Master's Thesis

Exploring Reflective Experiences of Daily Moods through Light Colors: Design and Field Trial of Lumino in Homes

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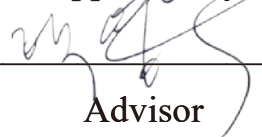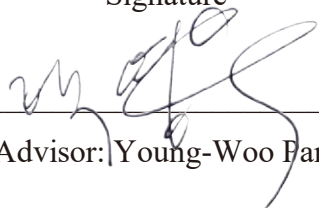Ulsan National Institute of Science and Technology

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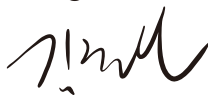This certifies that the thesis of Dohee Kim is approved.

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Abstract

Although archiving daily moods in a diary is a common behavior, reflection is difficult because of the pressure brought about by continuous self-tracking of personal moods. In this paper, I developed Lumino, a standalone device that enables users to log their daily moods with colored lights and switch mode to show the log by physically sliding a circular lighting plate. The results of three-week in-field study with six participants revealed that Lumino helped users encounter emotional archives as it separated reflective experiences from daily life activities. Moreover, Lumino helped prevent deep reflection on negative emotions and maintained privacy through abstract color expression. I also found user's various trials to control emotion reflections in their own usage patterns. I propose considerations for augmenting daily mood recording experiences combined with existing diary practices and further implications for designing how to support positively the negative reflections in everyday spaces.

Keyword: Mood self-tracking, Colored light, Physical interaction, Self-reflection, Home, Interactive lamp

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Terms and Abbreviations

HCI   Human-Computer Interaction

I. INTRODUCTION

1.1. Background

Personal mood self-tracking can help to increase the user's self-awareness and emotional well-being (Caldeira et al., 2017) When tracking these personal moods, it is important for users to be aware of their own emotion. In previous studies, researchers proposed various interactive technologies to help record and analyze the user's mood (Choe et al., 2017; Kanjo et al., 2015; Lindström et al., 2006). However, those studies remarked that the user's moods and thoughts could change depending on the situation. Thus, it is difficult to understand an individual's moods only by using sensing technology because the interpretation may differ (Calvo & Peters, 2014). In addition, considering emotions involve cognitive and interpretative components, the self-reporting method remains key in understanding the user's emotions and requires ways to enhance the user's engagement in reporting their data (Rapp & Cena, 2016).

In this regard, recent human-computer interaction (HCI) research developed interactive mediums that allow users to record their moods and devised various methods to analyze and represent the self-recorded mood. For example, one study aimed to stimulate reflections on emotions recorded via mixing bottles of colored emotional herbs (Mols et al., 2016b); and an interactive color lighting system, which could be an emotional diary (Noh et al., 2020). These cases describe colors can be used as an effective medium to express and reflect users' daily moods in a tangible product installed in everyday environments. In this regard, several studies suggest ways of collecting and expressing emotional states through one-to-one matching of color and mood (Angelini et al., 2015), (Church et al., 2010). Previous studies have shown that color strongly influences human emotions and that color-emotion associations exist (Hemphill, 1996); however, these cannot be considered reflecting the context, personal experience, and color preference. More specifically, one study described that when users expressed their emotions through color, it was necessary to understand that colors were rich in symbolism and that color-related emotions differ from person to person (Kaya & Epps, 2004). In addition, Naz's team stated that color perception relates to personal experience (Naz & Helen, 2004). Furthermore, color is an adequate way to express an individual's intangible data (emotions) physically, and it is possible to recall memories through color (van den Hoven & Eggen, 2008). That is, although emotions associated with a particular color exist (Manav, 2007), (Nijdam, 2009),(Manav, 2007; Von Goethe, 1840) an individual's interpretation of the color can be subjective.

By using the characteristics of colors and their relationships to personal moods, the user can select color and use it as an appropriate means to express mood. In addition, if an object expressing that color is placed in the user's living space, this could possibly provide expression-driven reflection in everyday life. Furthermore, the daily self-reflection activity, normally an internal process, becomes an externalization of the individual's thoughts and feeling (Mols et al., 2016b). Moreover, living with a reflective attitude has many benefits, such as gaining insight, supporting life change, and motivating behavior change (Li et al., 2010). Simultaneously, for everyday reflection experiences, users must understand that reflection takes time, and people can learn to be more reflective over time and with support (Moon, 2013). Thus, self-reflection is not easy in daily life, and people need encouragement to participate in reflective experiences (Baumer et al., 2014). To this end, HCI researchers have conducted studies to supplement the difficulties of self-reflection in daily life through a new interactive device. For instance, one study used volumetric changes to represent an individual's everyday behavior(Ju et al., 2019). In particular, there were cases using light or color, such as applying the property that stimulates emotions (Snyder et al., 2015; Yu et al., 2018) and using abstract color combinations (Mols et al., 2020). Researchers primarily focused on reflection through the ambient feedback of the surrounding environment or visualization using other objects. On the other hand, studies that encourage reflection via integrating the rich symbolism of color and the experience of recording individual moods with color-light interactions have been rare. In this, I found importance in exploring self-reflection of personal mood through colored light in the living environment.

1.2. Research Goal & Methodology

I captured the need to apply colored light characteristics to archive personal mood in a daily living space. Specifically, I found a new design space for archiving and reflecting personal moods through an everyday lighting device. In this research, I focused on exploring how personal mood can be expressed and reflected with color light, rather than revealing the mapping between specific emotions and colored lights. Based on the above research opportunity, I developed "Lumino" (Figure 1), an interactive lamp that enables users to record their daily emotions with colored light by using dials and expressing those archives through a circular lighting plate. To investigate how Lumino can support daily emotion archiving and reflection, I conducted a three-week field study in six participants' homes. This paper makes two contributions. First, it introduces Lumino and its design process, both of which provide implications for reflecting individuals' daily moods into their living spaces. Second, it describes the

results of the Lumino field study, providing insights into how recording and expressing an individual's daily mood with colored light enriches the user's self-reflection experience.
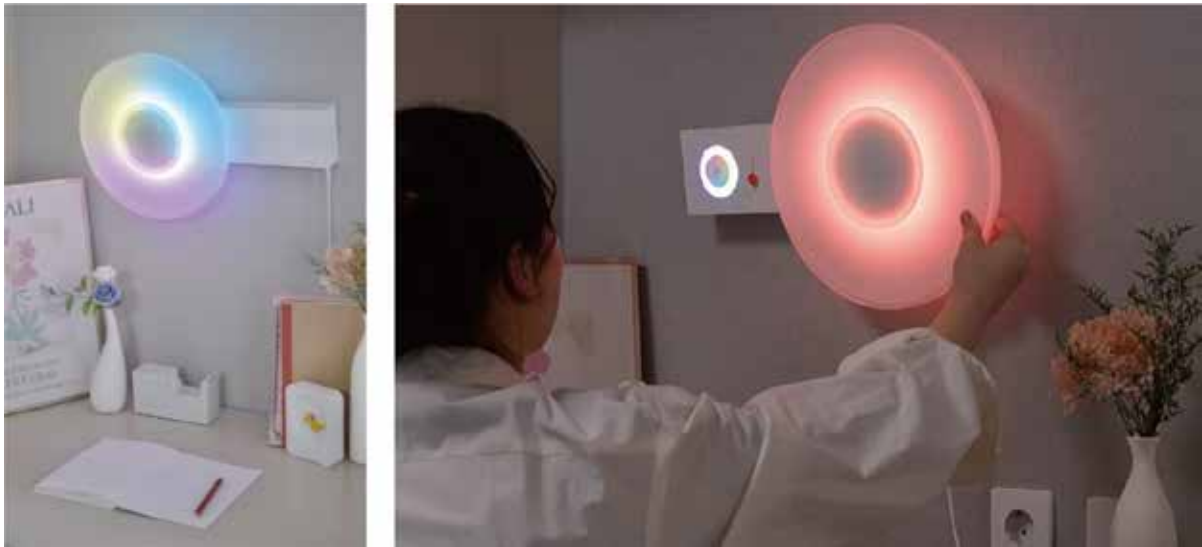
Figure 1. Lumino installed in homes. The device is in show mode, representing the user's recorded mood(left). The user is selecting her current emotion through the colored lights palette dial and the linear slider. This record mode can be switched from the show

II. RELATED WORK

2.1. Daily Reflection

Several studies to support daily reflection have been consistently conducted over the years in the field of HCI. In this section, I looked at how to support daily reflection through interactive mediums and tangible light objects.

2.1.1. Through an interactive medium

Media systems can take different roles in supporting reflections, such as triggering and capturing. Therefore, the new interactive medium to supplement the difficulties of self-reflection in daily life were studied by many researchers. For instance, Balance is an object that expresses positive and negative thoughts through weight, thus showing the balance of life (Figure 2, left); Dott acted as a trigger to induce reminiscences of that day by visually expressing the photos in the gallery on the phone in a frame (Mols et al., 2020) (Figure 2, right).

Figure 2. Balance showing the balance of life (left), Dott that visualize users' photo in a frame (right)

Also, one study explored interactive artifact that physically represents an individual's everyday behavior used abstract volumetric changes (Ju et al., 2019) (Figure 3). It made intangible data physical for self-reflection to enhance people's motivation and to encourage changes in behavior that are difficult to perform due to weak motivation. The existence of a physical referent can be a means of self-expression, and the exposure of data can induce participation in a conversation, which can affect a user's motivation. In addition, the abstract visualization can provide positive pressure that can lead to natural action for self-reflection (Consolvo et al., 2009).

Figure 3. Bookly, an interactive artifact that physically represents the accumulated time of users' reading activity through abstract volumetric changes

2.1.2. Through a tangible light object

Human factors such as mood and emotion influence when interacting with the lighting system (Magielse & Ross, 2011). In addition, interactive lighting and its deployed space would help users to feel the intended mood through the artificial lighting system. For example, researchers proposed a lamp to support visualizing the level of physical activity through shade with controllable transparency (Cha et al., 2016).

