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Statement by Author

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I hereby declare that I am the sole author of this thesis, that I have completely indicated all sources and help used, and that all parts of this work - including tables, maps and figures - if taken from other works or from the internet, whether copied literally or by sense, have been labeled including a citation of the source.

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Abstract

This thesis has its focus on self-injurious behavior and patients with Borderline Personality Disorder, whereas a concept for a Smartphone app to support therapists in their work with Borderline patients is developed. First of all, a comprehensive review of literature is performed. Subsequently, requirements from psychologists, psychotherapists, psychiatrists and researchers are elicited and analyzed. To that extent, 18 experts in the fields of self-injurious behavior and Borderline Personality Disorder who reside in Austria, Germany and the US are interviewed with respect to desired requirements for a supporting App. The latter is delivered as an Android prototype. Interviews are planned and analyzed based on the concept of Grounded Theory Methodology and the IKIWISI approach.

The prototype employs the Dialectical Behavior Therapy (DBT) with a core focus on skills and skills-training. The majority of the interview partners found such an app useful. The high level of detail in documenting self-injurious acts might, however, further support / reinforce a patient's dysfunctional behavior. Besides the importance of data privacy and security as well as prevention of third party access, a motivational or rewarding system was positioned as a key acceptance factor for the app. Furthermore, context-sensitive interventions being adapted to one's respective level of tension, regular reminders prompting the user to rate their tension throughout the day and individual handling of the app and its therapeutic contents are warranted. A close interdisciplinary cooperation is pivotal when embedding the app within the therapeutic process to enable mutual support. How a patient's overall state of mind affects acceptance of the app and how it may best communicate motivation and positive reinforcement are due for further investigation.

Keywords

Nonsuicidal self-injury, Borderline Personality Disorder, Dialectical Behavior Therapy, Requirements Engineering, Android development, Grounded Theory methodology, psychology, medical informatics.

Kurzfassung

In der vorliegenden Arbeit wird der Themenbereich der Selbstverletzungen bei Borderline-Patienten fokussiert und ein Konzept für eine Smartphone App entworfen, das Therapeuten in ihrer Arbeit mit Borderline-Patienten unterstützt. Zunächst werden neben umfangreichen Literaturrecherchen Anforderungen von Psychologen, Psychotherapeuten, Psychiatern und Wissenschaftlern erfasst und analysiert. Dabei wurden 18 Experten auf dem Gebiet von selbstverletzendem Verhalten und Borderline Persönlichkeitsstörung aus Österreich, Deutschland und den USA hinsichtlich konkreter Anforderungen an eine unterstützende App befragt, die als Android-Prototyp umgesetzt wurde. Interviews wurden nach dem Konzept der Grounded Theory Methodologie und dem IKIWISI Vorgehen geplant und analysiert.

Der Prototyp orientiert sich an der Dialektisch Behavioralen Therapie (DBT) mit dem Fokus auf der Vermittlung und Provokation von Skills und Skills-Training. Die Mehrheit der Interviewpartner empfand das App-Konzept als sinnvoll und nützlich. Eine zu detaillierte Dokumentation der Selbstverletzung könnte jedoch dazu führen, dass dysfunktionales Verhalten von Patienten sogar unterstützt / verstärkt wird. Neben Datenschutz und Datensicherheit ist auch der Einsatz eines motivationalen Systems von Bedeutung, um Akzeptanz und Verwendung der App zu forcieren. Desweiteren werden kontext-sensitive Interventionen auf Basis von Spannungsleveln, kontinuierliche Spannungsabfragen sowie die individuelle Anpassung der App gefordert. Für eine sinnhafte Einbindung der App in den Therapieprozess ist eine interdisziplinäre Zusammenarbeit unabdingbar. Zukünftige Untersuchungen sollen zeigen, wie sich das konkrete Befinden des Patienten auf die Motivation, die vorgestellte App zu verwenden, auswirkt und inwieweit diese App positiv verstärkend eingesetzt werden kann.

Schlüsselwörter

Nicht-suizidales selbstverletzendes Verhalten, Borderline Persönlichkeitsstörung, Dialektisch Behaviorale Therapie, Anforderungsanalyse, Android Entwicklung, Grounded Theory Methodologie, Psychologie, medizinische Informatik.

Contents

1 Introduction

"Then at one point I did not need to translate the notes; they went directly to my hands."

— Francesca Woodman (1976), *Photography*

> *There are a lot of patients, who want to see blood, see red, and want to see their own blood. There is a calming effect to that once they see their own blood [...] They can only say for themselves they are alive, if they see their blood pouring out of them. Otherwise they often believe, they are dead inside and they are sure of being dead already. Then there is no better proof for them than to see blood flowing and that's why they do it [note: self-injure].*
> *(Ms. I)*

Ms. I is only one of the experts on self-injury and Borderline Personality Disorder who were interviewed during this project. In her quote above, she talks about a very important part of self-injury, namely the function of it: self-regulation or the endeavor to feel alive and feel oneself again. It is an attempt to explain a phenomenon which is hard to comprehend. It is hard to comprehend because it is really scary if one is faced with self-injury in any way. Maybe even harder to comprehend because self-injury regardless of its negative and destructive consequences does in fact serve a positive effect. Thus, self-injury is borderline (note: the adjective, not the disorder).

1.1 Background information

Self-injurious or self-destructive behavior occurs in a variety of forms and functions. In a broad sense of view, each behavior not doing one's own health any good in the long run, be it of either physical or psychological relevance, can be seen as self-destructive behavior (Muehlenkamp et al., 2012). This includes, amongst others, use of tobacco, alcohol, other drugs, engaging in bulimia, eating junk food, or even something simple as procrastination. In principle, these acts are known as unhealthy or self-defeating behavioral patterns (Twenge, Catanese, and Baumeister, 2002) and are not uncommon in our society. Nock (2010) classifies these actions as indirectly harmful behaviors. Although some forms do not conflict with societal norms, nonetheless, they take their toll on a human's well-being.
A more direct and specific form of self-harmful behavior is called nonsuicidal self-injury (NSSI). NSSI or self-injurious behavior (SIB) - these terms are often used alike - is a behavior where wounds are deliberately inflicted upon oneself to bring about tissue damage, but, also to alleviate distress, to obtain some sense of contentment and peace (Whitlock, Eckenrode, and Silverman, 2006).
A vital characteristic of NSSI is the absence of any suicidal intent (Hilt et al., 2008). Self-injurious behavior per se is said to be a typical symptom of people with Borderline Personality Disorder, whereas suicidality is not always out of the question. About 70% to 80% of Borderline patients are said to have engaged in self-harming behavior, whereas the prevalence of Borderline Personality Disorder in the general population is reported to be about 1.2% (Bohus, 2002). It is, though, not the case that every person who self-injures is diagnosed with Borderline (Whitlock, Eckenrode, and Silverman, 2006).

