The future design of personal informatics

Potentials of designing personal informatics with a focus on the phenomenological matrix using theories of the self and storytelling

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The use of Self-tracking and personal informatics devices (PI devices) have grown rapidly the past decade. Albeit growing interest, research has disclosed several interactive problems between PI devices and their users; such as understanding, reflecting, and applying the PI device information. Researchers maintain that research is needed to test new ways of designing the interface based on eg.: storytelling or applying a phenomenological perspective. So far, there is a lack of research based on these theories. This thesis is carried out in collaboration with BrainLit, a company that has patented BioCentric Lighting ™, a technology that provides healthy environments by personalizing light according to a person's unique biology. This thesis tests the potential of designing a PI device to track light environment based on the theory of the self and storytelling. A pilot study was performed with two people. Then a main study was performed on 13 people who tracked their light for a day and then got to test an interactive prototype of a light-tracking app designed based on the theory of self and storytelling. This thesis helps to illustrate qualities that can help to solve three of the key challenges for PI designers: design for user understanding, design for user reflection, and design for users' application of the information shared by the personal informatics app. Although the working method was based on a phenomenological matrix, the final design did not adhere entirely to it, which may be due to the collaboration with a company that relates and relies heavily on objective figures.

The outcome of this thesis describes what qualities is important to be able to support the user in understanding, reflecting, and applying the information shared by the app.

CCS CONCEPTS • **Human-Computer interaction • Research through design • Personal Informatics devices**

Additional Keywords and Phrases: Personal informatics, Design, self-tracking data

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1 INTRODUCTION

The average age of the human population is increasing [51] and the interest in living a healthy and long life is increasing [59]. The use of mobile health apps[1] technology within healthcare and wellbeing is a phenomenon that has thus been growing for over a decade. Already in 2014, over 100,000 health apps were available for IOS and android [56]. In 2021, that same statistic was up to 350,000, and during that year alone, 90,000 health apps were added, averaging 250 new health apps every day [60]. The effects of these apps have been extensively studied during the past years [1,9,32,43,56,57].

It is generally accepted among researchers that health apps and wearables have opened a novel way for people to take control over their own health and wellbeing [4,46,56]. One of the key features of mobile health apps, that makes them powerful, is that they allow users to monitor themselves and their health and well-being [56,57]. Quantifiable self (QS) is about collecting data about oneself to create self-knowledge and use it to improve oneself [11,18], this is also known as personal informatics [37] and has been an explosive trend in recent years [18]. Self-tracking apps and wearables are undeniably prominent products within this field [18,34,44]. A cutting-edge example of self-tracking is tracking the light environment, the research field is young, and has shown a great impact on people's physical and mental health by artificially reproducing the circadian rhythm [19,24,39]. The research in the field has resulted in the Nobel Prize in physiology/medicine 2017, for disclosing the molecular mechanisms that control the circadian rhythm. This could increase interest in regulating the light environment, thus creating a demand for a light tracking apps which is the focus of this thesis.

A large body of literature argues that the interest in self-tracking apps [18,42,45] is growing rapidly and that users ultimately search for self-knowledge [35]. Other research suggests that the information provided by self-tracking devices can be irrelevant or hard to interpret, in turn making the self-tracking devices difficult to use [10,11]. Rapp and Cena's research showed that novice users of self-tracking devices often feel that the information they receive is useless, leading to no actionable insights [48]. Research has also shown that lack of motivation, visualizations, and difficulties interpreting data has been a barrier for people to gain sufficient self-knowledge through self-tracking devices (personal informatics) [35].

In response to the research in personal informatics research has shifted from a cognitive to a phenomenological perspective, arguing that this approach leads to a greater focus on supporting self-knowledge rather than behavioral change [37,50]. Rapp and Tirassa's theory of "the self in personal informatics" discuss the importance of emphasizing the role of "the self" as a promising way to turn numbers into meaningful information thus increasing self-knowledge and self-awareness [49]. Meanwhile, Hilviu and Rapp argue that storytelling is the superior way to convey personal informatics, claiming that narrations are effective in making people understand quantitative data [29]. Furthermore, it is argued that there is a need for research that explores narrative as part of a new ways of presenting data [29], to support self-reflection and self-knowledge in personal informatics [11]. Cosley et al. argue that further research is needed for the design and development of future personal informatics technologies, as they found a need for studies of design to influence mental mechanisms such as self-reflection [12].

Although several studies have concluded that emphasizing the self as proposed by Rapp and Tirassa [50] is discussed as a promising approach [29,49] when designing feedback to convey self-tracking information, few studies have been conducted using the design theory when designing personal informatics. Furthermore, little research has been done to evaluate how the theories of the self and narrative work when designing for personal informatics. In the field of self-

[1] "Mobile health apps" [26] in this thesis refers to any app or self-tracking device that can be used as a means to enhance one's health [2,19,25].

tracking of light exposure no such study has been done. Hence the purpose of this thesis is to evaluate the potential of using 1. the theories of "the self ", as explained by Rapp and Tirassa, and 2. storytelling, as explained by Hilviu and Rapp in experimental design research. Researchers have previously suggested the need for further experimental [29] and explanatory [49] research on making sense of self-tracking data through design. This thesis will examine the possibilities of using the theory of self (as it is explained in [50]) to design the interface of feedback for personal informatics in combination with storytelling features and explore how it can be used to convey information in an easy, reflective and actionable way to users. This study aims to answer the question:

RQ: What qualities of a personal informatics app, designed using theories of the self and storytelling, can support users in **understanding** and **reflecting** as well as **applying** the information shared by the app in their everyday life?

In this thesis understanding implies that the user experiences the absorption of information. Reflecting means that the user double loop learning [5]. Applicable means that the user can turn the information into something useful in the form of changed behavior or a new way of thinking [7].

To address this research gap, a prototype of self-tracking has been designed based on the theories of the self and storytelling to test their potential benefits in conveying actionable information. This was done in collaboration with BrainLit AB, a company that has patented BioCentric Lighting ™, a technology that provides a healthy personalized light-environments. With the help of BrainLit's expertise in the neurophysiology of biocentric light and circadian rhythm combined with human-computer interaction, a prototype has been developed and tested. The analysis shows key qualities that can support users in understanding and applying the information shared by the app in their everyday lives by self-knowledge through self-reflection and motivation.

2 BACKGROUND

There is a rich body of literature in the field of healthcare and wellbeing apps. Interest in health apps is increasing and the market for health-related apps is growing rapidly. Apps have certain characteristics that enable health-related information to be distributed among the general public, hence giving people power of autonomy, self-monitoring, and control of their own health [10]. Thus, creators of these apps have the power in their hands to influence their users through health-related information. The design of the information will affect if and how people can interpret the quantitative information that the health and well-being personal informatic apps provide.

2.1 Health apps and light tracking for wellbeing

According to Paglialonga et al [45], health apps can be categorized into broad groups based on function. Two broad categories are suggested: 1) health apps to facilitate the work of healthcare professionals such as doctors, psychologists, and others to facilitate patient tracking; 2) educational apps with the purpose of teaching and self-tracking. Patients and the general public belong within group 2 [45]. The health app examined in this thesis is within the second group. This categorization can be further specified as there is a difference between educational apps that only provide information (for example information about medicines [46]) and health apps managing information about oneself [45].

In this thesis, the latter of the two will be researched in the context of light exposure. Light not only enable us to see, but it also synchronizes the body with the solar day through internal biological activities, and research shows that getting the right type of light is important for our physical and mental wellbeing [24,39,19]. Getting the right type of light has been proven to improve alertness, cognition [36], and sleep [19,39].

2.2 Problems related to personal informatics

The findings of the literature review identified three keywords that are incorporated in the research question: understanding, reflecting, and applying. Therefore, this thesis's research question aims to focus on these three keywords to provide more insight into how these challenges can be handled.

Research shows that there are difficulties with data integration and interpretation [35]. Choe et al. results showed that it was difficult to create easy-to-understand visualizations of their own data. Which made some of the tracking redundant [11]. Research also shows that many people feel that it is difficult to understand statistical data [3] and are uncomfortable with analyzing data in personal informatics by themselves[40].

Being able to reflect upon the data tracked by the PI device has been shown to be fundamental [14,20,33,35] as it enables users to reflect on everyday events such as habits and patterns which facilitates the transition of understanding the data and making it actionable [21]. Furthermore, Cosley et al. suggest that the design of self-tracking devices should enable users to go from getting information (data) to being able to self-reflect based on the information from the self-tracking data [12].

Li et al.'s results also showed that an applicability barrier was that PI devices had no suggestions on how to act according to the tracked data. The results pointed to both reflection barriers and action barriers. Regarding the potential in creating the design for reflection, one of the problems was to create visualizations that provided a holistic view of all the data that the users had wanted to get an overview of. Some users found it difficult to interpret the data, which became another barrier to achieving self-reflection [35].

Ian Li et al. results also showed that an applicability barrier was that PI devices had no suggestions on how to act accordingly to the tracked data[35], making it difficult for the users to know how to change their behavior. Rapp and Cena found that the participants found it laborious to actively collect data and difficult to manage and visualize their data. Observations from their work also indicate that the users wanted actionable insights, as to what they should do accordingly to the data after tracking it. The fact that the self-tracking devices did not give actionable insight led to users feeling that no real insight was gained from the self-tracking[48].

2.3 Designs that facilitates the interaction with the personal informatics device

Based on this, other researchers have explored ways to design in ways that could facilitate understanding and reflection of the tracked data. Using charts has been suggested as a way of designing to facilitate the interpretation of the tracked data [11,13] as it could show habits or behavior and thus give the user insights [14]. The use of avatars has also been discussed to call on the user's empathy and thus evoke reflection upon data [14] and behavior by calling upon empathy through using visual characters [23,36]. Using everyday language rather than formal language has also been shown to help users understand the facts shared by the PI device[29,50].