Another study explored daily reflective experiences through expressing a photo's color as a tangible lighting artifact, helping to remember the moment's mood (Noh et al., 2020). It helped users visualize the mood of invisible moment and discovered the potential of using it as a colour diary that reflects the day (Figure 4).

Figure 4. LightPalette (a), a photo of artwork (b), five major colours selected from Pantone app (c)
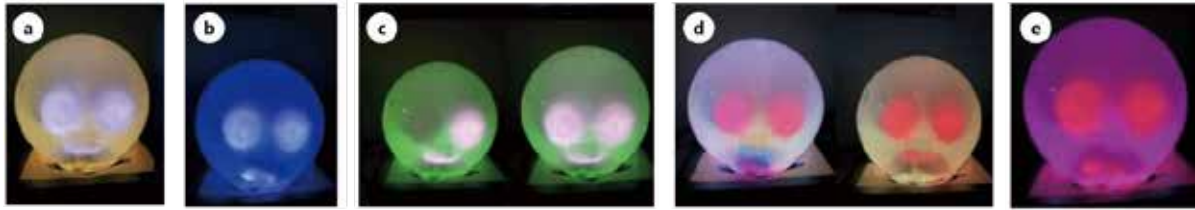
Figure 5. The five emotional states of anthropomorphic lamp; (a) happy, (b) sad, trusty with (c) eye blink, (d) ecstasy, and (e) angry

In addition, researchers have proposed ways to display and collect emotional states to colors (e.g., anger for red and sadness for blue) with facial expressions, and social interaction through an anthropomorphic lamp (Angelini et al., 2015) (Figure 5). They tried anthropomorphic design of the lamp to maintain high the interest in lamps through interaction with users.

These design cases not only emphasized the value of interaction with light, but also showed the potential for using them as an object for reflection in daily life. Particularly, this approach shows that interaction with tangible light can be a useful means of reflecting affective recordings.

2.2. Color and Mood

Various studies have shown that color and emotion are closely related. These studies show that emotions associated with a particular color exist(Manav, 2007),(Manav, 2007; Von Goethe, 1840). Based on this theory, the relationship between color and emotion was used to allow users to express their emotions by mapping them to colors. One study provided a method of eliciting a certain feeling through stimulating a specific feeling as it presented a color through the revealed color-emotion mapping study (Nijdam, 2009).
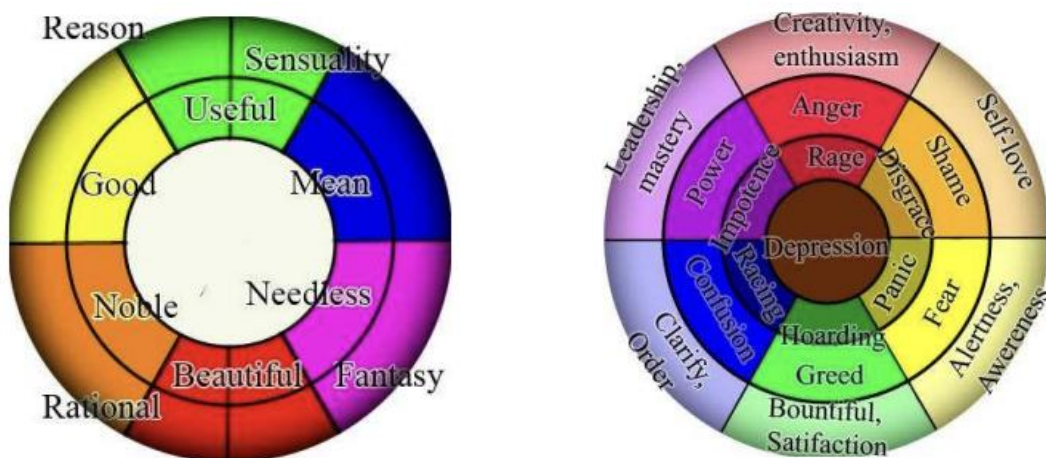
Figure 6. Goethe Color Circle (left) and Shirley Willette Color codification of emotions (right)
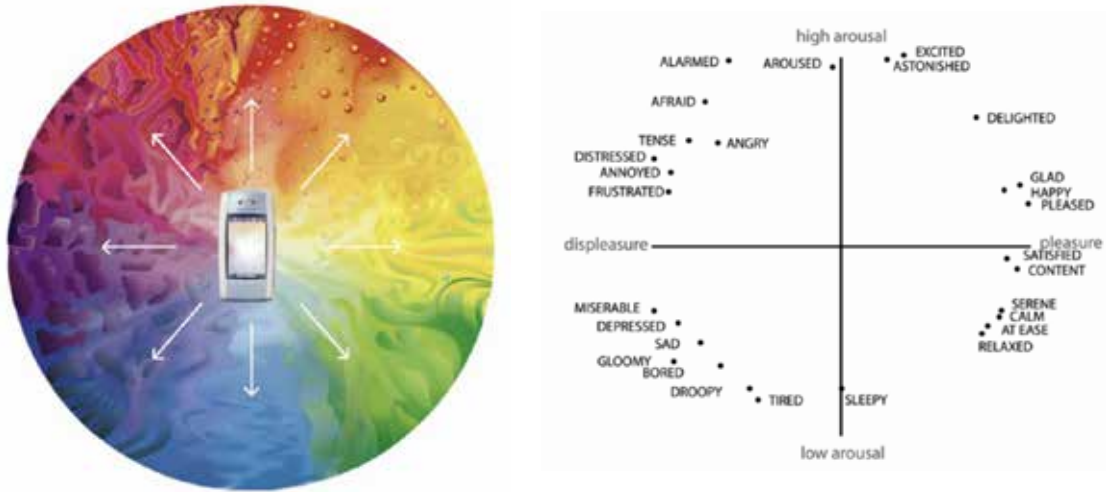
Figure 7. The whole circle with color, shape, and animations (left), Russell's circumplex model of affect (right)

They also proposed a way for users to customize color-mood mapping through the app to express their mood with color and share it with others. In Anna Ståhl's study, based on Russell's model, eMoto, a text messaging service that expresses emotions through color, shapes and animation, was proposed. They expressed the emotional records such as mood and emotions were expressed in a subtle way, rather than in clear-cut single states (Ståhl et al., 2005), (Figure 7). In this regard, understanding that moods tend to mix with each other rather than distinguishing the moods through defined boundaries or clear meanings is needed.

The above studies suggested the possibility that the color-lighting system could contribute to daily reflection through expressing individual mood. On the other hand, little has been explored by the field deployment of the prototypes in which exploring how people record their moods using their own color expressions without automatically applying existing theories of color and emotion mapping.

Based on the lessons from previous studies, I designed and implemented a device called Lumino, which provides tangible user interaction through color lighting system to support everyday reflection by recording mood with color expression. I explored its uses by participants in their living spaces for three weeks. Through this, I tried to identify possibilities for new daily reflective experiences by recording moods with the color of light.

III. LUMINO DESIGN

3.1. Designing a Personal Mood Diary through an Everyday Lighting Artifact
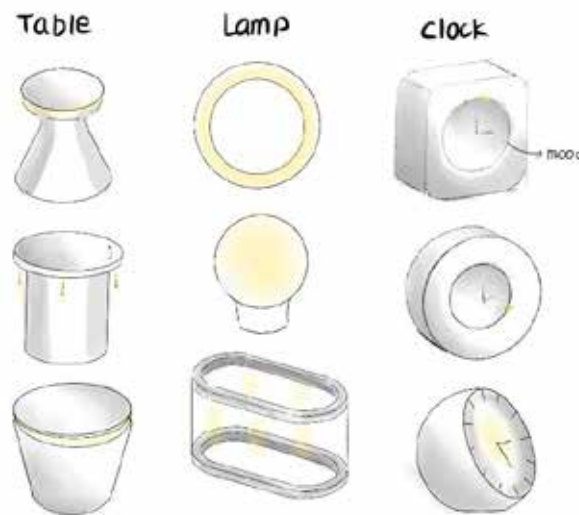
Figure 8. Initial idea sketches of several everyday objects

Lumino's design aims to visualize intangible moods and to enable the recording of subtle differences in personal moods through colored light in everyday life. Although mobile devices can record anywhere and conveniently, making personal data visible through tangible objects can induce its continued use in daily life and trigger memories through the physical presence of data, effectively integrating personal data into daily life (Lee et al., 2020). I considered a method to record moods as colored lights in artifacts that users can see and interact with in their living spaces.

I first investigated what types of everyday artifacts (e.g., table, lamp or clock; see Figure 8) would best represent the user's mood through colors. Among several everyday objects I considered, I expected a standalone light would be a great medium. Light can visualize the results of a tangible interaction, and visual stimulation such as light shining or color changing can augment the physical sense of interaction that a tangible object provides (Katz et al., 2020). In addition, by applying a tangible light's comprehensibility and familiarity (Li et al., 2020), I expected that a light could effectively remind users to aid in their daily reflections. Simultaneously, light functions as good interactive feedback to stimulate people's deeper emotions (Li et al., 2020), and a standalone artifact with a fixed location and timing creates a new ritual for daily reflection (Mols et al., 2016b), which helps to integrate the reflection experience in everyday life (Mols et al., 2016a). Thus, I focused on ways to integrate lighting inside the living space with a wall-mounted design. Furthermore, considering emotions are naturally complex

(Burkitt, 2002), I designed Lumino to record emotions multiple times a day. To indicate the sequence of various records based on time, a circular rotary frame was used through applying the metaphor of a circular clock, which can easily help users know and view the records in a clockwise order. In addition, rather than using a linear representation, I chose a circular frame to provide the feeling of navigating the records by rotating a handle. Through these design elements, I intended for Lumino to integrate naturally and harmoniously into the user's living space.