Therapeutic approaches to deal with self-injurious behavior do exist. One of the most prominent therapies to treat self-harm and especially Borderline Personality Disorder is dialectical behavior therapy (Whitlock, 2010; Bohus, 2002). In there, people go through some kind of a manualized structure during single therapy and group sessions, where they build coping skills, fill out protocols to detail their "state of health" / their feelings in order to learn to understand what triggers their individual problematic behaviors, what self-harm (in any context) does to them, what they could do to prevent that from happening (Bohus, 2002). These protocols are however mostly based on paper.

1.2 Problem description

Up to this point and to the best knowledge of the author, there are no valid electronic journals existent in order to document behavioral analyses and employ monitoring processes. Especially mobile applications which may provide context- and situation-sensitive interaction with the patients during times of high tension are rare, if not at all, lacking.
Both, patients and therapists, who work in behavior therapy, are used to work with these so-called diary cards, but then again, the problem with paper protocols is that they may not be as accurate as electronic journals to support therapeutic workflows:
Paper journals are somewhat all-rounders since they can capture highly varying information such as mood or behavior. One can enter data into so-called paper-and-pencil diaries at all time. This delivers the advantage of capturing over-time changes in behavior, but also is inherent to disadvantages. For instance, behavior dated past today's date, respectively, prior today's date can be entered amass at once (Shiffman, Stone, and Hufford, 2008). Thus, it does not deliver the kind of momentary assessment as anticipated in the first place. Furthermore, research (Bradburn, Rips, and Shevell, 1987) states that the assessment of a person's behavior over time based on sole memory is prone to a recall bias and may not adequately reflect actual behavior, but rather deliver averaged information. Hence, neither paper-and-pencil diaries (Shiffman, Stone, and Hufford, 2008), nor relying on a person's memories about recent activities (Bradburn, Rips, and Shevell, 1987) can sufficiently reflect behavioral patterns over time.

1.3 Aim

The aim of this project is to perform an initial step to apply well-known and commonly used paper diary cards to modern media like smartphones. It strives to design a mobile application that captures behavioral patterns of self-injury, provides quasi real-time data to therapists, and which tries to interact with the patients according to their need.

It is clearly stated, however, that this thesis centers upon deriving software requirements from experts in the field of NSSI and Borderline Personality Disorder (psychologists, psychotherapists, psychiatrists and researchers) by conducting face-to-face interviews and subsequently on designing the mobile diary-like application. The actual development of a fully-functional framework can not be in focus due to time and work effort of the project's center piece. Nonetheless, a prototypical implementation with the Android SDK is built alongside the engineering and analysis process in order to ease conversation and to support a common understanding between the stakeholders.

1.4 Motivation

Capturing varying information on paper seems to be obsolete since most aspects of our lives are handled via smartphones, nowadays. Hence, the motivation for doing this thesis lies in paving the way for making this transformation (from paper to electronic journals) in the bigger context

of Borderline Personality Disorder and self-injury happening. In particular, disadvantages of paper-and-pencil diaries ought to be tackled. It is likely that a mobile electronic NSSI / Borderline journal, which meets elicited requirements of above mentioned experts in respective area, may support therapeutic work. For starters, it could offer insights into their patients' "behavioral trajectories" which occur in-between scheduled sessions over time. At its best, using such an application in therapy may even prepare patients for behavioral change. In the author's humble opinion, it may represent a way to increase their level of empowerment and self-reflection or simply to help them learn to better understand their individual situation. Thereby, pitfalls of falsifiable paper-and-pencil diaries (Shiffman, Stone, and Hufford, 2008) as well as error-prone memory recalls (Bradburn, Rips, and Shevell, 1987) may be overcome, if not, completely avoided.

This project is also an attempt to "open" or cultivate a channel for interdisciplinary communication and collaboration between the fields of psychology and computer science. In the author's opinion, both areas profit by one another's expertise at great length and collaboration may positively impact the outcome of future research, clinical work or other applications with the human being in focus.

1.5 Structure

The remainder of this thesis is structured as follows.

Chapter 2 *"Behavioral patterns"* introduces the reader into the problem domain at hand, namely, non-suicidal self-injury. Additionally, ecological momentary assessment as well as current efforts on how to motivate behavioral change are discussed.

Chapter 3 *"Mobile information technology in healthcare"* covers, but is not necessarily limited to, definition and terminology of mobile health technology, as well as limitations of applications thereof and outlines current research trends.

Chapter 4 *"Empirical research"* delineates sociological aspects. An overview about how to perform empirical research and a more detailed insight into doing qualitative interviews is given.

Chapter 5 *"Requirements Engineering (RE)"* discusses software engineering methodologies, whereas a particular focus is set on the Requirements Engineering process and its different stages. The last part discusses in what ways and to what effects empirical research, compare Chapter 4, and Requirements Engineering intertwine. Thus, Chapters 2, 3, 4 and 5 introduce the theoretical background for this thesis.

Chapter 6 *"Qualitative interviewing"* represents the actual formal empirical research as in face-to-face expert interviews being conducted and concludes with an initial analysis of respondents' feedback.