Another finding that came out of looking at how the "quantified selfers" created their visualizations that worked better was that they had comparative measures. The comparison could be made with an average of their own measurements or against the general population if such data were available. Comparison measures allowed them to quickly create an understanding, [48] which is necessary for actionable insights.

Fawcette describes how those actionable insights could be part of the feedback system of the future, claiming that although computer science has contributed to good conditions to obtain and measure data, the way to analyze the data and create feedback to the users has lagged. Therefore, how the data is analyzed is combined with how it is presented, for example in the form of actionable insights that need to be improved for the future version of self-tracking devices[18].

2.4 The Self in personal informatics

It is argued by Rapp and Tirassa that the framework within which we are currently designing for personal informatics, is from a cognitive-behavioral paradigm, which makes the focus of the design lie on objective facts and behavior. Instead Rapp and Tirassa suggest using the phenomenological and constructivist paradigm when designing personal informatics to redirect users' focus on their thoughts and feelings which in turn can affect their behavior [50]. This work provides both a theoretical basis for designing personal informatics from a phenomenological stance and practical design guidelines for designing accordingly to provide users with better knowledge about themselves. Rapp and Tirassa divide the self into four different parts: the present-, the past-, the future-, and the interconnected -self. For each part, with connected design guidelines to each self [50]. Another study further suggests that PI devices designed with further emphasizes on the self will lead to users being able to convert numbers into self-knowledge and thus create meaningful information for the user [49]. In this theory we move within the framework of the self from a social psychological standpoint, within this frame, the self is seen as the experience people have of themselves. Since the goal of this thesis is to test a new way of designing that could possibly overcome the problems that previous research has found with PI designs, these design guidelines were used as a basis when making the prototype for this thesis. A more detailed description of how the design was made is further discussed in Chapter 4, Design Process.

2.5 Storytelling in personal informatics

The theory assumes that stories fit the human way of thinking and taking in information [17,23,27,29,38] and is used primarily in psychology and marketing [54]. Storytelling in personal informatics, thus, is a way of communicating tracked data through narrations [14,29,30]. A lot of research indicates that it is difficult for many users, especially novices, of personal informatics to take in information from numbers, and graphs [29,47]. Storytelling in personal informatics, thus, is a way of communicating tracked data through narrations[29,30]. Rapp and Hilviu argue that it can be beneficial to use traits from storytelling to convert numbers into something meaningful[29].

Storytelling makes it easier for the user to remember and retrieve information to create understanding. Cognitive psychology explains this by establishing two types of memories; semantic (a type of long-term memory, knowledge to understand our everyday life) and episodic (which allows us to remember events). By presenting information through narrative, the brain will easily be able to store the information as an event (connecting facts as one entity) making the information easier to remember [17,38]. In this study, a fabula (a story with a beginning, middle and an end)[30] was used along with main characters in the form of animated figures in the stories as well as the prototype. These design choices create a sense of empathy and relatedness[23,27,30,36]. Many of the participants initially knew little about the effects of light. A story in design 2.0 effectively conveyed information about the circadian rhythm and its effects on humans in an easy-to-understand and relatable way.

3 METHODOLOGY AND METHODS

This thesis takes its epistemological standpoint in what Harrison et al would call the ***phenomenological matrix***, i.e., it emphasizes the subjective truth of situated interactions. This epistemological standpoint sees people's situated experiences as key to acquiring knowledge [28]. Therefore, this thesis moves within the realm of the third paradigm in HCI, that of the ***theories of phenomenology and constructivism***. Phenomenology is a theory that makes it possible to study humans' interaction within the world through their embodied selves. Constructivism, just like phenomenology, follows a relativist viewpoint: there is no one objective truth in this world but many relative realities that can be interpreted and understood to gain knowledge [28]. Therefore, these theories are well suited to examining the human understanding of things because

these are theories that focus on what happens inside people, emphasizing people's emotions, thoughts, and beliefs [21,38], which aligns well with the objective to explore peoples' perceptions of a situated interaction [28,50], which aligns well with the objective to explore peoples' perceptions of a situated interaction [28].

Further, the principles of how to use the methods and gain knowledge through them i.e., the methodology used is ***research through design***. The goal of this methodology is to gain insights through testing and evaluating designs rather than designing the perfect artifact. This methodology allows for the design process to be a key part of being able to answer the research questions and the acquisition of knowledge [58]. Throughout the project, novel insights gained from testing and evaluations were incorporated into the analysis and brought forward through new designs thus following an iterative design. The information was used both to upgrade the design as well as result in more knowledge in accordance with the research through design [58]. Using a design prototype as a feedback loop for the users is a way of exploring and evaluating design ideas. By using prototypes and letting participants test the ideas, it was possible to investigate users' experiences through the act of design [15].

3.1 Method structure

The research question was addressed through methodological steps which are represented in Fig. 1. The structure of this study consists of a literature review that identified a research gap in the field of designing self-tracking devices. Subsequently, a pilot study was conducted which included a design process based on a brainstorming session with two experts at BrainLit[2], which resulted in the initial prototype design 0.1. Design 0.1 was tested by two other professionals at BrainLit, through think-aloud [26] followed by a semi structured interview [61]. The analysis of the material from the pilot study provided the basis for design 1.0. which was tested and evaluated by 13 participants. This was followed by the same process resulting in design 2.0. The main study thus consists of the evaluation of design 1.0 which led to design 2.0 which were both evaluated through think aloud and interviews. A more elaborate explanation of how and why these steps were used is provided further down in this chapter.

[2] One is a research specialist in the neurophysiology of Biocentric Light and circadian rhythm and the other a biomodelling expert in lights impact on human biology.

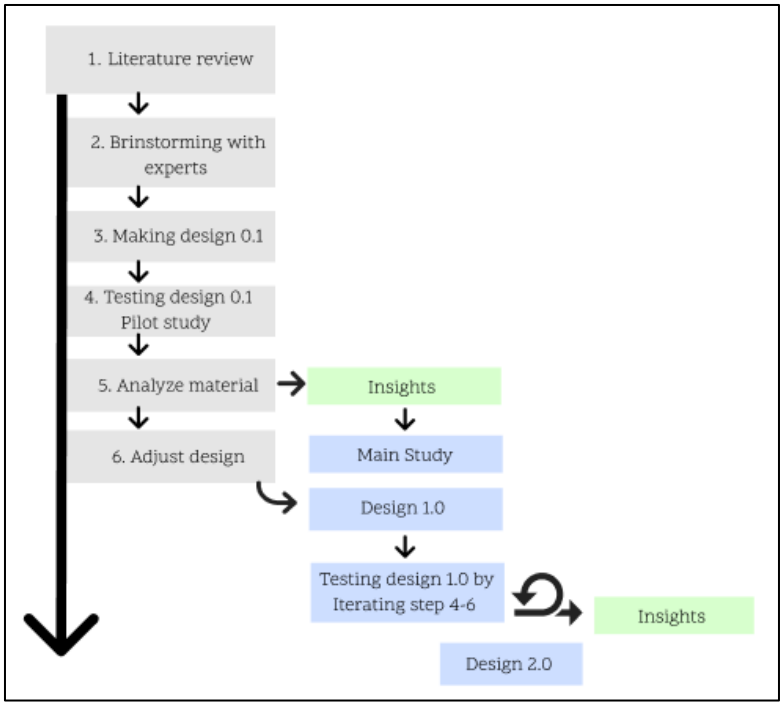

Fig 1: Method structure.

3.2 Methods

This section will further explain the methods represented in Fig 1.

3.2.1Methods in Pilot study.

To test self-tracking systems that are designed based on the theories of the self and storytelling, a prototype was created in Figma. Using a real design case (i.e., ***prototype building***) is a method that enables an in-depth examination of people's perception of technology in a specific situation**,** potentially yielding deep insights [15]. The first step of designing the prototype was therefore a ***brainstorming session with two experts*** in the field of light. The reason for using experts on light's impact on human biology was that the experts have prior knowledge of what customers (and thus the intended users) usually want to know about light, and what users usually do not know about the effects of light. They could also ensure that the prototype was scientifically based. The brainstorming was conducted through the process of ideation (stage 2 in fig.1) as it generates many diverse ideas in a short amount of time which could then be incorporated into the design process [29]. A more detailed description in 4.1.1 Brainstorming session.

Think-aloud and semi-structured interviews [26,61] were used as evaluation methods when testing all the designs. The combination of the two allows the detection of direct problems in the prototype, while also capturing the interaction with it and reflective thoughts about it [26]. Semi-structured interviews were beneficial to use, it made it possible to stay close to the interviewee's feelings and thoughts as it has a flexible structure, which is permissible for fluctuation depending on what the participant wants to talk about [61]. ***Interpretive phenomenological analysis*** (IPA) was used to get a detailed coding and analysis of the material (in this case ideas in brainstorming, think aloud, and interviews). IPA is a proven qualitative method [52]. and it is used in the following manner in this thesis: the first step was to ***transcribe*** the recorded

material [26] in the transcription, commas have been added and words that are incoherent in written language have been removed thus avoiding ridiculing the participants [16]. The transcribed material was then thematized. At first, almost everything was thematized. The themes were then reviewed several times and during the cyclical work, similarities and differences were found between the themes, which made it possible to divide the themed material into a "general table of themes". IPA structure is cyclical, to ensure that the thematization does not deviate from the original material. Then more specific themes were made with the aim of uncovering the essence of the general themes, answering the question of *what* in the design had good effects on users' understanding of themselves and the information [8]. This is what Smith et al call a ***master table of themes,*** here referred to as master themes [52]. The end state was when saturation was being met [61]. During the process, knowledge was extracted from the detailed description given by the participants in agreement with the methodology used, namely ***research through design*** [58]. The findings were then converted into design improvements to the design, following an ***iterative design process*** [6].

