

User prototypes as partly unconscious communication

Understanding young diabetics' visions for mobile diabetes technology

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Abstract: In this paper, we introduce user prototypes as a technique that supports users' articulation of emotions relevant for design: dreams, fears, motivations – their feelings and aspirations. Following Bateson's writings about communication through art, we consider user prototypes as “partly unconscious communication” and propose to analyze them by focusing on the emotional articulations integrated in the users' design language. We illustrate this with an example from a design research project on designing learning technology for young diabetics. The example shows how young people with diabetes can express emotional themes related to youth identity, the burden of being young with a chronic illness, and the need to be connected and feel safe through design of prototypes. The new conceptual space that arises from user prototypes shows potential for addressing emotions when designing for health and for further development of the technique user prototypes.

Key words: user prototypes, partly unconscious communication, generative design tools, young people, diabetes, mobile learning technology.

1. Introduction

This paper contributes to the user-based approach in the field of design and emotions by giving an example of how users can express their feelings and aspiration through materializing their dreams and ideas for technology design with an appropriate technique. Following Sanders, we wish to contribute to the development of “generative design tools” [1]. We propose to explore users' emotions early in the design phase with the technique of user prototypes.

Prototypes are “learning vehicles” in the design processes [2]. Prototypes are “external manifestations of thought” [3]. Prototypes support reflections – make “the world talk back to us” [4]. Prototypes are the designer's tool for communicating with the materials and with the practice they are designing for. Prototypes are central for co-design: The designer can communicate with the prototype and “the world” – users can talk back, respond, react or co-operate depending on perspectives and circumstances for the design process (see [3,5-8] as examples of reflections on prototyping and co-design).

But prototypes, if designed by users, can also be used to support users' expressions of inner thoughts and emotions. In this paper, we present how we worked with prototypes created by users to express their dreams and ideas. We call them “user prototypes” and based on our results with the technique, we present a definition of user prototypes as “partly unconscious communication” inspired by Bateson's writings on communication through art

and the insights we have got from working with user prototypes [9]. In particular, when designing for the health domain, we consider user prototypes as a powerful tool for users to express their thoughts and emotions related to life with illness.

We have worked with user prototypes in several design research projects, which have all contributed to the forming of our understanding of this technique. In this paper we have selected one research project to illustrate how to support user prototyping and analysis of user prototypes. The research concerns the design of mobile learning tools for children and adolescents with the chronic illness diabetes. First, we present our perspective and definition of user prototypes as partly unconscious communication. Secondly, we present the research project and the work with facilitating and analyzing user prototypes. Thirdly, we discuss user prototypes as a technique. The paper concludes with central points for user prototypes.

2. User prototypes as partly unconscious communication

Prototypes can have various forms and shapes from sketches on papers to hi-fi interactive types. Often we see different terms used for these different types of prototypes like sketches [10], mock-ups [7], hi-fi and low-fi prototypes. The difference is not so important for the work presented in this paper. Consequently, we use the term prototype, but emphasize the importance of the incompleteness central to prototypes [3] that supports exploration, communication, and learning. User prototypes have this purpose. We argue that, like designers, users externalize their thoughts in their prototypes. In this sense, we don't work with prototypes as the first (proto) type, but as a particular sort of communication which supports expressions of and insights to inner thoughts and emotions. In order to define this understanding we have found inspiration in Bateson's "Style, Grace and Information in Primitive Art" [9, p.128ff.]. Bateson writes about communication in or through art. In a very inspiring part of the text, he starts by quoting Isadora Duncan for the words: "If I could tell you what it meant there would be no point in dancing it." (Isadora Duncan, quoted by [9, p. 137]). Bateson elaborates: "If the message were the sort of message that could be communicated in words, there would be no point in dancing it, but it is not that sort of message which would be falsified if communicated in words, because the use of words (other than poetry) would imply that this is a fully conscious and voluntary message, and this would be simply untrue. I believe that what Isadora Duncan or any artist is trying to communicate is more like: "This is a particular sort of partly unconscious message. Let us engage in this particular sort of partly unconscious communication" [9, p. 138].