Chapter 7 *"Results"* The entire empirical phase of the project is covered in this chapter in detail. Conforming to the four stages the interview process is organized in, results are presented in their corresponding section:
Section 7.1 "Results - Pilot and Rounds I" will focus on illustrating first results from pilot phase and interview rounds I.
Section 7.2 "Results - Rounds II" will outline the development of these results after talking to experts and analyzing their interviews.
Section 7.3 "Results - Rounds III" will present a software requirements specification, final requirements after their evolution and refinement from interview rounds I and rounds II up to rounds III after a thorough analyzing process.
Section 7.4 "Details of design and implementation" illustrates usability and non-functional

requirements and Use Cases, which are given in natural language as well as modeled via UML. This section also elaborates on design aspects of the monitoring smartphone application, such as architecture, technological framework and network communication.

Chapter 8 *"Discussion"* concludes this thesis with a discussion of the actual thesis outcome as well as an outline of future directions and research based on the project's scope.

This chapter was to give a brief introduction to the problem description of self-harmful behavior and the lack of existing tools to continuously monitor its progress. Furthermore, motivation and aim for this project was outlined, while the reader was given an overview of what each thesis chapter is dealing with.

2 Behavioral patterns

"I could no longer play I could not play by instinct."

— Francesca Woodman (1976), *Photography, Providence, Rhode Island*

This part serves as a detailed insight into non-suicidal self-injury, starting with its definition, to representing some available statistics, functions and triggers of the "disease", summarizing who is affected by it in most cases towards illustrating the importance of assessment and briefly describing several treatment strategies. Subsequently, the implications on being diagnosed a Borderline patient are illustrated, as well as its interplay with nonsuicidal self-injury and a specific treatment plan is presented. Then, ecological momentary assessment and its association with NSSI is argued, while an outline of motivating behavior change concludes this chapter for the interested reader.

2.1 Nonsuicidal self-injury

Terminology describing self-harm, self-injurious or self-destructive behavior does differ among researchers in the field. A classification was aimed at by Nock (2010) who divided the general term of self-harm into two subcategories, namely direct and indirect self-harm. The general distinction focuses on the form of self-harm to take place. Indirect self-harm might go as far as to say that an eventual destruction of body tissue was not intended, a deliberate harm of the very own body could not have been anticipated. Indirect self-harming behaviors include smoking, taking drugs, bulimia and the like. While these are assumed to be less acute, direct self-injury means that a person "attacks" himself on purpose.

2.1.1 Definition

Klonsky et al. (2011, p. 6) define NSSI as a method to deliberately destruct and harm one's own healthy body tissue without any suicidal intent. So-called classic techniques involve cutting, carving, inserting objects under the skin, burning onself, picking at wounds, or pulling out hair, whereas rates of occurrence are severely differing in-between these methods (Klonsky et al., 2011; Nock, 2010; Kool, Van Meijel, and Bosman, 2009). Needless to say, tattooing or piercing - though somewhat reflecting the very definition of NSSI just given above - are not classified as forms of NSSI due to the fact that they are "culturally or socially sanctioned and acceptable" (Klonsky et al., 2011, p. 7). Although alternative terms, such as self-mutilation, deliberate self-harm (DSH), parasuicide, wrist cutting, self-abuse or self-inflicted violence are out there, they do differ compared to NSSI in terms of certain characteristics (Klonsky et al., 2011). For instance, one of the major differences between DSH and NSSI is the aspect of whether suicidal attempt is present or lacking (Muehlenkamp et al., 2012). Thus, suicidal attempts are not necessarily absent among people engaging in DSH.

2.1.2 Facts and figures

The Centers for Disease Control and Prevention (CDC), respectively, the National Center for Injury Prevention and Control (NCIPC) offer WISQARS™ (CDC, 2011) - an acronym for *Web-based injury statistics query and reporting system* - in order to report data upon self-inflicted injuries, among others. Self harm ranks up high among top 10 lists of causes of nonfatal injury

covering the United States in 2000. For instance, among age groups 15–19, 25–34, 35–44, 45–54, 55-64, as well as 65+ self harm via poisoning is reported the second-leading cause of nonfatal injury. Interestingly, self harm via cutting/piercing is almost uniformly ranked after poisoning as weapon of choice as well as distributed among all age groups starting at 14. For detailed information among prevalence and distribution see Figure 2.1.

NCIPC Home | WISQARS Home | Help | Contact Us

10 Leading Causes of Nonfatal Violence-Related Injury, United States

2000[1], All Races, Both Sexes, Disposition: All Cases

To obtain the percentage of all injuries by cause, select the age group category at the top of each column.