3.3 Light tracking

In this thesis, a group of people tested tracking their light environment and the self-tracking was done in two steps. Firstly, all participants tracked their light exposure through the measurement LUX, with an already existing app. Instructions were provided to the participants in an information letter. The participants, according to the instructions, tracked their LUX each hour for one day (when awake) and sent dent the information back to me (see Appendix A1). Secondly, the tracked data was incorporated into and visualized in a prototype of a personal informatics app. The two steps aimed at giving the participants the experience of light tracking by simulating the light tracking app. Through this phenomenological approach the participants were also given a possibility to relate to the data shown in the prototype [52]. Following the aim of this thesis this also allowed the participants to reflect on the feedback they got on their tracked data through the prototyped app. The participants did a think-aloud [26] while interacting with the app, and afterward they were interviewed [61].

3.4 Participants main study

The testing of designs 1.0 and 2.0 included 13 people, as seen in Table 1: five people from within the company BrainLit, two of whom were also involved in the pilot study, and 8 people outside of BrainLit. The supervisors from BrainLit made the internal recruitment of participants making sure that different experts were represented, giving different perspectives to the designs. Two failed attempts to recruit external respondents through one social media platform and one of Uppsala's departments resulted in an availability sample with 8 respondents. An availability sample is not ideal as it could lead to sampling bias which limits the population validity since there is a risk of the sample being too homogenic, hence limiting the generalizability [61]. To mitigate this, both students and professionals between the ages of 23 and 60 from two different parts of the country have been recruited. The same respondents tested both design iterations. This has the effect that participants will be knowledge biased as they have tested the system before. It's also a little harder to see how well the new educational additions made between designs 1.0 and 2.0 work. However, the reason for choosing to use the same respondents was to be able to elucidate a good comparison between the designs, as well as getting a deeper understanding of what the respondents thought worked or not with the app. A third reason was that it could have been difficult to find new participants given the initial recruitment process. The only requirement for the participants was that they did not have much experience doing self-tracking before. The reason for this is that previous research shows that people who have done a lot of self-tracking before having a more advanced way of relating to and interpreting self-tracking data [48].

Table 1: Age of the participants, if the participant is recruited from inside BrainLit, what experience do they have with self-tracking (no=has no experience with it, yes = have previous experience with self-tracking).

	Age	From BrainLit	Prior experience of self-tracking
P1	32	NO	NO
P2	25	NO	NO
P3	25	NO	NO
P4	23	NO	NO
P5	31	NO	NO
P6	25	NO	NO
P7	28	YES	NO
P8	45	YES	NO
P9	57	YES	NO
P10	59	YES	NO
P11	29	YES	NO
P12	60	NO	NO
P13	40	NO	YES (Fitbit looking at steps and sleep)

3.5 Ethical considerations

The participants were informed about their rights and how their data is handled in the information letter (see appendix A1) as well as before every interview. The information letter states that have the right to determine their participation whenever they want without any consequence. They also got to choose between doing the interviews in English or Swedish depending on what felt more comfortable. That their participation will be pseudonymized and the recordings were deleted after they were transcribed.

4 DESIGN PROCESS

This chapter describes how the initial design, design 0.1, was developed based on the master list created from an ideation session which was based on the theory of the self. The reasons for the later changes between the design iterations will be explained and the design represented pictorially throughout the chapter.

4.1 The pilot study, Design 0.1

4.1.1Brainstorming session

The brainstorming with the experts guided the design of 0.1. The brainstorming reviewed the guidelines from the theory of the self and, through them, defined what was to be included in design 0.1.

Sections	Features relevant for PI	Guidelines	Examples
Present Self		*Guideline 1*	
	Situated in a subjectively experienced world	PI should provide subjective meanings	Subjective tags; narration techniques to "tell the data"; data-driven avatars
	Changes due to changes in self-knowledge	PI should focus on self's wellness	Support for re-interpreting the current situation
Past Self		*Guideline 2a*	
	Organizes memories around important life episodes	PI should adopt s self-centric organization of historical data.	Detection and chaining of significant past episodes
	Is experienced from a subjective point of view	PI should help remember the past from an internal point of view	External and internal past contextual cues to recollect lifetime periods
		Guideline 2b	
	Is construed by the present self	PI should adapt past data to the needs of the user's present self	Adaptation of historical data to support the user's present self
	Provides resources for action to the present self	PI should use past data to support the reinterpretation of the present	Recommendations based on past data to interpret the current situation
Future Self		*Guideline 3*	
	Allows for the exploration of different possible futures	PI should help simulate alternate futures	Interactive narratives of how the selves will evolve in the future
	Can be explored (hoped or feared) serving motivational functions	PI should provide a range of (idealized and dreaded) future images of the self	Projections of ideal paths of evolution as well as worst-case scenarios
Interconnected Self		*Guideline 4a*	
	Is open to exchange with others	PI should create spaces of intimacy for self-disclosure	Small groups, private communication channels between members
		Guideline 4b	
	Is influenced by the comparison with others	PI should help users find others to which to compare	"Social matching" with the current user's self
	Can identify with others' experiences	PI should support users in empathizing with others	Narratives to present others' experience

Fig 2: Summarized guidelines presented by Rapp and Tirassa [50].

The brainstorming setup was through a process of ideation with two experts, as they had valuable insights into the field of light's impact on the human body. This was important to make sure that the personal informatics prototype would be reasonable from a scientific perspective. The ideation was used to generate design ideas for the interface of the prototype[53].

To ensure that the design ideas were built from a phenomenological perspective that focuses on the user to create better self-understanding, the design guidelines provided by Rapp and Tirassa [50] were used as a basis during the ideation. As previously mentioned, they divide the self into four different parts: present-, the past-, the future-, and the interconnected -self. Every part of the self has design guidelines connected to it. The ideation was hence divided into four parts with the design guidelines as a basis when coming up with ideas for the design. Initially, in the ideation session, the design guidelines for the four selves were read through and discussed by the participants. This created a common understanding of the theory among the participants [53] which in turn made the prototype's design closely linked to the theory [50].

The ideation session was then conducted by pen and paper, sketching down as many ideas as possible for each part of the self, based on the design guidelines. Printed guidelines were at hand while sketching ideas. Pen and paper were used as it is an easy-to-use method at the same time as it creates good conditions for conveying ideas [62]. Additionally, this method made it possible to easily change, add or erase things thus allowing our ideas to evolve freely, which was beneficial

at this early stage of designing [62]. The whole session resulted in 44 ideas in total, these were all thematized, coded, and analyzed according to interpretive phenomenological analysis (as explained in 3.2 methods). The analysis resulted in cohesive themes, or as Smith et al. would call it; master themes [52] which work as the requirements and basis for the design choices of:

Present self:

- Self-log
- Goals/recommendations
- Connect sunshine to something more connectable, like current circumstances (e.g. weather, connection to their own schedule)

Past self:

- Giving knowledge based on self-tracking data from before.
- Learning from objective facts (e.g., how much light an average Swedish person gets this time of the year)
- Learning from the self (e.g., connecting activity, sleep, and mood with how much and the quality of light intake)

Future self:

- Wishes and goals (of sunlight intake) along with information about what effects it can have on the body and mind
- Predictions (e.g., when you would be most productive due to your circadian rhythm)
- Experiment with the future (be able to play with light exposure and see what happens in text or graphs)

Interconnected self:

- Information spreading (such as sharing with others, much like social media)
- Possibilities of connection with others (e.g. do activities with others such as going for a walk to improve the intake of sunlight)

4.1.2The design 0.1.

The first page of the prototype: The master themes were then made into designs in Figma. Figma is a software used to create designs and interactive prototypes. The design resulted in a four-part computer screen. As explained by Rapp and Tirassa, it is the user's self that experiences the system, hence the interaction needs to be directed towards the self. Since the self is built on a flow of experiences it requires an interplay of all four parts of the self and its situatedness [50]. By including each part of the self in the prototype, the hope was to design in a way that speaks to the present self and creates an inner, holistic understanding of the self for the users [50]. Therefore, each of the "selves" became one of the four parts, see fig. 3. All parts were thus motivated by the master themes. The different parts are color-coded [55] and described with both names and icons which are design choices for educational reasons, making the interface easier to interpret [2,31,42].

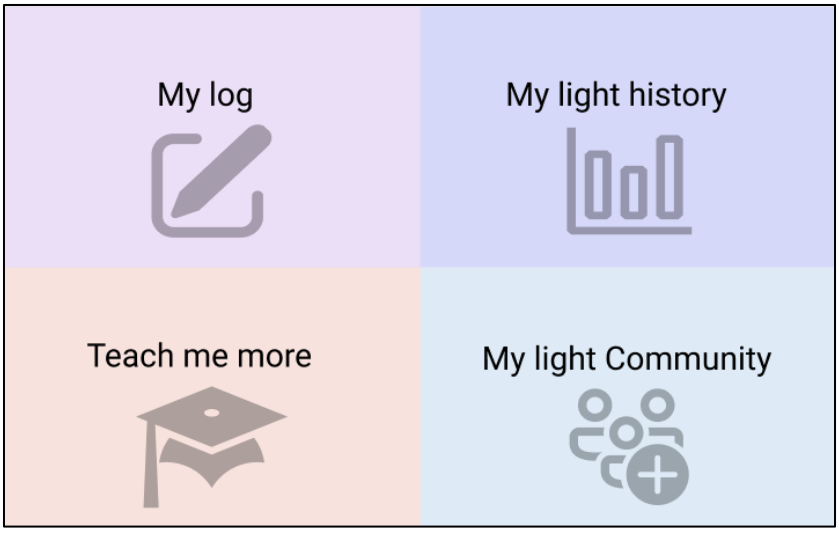

Fig. 3: The main page shows the four parts of design 0.1.