3.2. Separating Mood Record Mode and Show Mode within a Tangible Interface

3.2.1. *Hide the recording interface through slide interaction*

Along with the above design decisions, I carefully devised an interface that records moods with color. According to Snyder et al., to account for individual differences, a feedback system needs to allow users to select meaningful parameters (Snyder et al., 2015). In addition, the system should protect privacy when representing personal data (Sauvé et al., 2017). I designed Lumino's recording interface to give users the freedom to choose a meaningful color, which functions as a private key only to the individual knows, thus preventing others from interpreting the meaning. Additionally, I intended to hide the recording interface so that it would not look like "lighting that records moods" when others see it. In the recording interface, I expected that the popular round digital color palette, an interface for color selection in a color-lighting system similar to Philips Hue, would serve as a guide to reduce the sense of difference from existing digital color selection methods when users choose colors in Lumino.

I sketched ideas reflecting the above features, and I considered several ways of hiding the interface: utilizing the device's movement as an input device, move through rotation, slide from bottom to top, and slide left and right (Figure 9. a). I decided to apply physical slide left and right interaction to show and hide the color-selecting interfaces in Lumino because this would give users the sense of opening and closing their diary as the records indicate their everyday moods (Figure 9. b). In addition, I expected this method could lower the user's mental barriers toward a new method.
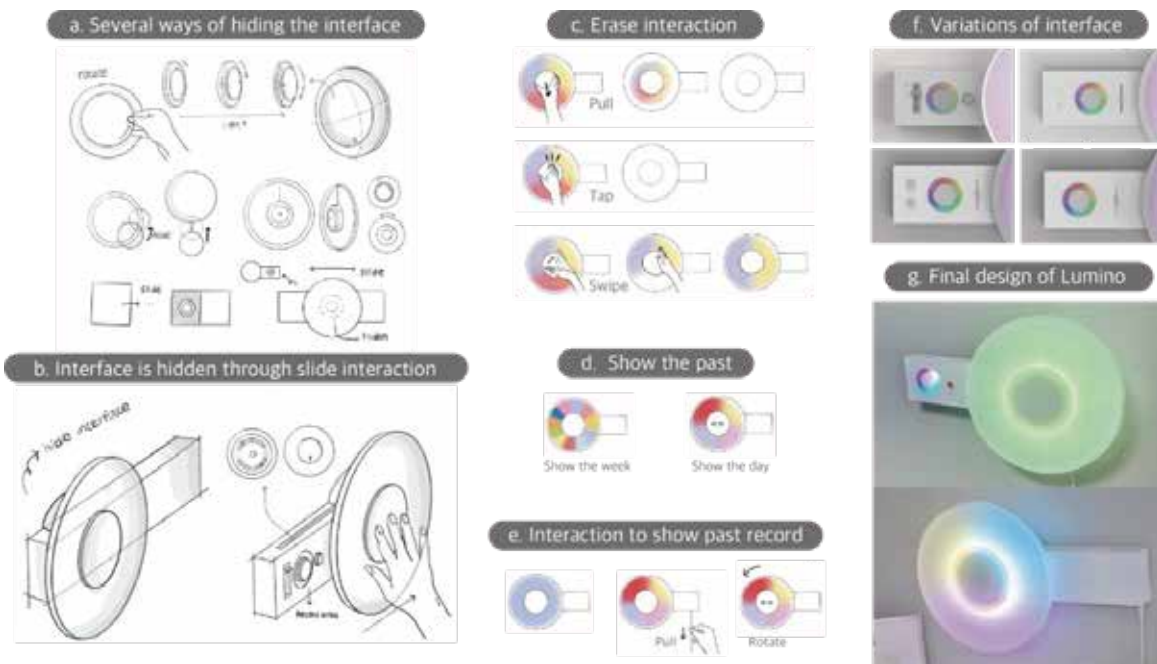
Figure 9. Lumino design process: a-e) Ideation sketches. f) Variations of interface. g) Final design

3.2.2. Discard and hide the emotion

Continuously viewing negative emotions can negatively affect the user (Haaga et al., 1991), thus, I aided users to discard and hide recorded moods in Lumino's show mode. Among the three discarding interactions, I decided to apply hand swiping interaction (Figure 9. c) to give the feeling of throwing away moods. Furthermore, I designed Lumino to be used as a mood light for when the user wished to hide or did not want to see the recorded moods.

3.2.3. Look back on the records

I considered two methods of showing past moods through Lumino: displaying archived records a week at a time and displaying records for each day (Figure 9. d). Users might not remember colored records after long durations because they are abstract; however, the more unique the experience is, the easier it is to remember (Mols et al., 2020). When displaying each day's moods, I chose a counterclockwise rotating interaction for reflecting on the past to provide a feeling of going back to the past records. Additionally, I designed Lumino to give hints for recalling abstract records that are hard to remember through having the color and date (Figure 9. e) recorded on that day appear together.

3.3. Interaction of Lumino

Lumino consists of a lighting plate that slides and rotates, a display showing the date (Figure 10), and switches for controlling the mood-light mode and brightness (Figure 11). Interaction with Lumino depends on whether the circular plate is on the right or left.

3.3.1. Slide the plate to the right to record emotions: Record mode

When the user slides the plate to the right to record, an interface is revealed, on which the user chooses a color to represent their emotions (Figure 10. a). I used RGBW panels to express various and subtle differences in color. The user adjusts RGB through a dial and the ratio of W (whiteness) through a slider (Figure 10. b). As the slider moves up, the color becomes brighter with the white light added to the plate. In this state, the plate shows the chosen color in real-time as the user adjusts the button.
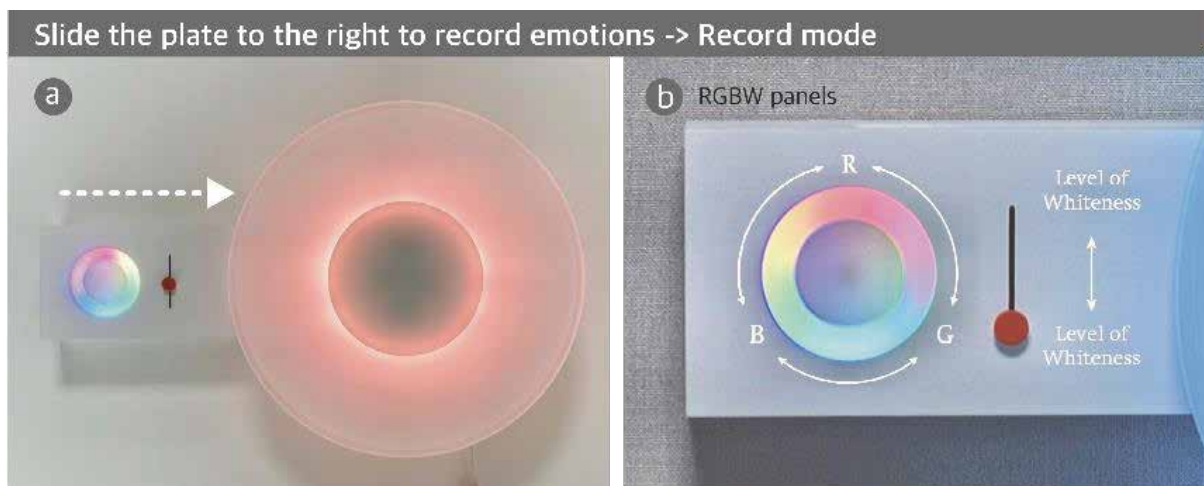
Figure 10. Slide the plate to the right, Lumino switches to record mode: a) In record mode, the dial and slider for recording are revealed, and the plate shows the chosen color. b) RGBW panels to express emotions