Rank	Age Groups											
	<1	1-4	5-9	10-14	15-19	20-24	25-34	35-44	45-54	55-64	65+	All Ages
1	Other Assault[A] Struck by/ Again 2,821	Other Assault[A] Struck by/ Again 18,777	Other Assault[A] Struck by/ Again 49,635*	Other Assault[A] Struck by/ Again 101,818	Other Assault[A] Struck by/ Again 213,404	Other Assault[A] Struck by/ Again 217,515	Other Assault[A] Struck by/ Again 295,879	Other Assault[A] Struck by/ Again 240,276	Other Assault[A] Struck by/ Again 104,493	Other Assault[A] Struck by/ Again 29,436	Other Assault[A] Struck by/ Again 19,722	Other Assault[A] Struck by/ Again 1,294,597
2	Other Assault[A] Fall 784*	Sexual Assault 10,172	Sexual Assault 9,440	Sexual Assault 9,122	Self-harm Poisoning 34,549	Other Assault[A] Cut/Pierce 25,348	Self-harm Poisoning 40,603	Self-harm Poisoning 39,183	Self-harm Poisoning 17,991	Self-harm Poisoning 4,180	Self-harm Poisoning 2,465	Self-harm Poisoning 170,243
3	Other Assault[A] Other Bite/ Stin 471*	Other Assault[A] Other Bite/ Stin 1,735	Other Assault[A] Other Bite/ Stin 2,987*	Self-harm Poisoning 8,259	Other Assault[A] Cut/Pierce 22,373*	Self-harm Poisoning 22,943	Other Assault[A] Cut/Pierce 30,557	Other Assault[A] Cut/Pierce 22,975	Other Assault[A] Cut/Pierce 8,371	Other Assault[A] Cut/Pierce 2,402*	Self-harm Cut/Pierce 1,215*	Other Assault[A] Cut/Pierce 122,080
4	Other Assault[A] Fire/Burn 229*	Other Assault[A] Fire/Burn 1,333*	Other Assault[A] Fall 2,458*	Other Assault[A] Cut/Pierce 5,790*	Self-harm Cut/Pierce 12,767	Self-harm Cut/Pierce 15,126	Self-harm Cut/Pierce 14,589	Self-harm Cut/Pierce 14,082	Other Assault[A] Other Bite/ Stin 3,986	Other Assault[A] Other Bite/ Stin 1,193*	Other Assault[A] Fall 746*	Self-harm Cut/Pierce 65,256
5	Other Assault[A] Natural/ Environ 210*	Other Assault[A] Cut/Pierce 1,111*	Other Assault[A] Cut/Pierce 2,118*	Self-harm Cut/Pierce 3,815	Sexual Assault 11,253	Other Assault[A] Firearm Gunshot 13,249*	Other Assault[A] Firearm Gunshot 13,272	Legal Int. Struck by/ Against 11,063	Self-harm Cut/Pierce 3,201	Other Assault[A] Fall 965*	Other Assault[A] Cut/Pierce 610*	Sexual Assault 63,984
6	Sexual Assault 189*	Other Assault[A] Overexertion 938*	Other Assault[A] Unknown/ Unspeci 1,005*	Other Assault[A] Other Bite/ Stin 3,278	Other Assault[A] Firearm Gunshot 10,630*	Other Assault[A] Other Bite/ Stin 8,702	Other Assault[A] Other Bite/ Stin 12,486	Other Assault[A] Other Bite/ Stin 9,949	Legal Int. Struck by/ Against 2,818*	Other Assault[A] Pedestrian 920*	Other Assault[A] Other Bite/ Stin 547*	Other Assault[A] Other Bite/ Stin 52,141
7	Other Assault[A] MV-Occupant 53*	Other Assault[A] Unknown/ Unspeci 921*	Other Assault[A] Overexertion 643*	Other Assault[A] Fall 1,706*	Other Assault[A] Other Bite/ Stin 6,807	Sexual Assault 8,048*	Legal Int. Struck by/ Against 10,923	Other Assault[A] Firearm Gunshot 7,621	Other Assault[A] Overexertion 2,418*	Legal Int. Struck by/ Against 503*	Other Assault[A] Firearm Gunshot 547*	Other Assault[A] Firearm Gunshot 48,570
8	Other Assault[A] Overexertion 24*	Other Assault[A] Firearm Gunshot 318*	Other Assault[A] Fire/Burn 457*	Other Assault[A] Unknown/ Unspeci 1,327*	Legal Int. Struck by/ Against 4,909*	Legal Int. Struck by/ Against 6,145	Sexual Assault 9,301	Sexual Assault 4,095	Other Assault[A] Fall 2,111*	Self-harm Cut/Pierce 440*	Self-harm Firearm Gunshot 315*	Legal Int. Struck by/ Against 37,350
9	Other Assault[A] Unknown/ Unspeci 24*	Other Assault[A] Pedal Cyclist 273*	Other Assault[A] Pedestrian 315*	Other Assault[A] Overexertion 1,246*	Other Assault[A] Overexertion 2,602	Other Assault[A] Overexertion 3,265	Other Assault[A] Overexertion 7,476	Other Assault[A] Fall 3,385	Other Assault[A] Firearm Gunshot 2,098*	Self-harm Firearm Gunshot 428*	Three Tied 240*	Other Assault[A] Overexertion 21,657
10	Four Tied 19*	Other Assault[A] Inhalation/ Suff 239*	Legal Int. Fire/Burn 296*	Other Assault[A] BB/Pellet Gunsh 1,245*	Other Assault[A] BB/Pellet Gunsh 1,954*	Self-harm Other Specified 2,922*	Other Assault[A] Fall 4,106	Other Assault[A] Overexertion 2,825	Sexual Assault 1,946*	Self-harm Struck by/ Against 372*	Three Tied 240*	Other Assault[A] Fall 20,215

Figure 2.1: Ten leading causes of nonfatal violence-related injury among age cohorts in the United States from 2000 are shown. Cell items marked with an *A* in the upper right corner mark categories that are not classified as sexual assaults. Figure generated via and taken from NCIPC (2010).

Average prevalence rates were calculated upon literature review in the field of NSSI and DSH considering USA as well as numerous European countries (Muehlenkamp et al., 2012), as is illustrated in Figure 2.2.

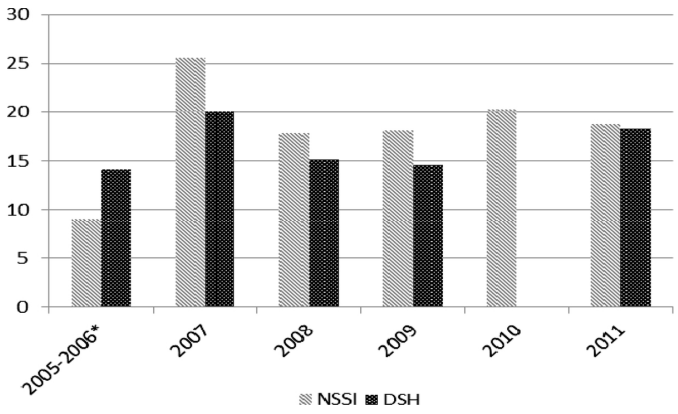

Figure 2.2: This diagram shows calculated annual prevalence rates from a period of 2005–2011 with respect to NSSI and DSH among the United States as well as European countries based on literature reviews. Figure taken and adapted from Muehlenkamp et al. (2012, p.6).

A high increase of NSSI in the period of 2005 / 2006-2007 is shown in Figure 2.2, subsequently the rates of NSSI as well as DSH are somewhat fluctuating, but do not reflect any further significantly increasing trends (Muehlenkamp et al., 2012).