When the user clicks on *My log*:

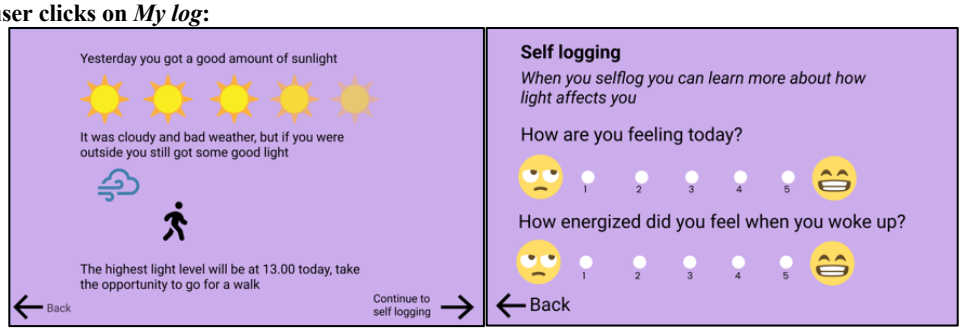

Fig 4 (left): first page of self-log. Fig 5 (right): A self-reporting log on mood and energy.

The figures above represent the design created in accordance with the first trait from the master themes, namely the present-self. As shown in the left figure the self-log provided information about the light exposure the user had and what the weather was like the previous days. Thereafter the user gets a recommendation that is connected to current circumstances (e.g. weather) [50], using comparative measures has been shown to make it easy for users to understand information[11]. The information is written in a casual tone to easily be understood by users of self-tracking systems, as suggested by previous research [29,50]. In the figure to the left, the users' mood and energy, can be self-reported on a scale from 1 to 5, as it is evidenced by research that getting the right light has positive effects on both parameters [19,24,39]. Icons and smilies are also used to make the content digestible [31,42].

The reason for putting together the different parts of the self-log with connectable circumstances (weather), recommendations, and an emotional element in the form of a self-log, was to create a design that speaks to the self. As the present self can be described as a flow of subjective situated experiences, which constantly redefines the self. To create a design that speaks to the self, it is required that the design is situated in the user's own experience of the world. By combining connectable external factors that are dynamic (i.e., weather, and recommendation) with internal factors that correspond to how we feel right now (self-report log), a design is also created that is changeable as the user's subjective

reality. This creates the possibility for different interpretations of the information based on the user's self [50]. By making the facts easy to interpret, adding connectable and changing information as well as recommendations, was the idea to create change in the user due to intrinsic motivation rather than behavior change.

When pressing the *My Light History:*

The figures below describe the light history of the participants, more information is presented below.

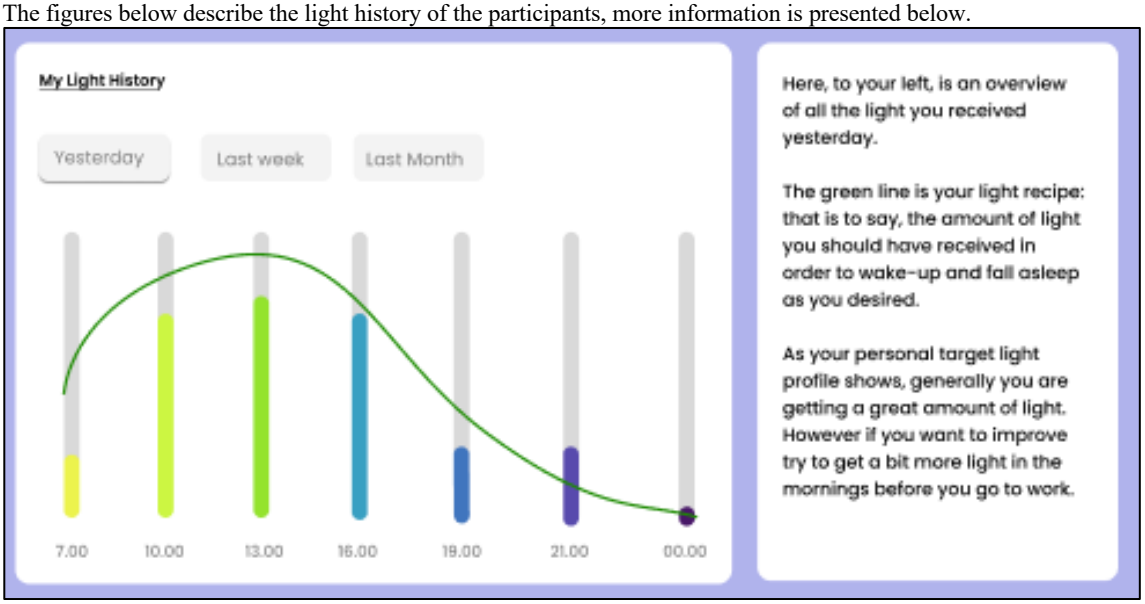

Fig 6: My light history

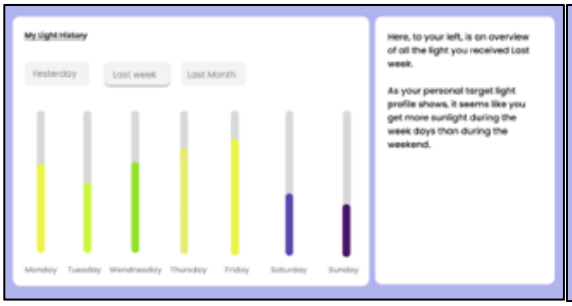

Fig 7 (left): My light history last week. Fig 8 (left): My light history last month

The figures above represent the designs created in accordance with the master themes for the past self. Fig. 6 shows the main page of the part *My light history* containing a chart with self-tracking data from the participants on their light exposure that the participants manually tracked and reported. The diagram consists of an x-axis representing the time between 07.00-00.00 and a Y-axis representing the amount of light exposure the user has had the day before. Light exposure is visualized in the form of bars, high bars = high light exposure, low bars = low light exposure. This type of bar chart has been proven to be effective for representing personal data [11,13]. A written explanation of the chart is also added to facilitate the interpretation of information, as research has shown that many feel uncomfortable doing it themselves [41]. Fig. 7 represents an overview of one week of tracked data. Fig. 8 represents data from one month. These two views have a

summing color, representing what that day's light exposure was like. For the week, each day's light exposure is summed up and shown by the height of the colored filling of the bar. Very much light exposure equals a high-filled bar and vice versa. In the monthly view, different colors represent how the daylight exposure has been. A good day is represented by a green ring, too little light in the morning can result in feeling sleepy (red). Too much light in the evening, and thus may have had difficulty falling asleep (blue). The data shown in these two charts was fabricated data, it was added to give participants a sense of what it would be like if they had been tracking for a longer period. This was done because research has shown that it is of great value for users of personal informatics to be able to go back in their data to learn things about themselves by, for example, finding patterns [11,14,14,33].

As explained by the theory of the self, relevant design features for the past self are those that organize the memories of the user as they are experienced and thereby provide actions to the present self [50]. Therefore, a green line is also placed in the diagram as a reference point for the participants. The green line represents "your light recipe": that is to say, the amount of light you should have received to wake up and fall asleep as you desire, which is estimated by the biomodelling expert in light impact on human biology at BrainLit. The aim of this design is to provide a reference point adding to the self-tracking data, which can encourage comparison and reflection thus providing actionable information for the present self-using self-tracking data from before [11,20,50].

When pressing the *Teach me more:*

The figures below show what the design for *Teach me more* looks like, this is further described below.

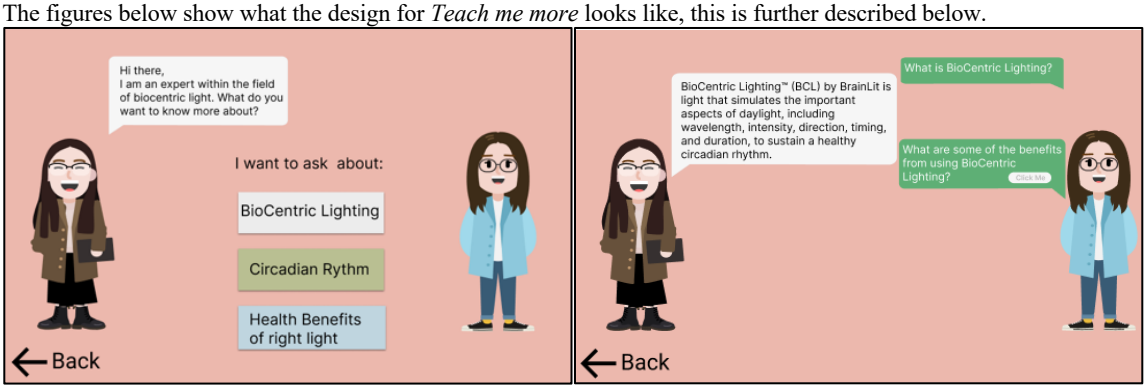

Fig 9 (left): Main page in *Teach Me More*. Fig 10 (left): Picture of chatbot (when pressing Biocentric Lighting).