3.3.2. Slide the plate to the left to display emotions: Show mode

When the user slides the plate to the left after finishing the recording, the recorded color is shown simultaneously with the day's previous record (Figure 11. a). The user can also swipe a hand in front of the plate to discard the recorded moods (Figure 11. c). Turning the plate counterclockwise shows past recorded moods with the date (Figure 11. b). Lumino returns to the recent recordings when the user turns the plate clockwise. There are two switches on the right side (Figure 11. d). Users can push the top button to switch to mood-light mode (Figure 11. e) and push the bottom button to adjust the light's brightness (three stages: the brightest, one level darker, and off) (Figure 11. f).
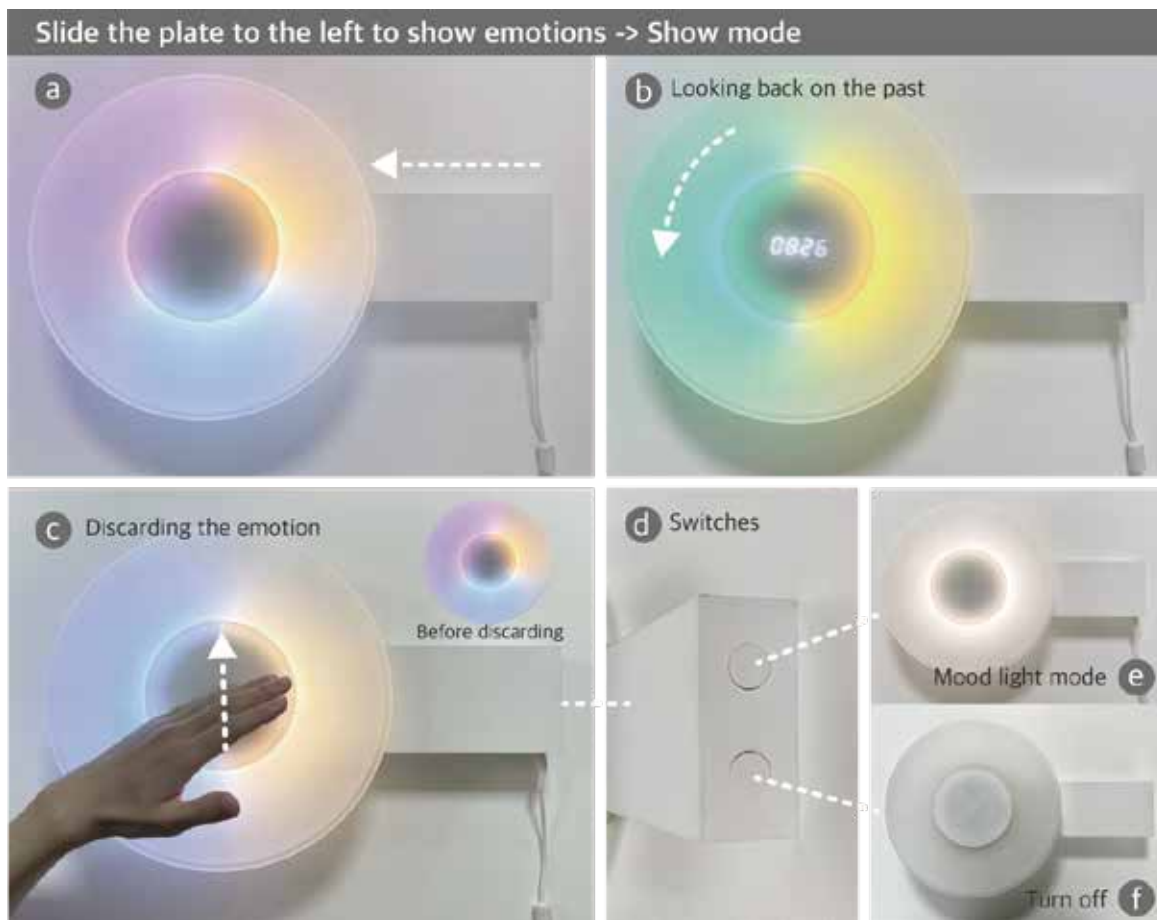
Figure 11. Slide the plate to the left, Lumino switches to show mode: a) The dial and slider for recording are hidden, and the plate shows the previously recorded color. b) Turning the plate counterclockwise shows past recorded emotions with the date. c) Discarding the recorded emotion by swiping. d) Two switches for e) mood-light mode that can hide the recorded moods. f) adjusting the brightness

3.4. Implementation

3.4.1. Software

I used Google Firebase and Raspberry Pi local to save the interactions between participants and Lumino in real-time as text files through software logging. I saved the logs, which included timestamps, the color recorded and discarded by the user (i.e., RGBW), the Lumino mode (e.g., show mode, record mode, or mood-light mode); and the selected target date when retrieving archived data. When the Raspberry Pi in Lumino was booted, if there was a recorded color on a specific date in the Raspberry Pi's locally stored color log, the color was sent to Arduino via serial communication, synchronizing Arduino to have the day's color. Afterward, when recording and discarding emotions, the day's color is updated on Google Firebase and Raspberry Pi local. When users review past colors, the selected target date is requested from the Raspberry Pi, and it sends the day's color from the file stored locally to Arduino after the parsing process.

3.4.2. Hardware

To implement Lumino's stable interaction, I repeated the process of testing and improving the internal–external structure through 3D printing. Lumino consists of two parts: the main body and the circular plate (Figure 12, a). To slide the circular plate softly, I used a ball bearing moved on a rail and a hall sensor to detect the slide (Figure 12, d). Because the wires for the parts in the circular plate must connect to the main body, I made a long gap in the lower rail for the wires to move with the plate when it slid (Figure 12, b). Additionally, I carefully decided on the circular plate's rotation speed to allow the plate to rotate stably and provide feedback that is neither too fast nor too slow when participants looked at archived data. I combined one of the gears with a rotary encoder. The reduction ratio is 4:1 (Figure 12, c). The discarded interaction used two touch sensors.

Figure 12. Detailed structure of Lumino: a) Lumino's two main parts. b) The rail with a gap allows wires to move together. c) Circular plate structure. d) Ball bearings moving on a rail. e) Two Luminos with different colors.

IV. USER STUDY

4.1. Study Goal

I conducted a field study over three weeks in user's everyday spaces to look deeply into how Lumino affects an individual's daily mood recording and the self-reflection experience from the archived data. Specifically, I wanted to identify (1) how Lumino helps to record personal emotions through the colored light, (2) what types of colored light can be expressed through Lumino in a living space, and (3) how Lumino supports a user's self-reflection in daily life by allowing the user to view the colored light archives representing moods.

4.2. Methodology

4.2.1. Recruitment

I recruited through SNS to gather participants (Figure 13). Those who wish to participate fill out the brief online survey that included questions regarding their usual emotion recording methods, patterns, and habits.

Criteria for selecting these participants were as follows:

(1) a person who has consistently recorded moods (e.g., through a diary) more than four times a week

(2) a person who has a comfortable space to record moods through Lumino at home (e.g., personal room or a studio room).

Also, I selected applicants with different types of recording experiences using various tools.

Figure 13. Recruitment poster

4.2.2. Participants

I selected six young adults (ages 22–31, three males and three females, P1–P6) among 30 applicants. To investigate as many diverse experiences as possible, I included applicants who were living alone (P1 and P3) and those who were living with others (P2, P4, P5, and P6). The criteria ensured I selected people interested in recording who could continue to archive their daily moods during the experiment. The participants' detailed information follows.

P1: Writer (26 years old, male). In his writing, he compares his experiences to scientific theories and shares his writings to communicate with others through two social media platforms. He enjoys writing and contemplating, mostly at night or at dawn, in a space where he is alone.

P2: Computer engineering college student (22 years old, female). She usually uses a cell phone app to record the day through using simple descriptions and photos. In addition, she uses a scheduler to manage her timetable. She lives with family members who openly share their feelings.

P3: Ergonomics researcher (28 years old, male). He has used various recording methods, such as cell phone apps, chatbots, and diaries, but he cannot record regularly because it is cumbersome. However, he has a great interest in monitoring his own emotions and goes to great lengths to overcome his depression.

P4: Restaurant staff member (31 years old, female). She has been keeping her diary for more than 10 years, and she does not see anything negative when she looks back on her previous diaries. Even during her busy life, she tries not to forget her records, even for a day.

P5: Design researcher (25 years old, male). He used to write things in his notebook and diary, and currently, he uses the Notion app. He meticulously organizes and records everything, and he currently lives with two roommates.

P6: Architecture majoring student (22 years old, female). She has kept her diary for more than 10 years, and she organizes her day, normally before going to bed. She usually reflects on her past through her diary. She lives with her family and does not share her diary's contents.

4.2.3. Deployment

I held a 20-minute pre-interview the day before the deployment. The user determined where best to deploy Lumino, and I asked them about the reasons for the placement during the interview. Pre-interviews included an introduction of the user study, and questions about their usual recording experiences and habits. In addition, before the experiment, participants consented to logging the usage history data. Through technical testing, I ensured there was no problem with collecting participant's recording data and expressing their moods with Lumino's colored lights. I installed the Lumino in the places the participants chose in their respective living spaces. Four participants installed Lumino on walls in their homes, and two participants placed their devices on tables using holders (Figure 14).

After installation, I set the Wi-Fi information of the deployed personal living spaces. On the first day of deployment, I demonstrated how to use Lumino and provided a 10-minute tutorial booklet to help participants learn all of Lumino's functions and uses during the field trial period. Additionally, I used Virtual Network Computing remote access software to enable troubleshooting for operational problems during the study. Also, I did not limit participants' existing diary practices because I wanted to see how a new design intervention (Lumino) could affect their existing archiving method.

Figure 14. Lumino installed in participants' homes.

4.2.4. Interview

I conducted semi-structured interviews weekly, and each interview took approximately 40 minutes. I fully transcribed all the interview recordings. During the weekly interviews, I commonly asked and heard about the following contents: (1) recording moods with colored light and the mood reflection experience, (2) when and in what context participants used Lumino, (3) the physical interaction experience of Lumino, (4) experiences in the space where participants installed Lumino, (5) exposure to others and its influence on participants' use, (6) overall use pattern of Lumino and thoughts after using Lumino, and (7) different aspects compared to the previously used recording methods. In addition, I added more questions according to personal experiences based on their usage logs or patterns in the previous week.

4.2.5. Data collection & Data analysis

To archive changes in the participants' recording patterns, I collected usage logs of their recorded and discarded colors with RGBW values, retrieval dates for archived logs, and each mode used. I also saved timestamps at every moment of interaction with the Lumino to track changes in Lumino usage patterns (Figure 15). For three weeks, the six participants recorded 268 times, with a combined total of 356 interactions with Lumino (Table 1). I transcribed the interview recordings, and three coauthors generated open codes after each interview for three weeks. Through using those codes, I went through an iterative affinity diagramming process and created a thematic connection of the open codes. The codes derived from this process created three large clusters as follows: (1) recording and reflecting mood in Lumino through colored light, (2) Lumino's existence and privacy issues in the living space, and (3) personal patterns of Lumino usage for controlling emotions. Three researchers together reviewed each cluster's open code; they extracted meaningful codes and statements. By analyzing thematic associations through descriptive quantitative analysis of usage logs and interviews, I detailed how Lumino supported participants' mood recordings and reflection experiences.