2.1.3 Functions and triggering factors

There has been some research as to why people engage in NSSI and as to what functions NSSI acts fulfill for the persons themselves, meaning what effect does engaging in a self-injurious behavior have in store for a person. Nock (2010, p. 349) suggests a functional model which is based on four columns, respectively, "reinforcement processes". Latter processes comprise either positive or negative characteristics and serve either intrapersonal or interpersonal functions. For instance, an intrapersonal positive reinforcement could reflect a positive feeling, such as satisfaction, after acting in a self-harmful way. Ironically, feeling pain also serves as an intrapersonal positive stimulus (Hilt et al., 2008). Generally, intrapersonal reinforcement is only concerned about the occurrence of a feeling regarding oneself, be it of either positive or negative nature. A negative reinforcement of the same - the intrapersonal - category might be classified as a relief of tension, despair, madness et cetera (Nock, 2010). Getting someone's attention due to "showing off" NSSI is classified as an interpersonal positive reinforcement. Thus, intrapersonal types put the concern on oneself, while interpersonal types rather deal with social interaction and one's environment. The interested reader is referred to Nock (2010) for details on the aforementioned model.

Table 2.1 shows a few triggering factors known to be associated with NSSI. The data shown mainly refer to Klonsky et al. (2011), unless specifically cited.

factor	type	
	trigger	*function*
self-punishment[1]	✗	✗
high level of negative emotion	✗	
"lack of connection"[2]	✗	
"existence of a very close connection"[3]	✗	
self-derogation, lack of self-worth, and self-esteem	✗	
self-hatred	✗	
way of coping with distress		✗
social signaling[4]		✗
emotion regulation		✗
poorly developed verbal communication skills		✗
physical abuse during childhood	✗	
abuse (alcohol, other drugs, etc.)	✗	

Table 2.1: Factors triggering and working as a function of NSSI. Order of appearance does not reflect any ranking with respect to occurrence and the list, as such, is not exhaustive.

On a sidemark, it can be mentioned, that higher thresholds of pain have been found compared to non-injurious populations which is explained by habituation (Ludäscher et al., 2009) as cited by Groschwitz and Plener (2012).
It can be pointed out that NSSI co-occurs with several mental disorders, e.g. Borderline Personality Disorder (Klonsky et al., 2011), depression or posttraumatic stress disorder (PTSD) (Guertin, Lloyd-Richardson, and Spirito, 2001). In this case NSSI, rather, is a comorbidity than a behavior to be considered in an isolated fashion. In psychotic disorders, self-injury occurs in its likely most severe forms, more commonly entitled as *self-multilation*, such as single-episode

[1] (Nock, 2010)
[2] (Kool, Van Meijel, and Bosman, 2009, p. 27)
[3] (Kool, Van Meijel, and Bosman, 2009, p. 27)
[4] (Nock, 2010)

castration, eye enucleation, amputation and the like (Large et al., 2009; Nock, 2010). These highly destructive and life-threatening forms are out of the scope of this project. However, this project will evolve in a way that NSSI be considered in the context of Borderline Personality Disorder which is why its association with BPD will be delineated in Section 2.2 of this chapter. Additionally, drug or alcohol abuse and eating disorders are likely to be concomitant factors serving the same purpose as NSSI (Nock, 2010). On taking this issue even further, alcohol and other substances are risk factors that make suicidal behaviors in general, thus, also acting upon NSSI, in particular, even more feasible (Hufford, 2001). However, there is a chance of getting NSSI mistaken with Obsessive-Compulsive Disorder or Body Dismorphic Disorder. While showing similar characteristics, underlying factors triggering aforementioned behavioral patterns do not align (Klonsky et al., 2011).

2.1.4 Susceptibility

Controversial findings have been brought up with respect to gender differences. While some studies stated higher NSSI prevalence rates among females (Ross and Heath, 2002), others do not confirm these results (Hilt et al., 2008). However, there is evidence that males and females differ in terms of type of self-injury engaged in. For instance, men are more likely to engage in self-battery (Whitlock, Eckenrode, and Silverman, 2006), that is (Skegg, 2005) self-hitting, head/fist banging against something, pinching. In addition, originating from the same study word is that the body spot being "worked on" is gender-related (Whitlock, Eckenrode, and Silverman, 2006), while function and frequency still lack substantial research efforts (Klonsky et al., 2011). Dominant occurrence of NSSI among ethnic groups has not been extensively studied, to date. Mixed results as well as no evidence thereof, compare (Hilt et al., 2008), are reported. Interested readers are referred to Klonsky et al. (2011) for an overview pointing to further sources.

Despite of indications that acting upon NSSI began in early childhood (Yates, Carlson, and B. 2008), particularly, below 10 years of age, average reported age of onset ranges in an interval of 12 - 16 years (Ross and Heath, 2002; Whitlock, Eckenrode, and Silverman, 2006). It is pointed out that rates among adolescents engaging in NSSI are way higher than in adults (Nock, 2010). Interestingly, Klonsky et al. (2011) mention - supported by evidence of other sources - that rates among clinical settings are invariably higher compared to nonclinical populations and that self-injurious behavior is at risk of being "contagious". The contagion therein results in probable imitation by others if one is known or seen to be self-harming (Klonsky et al., 2011). It is to note, further, that, although NSSI does not provide intents of suicide, a link to suicidal behavior must not be disregarded, but rather, be kept in mind as a potential threat succeeding or even during NSSI (Skegg, 2005). Hence, behavior and cognition, thoughts, suicide risk and the overall mental state should be observed carefully and closely (Klonsky et al., 2011).

