Fleck & Fitzpatrick, 2010).

Existing mechanisms to support reflection in creation often use prompts (Fessl et el., 2017), an approach especially taken to trigger written reflection. As an alternative to such content-triggers, opportunity or direction triggers can be used (Mols, Van den Hoven & Eggen, 2016). Opportunity triggers are described as the most open prompts, only highlighting the potential for reflection to occur. Direction triggers provide some more guidance, by suggesting a way to reflect (e.g. something that went well today) without providing any subject or content (which a content-trigger provides). In our designs, Cogito relied on opportunity triggers while Dott and Balance provided some direction. The object was designed to provide triggers in the periphery of attention by using a light pattern. The current study provided limited insights in this triggering, which we believe would be worth further exploration.

To stimulate reflection, we found that direction triggers are easier to interpret and to make meaningful for most people, compared to only giving opportunity. In addition to such direction triggers, we recognise several mechanisms in our designs that supported reflection in creation. Primarily, we see that the concepts supported reflection by stimulating to *externalise* thoughts and feelings. Isaacs et al. (2013), found externalising to be just the first step, with reflection mainly occurring on retrieval of media, but we saw reflection already (and primarily) happening in the creation phase. Especially with Cogito and Balance, creating media required to bring into words what one is thinking or feeling. In addition, the *briefness* of the messages was often seen as a stimulant to get to the core of a thought and make reflections more specific. Other mechanisms that supported reflection were seen in the possibility to *adjust the media* during creation (thus resulting in mini-iterations) and by having a certain *threshold*.

To understand these last mechanisms further, it would be valuable to know how much time was spend on creating a media item and if the reflection would be stronger or better remembered when more time was spent. However, in our current set-up this time was not tracked. Additionally, our findings might be skewed towards creation, as more emphasis in the explanation of the concepts use was given to how to create media, as this was often more challenging than reviewing media. This might have given the impression to participants that creation was more important. The study duration of two weeks might have also reduced the potential value of review, as all captured experiences were so recent that they might be easily reflected upon without media, thus retrieval provided only limited new perspectives.

## 7. Conclusion

Reflection is a topic of great interest within HCI, in methods of design as well as to be supported amongst users (Sengers et al., 2005). In accordance with (Baumer, 2015; Mols, Van den Hoven & Eggen, 2016), we have grounded our work in a stronger theoretical understanding of reflection, based on Dewey (1933) and Mezirow (1990) but focusing on a flexible and open-ended type of reflection (Ekebergh, 2007). To support such open-ended reflection, we propose focusing more on personally created media, rather than system collected data. We have designed and evaluated three concepts for reflective media interaction: Balance, Cogito and Dott. In the explorative and comparative evaluation of these concepts, we found that their use greatly depends on the opportunities that arise from peoples' personal habits, influencing the potential for reflection to be triggered.

Based on our study, we contribute to the extensive body of work on reflection in threefold. Our primary contribution proposes reflection can be supported in creation. Many designs for reflection use system created or collected data, focusing reflection on the moments of retrieval. However, when using media, the *creation* has potential to support reflection, by supporting externalizing thoughts and feelings. Reflection can be supported further by requirement briefness or through an adaptive process of creation.

Secondly, we highlight that designs for reflection should take their context in close consideration; as it is of vital influence to the opportunity for reflection. Although many applications now focus on mobile availability, the home can be further explored as a context for reflection, using situated and embodied triggers.

And finally, in everyday life, open-ended reflection does not adhere to structured step-based models of reflection, but is more flexible. Further research should explore how longitudinal use supports such exploration and integration over time.

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