	P1	P2	P3	P4	P5	P6	Total
Total number of recorded moods	40	35	44	56	37	56	268
Total number of discarded moods	0	0	0	7	0	1	8
Total number of looking back on the past	8	6	7	2	8	3	34
Total number of using mood-light mode	1	18	0	14	10	3	46
Sum	49	59	51	79	55	63	356

Table 1. Total frequency of interactions and number of recordings during the three-week deployment study

V. FINDINGS

I confirmed moments when the participants recorded and reflected their daily moods using Lumino as an emotional diary. In the first-week interview, all participants mentioned they became accustomed to using Lumino by day 3 of the field trial. P1 noted, *"It was easy to manipulate and intuitive, so it was not difficult to learn how to use it."* Similarly, P6 stated, *"I can open it when I want to record, and I can rotate it when I want to see the record. It felt similar to my diary, so it was easy to understand."* On the other hand, some participants mentioned they initially had difficulty recording only moods, but the participants gradually adapted. P3 noted, *"When I first used it, it took a long time to record because I was thinking about what my feelings were, but I gradually got used to it and was able to create my mood color-recording pattern."*

I identified that Lumino gradually became routine in the users' daily lives. Most participants recorded their moods through colored lights after waking up, after returning home, and just before going to bed (Figure 15, a). Moreover, during interviews, I heard that most participants looked back at the previous week's recorded history once a week (Figure 15, b). P3 mentioned, *"I wanted to see how I felt during the week. When I rotated it* (the circular plate to see mood archives)*, I was able to identify my mood patterns visually."* In addition, three participants (i.e., P4, P5, and P6) remarked that they used the device with their usual diaries. P4 mentioned*, "It* (Lumino) *helped me remember once more by recording my emotions in the Lumino first, then writing a diary while looking at the colors* (expressed in Lumino)*."* Based on interviews and usage log data from six participants' three-week experiences of Lumino in their homes, I was able to identify the following findings.
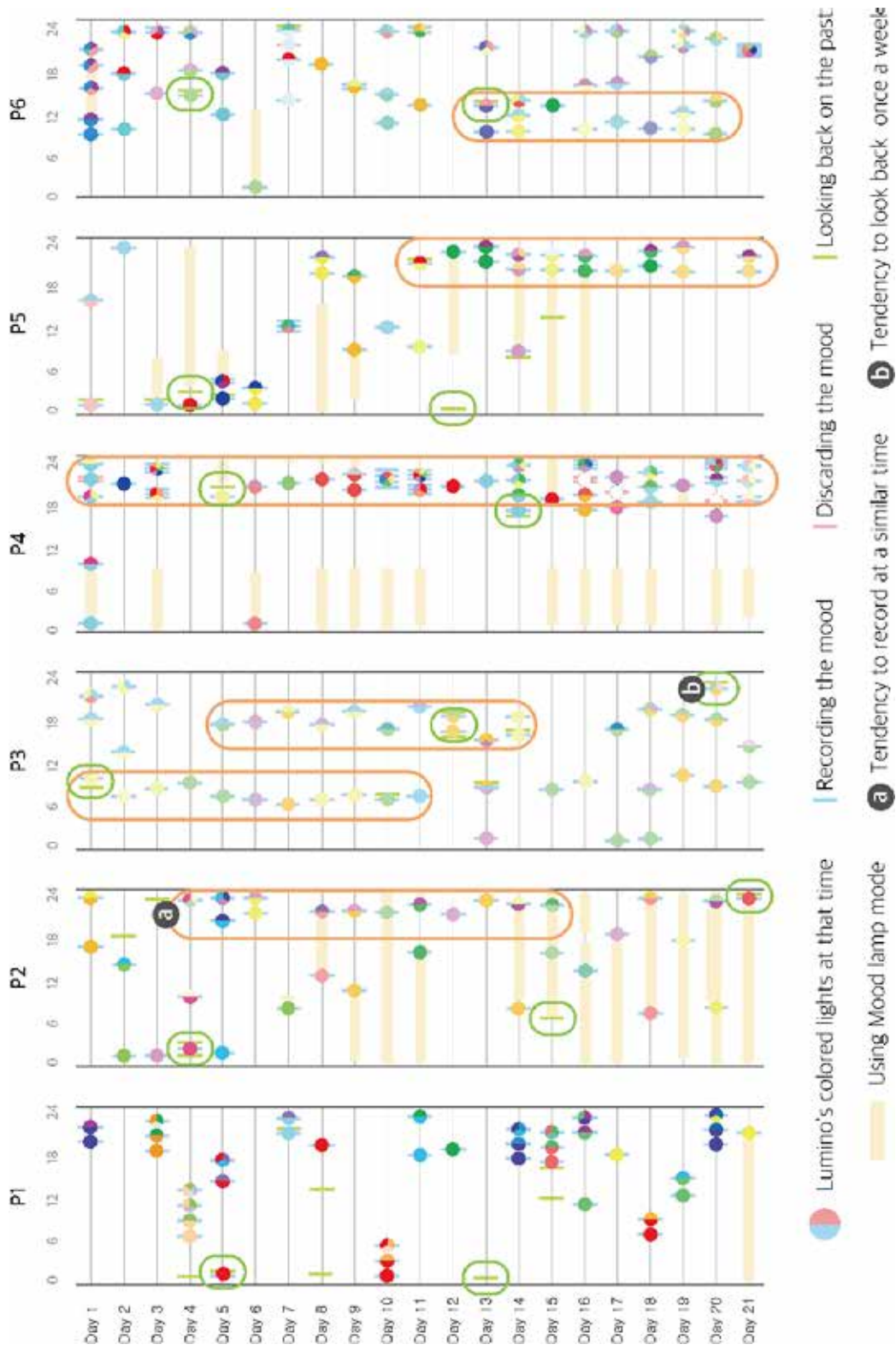
Figure 15. Usage log data of six participants (P1 - P6) over three weeks: a) Most of the participants recorded moods at a similar time (orange squares). b) All participants looked back on the past records once a week (green squares)

5.1. Toward Better Reflective Experiences in Daily Life

5.1.1. In and out from emotion reflection

Five participants mentioned that starting and ending self-reflection when they wanted was helpful for their reflective experiences. Hiding moods in Lumino, similar to closing a diary, and seeing moods, similar to opening a diary, affected how they used the device in connection with their moods. P2 remarked, *"I think it's good because the functions to slide and adjust the color feel like a secret place that only I know how to access. It's nice to be able to hide my diary, just like not opening it up for other people to see. I like it because it feels like something hidden that only I can use."* In addition, P5 noted*, "It can only be recorded when it is opened* (slide Lumino to the right) *and cannot be recorded when it is closed. So, when I open it, it feels like Lumino and I are connected. When I close it, it feels like the connection is cut off."* He continued, *"Only at the moment of recording, I was able to look back on the day and end the day comfortably."*

P1 stated that the interactive experience of using Lumino helped him not to focus on reflecting his archived moods all day by closing the plate when he did not want to see the data. He mentioned, *"Just as emotions are hidden in the human heart, I think hiding the interface was good for psychologically connecting with emotions. I felt like I was opening and closing my heart when opening and closing Lumino because it was controlled with an active interaction."* He continued, *"It's like log-in and log-out. Just as it is necessary to log out and completely separate when I want to quit after logging in to SNS to view, share, and communicate, looking into my emotions all day can be tiring, and sometimes I don't want to. But I feel like Lumino can only be accessed when I want to."*

In addition, P5 explained that expressing complex emotions from the mind and checking them with the eyes allowed him to look at himself objectively: *"The color that records my emotions is blurry, and even if I accumulate various colors, the boundaries are not distinguished clearly and they look mixed, so I think the emotions expressed in Lumino are the same as those in my mind. Therefore, looking at it from a distance feels like looking at my emotions one step away. Thus, it helps self-objectification well. Lumino's characteristics made me look deeply into my emotions when recording, at the same time it, helped me not to deepen when reflecting my emotions."*

According to a previous study (Choe et al., 2014), the burden of living a reflective life that tracks an individual's emotional state sometimes causes emotional fatigue. I confirmed that enabling users to see and hide their archived mood expression by physically dividing its functions can reduce the burden of reflection in daily life. Furthermore, looking at visually expressed emotions through Lumino can be a means to prevent deep reflection, in that it can psychologically distance the user from themselves, which can support better reflection (Ayduk & Kross, 2010).

5.1.2. Privacy and exposure of personal emotions through colored lights

Each participant expressed their emotions through Lumino, but also expressed certain feelings and moods. The method of expressing them with color differed among participants, and each participant had their own patterns. Participants sometimes expressed their emotions with colors that Goethe's color theory of color-emotion mappings revealed (e.g., yellow: joy, blue: sadness) (Von Goethe, 1840). At the same time, most participants expressed a positive mood with their favorite colors and bright colors, and when expressing their feelings, they used colors from the weather or food they ate. In addition, some participants expressed colors through their memories, such as expressing blue as a refreshing feeling after reminiscing about the experience of going to the sea. As such, participants tended to be more personal in expressing their moods in color. This finding is in line with few previous studies (Kaya & Epps, 2004) (Naz & Helen, 2004) in that color-related emotions differ from person to person. For this reason, all six participants mentioned that it was okay to show their moods publicly through Lumino because the device recorded their moods with colored lights.

Initially, P1 mentioned that he was unlikely to record in places other than his personal space due to the fear of anyone watching: *"I think recording moods goes hand-in-hand with keeping a diary. I think of it* (Lumino) *as a lamp like a diary, so I think it is good to install it in a place where I'm alone because it reduces the burden* (of others watching)*."* However, after one week of use, he stated, *"Lighting is like a password that only I can interpret. Even if other people see the same color* (expressed in my Lumino) *with them, everyone has a different interpretation. So, I think it can be revealed to others with confidence. Now, I wonder what other people will think when they look at the colors I recorded."* Similarly, P2 mentioned, *"Unlike a written diary, lighting is like a password that only I can understand. I know what it feels like, but I think others don't."* P6 installed Lumino in a shared space, and she noted that it felt burdensome because all family members could see Lumino. However, from the third day's use, she mentioned that it was less burdensome, even if others viewed the colored lights, because people could not guess what emotions she felt in what situation.