2.1.5 Assessment

Assessing self-injurious behavior that is non-suicidal is a key factor in order to understand this specific engagement. The section entitled *"Ecological momentary assessment"* will broadly discuss the mechanism of assessment as well as its responsibilities, benefits and risks, in general. A specialized focus on NSSI and the opportunities arising from our modern society to assess and monitor the self-harming patterns will follow. However, for the sake of completeness the current paragraph seeks to outline the focus of research as to what is essential to assess and monitor with respect to NSSI. Research suggests and, therein, mostly conforms to assessing NSSI based on characteristics depicted in Table 2.2.

item	characteristic	description
1	first and last episode of injury	*last as in most recent episode*
2	frequency	*based on daily, weekly, monthly focus*
3	severity	*e.g. "extent of bleeding and bruising", is medical attention required*
4	type of behavior	*compare Section 2.1.1 "Definition"*
5	emotion/cognition before, during, after NSSI	*thoughts and feelings expressed by a patient*
6	tool being used	*e.g., knife, scissors, razor blade, poisonous substance*
7	accessibility of tools in use	
8	body location	*arms, stomach, thighs, buttocks*
9	episode duration	
10	number of wounds	*regarded per episode*
11	frequency of urges and thoughts about NSSI	*this is sth different from frequency of episodes and should be regarded separately*
12	resistance to urges	*e.g., measure number of times, relative expression (mostly, rarely, never, ...)*
13	time lapse between an urge and acting on NSSI	*might deliver an anchoring point for treatment options and directing towards alternate behavioral routes*
14	situation	*performed in private? let others know about it?*

Table 2.2: Research has identified a number of aspects that require attention for a thorough assessment and understanding of why a person engages in NSSI and how interference towards a more healthy behavior may be implemented. Items 1 - 4 refer to Kool, Van Meijel, and Bosman (2009), items 5 - 13 refer to Klonsky et al. (2011), while 14 refers to Skegg (2005).

2.1.6 Treatment

Apart from emergent medical intervention, therapeutic supervision is of paramount importance. The ultimate goal therein lies in adapting coping mechanisms and behavior that are more healthy in comparison to NSSI. However, paving the way for this to happen is challenging and subject to medical professionals and the patients they are seeing / working with. Hence, the author does not intend to give much detailed information on this topic, but rather, illustrates a few broad treatment options that have been discussed in research. Unless specifically cited, this section refers to Klonsky et al. (2011).

Baby steps towards healthier coping strategies may start with patterns simulating self-injurious behavior without any destructive outcome. These could be "drawing on one's skin with a red marker, imagining an act of NSSI, holding an ice cube on the skin, applying a topical stimulant (e.g., BenGay), and snapping a rubber band on the wrist" (Klonsky et al., 2011, p. 54). Needless to say, that this simulation is supposed to be of temporary help only. Alternate routes upon coping with distress may be introduced gradually. It basically depends on what is of interest to the client, but things like talking to friends, going out, exercising, listening to music, engaging

in relaxation techniques have been proven effective before. Additionally, restriction of access to tools reported to being used for NSSI or complete removal thereof, may be of further support.

Treatment plans that have been proposed by research with promising results involve dialectical behavior therapy and problem-solving (Muehlenkamp, 2006). Both approaches are categorized as cognitive behavioral therapy or treatment and - amongst others - have the ultimate objective to reduce self-injurious behavior and teach healthier emotion regulation skills while continually assessing thoughts and feelings (DeVylder, 2010). Efficacy in real-world settings is, however, critically appraised since much more research needs to be conducted to support the body of evidence.

2.2 Borderline Personality Disorder

NSSI belongs to category five of the Borderline Personality Disorder (BPD), see below. Thus, it is strongly associated with BPD (APA, 2000; Klonsky et al., 2011). BPD as such is a severe diagnosis, whereas patients diagnosed with it need to meet five of the identified 9 criteria (with respect to DSM-IV) as follows (APA, 2000):

> 1. frantic efforts to avoid real or imagined abandonment. Note: Do not include suicidal or self-mutilating behavior covered in Criterion 5.
> 2. a pattern of unstable and intense interpersonal relationships characterized by alternating between extremes of idealization and devaluation.
> 3. identity disturbance: markedly and persistently unstable self-image or sense of self.
> 4. impulsivity in at least two areas that are potentially self-damaging (e.g., spending, sex, substance abuse, reckless driving, binge eating). Note: Do not include suicidal or self-mutilating behavior covered in Criterion 5.
> 5. recurrent suicidal behavior, gestures, or threats, or self-mutilating behavior.
> 6. affective instability due to a marked reactivity of mood (e.g., intense episodic dysphoria, irritability, or anxiety usually lasting a few hours and only rarely more than a few days).
> 7. chronic feelings of emptiness.
> 8. inappropriate, intense anger or difficulty controlling anger (e.g., frequent displays of temper, constant anger, recurrent physical fights).
> 9. transient, stress-related paranoid ideation or severe dissociative symptoms.

According to ICD-10 BPD is diagnosed as F60.3 an emotionally unstable personality disorder (either of impulsive or of borderline type), i.e. a subcategory of specific personality disorders.

2.2.1 Behavior therapy

Dialectical behavior therapy has been invented by Marsha M. Linehan as some kind of a subform of behavior therapy. (It is also similar to cognitive behavior therapy.) Thus, it covers a variety of strategic actions originating from other therapeutic schools and methods. Additionally, it has been scientifically proven effective for treatment of BPD (Comtois, Cochran, and Linehan, 2000). For instance, a randomized clinical trial recruited 44 participants (these were bound to analysis after excluding all drop-outs) that presented with BPD (Linehan et al., 1991). One half of the group was treated with dialectical behavior therapy (DBT), while the other half received a therapy subject to be common with respect to BPD. DBT illustrated significant outcome regarding parasuicidal behavior, i.e. deliberate self-harm without classification as to suicidal or nonsuicidal intents. Additionally, DBT was in favor concerning reduction of therapeutic cancellations, fewer stationary psychiatric hospitalizations. A significant reduction attributable to DBT

had also been found in reducing anger. According to Comtois, Cochran, and Linehan (2000, p. 577) DBT is constituted by four aims that are important:

- behavioral control,
- self-worth / self-esteem / self-respect,
- capability of learning a spectrum of emotions,
- enduring ability to be joyful for life.

Additionally, DBT is said to address competence enhancement, improvement in motivation, which is especially important since Borderliners tend to cancel therapeutic allies, change therapies in total accordance to the very definition of their disorder (Comtois, Cochran, and Linehan, 2000; Sendera and Sendera, 2010). Moreover, acquired skills need to be transferred to general situations, structuring one's environment as well as skill-enhancement and motivation of therapists.

DBT is based on the following eight assumptions (Linehan, 2008, pp. 78–80):

(a) Patients are trying really hard.

(b) Patients do want to change.

(c) Patients have to try harder and need to endorse their motivation at a higher level in order to change.