Two out of three requirements from the master themes for the future self were too advanced to pursue, because it would require a coding system, which Figma is not. This problem was solved by finding a common feature of all three requirements which was creating an understanding of how light exposure can affect the self. Therefore, Teach Me More was created, which is part of the system that aims to create an understanding of the effects of light on the user's health and wellbeing. First, the user chooses what he/she wants to know more about (see Fig.9) which leads the user to the next page (see Fig:10) where a chatbot is used as a design. Chatbots were used as the interactive design to give the information as it has been shown to possibly strengthen users' autonomy, knowledge, and arguably social relatedness [22,23,29]. By building an understanding of the light and its effects on well-being, the idea is that knowledge would create an inner motivation for the user to improve behavioral patterns around their light environment [50].

When pressing *Light Community*:

The figures below show what the design for *My Light Community* looked like, the reason for the design is described below.

Fig 11: Picture of *My Light Community*.

The requirements for the interconnected self are focused on building connections with others through features that provide the opportunity for exchange, comparison, and identification (see fig: 2). Hence, the design includes a chat function and a feed where users can post information about their light (for comparison) and invite to outdoor activities (for exchange and identification) to get more good light.

Findings from the pilot study informed the next design was the benefits of remaking the design into a mobile-based prototype as well as adding features from the theory of storytelling. Two professionals from BrainLit participated in the pilot study, evaluating design 0.1 by going through the interactive prototype, which was performed on a computer. After the pilot study, it could be stated that it was not optimal to use a computer as it did not correspond to how users would normally want to interact with a self-tracking device. As it is advantageous to create a prototype with similarities to real-life situations from a phenomenological perspective this was changed into a design for a smartphone in design 1.0. The changes are further discussed in 4.2 Design 1.0.

4.2 Design 1.0

An observation that was made when testing design 0.1 was the reluctance to reading longer passages of texts in the design. To address this reluctance, the theory of storytelling in personal informatics was incorporated into design 1.0, as it is a theory focusing on how to communicate information in an easy-to-understand and relatable way. Thus, the main study tests how an interface for personal informatics based on both, the self, and storytelling, is experienced by users. This was done in part “teach me more part”, in the form of a short story that essentially describes five good effects that the right light can have on your physical and mental state. The story was designed using an animated character, to create a sense of relatedness and reflection on ones-self [50]. Below is a picture of the story:

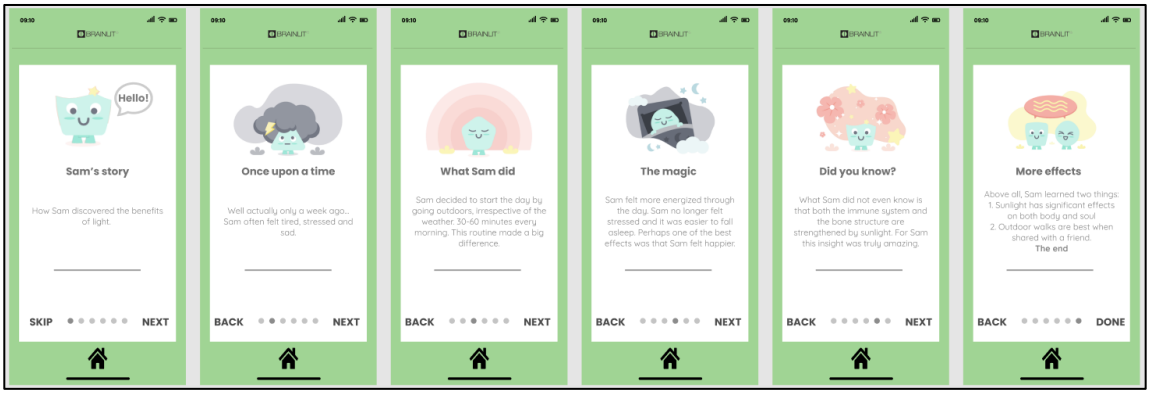

Fig 12: Picture of "Sam's story" in *Teach Me More*.

4.2.1 Design changes for design 2.0

A theme that emerged during the interviews was that the respondents wanted to combine self-log with light-tracking data to be able to compare the tracked light with the self-log and thereby gain more insight from the information.

Most participants wanted the information they got in *Teach Me More,* earlier on in the app to gain an understanding of the importance of light impact on their health. Therefore, a longer introduction, based on the theory of storytelling, was added to design 2.0.

Another requirement that emerged from the interviews was that there would be clear explanations of the colors in the monthly view, and to use the same colors in the weekly view as well to make the information easier to interpret. This was also added in design 2.0.

My light community was the party that most participants felt unsure about if they liked. The biggest criticism was directed at the part that was like social media as none of the participants could see themselves sharing things about their light. However, there were some who liked the social and competition-oriented aspects. Therefore, this part was turned into Activities, which is a voluntary part of the app that is there to make light tracking more sociable. The user can organize walks, and runs, start competitions, or track their own goals.

4.3 Design 2.0

Large parts of design 1.0 were retained because the design was met with a very positive response. However, the major changes made to design 2.0 were first, to add a more informative introduction and secondly to add a self-log to the light tracking, thirdly information on how to interpret the colors of the monthly view and the weekly view was added.

Most participants (outside of BrainLit) commented that they wanted a more informative introduction to understand why tracking light can be so important and thus create a stronger incentive to track their light environment. Therefore, a new introduction was added. This introduction was made accordingly to design traits from the theory of storytelling; with a fabula[29]. The saga describes why the circadian rhythm is important to us humans and how it came about from the beginning. The story is written in easy language to make it easy to understand[29,50] At the end there is also an element of character where you get to choose what kind of circadian rhythm you have yourself by answering if you are an early bird, regular or night owl (based on descriptions in the design) to create a feeling of relatedness to the subject [23,27,30,36]. See fig. 13.

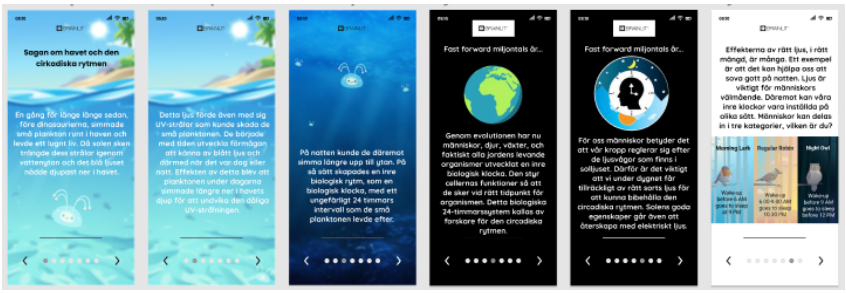

Fig 13: Picture of the introduction saga.

The second big change was adding the self-log to the light-tracking which was added since most of the participants had suggested it. Fig. 14 shows the self-log and Fig. 15 the monthly view with self-log, fig. 16 the monthly view without the self-log. Adding the self-log to the light exposure was a change that received good reviews. It helped the participants to reflect on their data as they had something to compare their tracked data with. However, it was also criticized for being visually a bit difficult to interpret. This could thus have been a change for design 3.0. Lastly, explanations were added to explain the meaning of the colors used in the weekly and monthly views as seen in fig. 15-17. A written analysis of what could be said from the tracked data and the self-log was also added, as seen in Fig 17. The blue arrows represent where it is possible to scroll.

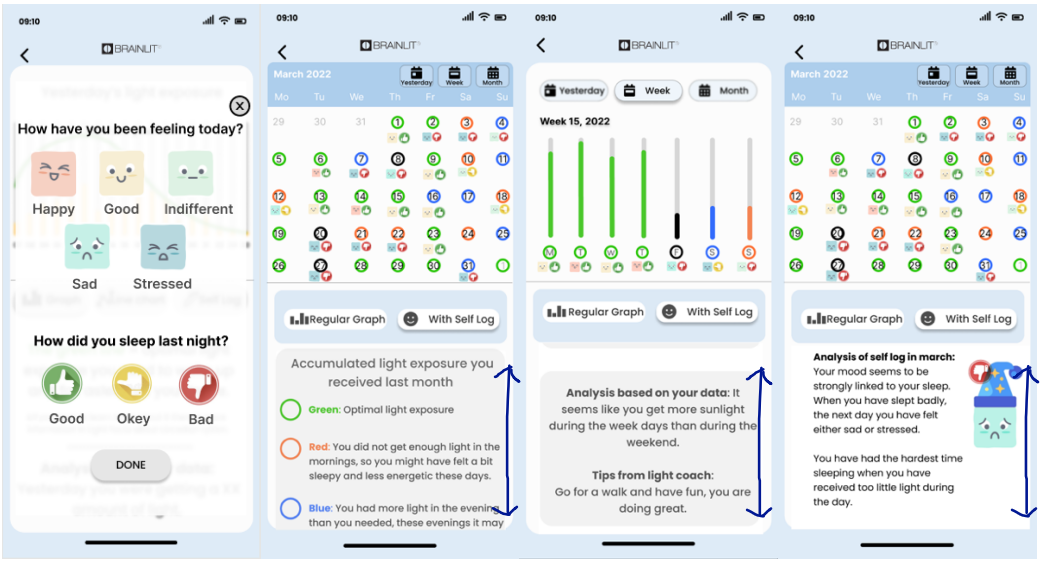

Fig 14: Picture of the self-log. Fig. 15: Monthly-view with explanations for the color-coding and the self-log incorporated in monthly view. Fig16: weekly view with self-log, analysis of the data and a tips. Fig 17: monthly view with self-log and scrolled down to the analysis of tracked light and self-log.