However, all five participants who installed Lumino in their personal space remarked that if others knew the recorded color's meaning, they were reluctant to expose it. For example, P3 mentioned, *"It is somewhat acceptable to show my emotions through color. But, if they knew what colors meant and what emotions they were, then I would not use it because it's like showing my feelings."* P6 also mentioned, *"I recorded red* (to Lumino) *when I was angry and shared the meaning with my family, but now that my family knows the meaning, I was careful to use red even if I was not angry."* She added, *"To be honest, I was a little embarrassed at first because my family was interested in the color change because everyone notices whenever I change my feelings, and I may have feelings I want to hide from my family. But sometimes, it was nice to see the colors (in Lumino), and it seemed to recognize how I felt. I think it's been a way for me to express myself to my family."* Moreover, I could see that the P5,

who lives with other people, used the mood-light mode frequently when going out or going to bed. He noted, *"Actually, it doesn't really matter if other people see it, but I just felt uncomfortable, so I changed it to a mood light."*

I was able to confirm that participants considered the moods recording through colored lights as a personal diary when only the user knew the meaning. At the same time, if they shared the meaning and the colors changed, I found that it affected their Lumino use patterns (e.g., expressing angry emotion with different colors, such as changing the color to normal white). On the other hand, I saw that disclosing the user's colored light moods to others could sometimes be a self-expression, which may potentially affect triggering a reflective conversation through sharing the meaning with someone close to the user (Mols et al., 2020).

5.2. Feeling and Handling Archived Daily Positive and Negative Emotions

5.2.1. Reflection of negative emotions through abstract color light expressions

Four participants noted that, when looking at records through Lumino, abstract records of colored light helped them not to fall too deeply into reflecting of negative emotions. P1 mentioned, *"I think Lumino is helping me not to be seized by emotions. When I'm very sad, and if I don't do anything, I keep thinking about it. But when I look at Lumino, I think it's really good that I can only accept just that I'm sad today."* He also had an experience of misreading and noted, *"It was better because one day I saw the color that recorded sadness, but I felt a completely different feeling."* In addition, P3, who has constantly monitored his emotions, mentioned his experience of reflecting negative emotions through Lumino. He initially said, *"For me, blue is a depressing feeling. The blue lighting makes it feel like a gloomy space."* But after looking back at his past records, he said, *"It's strange. It didn't work like I thought it would. The color doesn't directly express the mood, but when you see it, it tells you metaphorically, which is very comforting. The words are direct, so if I write a diary on a tough day, I don't want to see it again, but it's okay to see it through Lumino."*

On the other hand, P4, who did not want to look back because it affected the current moods when looking at her usual diary, mentioned, *"I looked back on my past emotions through Lumino, and when I saw the red and the date together, I suddenly got angry when I thought of that day."* She continued that reflection through Lumino affected her real moods. Accordingly, I found that the effect of negative reflection differed depending on people's attitudes toward negative emotions. I heard from four participants that the tangible colored light continued to illuminate the space, which helped in their

daily life reflections. While looking at the lighting, P6 commented, *"I recorded it in purple while drawing with my favorite purple color, and it was even better because it felt like my emotions were assimilated into the color."* In addition, *"Even if I'm busy and don't pay attention, I can see the color of Lumino. I think it's very important for depressed people like me to look back on their emotions, but I think it's great to look back on the emotions by seeing colors indirectly."*

Based on the above findings, I confirmed that experiences with Lumino helped to integrate reflection with everyday life and supported positive and negative reflections it filled the space with the lighting color. Furthermore, some participants remarked that they experienced memories of negative emotions, which the abstract expression of colored light reflected, in a positive way.

5.2.2. Various use patterns according to previous diary writing patterns and tools

I found some characteristics that participants made their own recording patterns while using Lumino. Although three weeks is a short amount of time to explore in depth, I found three cases: 1) the pattern was fixed, 2) a pattern changed in the middle, and 3) there was no specific pattern.

The pattern was fixed - participants consistently used certain colors to express their specific moods (P3, P4, and P6): These participants recorded the same mood with the same color throughout the experiment. Although each participant had a different color to represent their mood, they adhered to their own usage pattern. For example, P4 always used purple to record excitement and blue to record freshness. Also, P3 used yellow when recording good moods and blue when recording sad moods. He mentioned, *"The colors I record are consistent, and seeing the colors almost the same for a few days helped me to become aware of my mood patterns."* All three participants were monitoring themselves and doing self-reflection, such as writing a diary or using a mobile app regularly before the experiment.

The pattern changed in the middle– participants consistently used certain colors to express their specific moods, but the color changed in the middle of the user study (P2, P5): Two participants usually used the same color for the same mood, but the color changed in the middle of the user study. P2 recorded her depressed mood in light blue at the beginning of the study, but halfway through, she changed it to her favorite yellow to change her mood. In addition, P5 used color to express his emotions, but later used certain colors to overcome emotions. He mentioned, "I usually express tension in red, but when I accidentally turned the color and saw purple, I found that my mood calmed down, and from then on, I used purple for tension." They used a scheduler and had a planning tendency with excellent self-management such as time and schedule before the user study, and there were many attempts to control their emotions through Lumino.

No specific pattern – participant used different color to express their specific mood (P1):
One participant used several colors for the same mood and did not attempt to map color and mood by changing the color used every day. P1 said, *"As the same moods is felt differently depending on the situation and time, there are subtle differences every day. In addition, color can be interpreted in various ways, so it was good to express how I feel now more delicately than in writing."* He usually writes emotionally with a lot of words to metaphor his feelings, and he used Lumino to express momentary feelings.

In addition, I found changes in the participants' existing diary practices after using Lumino. Participants who recorded moods in handwritten diaries or planners did not stop writing and continued with Lumino. P6 mentioned, *"I recorded emotional content in Lumino, and I wrote down facts such as causes and effects in a diary."* Also, P5 commented, *"I thought the planner and Lumino were different, so I used them together, but they didn't affect each other significantly."* They used their existing recording method and Lumino together because they recognized it as a different recording method. On the other hand, the participants who recorded moods in the app stopped using the app when using Lumino. P3, who usually used a mobile phone app to record moods briefly, said, *"Unlike the app, recording on Lumino is fun and simple, so I used Lumino instead of the app. Recording the highlights of the day is the same as the app, but using the app was cumbersome and Lumino was not."* They believed that recording through Lumino could replace the role of the app.

I confirmed that mood recording using light-color reflected the individual's usual habit of recording moods in a diary and checking them. In addition, unlike the various tools for recording moods recently, Lumino was used to record mood in an everyday space and to expose through light-color. Through this, I confirmed that Lumino's method and other tools that the user used by users for mood recording can play a complementary role as a new personal diary (Lee et al., 2020).

5.2.3. Trials of controlling mood reflections using various interactions in Lumino

Within this pattern, participants sometimes used Lumino in their own special method. Three participants either discarded the record or used the mood-light mode because they did not want to reflect negative moods. P4 discarded the moods later on the same day and mentioned, *"Someday, something pleasant happened at the end, so I erased all the colors and threw away the record because I wanted to have only good feelings."* She added another experience from the previous day that she thought she would remember again when she saw negative moods through Lumino. Therefore, when she recorded a bad mood color, she changed the device to mood-light mode to avoid seeing it as much as possible. Similarly, P6 stated, *"After time has passed, I think I was a little shy about having those feelings displayed. It's an emotion related to social life, but I thought it was too expressive, so I didn't like it, so I deleted it."*

The act of throwing away emotions also changed the user's mood, and when P4 saw the record disappear through a hand-swiping motion, he remarked, *"I felt good because the colors were easily blown away, so the emotions also went away. I really hope this bad feeling goes away easily."* P6 mentioned that, when she discarded angry emotions at the end of the day, *"It felt like I was throwing away the bad things from my memory, so I felt empty."* All three participants who never removed a record remarked that they did not discard any bad moods because it was their personal record. However, I could see that they tried to reduce viewing negative moods in their own ways. Although P1 mentioned that the expressed colors affected his moods, and by using this characteristic, he used Lumino intentionally. He noted, *"There was a time when I felt calm when I saw green leaves falling. So, I intentionally expressed green as a natural color so that today's mood can be changed stably."* In addition, he used the properties of light, *"If I mix all the lights, I get white light. So, I used white to reset my anxious mind."* Similarly, P5 stated, *"When I want to concentrate, I record red, which is easy to concentrate, and when I wake up in the morning, I want to be calm, so I sleep with blue. I used it to express my emotions, but I think I also used it to control my emotions* (Figure 16. e).*"*
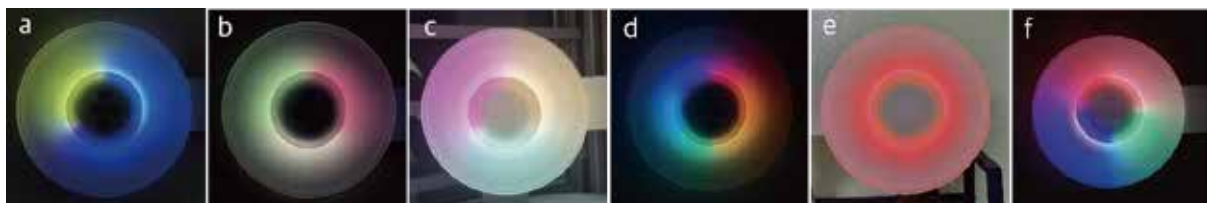
Figure 16. Lumino use cases per 6 participants. a) P1's record of Day 20: He recorded yellow to reduce the proportion of blue in negative emotions. b) P2's record of Day 4: She recorded coral to represent the calm feeling of dawn, light yellow to show purposeful feeling, and lime for stability. c) P3's record of Day 3: He recorded yellow as pleasant, light blue as tiredness, and red as stress relief. d) P4's record of Day 11: She wanted to look at a rainbow and recorded it through Lumino. e) P5's record of Day 4: He recorded red to focus on his work. f) P6's record of Day 21: She recorded with her family and played a game

Using Lumino's characteristics (with more records the color ratio of each emotion log becomes less), P1 mentioned, *"When I have a bad feeling, the color seems to darken. Then, I think I'm trying to reduce the negative emotions by recording different colors and making the dark colors a little less (Figure 16. a)."* Likewise, P4 stated, *"I felt good and wanted to see the rainbow, but couldn't see it in reality, so I recorded the rainbow color on Lumino, which I could see right in front of my eyes and prayed that only good things would happen (Figure 16. d)."* In Noh et al. users adjusted the initial color extracted from the photo, leading to the desired reflection direction (Noh et al., 2020). Similarly, in my study, participants saw new ways to utilize Lumino, using its properties and light to control their reflections. Based on these results, I found that there is a need for further discussion about how to deal effectively with the reflection of negative emotions through interaction with tangible objects.