(d) Patients did neither ask nor cause their troubles, but they do need to solve their problems on their own.

(e) Life of a suicidal Borderline patient is unbearable.

(f) Patients need to adapt to new behavioral strategies affecting all areas of life that are relevant.

(g) Patients can not fail at therapy.

(h) Therapists of patients with BPD need support.

Their purpose is to support the therapeutic compliance, thus, the therapeutic process and workflow as such, which delineates emotional outbursts, ups and downs, perhaps several incidents of discontinuation of therapy to acquire skills of (nonjudgmental) dealing with whatever is in store for both patient and therapist (Sendera and Sendera, 2012).

Techniques that are involved in DBT are briefly outlined below. If not specifically cited otherwise, they refer to Comtois, Cochran, and Linehan (2000).

Clarification or Education
This is to inform the patient about reason and aim of certain techniques and is especially important to form an understanding of why patients have to deliberately undergo emotionally stressful situations in an effort to get better.

Self-monitoring
Diary cards and assignments are handed out to the patient in order to document certain parameters of interest. Its purpose is confronting the patient with details with respect to behavior as well as delivering the very same information to the therapist. Amongst others (e.g., medication, alcohol consumption), things to be monitored and documented include self-injurious thoughts / impulses and self-injurious acts. Additionally, scale-oriented ratings of emotions are recorded, pointing to loose thinking of one's emotions as extremes, as in black and white only (Comtois, Cochran, and Linehan, 2000). This exact mode of thinking - things are either black or white

without any nuances in-between - totally reflects and fits to patients with BPD (Sendera and Sendera, 2010).

Behavior and results analysis
Analysing one's behavior (including cognitions, emotions, triggers, intensifiers, consequences) that is associated to (or may even compromise) a therapy goal helps identify, understand and eventually circumvent potentially "dangerous" situations. As a means to reduce occurrence of previously found bad outcomes skills training may be among the pool of solutions. Due to the multitude of criteria that can be fulfilled in Borderliners (and which essentially differ from each other and call for different actions) interventions targeting at problems of higher priority need to be selected and tackled first.

Skills training
The main aim of skills training is to hand over new skills to a patient, so they can deal with triggering situations in a way to get closer to their actual and less harmful goals. It can be understood as some kind of "emergency package" that is ubiquituously accessible and applicable to the patient depending on the kind of situation they are facing. The ultimate goal of skills training is to have skills readily available that can be applied generally, regardless of whatever context a situation is turning up in.

Exposure
It may be the case that some patients avoid tricky / frightening / fearful situations in an effort to avoid dealing with whatever feelings might arise. In particular, it has been found that Borderliners try to escape dealing with or experiencing emotions (of any kind) resulting in emotions regarding work or private relations. Hence, confronting patients, exposing them to situations or hypothetically just making them think about these situations is seen as yet another strategy.

Managing influencing factors
Factors that influence / induce certain behaviors may be regarded as intensifiers on the one hand and punishments on the other hand. The distinction between the both of them is that intensifying centers along a positive line of reinforcement, thus, adding an additional positive factor or removing a negative one, while punishment centers along a negative line of reinforcement, thus, adding an additional negative factor or removing a positive one. The factors need to be identified and tailored to the individual patient. For instance, Borderline patients may not be equipped to handle intensifiers due to the nature of their disorder; they may be regarded as punishments.

Cognitive re-structuring
This is a strategy derived from cognitive therapy by Aaron T. Beck (Beck et al., 2010). It is based on the fact that people - especially those suffering from depression - have internalized countless negative cognitions and opinions about themselves and about how they come across. Also, they tend to generalize negative experiences originating from specific situations and apply these towards general and daily life. Cognitive therapy, respectively, cognitive re-structuring aims to identify these automated cognitive negative processes and educate the patient as well as support them in developing more positive and nuanced attitudes towards life.

2.3 Ecological momentary assessment

Research or treatment where behavior is the point of interest is an ambitious and complex task. Changes, e.g., mood swings, cravings, urges, emotional turbulences, are rapid and may occur multiple times during the day. When it comes to looking at one's behavior retrospectively, e.g. last week, last month, memory tends to give a somewhat blurry picture, summarizing and averaging information (Bradburn, Rips, and Shevell, 1987). Additionally, peaks as in especially positively or negatively connotated events become even more apparent or emotionally linked than when they appeared during the time being due to saliency (Yoshiuchi, Yamamoto, and

Akabayashi, 2008). Actual behavior and feelings cannot be accurately recalled, thus, the dynamics of behavior gets lost along the way. This phenomenon is called recall bias (Yoshiuchi, Yamamoto, and Akabayashi, 2008; Bradburn, Rips, and Shevell, 1987) among researchers. Ecological momentary assessment (EMA) addresses these issues and challenges.

By means of dynamic base methodologies, EMA repeatedly collects information in "real-time" in the exact environment and situation where behavior, or rather, behavioral change occurs (Yoshiuchi, Yamamoto, and Akabayashi, 2008; Consolvo and Walker, 2003; Shiffman, Stone, and Hufford, 2008). This can be accomplished with (as well as without) support of information technology (IT), e.g., via paper-and-pencil diaries. However, using electronic tools to snapshot the present is far more likely to be fruitful for two reasons (Shiffman, Stone, and Hufford, 2008). First of all, paper journals do not restrict the possibility to enter information amass at once, i.e., it circumvents the actual purpose of capturing dynamics and results in recall bias. Secondly, data can be antedated, i.e., entering yesterday's information today, and postdated, i.e., entering tomorrow's information today, thus rather, predicting the unpredictable by entering imaginary information about behavior that has not happened, yet, and may be unlikely to even happen at all.

With respect to self-injury, EMA fulfills the exact purpose that has been described above. Since NSSI - as outlined - does not occur during therapeutic settings, but rather, is situated in a private environment, dynamic assessment is yielded in order to track behavior, mood, emotions, urges to inflict harm upon oneself, aspects that trigger harmful acts, and other circumstances, such as being under influence.