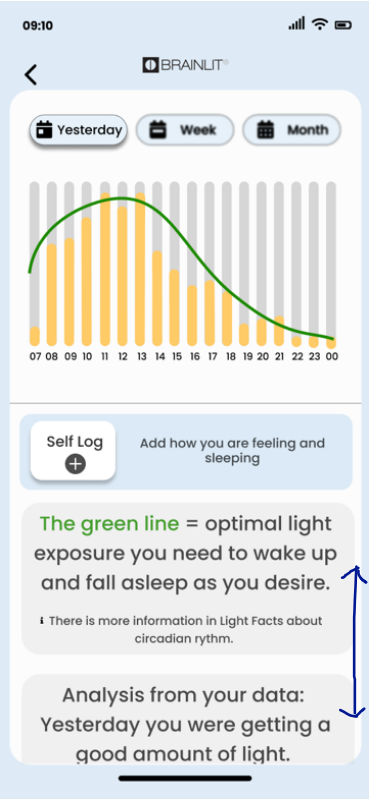

Fig 18: View of yesterday's light exposure.

5 RESULTS AND ANALYSIS

An interactive prototype of a self-tracking app was designed based on the theories of the self and storytelling. The prototype has been tested by 13 participants to evaluate how such a personal informatics design is perceived as supporting users in understanding, reflecting, and applying the information shared by the app. Based on the material that has been collected and analyzed in this study some key qualities that could support those aspects have been discovered which will be described and exemplified with design features. The results section is presented as follows: general opinions about the app, qualities that support 1. understanding, 2. Reflection, and 3. applicability. Analysis of the result is incorporated in each part such as comparisons with previous research, and reflections will be provided in this chapter.

5.1 General opinions about the personal informatics design

Overall, the participants were satisfied with the app (design 2.0). The interaction with the app was described as easy to use, manage, and understand as well as motivating to change or to do better. The participants thought that every part of the app added something, thus no part of the app was considered redundant. P11 described it as follows: "I think it is well balanced. There is a good logic between all things that are included. You track, you get information about the light, and then if you want to have activities to compare your light tracking to something, the app has that too." However, there was a consensus among the participants' responses, that the part Light Tracking (consisting of what previously was *My light History* and

My Log) was considered the most important part of the app, as it contained the self-tracking information. On the contrary, Activities were considered the least necessary within the app.

5.2 Qualities that support understanding

5.2.1. Written explanations for interpreting data.

Using written explanations on how to interpret the data proved to be of great help to the participants in understanding their collected data (see Fig:15 and Fig:16 in 4.3). This feature was created as a means to fulfill the design criterion (for the past self) to organize the data so it could be recalled as memories and experienced by the present self [50]. An example of this was the explanation that existed for color-coding, for the weekly- and monthly-view. Many participants saw this as a major improvement between designs 1.0 and 2.0. P9 describes: "*The calendar view, I like it and that the explanations are on the same page, because I remember it as if they were not on the same page the previous design and I think it is a good deed, so you do not have to sit and scroll to understand it.*" This was also done through written analysis of the data i.e., the written analysis of the month's light exposure and self-log (see example in 4.3, fig 16). P8 tells what he thought of having an analysis of his mood together with light exposure: "*Well it was great. I would have used it if I had not understood it, absolutely. If you do not see the pattern yourself. I "actually thought about it, with the monthly view, that you can see the days lined up. It could be unclear because you might have had a mood that has nothing to do with sleep or something*." The written analysis seems to help the user with interpreting the data, as it is also proven to be something that users of PI devices are not comfortable doing [41].

5.2.2. Using storytelling

Storytelling traits were added as a complement to the theory of the self after the pilot study, to possibly solve the problem that users were reluctant to include information in longer pieces of text. Storytelling was used in two places in the app, the first of which was in the part *Teach Me More*, a story that explained five benefits of getting good light, and the second was the informative introduction. Two positive aspects emerged from using storytelling: 1, storytelling made it feel easy for the participants to absorb information. 2, the participants were seemingly willing to read longer passages of text when it was written with a narrative, like a story. During an interview on design 2.0, P10 describes what he thought about the introductory story "*I thought it was great. It was easy-going, so I think it was easy to understand*." P12 described her feeling about having the story as an introduction: "*I like the little story in the beginning very much. You feel welcome to the app, and it was a bit cute, not just technical and boxy*." Most of the participants spoke in terms of the story being cute, warm, or funny, which could indicate that the design calls for their relatedness, which some research shows help people absorb information [14,29].

5.3 Qualities that support reflection

5.3.1. Manual tracking

Many participants said that it was difficult to remember to track their LUX every hour which aligns with previous research [35,48], but it also had good effects as it gave insights. The interviewees described that manual tracking gave them insights while they tracked their light, which p1 describes: "*I was very surprised at what differences there were, it was light depending on whether I might be inside or if I had lights on, I got a very little number on the app. So, it was very fun, and I became aware, I went around waving my mobile to find different places with different lights. Everyone who saw me do it also wanted to try so it was a very fun way to still understand light, I think*". Another such example was the participants'

reaction to their light environment at home, which P8, a professional at BrainLit, described: "*It was interesting to see how low lighting we have at home, I knew the LUX was lower than in the office, but I did not know it was that low. It was 1400 LUX here* (talking about BrainLit office) *and then I came home, and it was 40 lux at the kitchen table. So, it was a bit interesting that it was such a big difference."* The manual tracking also had the effect that the participants could reflect on what they did during a certain time and why they received a high or low LUX number. As P2 describes when the tracked data for the first time: "*yes this is my data, well. It's crazy that I got so much light at 6 pm but it was because I was just out then going for a walk*".

5.3.2. Designs creating space for reflection

According to the analyzed data we can infer that some design features seemed having a reflective and motivating effect on the users. Common to these designs was that they left room for the user's reflections, by designing with two variables. An example of this was adding the green line (light recipe) to the personal information (light tracking). The aim of this design was to provide a reference point adding to the self-tracking data, to encourage comparison and reflection thus providing actionable information for the present self-using using self-tracking data [11,20,50]. These results provide further support for the hypothesis that comparable measures can have a reflective effect on users of personal informatics. A possible explanation for this might be that the green line came to represent how the participants wanted their light intake to be. This made them reflect on where and when they had received a lot or a little light but also on how they could improve light intake. P5 describes: "*Fun to see my own light. And I interpret the green line as something you strive for something you would like to achieve*." And P6 stated: "I like the green line, it made me reflect". Another, example of such "comparing design" was the incorporated self-log in the visualization together with the collected data. This enabled the user to compare the light exposure to the variables in the self-log (in this case mood and sleep). P12 answers the question if adding the self-log to tracking gave her additional knowledge: "*Yes, but it does because then I connect my light to how I feel* [...]". Hence these findings suggest that a design creating an opportunity for comparison could have the effect of making users reflect upon their data.

5.4 Qualities supporting applicability

5.4.1. Combing understanding and reflection lead to motivation for change

The analyzed material indicated that it gave the participants motivation to change their behavior when they 1, understood why and how the light environment can be of great importance to their wellbeing and 2., what their own light habits look like in comparison thus reflecting on their data. P1 describes feeling motivated by the app: "*I got to know what optimal light exposure is and that I get less than that, which motivates me to go out more or sit outside more work, or what I can do to get more light*." This finding is not based on a design trait and is therefore not as specific as the others. Instead, it was a finding that came out of IPA[52] of the reflections that the participants conveyed during the interviews. Designing PI devices for the self is trying to convey the users' data as subjective meanings rather than objective figures[28,50], and thus create intrinsic motivation to learn and change for the better.

5.4.2. Using applicable tips and social aspects

Previous research has shown that users' experience of a PI device that does not provide actionable information becomes useless [48]. To address this, written tips were added, the tips were directly connected to the participants' data on how they could improve their light exposure, to make the device applicable. P12 describes her feelings towards getting tips within the app: "*I like it, it's a bit fun to get tips and it's simple, concise, and doable I think*".

Throughout the different designs, participants have commented that a social aspect of the PI device would motivate them to act, for example by going for a walk with someone. P11: "*But just to make it a social thing and something you might feel compelled to do because you have a friend waiting for you, then it would be a good way to get started, I guess*." Some thought it was fun with the more competitive aspect of activities and the common positive factor was that it was social. P2: […]"*But I had looked at other people's numbers and see how much light others get. Then it becomes a bit like a competition, and it would have been fun and motivating.*" These findings could arguably indicate that using the design guidelines from the theory of the self [50] when designing a PI device makes the design focus on the user's experience and intrinsic motivation.

6 DISCUSSION

The research question in this thesis is: how can a self-tracking app be designed using theories of the self and storytelling, to support users in **understanding** and **reflecting** as well as **applying** the information shared by the app in their everyday life? The results and analysis conclude that the app, designed based on the theories of the self and storytelling for personal informatics, successfully supports users in understanding, reflecting, and applying the app information. There is however a gap between the theoretical framework and the empirical HCI application. Therefore, the design features will be critically analyzed based on the theoretical framework of this thesis and optional design solutions will be addressed, in the following section. How the interpretations of the results can be broadened and used in future HCI work will be elaborated.