We see user prototypes as a particular sort of partly unconscious communication and call for engaging in this particular sort of communication. We wish to highlight that prototypes are another language than spoken language. In his reflections of art, Bateson continues: "The algorithms of the heart, or, as they say, of the unconscious, are, however, coded and organized in a manner totally different from the algorithms of language" [9, p. 139]. This is especially what we have found as one central insight in our work with user prototypes. User prototypes supports expressions in another type of language and these expressions give insights to emotions that are difficult to express in "the algorithms of language". By facilitating and analyzing user prototypes the designer must engage in this particular sort of communication which is different than the type of communication found in requirements. By engaging in user-prototype-communication the designer get insights of users dreams, fears, motivations – their feelings and emotions. It is this type of insight which must not be mistaken, or taken, for requirements. They are insights to be analyzed and worked on, not requirements to be fulfilled. Thus, understanding and working on insights call for reflections on how to facilitate and analyze this type of

communication. In the following, we present how we have worked with facilitating and analyzing user prototypes, the insights this work has yielded in a concrete design research project, and how these insights can be build upon in follow up design activities.

3. User prototypes on how to support young diabetics with mobile technology

The case chosen for this paper is the design of mobile technology support for children and adolescents with the chronic illness diabetes. Diabetics are confronted and challenged with ongoing daily tasks like regulating the blood sugar, calculating insulin doses or medication, counting carbohydrates in food, logging and monitoring measurements. This is in particular challenging for young diabetics. Their parents and the health care team support young diabetics in these tasks. But they have to and want to take over tasks and responsibility in late childhood. Mobile phones are part of young diabetics' life and identity, like it is for other youth. Additionally, these devices are used to communicate with family members in relation to the management of their diabetes. In our project, we wanted to study on how mobile technology could support the young diabetics in becoming a manager of their diabetes. When designing for the young users research has shown that children can be successfully involved earlier in the co-design of interactive technology, e.g. as users, testers, informants, design partner [11]. Children and teenagers can contribute with their imagination, visions, creativity and expectation in different phases of the design process of technology. In the context of health technology the clinical perspective often dominates the design. Rules and norms based on theories and/or the involvement of stakeholders (clinicians, other health officials or even parents) define how to treat the patient best. Based on that knowledge (hopefully) the patient's perspective influences the design process. Nevertheless, we argue that the additional view of young users should be considered in the design process. We want to contribute with the user prototype method as an example to understand young diabetics' feelings, emotions, dreams but also attitude and fears towards their disease by articulating their vision towards mobile diabetes technology. This challenge brings our point of user prototypes as partly unconscious communication to the very foreground.

3.1. Methods for facilitating user prototypes as partly unconscious communication

We have worked with user prototyping in workshops with plans and materials supporting the process of expression. In the case of design of mobile technology support for young diabetics we facilitated a futuristic and non-constrictive setting for promoting ideas and visions. While the workshop is described in detail in [12], we present the overall realization in this paper. In summary, 12 girls and 12 boys with type-1 diabetes (from ages 10 to 16) designed their own mobile diabetes supporter alone, or in groups of two or three. The workshop was divided in three sessions to create smaller work groups. The workshop realization was divided in two parts a) introduction and contextualization, b) design and discussion.

Part a) Introduction and contextualization

The young diabetics participated in two activities in order to prepare them for the design task. First, they were introduced to four themes important for diabetics: (1) calculation/finding, (2) status/remembering, (3) sharing/cooperation and (4) learning about diabetes, which are. Secondly, they took part in a workshop where the concept of mobility and mobile devices was discussed in order to introduce the diabetics to various aspects concerning design of mobile technology. Already known, used and possible technology in the context of being mobile was discussed by giving thoughts in different directions (e.g. insulin pump, stopwatch, blood glucose meter, stuffed animal). The goal was to show the participants possibilities within an area unknown to some of

them and to give the young designers room for creativity instead of limiting the design of their mobile systems to those functions currently available in PDAs or mobile phones.

Part b) Design and discussion

The task for the diabetic teenager was to design "their own mobile diabetes supporter" by focusing on one of four themes. Therefore, the design part was introduced with the presentation of the four task sheets containing tasks and questions according to a specific theme. The participants were told that they were the designers of future diabetes technology, and they had no restrictions in creating the mobile supporter, its functionalities, or its design. After the participants chose one theme, they received a toolkit, a "creativity pack" (Figure 1a), with different materials, i.e., Polaroid camera, 3D paper prototype of a PDA, a stuffed animal, modeling clay, glue, paper and pens, scissors, prepared stickers as well as blank stickers.



Figure 1. a) Example of a "creativity pack" with different materials, b) young diabetics working on a user prototype

The design activity (Figure 1b) was followed by a presentation and discussion of the results, which were audio recorded. Additionally, the design results were photographed.