VI. DISCUSSION

Through Lumino, I explored how to support reflective experiences of personal mood archives using colored lights in everyday life. As interest in emotional well-being increases, moods, as well as other meaningful personal data, can be recorded and reflected in everyday spaces. In this regard, previous HCI studies (Ju et al., 2019; Lee et al., 2020; Ylirisku et al., 2013) emphasized the importance of integrating personal data into people's daily lives, and further research is necessary to reflect these archived records naturally in living spaces. In this section, I discuss the considerations for interactive mood-based lighting in everyday spaces, including negative emotion reflections through colored lights and the relationship between existing diary practices and mood-recording tangible objects.

6.1. Existing Diary Practices and their Relation to Everyday Mood-Recording Tangible Objects

During the analysis of findings, I discovered new design spaces for augmenting the mood recording experience at the following two stages. These considerations provide opportunities for future HCI research to design interactive artifacts for augmenting mood recording combined with an existing diary practice experience, further showing potential for designing user experience of other types of recording method (e.g., writing, picture).

Mood record first: Continuing to perform self-reflection behaviors through recording, such as writing a diary, can be difficult despite having sufficient motivation and ability. At this point, an appropriate trigger can play an important role in performing the behavior (Fogg, 2009). Providing emotional content first in colored light can induce users to record in a different way. In my user study, some participants recorded moods on Lumino first and then wrote a diary while watching them. Moreover, colored mood recordings triggered writing more emotional aspects than factual writings such as about events or experiences, which helped to deepen the understanding of an individual's moods. Visibility of recorded moods lowered the threshold to start emotional writing and stimulated people to continue writing more. Lowering the threshold for starting behavior is an important factor maintaining reflective behavior (Mols & Markopoulos, 2012). As such, pre-exposure of color mood records in daily life can be an efficient way for users to strengthen their existing diary habits.

Mood record later: At the same time, in the user study, other participants recorded the moods in Lumino after their existing practices of writing their diary. From the participants who tried to express subtle differences in feelings that are difficult to express in writing on the Lumino device instead, a continuous scale was necessary for mood recording. (e.g., expressing the degree of feeling with the brightness of the light, expressing the subtle difference of feeling with a subtle color difference). As a

device element for momentary feeling recording, visual expression of subtle differences can supplement the limitation of existing recording like tangible light can express information through elements such as color and brightness (Li et al., 2020).

Expressing mood records in Lumino is complementary to participants' records and reflection experiences when combined with existing diary practice. Thus, rather than sticking to only mood recording, it is important to consider how it can be used with other recording methods. If I limited participants to using only Lumino during the study, it would have been difficult for the participants who wanted to record the cause of the mood. They used their existing diaries to write down those causes of moods because the expression of the color may not be remembered well when it is reflected. In this regard, one study has remarked that a color's mood record can influence the user's experience with its own expression, but it can also be difficult to understand due to the openness of abstract and ambiguous expressions (Ståhl & Höök, 2008). Thus, it is necessary to explore additional ways to serve as hints when recording moods with vague expressions."

6.2. Effects and Possibilities of Reflecting Negative Emotions through Colored Lights

Negative self-reflection allows people to learn from mistakes or choose behaviors that will likely lead to positive outcomes (Verplanken et al., 2007). Therefore, encouraging healthy reflection is not always the positive factors but also the negative factors need to be considered. Accordingly, HCI researchers have studied how to support positive and negative reflections of personal emotions (Mols et al., 2020). In addition, understanding of their own emotions when they encounter negative incidents helps emotional well-being (Ayduk & Kross, 2010). Based on the results, I found new design opportunities for supporting daily emotional reflection, while maintaining negative reflection as constructive user experiences.

One way could create a complementary relationship through physicalizing both positive and negative reflections at the same time. In the field study, participants attempted to accommodate most of the negative emotions recorded and expressed as colored lights in Lumino, as well as positive emotions. In this perspective, the colored lights that indicated the participant's positive feelings showed potential in assisting the user with positive reflection and neutralizing negative reflection (e.g., P4 looked at the yellow of hope recorded next to the blue of his anxious feelings, he could relieve the anxiety). Simultaneously, colored lights representing negativity could potentially create positive tension in the user's life (e.g., P5 looked at the red of anxiety next to the blue representing his calm feelings, which helped him not to feel too relieved in his current life). In other words, when having negative self-reflection, if the user views other emotions, the negative emotions expressed with colored lights can sufficiently contribute to the user's healthy reflection as well as positive emotions.

In addition, when physically showing negative emotions, I had to consider how to adjust the level of exposure according to the user's will. According to Nolen et al., deepening negative self-reflection can increase access to negative thoughts and emotions, which can preserve negative mood states (Nolen-Hoeksema et al., 2008). Also, some researchers have stated that if negative self-reflection occurs frequently, an individual's self-esteem may decrease or cause negative consequences, such as depression (Haaga et al., 1991). One study emphasized the need for users to stop reflecting or reflect less frequently to consider the potentially worrying effects of reflection (Mols et al., 2016a). I confirmed this necessity in my study through participants' behavior when addressing negative emotions through Lumino (e.g., P6's behavior to discard emotions that felt too depressing, or P4's behavior to change the mood-light mode when negative emotions were recorded). In that way, Lumino could provide a new design opportunity to control negative emotion reflection at the user's will, that is designing an interface that exposes individual emotions as a specific sensory modality or adding selections, through a physical interaction, according to individual needs or considering temporal variation (e.g., delaying confirmation of logs and applying ephemeral characteristics to the logs) for negative emotional logs.

Moreover, when supporting reflection of mood recordings, it is necessary to consider the ambiguity of expression. Ayduk's team revealed that the psychological distance from oneself during reflection plays an important role in whether there is a positive or negative direction in negative self-reflection (Ayduk & Kross, 2010). From field trial, I found that participants looked back on records through colored lights, however they psychologically distanced themselves about the depth of reflection on negative emotion logs. The ambiguity of the colored records led participants to become less "immersed" and more "distanced" from their emotions. In other words, as the understanding of emotions through color shown in Lumino is closer to a self-distanced perspective compared to a self-immersed perspective, it can possibly lead a negative emotional reflection in a positive direction. In line with a previous study (Noh et al., 2020), this abstract visual supported reflection through allowing for expressivity, and its briefness helped to reach the core of memory quickly.

6.3. Designing for Personal Mood Reflective Experiences in Everyday Life

Through Lumino's field trial, I discovered the various roles that ambient lighting, used for recording and displaying personal moods through colored lights, can play in a home environment. These considerations provide opportunities for future HCI research to design interactive artifacts for supporting self-reflection experiences on personal mood through colored lights, further showing the potential for designing user experiences in various everyday living environments.

Reflective color lighting in everyday spaces: When designing everyday objects to help with reflection in the home environment, the basic function of the object and the role of evoking reflection need to be seamlessly synthesized with each other (Ghajargar & Bardzell, 2021). I borrowed Lumino's practical and functional forms from a wall lamp that already exists and meaningful objects within the familiar context of the home environment. The device did not provide friction with its basic function as a lighting. For instance, Lumino is always on even if users do not record their moods, so it retains its functionality as a useful everyday object. Also, Lumino helped evoke reflection among users by allowing them to manipulate an artifact through unfamiliar uses and functions (e.g., sliding, rotation) (Ghajargar & Wiberg, 2018). By doing so, the artifact can serve as a trigger, helping users reflect on the meaning of the colored lights while serving its fundamental role as a lighting. Thus, I consider the above aspects can be important elements in designing an object that encourages reflection in everyday spaces.

Mementos with a reflective purpose or objects related to the self primarily exist in private rooms (Petrelli et al., 2008). Considering this, the home is a suitable place to evoke personal reflection (Ghajargar, 2017). In addition, in my user study, recording moods in a personal space showed that the participants were honest about their recordings without worrying that others might see them. Private space can play an important role for users who want to record and reflect their true emotions. In addition, I confirmed from the participants that using Lumino with other recording methods in their personal spaces could help to enrich the experience. For example, P4 recorded moods through Lumino in his room and wrote a diary while watching, P5 read the diary while viewing the mood records archived in Lumino with colored light, and P6 compared recorded moods in Lumino with a picture taken with a cell phone. At the same time, colored light is a good means to display personal information in public places because its meaning is private and has an abstract quality (Aliakseyeu et al., 2016). I found similar value in study participant's comments that moods that the colored lights caused, when expressed in Lumino, protected privacy because of the abstract characteristics. This showed the possibilities of enabling the exposure of the emotional diary in the shared space. Objects installed in places shared with other family members in the house (e.g., living room or kitchen) can initiate conversations with other people (Petrelli et al., 2008). The lamp can also be used to display one's identity in a shared space and play a social role (e.g., P6 used Lumino to record each family member's moods, and they played a game

of matching each other's feelings [Figure 16. f]). If the user wants to use Lumino as a personal mood diary without sharing it with others, the user can select whether they wish to expose the colored light log of the emotion he recorded in the interface. During the user study, participants who were reluctant to expose their Lumino logs when leaving the home turned off the device or changed it to mood-light mode. Kim et al. mentioned that personal information expressed in a tangible interface in a shared space people who know each other use could help to protect privacy through a social message given to each other via a change in the interface's physical state (Kim et al., 2021). Thus, for use in a shared house, the design should have shared and private modes, which are seen as physical changes in the device.