6.1 The gap between the theoretical framework and the final design

The initial objective of the thesis was to identify what design qualities using theories **of the self** and **storytelling**, to support users in **understanding** and **reflecting** as well as **applying** the information shared by a PI device. However, it can be argued that the final design does not exactly follow the phenomenological matrix but rather a normative structure. The tracked data is presented in comparison with objective norms, for example, the green line (see fig. 18) describes the "optimal light exposure" which is a normative standard of what the "average person" should get. The data was provided by the experts at BrainLit. Using normative standards stands contrary to the phenomenological theoretical framework of this thesis, and it is in this tension field the thesis is delivering results. My interpretation of why this came to be is that the initial objective became partly and subconsciously de-prioritized in the collaborative design process with the company. BrainLit relies all its work on objective standards as they work with biological, objective, and normative standards in making their product. Hence, it was difficult to design based solely on subjective experiences without connection to BrainLit's (objective) data for the company's knowledge to be recognized in the prototype. Using more than only subjective experiences will give BrainLit much useful information. For future research in phenomenological design of PI devices, it could be advantageous to do so also without collaboration with a company to enhance the design process and make it easier to follow the phenomenological approach throughout the design process. In the study, self-logging was used to add a subjective description to the objective facts of the light-tracking. To make the design even more subjective, the tracking itself could be a self-assessment scale by enabling the user to rank how much good light they have received during the day and how they have measured, rather than using objective measures for the standard of the light exposure. This would make the design more grounded in the phenomenological matrix. Finally, a further discussion of possibilities when building health care/wellness PI devices from a phenomenological perspective as it rejects objective and normative data. This question could be further elaborated by comparing mental and physical health apps. In mental health the subjective standards are of utmost importance thus the phenomenological design guidelines would probably work well. However, it might be that physical health apps would need to use objective data and standards to be of help for the user which in turn

may rule out the phenomenological design of that PI device. With more research in the field of phenomenologically based designs of PI devices, a more nuanced picture of this type of design's advantages and disadvantages could be created.

6.2 Design qualities

The idea was that the design would be strictly linked to the phenomenological matrix, which was not possible as the conditions under which this thesis was made did not allow to strictly follow it. This in itself is a lesson for subsequent work in empirically-based research there is the risk of goal incongruence between the company and the researcher. Nonetheless, following the methodology of research through design (REF) it is possible to learn from the emerged findings from the study to create future interfaces for PI devices. The following paragraphs will present the design qualities that supported the user in understanding, reflecting on, and applying the facts shared by the app. The findings are written as general design guidelines to broaden usability.

6.2.1Qualities supporting understanding:

Using storytelling[29] made it easy for the participants to absorb information and the participants were more willing to read when the text was written with a narrative, like a story. This was concluded from the observations when the users interacted with the prototype since no instructions were required for them to start reading and none of the participants commented on the text being too long, which had happened more often in other parts of the app that were not written accordingly to storytelling. The participants also described their experience of the story in the introduction as easy to understand, hence the results match those observed in earlier studies [17,27,29,30,38].

Using clear guiding markers through the app proved to provide good conditions for making users understand the content of the shared information. One design example from the prototype was having written explanations of the visualized data (diagrams) and analyses linked to the data being tracked. It helped the user to understand how to interpret diagrams as well as guided the users in analyzing the data by themselves. These designs were created to fulfill the design criterion for the past self to organize the data so it could be recalled as memories and experienced by the present self [50]. An explanation to why written explanations and analyses may have worked well could be that it created an easy-to-understand interface as well as that it simultaneously removed the laborious step for the user, having to analyze their own data [3,40]. Having written analyzes of the data also seemed to lead them in their interaction with the data, as some of the participants, after reading the text, could more easily identify patterns in their data themselves. An alternative explanation that cannot be ruled out, as to why this worked well, is whether the interface is clear enough in itself. The color-coding in the weekly and monthly view (see Fig. 15), for example, was not considered self-explanatory.

6.2.2Qualities supporting reflection:

Manual tracking contributed to the user's understanding of their light environment. This was a somewhat unanticipated finding as some previous research suggests that manual tracking takes much time resulting in fewer users reflecting [35] and that manual tracking feels tedious [48]. However, these findings suggest that manual tracking could be positive as it seemingly makes users reflect on their data through their experiences of tracking it, which is also supported by other empirical research in self-tracking [11].

6.2.3Qualities supporting applicability:

Previous research has shown that users' experience of a PI device that does not provide actionable information becomes useless [48]. To address this, written tips were added, the tips were directly connected to the participants' data on how they

could improve their light exposure. Written tips on how the PI data can be used proved to be a valuable product for the user as it made the facts something useful for them.

A social part of the app, the *Activities* (which used to be *My Light Community*) was a feature created to fulfill the design criterion for the interconnected self and enable exchange with others and create the conditions for communication and comparison with others. The participants described that having their experience shared (physically rather than in a feed) would give them an incentive to act on the information shared by the app.

6.3 Shortcomings

Some app features showed limitations in supporting users in understanding and reflecting as well as applying the information shared by the app in their everyday life. An example of this was *Activities,* a part of the app that did not receive equally positive responses as the other parts. This part of the app was created to fulfill the design criterion for the interconnected self [50]. The design guidelines highlight the importance of the social aspects in identifying one's own experiences with others. Some participants were hesitant about whether they would use it themselves. A problem in design 1.0 was the feed feature as the participants did not see the point of sharing things about their light exposure to others. One reason why this did not get as good a response as other parts of the app may be the fact that it was a PI device for tracking light environments. If the PI device had been aimed at users who want to exercise more, it might have been a quality that would fit better. This quality, is the feed, was therefore removed in design 2.0. Although the participants did not see the point of sharing information about their light exposure in a feed, they saw the potential in having a social aspect in the app. Since the social part, *activities*, was more appreciated it was further elaborated in the design 2.0. To see an overview of the thematical analysis of design 2.0 see Appendix 3.

7 CONCLUSION

7.1 Thesis contribution

This work aligns well with a recent trend in HCI that proposes designing PI devices following a phenomenological design approach. This thesis thus contributes to work on personal informatics [29,49,50]. It illustrates the usefulness of designing personal informatics devices for the self by using the design guidelines from [50] and convey information through storytelling [29], to support users in understanding [11,40], reflecting[14,20,33] and applying [21,48] the information shared by the app which are three key challenges in designing personal informatics [35]. The findings in this thesis contain a series of qualities that design of self-tracking apps could benefit from using a phenomenological approach to achieve an interface that supports understanding, reflection, and applicability.

7.2 Thesis limitations and future work

Using an availability sample is not ideal as it could lead to sampling bias which limits the population validity. With a small sample size, caution must also be applied, as the findings might not be generalizable. The scope of this study was limited in terms of a specific case, limiting the generalizability. The study has provided general insight into how designing apps based on a phenomenological perspective could work and how it could be perceived by users, thus taking us one step closer to the PI design of the future. However, this thesis has so far only tested the design with a prototype of an app. This means that there is a lot of research left to do to test the phenomenological design approach in designing PI devices. To produce apps that work for real use requires more research in computer science to sort out the back-end [18]. Larger randomized

controlled tests of PI devices would also provide more definitive answers to the question of whether it is beneficial for the user to have a PI device that is designed based on the phenomenological matrix.

7.3 A step-based take on the findings

The analysis of the themed material disclosed a 4-step process for the participants to act based on the personal informatic app. The steps that proved effective in this study were to **first** build an understanding of why a user's light environment is important and what effects it has. This was done through an introduction to the app that provided scientific evidence as to why it is important [25] to get the right light and what consequences it can have on the body. The introduction was written according to the theory of storytelling with a fabula [29], which apparently made it easier for the participants to absorb information. The **second** was to build an understanding of the tracked data and to show patterns. Both adding explanatory text to the visualized data and adding written analysis of the tracked data proved successful in doing so. The **third** was to design for self-reflection. To do this it may be beneficial to display the tracked data in combination with other connectable facts as it could contribute to a reflection on the personal data. **Fourthly**, combining an understanding of what is being tracked and reflecting on your own habits can create an inner motivation to apply the newly aquired knowledge to change or improve behavior. These qualities influenced the participants' perception of the app as understandable, reflective, and applicable.Using an availability sample is not ideal as it could lead to sampling bias which limits the population validity. With a small sample size, caution must also be applied, as the findings might not be generalizable. The scope of this study was limited in terms of a specific case, limiting the generalizability. The study has provided general insight into how designing apps based on a phenomenological perspective could work and how it could be perceived by users, thus taking us one step closer to the PI design of the future. However, this thesis has so far only tested the design with a prototype of an app. This means that there is a lot of research left to do to test the phenomenological design approach in designing PI devices. To produce apps that work for real use requires more research in computer science to sort out the back-end [18]. Larger randomized controlled tests of PI devices would also provide more definitive answers to the question of whether it is beneficial for the user to have a PI device that is designed based on the phenomenological matrix.

7.4 Summarized conclusion

This thesis indicates that written explanations and analyses linked to the data being tracked support users in understanding the content within the personal informatics device. Manually tracking data can be laborious and difficult [38], which turned out Scientific Storytelling Using to be the case this time as well. However, this data also provided insights and gave room for reflections for the user which has also been suggested by previous research [11]. Designs with two variables allow the user to compare their data with something which contributes to reflection. This has also been shown by previous research [11]. Making the participants understand the tracked data and make them reflect on it led to motivation to do better. Written tips on how to improve based on the data being tracked and gave participants useful guidance on what or how they can change their behavior. Being able to act (on tips) with someone else showed to be motivational to apply the information shared by the app. These last findings can increase the understanding of how the design of PI devices affects peoples' motivation to act and live healthier and happier life.

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A APPENDICES

A.1 Information letter (AppendixH2)

STUDY FOR MASTER THESIS BRAINLIT 2022-06-27

Intro:

Hi! My name is Edda Carlhenricsdotter, and I am a Master's student in Human-Computer Interaction at Uppsala University. Thank you for taking your time to read this and considering participating in my study! I am currently doing my master thesis project, which focuses on self-tracking devices and how to design feedback to the user, you, in the best way possible. And I am asking you to be a participant in my study. Previous research has shown that many people find it difficult to get any real insights from self-tracking devices. Your participation can take us one step closer to answering how the design of the interface can be made better.

Background:

This Master thesis project is being conducted in collaboration with BrainLit. BrainLit creates lamps that use BioCentric Lighting™, which aims to synchronize our biological needs with solar time and simulate the most important aspects of daylight that influence your health and well-being. Adequate lighting has also been shown to improve alertness, cognition, and sleep. In other words, BrainLit makes lamp systems that give you the positive aspects of sunlight and make you feel better when you are indoors. For more information, please visit https://www.brainlit.com/.