3.2. Analyzing user prototypes as unconscious communication

The results of the workshop were 12 user prototypes, which varied in their styles and level of detail (cf. Figure 2-4). The designs ranged from collections of functionalities in brainstorming style (e.g., glued stickers on a paper PDA) to detailed definitions of interfaces (e.g., screen layout, buttons, and lights). We see the design of the young diabetics not only as objects, which we can translate into real design, but rather as designs of expressions articulating expectations and visions for technology support. Therefore, we call for a more analytic perspective on the design results. We invested effort not only in understanding the functionality, which young diabetics want to have for their mobile supporter (the how), but in understanding the purpose of requiring them (the why) - the emotional articulations integrated in the users design language. We examined what the design results can tell us about how the young diabetic copes with being young and diabetic at the same time. We analyzed the results of the user prototypes by looking on the form and functionalities expressed by the young diabetics. Furthermore we analyzed the related talks, which explain the young diabetics' thoughts in design, by using transcripts of the audio records.

4. Results of analyzing user prototypes as insights of partly unconscious communication

The following three themes were found in this analysis:

4.1. Multimembership – diabetes, youth, ...

"I have designed a keychain, a fashionable keychain", describes a 15-year-old girl of her design of a digital food database (Figure 2a). On a functional level, the design highlights the difficulty of accessing food information, since a diabetic has to determine carbohydrates in the food to be able to calculate the appropriate amount of

insulin. But the form the young designer has chosen, expresses also her wish of being young, teenager, fashionable, cool instead of only focusing on the medical aspect in design. The words “LOVE” written on the front side and four buttons on the back and an expandable display to access the database gave insight into how the youth and the diabetes world are overlapping. Also other designs suggested alternative styles by presenting e.g., jewelry as (part of) a medical device (e.g. ring in Figure 2c).

The fashion ideas are quite similar to Pullin’s examples of the need to think of fashion and identity in medical devices. Just like Pulling [13] argues for designing eye-wear and hear-wear (vs. technology for eye and hear impairment), the young diabetics express design for diabetes-wear (vs. technology for diabetes). Diabetes is wrapped in youth design and youth functionality. The ambition is to express youth (vs. express disease) and a pleasure of having a fashionable tool.

None of the participants used the stuffed animals, which were part of the creativity pack (see Figure 1a), in their designs. But two groups mentioned them (in separate sessions) in relation to a younger target group. “It [the mobile supporter] should be small and compact. ... For smaller ones [diabetic kids] we’d choose a stuffed-animal style and for bigger ones [diabetic teenagers] it should be preferable unobtrusive, for example in the belt.” Another group imaged: “A stuffed animal, a kind of crocodile for example and in the inner is a blood glucose meter for the night. ... In that way, they [very young diabetics] can get to love their meter. “, “If it is cozy and fluffy ... And it has to smell good.” The young diabetics aged 10 and older considered themselves no longer as children who would need a stuffed animal. But they imagined how a device can become “alive” by triggering positive emotions through the interpretation of aesthetic experience of a device.



Figure 2. addressing the youth culture: a) keychain “LOVE” containing a food database, b) individual label and brand on an insulin pump device, c) finger ring to inform about the health status

While some designs articulated to focus on the identity as young people by using new forms, others defined it by functionalities. The designs were mainly inspired by the given material (PDA, stickers), introduced mobile technology as well as their own experience with medical and mobile devices. Thus the look of the design resulted in a mix of mobile devices and diabetes technology. A group describes their device: “This is a kind of insulin pump. Not really. This has an integrated mobile phone and here is the stylus and the touch screen.“, while another group called their device a “Mobile-Phone-Insulin-Pump-Organizer-Blood-Glucose-Meter”. Also additional “fun” functionality was added to the “medical” device not having to deal necessarily with diabetes. On the question why they would need the camera a boy answered smiling “To take photos” and added, “It has to be a bit fun, too.”

We conclude that the young diabetics express a dream of being young (vs. being diabetic). Individuality and personality are important in the life of a child or teenager, respectively, and should be addressed in design – also in design of technology for medical purposes. Young people diagnosed with diabetes belong to a youth

community and want to be considered as “normal” teenagers. Thus, there are no sharp boundaries but an overlapping of diabetes and youth. Design that supports this co-existence is desired.

4.2. Make me think less

“In my case she [mother] can see if my values are good or bad. Then she can say. Inject 5 units. (...) Then I do not have to think so much.”, articulated a 12 years old girl about how to interact with her dream supporter.

A strong wish emerging in many designs is the wish of being able to assign their responsibility for the disease. Young diabetics wish to be supported in their everyday diabetes activities and routines. We found three different roles of how mobile systems (or communication possibilities) should support young diabetics acting and wish for less-thinking.