Peripheral awareness as an interaction technique for everyday self-reflection: For natural and consistent self-reflection in everyday life, it is important that the device help the user perceive their data related to moods. In this regard, providing peripheral awareness with lamps can effectively strengthen self-reflection regarding moods. Light is a suitable medium for providing ambient information (Noh et al., 2020), because it can show personal moods in an abstract way and provide attention-grabbing effects. In the field study, I found that the color of the light filling the space can make people perceive the ambient device naturally and help them engage in mood-archiving activities. Furthermore, as ambient lighting promotes the environment's mood (Aliakseyeu et al., 2016), the unconscious interaction with the lighting device located in the space may enable users to feel their moods better by creating a suitable environment for self-reflection. In addition, expression through colored lighting is greatly influenced by one's experience and preference. Peripheral awareness of data related to oneself can help users conduct daily self-reflection without burden. As such, an ambient device such as a lamp normally requires minimal attention and cognitive load for perception (Mankoff et al., 2003); therefore, an ambient lighting artifact expressing personal moods could be a proper medium to help users be aware of their data.

VII. LIMITATION & FUTURE WORK

7.1. Limitation

I identified opportunities in which recording emotions through a standalone artifact in a fixed location in the home environment became a daily routine and helped reflection. At the same time, if the real-time recording is not possible when the user is in another space (i.e., outside the house), users could not remember the mood at that time when they enter the home, and their momentary moods may differ. It might also affect their mood recording and reflection experiences; thus, tangible objects that record moods in everyday spaces need further research on the methods to record remotely in real-time (e.g., via a smartphone app). Also, in this study, participants expressed their moods in their own way and showed three patterns. Although I could find that these personalized colors were helpful for individuals to keep their privacy because their perception of color was different, but it may not be necessarily the case when people in the same cultural group have similar perceptions of colors. In addition, since color is abstract information, it is difficult to remember the day only with color. Therefore, when recalling the past through Lumino, the date was shown together to act as a hint. However, even though the date is accurate information, it is difficult for people to notice. Something like Yesterday or last week can be more effective than a specific date.

7.2. Future Work

In this experiment, since the participants were selected as people who have been recording, they are thought to be people who have some understanding of emotions, but the sensibility of emotions is different for each person. In addition, most of the participants in this experiment were in 20s and the number is too small to find people's record patterns. For future study, I will be able to find more colorful recording patterns in the experiment by conducting questionnaires to determine sensibility in advance when selecting participants. Also, by increasing the number of experimenters, it is possible to see what pattern most people project their daily mood on average.

Currently, mental health care experience is being studied mainly for digital products, and it is necessary to find out what role a tangible object such as Lumino can play in it through future work. In addition, it is possible to study what kind of digital mental healthcare ecosystem can be created when it is provided with an app rather than an independent tangible object. In this regard, future research will explore ways to integrate with other interactive technologies(apps) that help record users' moods without compromising the original recording and reflection experience.

When users are out of the house, they can prevent volatilization of emotions because they can record using the app. Also, in a shared space, products can be a means of self-expression and can have social effects by facilitating conversations with other members. Also, in this study, it was found that expressing mood in Lumino in a personal space can complement the participants' recording and reflection experience when combined with the existing recording method. Since the record through color is ambiguous, detailed additional records are possible through the app, and subtle differences that are difficult to express in writing can be expressed through the product. In addition, there is a possibility of having a synergistic effect if reflection is performed with the app in the atmosphere created by lighting product (Figure 17).

Figure 17. Eco system between product and app

Apps within this ecosystem can be designed like the figure below (Figure 18). This app "Lumiary" an application that works with Lumino, which is just a wireframe. It does not impair the advantages of physical objects and enables various scenarios depending on the situation. If user click the calendar icon on the home screen of Lumiary (Figure 18. 1-a), a calendar that shows the emotional record for one month briefly appears (Figure 18. 2). If he clicks on the date, the timeline of the mood record for that day is briefly displayed (Figure 18. 3), and if he click on the record, detailed information is displayed (Figure 18. 4). When user record their moods in Lumino, a notification appears on the home screen of the app (Figure 18. 1-c). Also, in situations where it is impossible to record in the Lumino, such as outside, it is possible to record through the record icon in the Lumary (Figure 18. 1-b, 16. 5). If additional record is needed, it is possible through photos and texts in Lumiary (Figure 18. 6).
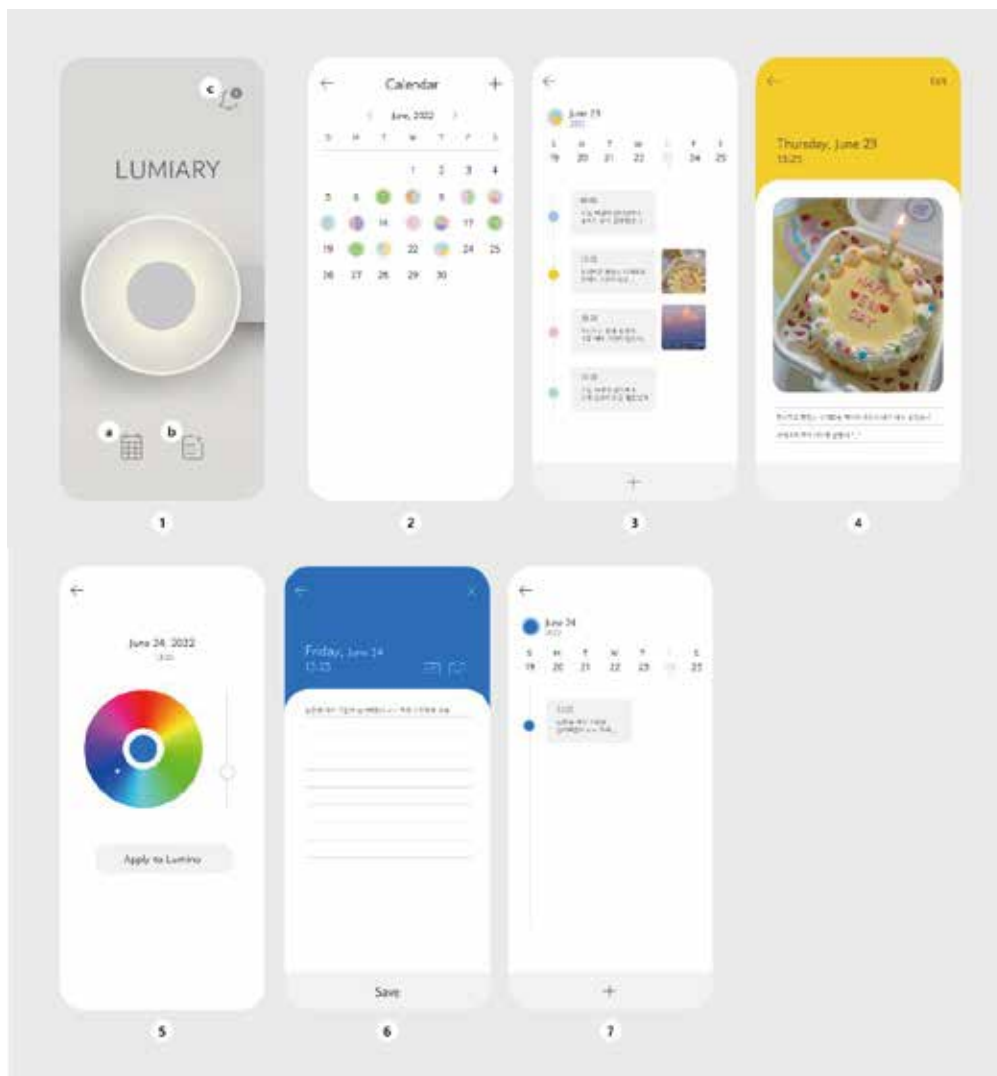

Figure 18. Luminary, an application that works with Lumino. 1) Home screen of Lumiary, 2) Calendar showing mood records for one month, 3) Timeline of recorded moods for the day, 4) One record detailing, 5) Color mood recording through the app, 6) Additional records through text and photos, 7) after recording

VIII. CONCLUSION

In this study, I designed and developed Lumino to explore how an interactive lighting device could support daily self-reflection through archiving and showing daily moods using colored lights in everyday living spaces. I carefully devised Lumino's design through several iterations, to integrate emotion reflection experience into the user's living space seamlessly by providing ways to record moods in colored lights through daily tangible objects. During the development process, I increased the design and technical quality to make the device's field trial stable. Through the three-week field study, I showed that Lumino separated emotion reflection from daily life through physical interaction through making participants be in and out from the reflective experiences of their emotions. In addition, when only the participant knew the meaning of the colored lights, Lumino worked as a personal diary; however, when the meaning was shared, or family members noticed the color change, some participants tended to change their use patterns. Lastly, I could see various use patterns of Lumino according to participants' previous diary writing habits and tools, further showing possibilities of playing a complementary role as a new personal diary; along with their trials to control positive and negative reflections through the Lumino's interaction. Based on these findings, I proposed considerations for a synergistic combination with other recording methods and color-moods recording. In addition, there are further possibilities to support daily emotional reflection while maintaining negative emotion reflection through colored lights. Finally, I proposed roles and design considerations of daily emotion reflective color lighting in personal and shared spaces.

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