As light environment can affect body and mind, it is something that can be self-tracked to improve health. This essay tests a new way of designing feedback for self-tracking systems.

Study:

I would like you to track your light exposure for one day and share the information with me. The day after you have tracked your light exposure, you will be provided with a prototype of a future app which aims to provide information about your light environment, which is made based on the data you sent, and information about how you could improve your light environment. We will go through the system and afterwards I will have a short interview with you about your thoughts of the system. When you have participated, I will ask if you are willing to participate in an evaluation of a later design.

Part 1. Conducting information about your light exposure

The aim is to understand the light exposure you experience on an average workday.

How to track your light exposure:

1. Download a mobile app which can measure your light exposure (Intensity measured in units lux)[3]:
   - **Android:** https://play.google.com/store/apps/details?id=com.doggoapps.luxlight&hl=en&gl=US
   - **Apple:** https://apps.apple.com/se/app/light-meter-lm-3000/id1554264761#?platform=iphone (It will complain that you need a *diffuser*, but don't

[3] Reiter RJ, Rosales-Corral S, Sharma R. Circadian disruption, melatonin rhythm perturbations and their contributions to chaotic physiology. Adv Med Sci. 2020 Sep;65(2):394-402.

worry, ignore that warning, unfortunately the dialog will persist but it won't obscure the measured output)

2. Test your light surroundings once per hour (over the course of the whole day, from getting up in the morning to going to bed in the evening).
    - To do the measurement simply put your phone on a flat surface (preferably your desk, or the palm of your hand at roughly desk height).
    - Open your light meter [make sure it is measuring in Lux (*it should be by default*) not FC = footcandle]. Let it measure ~5 seconds and then note down the average (AVG) light intensity (in Lux).
    - Write down result in attached excel spreadsheet.
    - *Additionally:* If you go outdoors for more than 30 mins (during the daytime) please make a note of that in the excel sheet in the additional box.
    - Write in spreadsheet an estimate of when you fell asleep (*not when you went to your bed, but when you actually fell asleep*) and when you woke up (*became awake, not when you left the bed*)
3. At the end of the day, send the collected information in the excel file to: Calhenricsdotter@gmail.com or Via SMS to 0727285515

If you have any problems setting up the app or measuring the intensity please feel free to send an email as well.

Part 2. Analyzing feedback-system:

- The next day you will get feedback in the form of an interactive prototype with information that is provided from the light exposure you have had the previous day.
- When you see the interface of the prototype, I will ask you to think aloud; that is to tell me your thoughts and feelings you have of the design as you go through the prototype
- Finally, a brief interview (approximately 15 minutes) on how the whole process was for you. That includes your thoughts, feelings of the self-tracking experience, and inputs for improvement.
- Both the think aloud session and interview will be recorded for later analysis.

Your rights as a participant:

You have the right to terminate your participation in the study whenever you want without consequences. We can speak Swedish if you feel more comfortable participating in the think aloud session and interview in Swedish. However, what is written in the interface will be in English.

Privacy:
If you do agree to participate, be aware that:

- All the data that is collected will be stored on my, Edda Carlhenricsdotters and by BrainLit.
- The information is only for research-related purposes and if the information from your participation is incorporated in the text, then it will be anonymized (no identifiable data about you) for the purpose of the thesis.
- Anonymized data from your participation may be stored by BrainLit for future use. The recordings will be deleted as soon as this thesis is approved.

For more information about BrainLit's GDPR policy, see https://www.brainlit.com/legal/privacy-policy/

To participate, and if you have any questions regarding this information, please contact me at: carlhenricsdotter@gmail.com

A.2 Questions for think-aloud and interview Design 1.0

Introduction for the participants:
We will go through a simulation of a feedback system for a light tracking app that is made based on information about your light environment which you collected yesterday. There will be a few different parts to go through and you will be free to go around the system the way you want. While you are doing this, I want you to "think aloud" about what you see. Everything you think or feel is important information to me.

During the think-aloud
Tasks:

1. Please go through the introduction of the app and tell me what you think of it
    a. How was the information; did you understand what it described?
    b. Did it feel reasonable?

2. In Light exposure:
    a. How do you interpret what you see? Does it feel easy to interpret?
    b. If you do not understand what would you do then?
    c. Does it feel like you get an understanding of your light intake my light history?
    d. If you go into the lamp, I want to hear what you feel for that information

3. Last Week
    a. How do you interpret what you see?
    b. How do you feel about the analyzes?
    c. Is it any of yesterday, last week last month that makes you reflect more or less?
4. Self-log
    a. What makes the self-lodge make you think or feel?
    b. Does it feel relevant to give keep a self log?
    c. What do you feel you can get out of using a self log.
5. Community
    Here you can add friends from other social media who are also doing the same light-tracking.
    a. You are eager to go for a walk with Hanna cool, so press join.
    b. You have received a message that you can go in and look at.
    c. Would you like to see your friends if they track their light?
    i. Why / why not
    d. Then we go back to the homepage
6. We go into light facts
    a. If you try to ignore the video itself and look more at the general idea of getting information in the form of a video, how does it feel to you?
    b. How did you think it was to get information using a story?
    c. Did the story / video make you feel in a certain way?

Interview questions after the prototype is tested:

How did it feel to track your light?

The idea is that this device would track your light automatically, instead of you having to do it manually. How would you have felt about giving out your lighting information to such an app?

Of the four parts of the app, was there one that you felt gave you the most? Why?

Of the four parts of the app, was there any that you felt was redundant? Why?

How do you think about light before and after doing this?

Did it feel natural to get the information this way?

Did you ever get an “aha-moment” during the time we went through the program?

Was there any part of the app that made you reflect about yourself?

Did you feel that you got any specific insight from the app?

What in the app gave you, personally, the most? Can you describe it?

Could you try to describe what it was like to go through the app, what feelings and thoughts did you get from the different parts of the app?

Same questionnaire in Swedish.

INTRO:

Nu kommer vi att gå igenom en simulation av ett feedbacksystem för en ljus trackning-app som är gjord utifrån ljus-information som du samlade igår. Det kommer finnas lite olika delar att gå igenom och du kommer vara fri att gå runt i systemet på det sättet som du vill. Under tiden du gör det vill jag att du ”tänker högt” om det du ser. Allt du tänker, känner och tycker är viktig information för mig.

1. Du kan få gå igenom introduktionen för appen och berättar vad du tycker om den
    a. Hur var informationen, förstod du vad den beskrev?
    b. Känns den rimlig?

2. Light exposure:
    a. Hur tolkar du det du ser? Känns det lätt att tolka?
    b. Om du inte förstår vad skulle du göra då?
    c. Känns det som att du får en förståelse för ditt ljusintag my light history?
    d. Om du går in på lampan, så vill jag höra vad du känner för den informationen

3. Last week
    a. Hur tolkar du det du ser?
    b. Vad känner du för analyserna?
    c. Är det någon av yesterday, last week last month som får dig att reflektera mer eller mindre?
4. Self-log
    a. Vad får self-logen dig att tänka eller känna?
    b. Känns det relevant att ge föra en self log?
    c. Vad känner du att man kan få ut av att använda en self log.

5. Community

Här kan du lägga till vänner från andra sociala medier som också håller på med samma light-tracking.

   a. Du är sugen på att gå på promenad med Hanna cool, så tryck join in.
   b. Du har fått ett meddelande som du kan gå in och titta på.
   c. Skulle du vilja kunna se dina vänner om de trackar sitt ljus?
      i. Varför/varför inte
   d. Då går vi tillbaka till homepage

6. Light facts
   a. Om du försöker bortse från själva videon och mer ser till den generella idén av att få information i form av en video, hur känns det för dig?
   b. Hur tyckte du det var att få information med hjälp av en historia?
   c. Fick berättelsen/videon dig att känna på något visst sätt?

Intervjufrågor efter att prototypen testats:

Hur kändes det att tracka ditt ljus?

Tanken är att denna typ av device skall tracka ditt ljus automatiskt, i stället för att du hade behövt skriva in ditt ljus själv.

Hur hade känt för att ge ut din ljus-information till en sådan app?

Av de fyra delarna av appen var det någon som du kände gav dig mest? Varför?

Av de fyra delarna av appen var det någon som du kände var överflödig? Varför?

Hur tänker du på ljus innan och efter att ha gjort detta?

Kändes det naturligt att få informationen på detta sätt?

Var det någon gång under tiden vi gick igenom programmet som du fick en ”aha-upplevelse”?

Var det någon del av appen som fick dig att tänka efter?

Kände du att du fick någon specifik insikt av appen?

Vad i appen gav dig, personligen, mest? Kan du beskriva det?

Skulle du kunna beskriva hur det var att gå igenom appen, vilka känslor och tankar fick du av de olika delarna av appen?

A.3 Overview of the thematical analysis of design 2.0 (Appendix 3)

Master Table of Themes, design 2.0

Part of the app	Analyzed material
Introduction saga	• Appreciated, easy to understand. • Makes me happy as it feels inviting and warm.
Light tracking (light tracking + self-log)	• Considered the most important part of the app. • Provides self-understanding through a combination of light tracking data and self-log. • Unclear impression of the design with light and self-log presented together.
Light facts	• Positive that there is a page just for information • It is good that you can learn the information in different ways.

	• Of minor importance compared with tracking light.
Activities	• Motivating to use with others. • Some stay skeptical about whether they would use it themselves, as there are other apps to get in contact with other friends to take a walk for example.
Future changes	• Make a clearer design so it is easier to see the combination of tracked light and self-log.