Deliver information: The diabetics require easy information access. Taking the example of food, the determination of carbohydrate in food should become easier. While some seek to have more information about the food, to support the estimation/calculation of food intake, others want to make the task as simple as possible. “Maybe one can take a photo from the food, it can be seen how it looks, it can be weighted from the inner.”, describes the determination food sizes with the help of picture recognition.



Figure 3. a) design with integrated camera to photograph food, b) diversity of support functionality to be integrated in the insulin pump visible in c)

Advisor: Diabetics seek to get support in their decisions in difficult tasks, e.g. for regulating the blood glucose value, which require them to consider different aspects (current and past status, plans for physical activity, food intake).

“With this blood glucose value, you should get to know what is best, what you can eat, what you can do for activities with this blood glucose value.”, “If you have for example high blood sugar, it should suggest how long you can do what [kind of activity], in order to make the value goes down to a level which is perfect.” A girl presented the features of her groups’ mobile device explained: “... And we put many question marks on it. If there is an emergency and we don’t know what to do, we want to ask the computer what to do ...” The workshop supervisor asked if the computer should answer the questions or if they would use the computer to communicate with somebody else to get an answer on the question. The girl replied: “The computer should answer these questions; that is what it is after all for.”

The young diabetics do not only have high expectations in what technology can accomplish; their trust in information from others seems to be high as well. A group suggested contacting diabetics in order to get help in an urgent question via chat. Asking the presenter of this idea how she would choose the other diabetics, she answered with: “Well. First, I would ask what experience this person has. This is somehow important.”

Executor: Designs suggest a full-automated device, which should eliminate the need for active participation of the diabetic. Some young diabetics would like to have an automated regulation conducted by a machine. “The

device should also recognize and report immediately low and high blood sugar values.”, “We decided that we wanted the blood sugar value be automatically adjusted.” This would avoid that young diabetics had to think and act at all in relation to specific activities, i.e. measuring the blood glucose value, adapting insulin autonomously. The young diabetics have high expectations in what technology should accomplish and seems to consider technology as trustworthy and able to help them in the right situations.

We conclude that young diabetics expressed the burden they feel having to cope with the disease in their design. Underlying much of the diabetics’ thinking is the wish that technology substitutes or connects the young diabetic to instant information, which lightens their load as a diabetic, or even allows them to avoid being confronted with the disease. Ideally, they want the mobile device to be the disease manager. But facing the reality, diabetes is too complex a disease to be possible to rely on a device, without thinking. Existing technology, which can already ease or automate routines, e.g. continuous blood glucose meter or advisory systems [14], can only remove part of the burden. It still requires young diabetics to gradually take over more and more responsibility [15] to be able to manage on their own. Design that support this responsibility, but at the same time acknowledges the strain of the disease and the wish to reduce the burden is important.

4.3. Feel connected

In 10 of 12 designs different forms of sharing diabetes were suggested. Young diabetics want to... “be connected with physician, diabetic friends or other important friends and family.“ Many designs express the wish to get support to master the challenging day-to-day routines, but also the feeling of security and sharing with peers is important.



Figure 4. feel connected and safe: a) jewelry set to share health information with parents and to network with others, b) sharing their diabetes with family members and peers, c) emergency button in the medical device

Make me feel safe vs. Surveillance: There is a high interest (articulated in seven designs) in having emergency functionality (e.g., urgent buttons, automated notification of others) in the mobile device. “It should have a function, if you have not been in touch for a longer time. If you e.g. collapsed and nobody has seen it, that it (...) should immediately call, to report somebody.” Systems should enable the transfer of low glucose values and positioning functionality to inform health care personal or parents. This addresses the fear of being helpless caused by the general problematic of low awareness and knowledge about diabetes in society. Kids know about this and fear that nobody could help them when needed. A backup system should assure help and creates emotional hold in emergency situations. Feeling secured is not only an issue for diabetics, but also for their parents. The children know their parents would like to know about how and where they are. Therefore, they feel responsible to calm them by actively or passively informing them about their status: “that one can send sms or

mms. For example to the parents, to report how one is, what one is doing at the moment, and that they do not have to worry. “, “They should know it [blood glucose values], but they don’t have to help me.”

Nevertheless, accessing a diabetic’s data brings up issues of privacy. While some young diabetics request permanent control and support from their parents, others diabetics (we assume those more mature and responsible for themselves) want to have only a shared care, in case of an emergency and want switch off function, to decide which private data accessible to others.

Networking: The diabetics wish to stay in contact with other diabetics facing the same problems and struggles e.g., to share their experiences and ideas while being mobile. They are looking for common social communication technologies (i.e., Internet forum, chat, social mobile networks) in order to come in contact (virtual or personal on the street). “I can find other people with diabetes. [...] Maybe all of them have such a finger ring and then I can find others, which have the same like me”.

We conclude that being connected is central to feeling safe but also to feeling connected and included in society in general. As described by Preece, networking is crucial for what she refers to as “emphatic communication” where people comfort and support each other in their daily living with illness. It makes them feel connected (vs. alone). Connectivity is in general quite different from traditional medical ideals of diabetes as *self*-management. But designing for connectivity is important to support inclusiveness of diabetics in society or community.

4.4. Summing up – Emerging themes and designs

In sum the analysis for our design case points towards the following emerging themes and principles:

- Identity: Youth technology with diabetes functionality: Designing for young diabetics means to focus rather on diabetic youth, then on young diabetics, to consider emotional aspects in technology support.
- Burden: Lightening the load: Designing for young diabetics means reducing the load lying on the diabetic day-by-day so they feel more comfortable and less confronted with the disease.
- Connectivity: Possibilities to connect: Designing for young diabetics means focusing on individual diabetics as well as their surroundings to enable connections to others to get help, to share, to cooperate with or to learn from.

In the case of design of mobile technology support for young diabetics, we have worked with the emerging themes and principles in the following way: the aim was to design learning tools to support the young diabetics in learning to become self-managers. We worked deliberately not only on pedagogical and medical factors but emphasized the emotional themes expressed by the young diabetics in the design.

Table 1. Three themes translated to the design of learning technology

Identity	Burden	Connectivity
<ul style="list-style-type: none"> • in the choice of mobile technology as platform for the design • the design of stories aiming to match the universe of the young diabetics 	<ul style="list-style-type: none"> • mobile games to wrap up the clinical learning tasks in a game universe • reduce the load by empowering through the creation of learning experiences in contrast to traditional learning material and teaching practices 	<ul style="list-style-type: none"> • designing collaborative learning tools supporting co-solving of tasks to promote sharing and discussion • promote competition to connect and motivate in learning

In Table 1 we describe how we applied the three themes in the design of learning technology. Based on these implications and additional use of further participatory design methods, we designed two different learning tools

for young diabetics: (1) The dragon quest - a mobile game designed for a diabetes summer camp setting, not only focusing on diabetes learning content, but also on being active and exploring the field in pairs framed by a story about a dragon to be helped. (2) A food quiz as a collection of mini games to compete against each others “sweet” monster by solving carbohydrate counting tasks. A more detailed description of the prototypes is given in [16], [17].

While our design domain is within the field of learning, the results of the user prototypes and the proposed design principled might also influence other design domains, e.g. supportive tools and product design. Existing products available for diabetics often have a medical focus [14]. Different colors to choose from or stickers offered for youth to customize their medical devices is in our view only a small step from medical thinking towards design thinking. Bringing together designers and medical engineers could lead to products which focus on design for co-existence of identity and illness, burden and responsibility and self-management and connectivity.

6. Conclusions

When Isadora Duncan was communicating by dancing, it was her “language”, a skill she had learned and mastered to a level making her able to express things she could not communicate with words [9]. When we facilitate users in making prototypes, we, as designers, ask them to use an unfamiliar language. Prototypes are “design-thinking enablers deeply embedded an immersed in design practice” [3]. We, as designers, master this language. Users do not. We ask them to use our language, a design language, to work with materials at hand, within a solution space and we force them to externalize their ideas, dreams, visions, and fears. In other words, we force them to stand out in the world (us) and hear the world talk back to them. However, we have found the insight generated via user prototypes so valuable that we call for further research on how to improve this technique toward the support of user expressions. The research project chosen for this paper shows the value of the technique: the insights found in the young participants prototypes are insights to their feelings, “algorithms of the heart” rather than “algorithms of language” [8, p.139]. The insights are deep and not to be mistaken for requirements. They are to be understood as motives, desires, feelings, and dreams.

We presented in this paper the technique user prototypes and a concrete example on how this technique influenced design. The design of mobile learning technology supporting young diabetics should address themes of identity, the burden of being young with a chronic illness and the need to be connected and feeling safe. The new conceptual spaces that arise from the use of user prototypes are interesting also for other design domains. They point towards a potential for addressing emotions when designing for health and for further development of the technique of user prototypes.

7. Acknowledgement

We thank our colleague Ann Bygholm for pointing us towards Bateson’s writings on partly unconscious communication. Thanks to the health care and organization team of the summer camp enabling research in the camp and to all young diabetics who participated in the study to date.

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