EMA - approaches can pursue triggering based on events, i.e., the patient themselves record an urge or self-injurious act to happen, versus repeatedly sampling, i.e., prompting/"beeping" a person multiple (maybe even random) times a day aiming at establishing a picture of mood and mood changes, which is also referred to as Experience Sampling Method (ESM) (Consolvo and Walker, 2003). Certainly, this is not the one solution the world has been waiting for the entire time satisfying all needs. In fact, both sampling approaches - scheduled and event-based - are falsifiable, too. That is, a person can easily change behavior, if not just give incorrect information, upon anticipation of a prompt. On the other hand, the simple fact that an event has occured does not imply the person to actually report it by then (Consolvo and Walker, 2003). Overcoming or, at least, tackling the latter could be an approach to combine ESM / EMA with the Day Reconstruction Method (DRM) (Khan, Markopoulos, and Ijsselsteijn, 2007). DRM is meant for recalling one's actions and experience over the actual day, thus limiting recall bias to some extent. Upon combining it with ESM that covers events of interest, one could fill the gap as to what has happened throughout the day or why events have been reported later than they occurred. For details, interested readers are referred to (Khan, Markopoulos, and Ijsselsteijn, 2007).

Nonetheless, EMA offers an alternative to get rid of falsifiable paper journals, reducing recall bias (Consolvo and Walker, 2003) - though bringing about other challenges - that is compliant with tremendous use of smartphones and the way people go about their lives. It has been confirmed (Nock, 2010) that studies with the purpose of "real-time" monitoring of self-injurious behavior are limited in numbers. The majority of this limited set centers on the patients themselves and what data can be gathered thereupon for research. Apparently, none of them, at best there are a few studies somewhere out there, focuses on electronic tools to support medical professionals throughout their therapeutic activities. For instance, patients collect information as they go about their lives in order to capture dynamic behavior that is of interest to the therapist. Subsequently, all these information is transferred to the medical record - compare Chapter 3 - of this patient that is kept in hands of the medical person. Based on this reasoning - and consistent findings among literature - refinement and improvement of current methods available regarding weekly and monthly assessments are proposed (Nock, 2010).

State of the art research and applications dealing with EMA, not necessarily restricted to self-injurious behavior but unhealthy behavior and mental state, mood fluctuations, in general, are outlined in Chapter 3.

2.4 Motivating behavior change

Speaking from your own perspective, sometimes one is pretty reluctant to change a behavior that has already become a habitat. This is only one reason, why many different models and strategies have been developed to motivate behavior change in individuals. Henceforth, psychological behavior change models, on to IT-supported models, towards gamification and motivation factors will be delineated.

2.4.1 Psychological perspective

Behavior change that is enduring and of interest to live a healthier life targets long-term changes. This can pertain to changing your lifestyle, e.g., unhealthy diets, tobacco use, alcohol consumption, little physical activity, or simply risky behavior. If one were able to perform a change in behavior for a short-term only, the likelihood of returning to the status quo, as in unhealthy lifestyle, is pretty high. This is why behavior change needs to endure to not affect only physical, but also mental change. From a psychological point of view certain behavior change models have been employed and adapted to meet these needs. Among the ones that are most common, one finds the Transtheoretical Model (TTM), the Health Belief Model (HBM) and the Social Cognitive Theory (SCT) (Redding et al., 2000).

For instance, the TTM (Prochaska, 2008) has been developed for long-term behavior change, such as after being diagnosed with diabetes. The model is divided up into the six stages pre-contemplation, contemplation, preparation, action, maintenance and termination. All of these look at different specific time frames and depend on the state of mind the patients themselves are in. Adhering to this model does not mean these stages are linearily processed; rather, TTM is thought of as a spiral model, whereas patients jump back and forth between the stages.

Bandura's SCT relies on three key terms - the individual, one's behavior and one's environment - as what is referred to as "triadic reciprocity" (Redding et al., 2000, p. 185). Thus, they are interlinked; every part (and its modification) somehow influences and affects all of the others. Besides self-efficacy, expected outcomes, self-regulation and reinforcement in terms of motivational factors (e.g., rewards and incentives) are regarded important.

HBM mainly deals with disease prevention and is based on four key constructs - perceived susceptibility, perceived severity, perceived benefits and perceived barriers (Redding et al., 2000). Interestingly, all of these dimensions center on a subjective opinion. For instance, perceived susceptibility refers to the person's attitude or estimation as to how likely they are to catch the disease in question. Moreover, personal consequences are taken in consideration, as well as pros and cons of applying a behavior change.

2.4.2 Bridging psychology and IT-supported behavior change

Another model is attributed towards cognitive behavior therapy (CBT). According to Beck (2011), it is rooted in dysfunctional emotions and cognitions that are assessed and evaluated in order to subsequently introduce change and particulary prevent relapse. Negative thoughts and beliefs may affect psychiatric disorders and psychological problems or come along as byproducts and several diseases, such as chronic pain, migraine, obesity, hypertension, can even carry psychological components. CBT seeks to address these negative cognitions in a person, and evaluate them continuously, while working towards specified goals (Beck, 2011). If dysfunctional beliefs are turned into a more positive attitude, enduring change of behavior and one's

thinking is more likely to be "implanted".
One way to deliver CBT is by means of computing devices. Amongst computer-based cognitive behavioral therapy (CCBT), one finds tools concerned with depressive symptoms, anxiety disorders, migraine, insomnia, pain, cancer, eating disorders or other health problems - a detailed review is given in Cuijpers, Straten, and Andersson (2008). These computerized interventions do not replace a therapist, but are meant as adjuncts to therapy and offer several benefits. Patients are enabled to do self-management, engage in self-help and therapy reaches out towards rural and remote areas or simply reaches patients that would not have had access to treatment otherwise. Additionally, motivational features can easily be applied by persuasion strategies like self-monitoring (Fogg, 2003), cited after Kaipainen (2009), audio-visual enhancements or gaming rewards (Marks, Cavanagh, and Gega, 2007), cited after Cuijpers, Straten, and Andersson (2008). Therein, it is said that it is time efficient for both parties. On the other hand, the same authors claim that CCBT comes with issues like nonopportunity to ask follow-up questions, choosing methods that are most convenient, but not necessarily suitable and needed for the patient. More research is needed on acceptance and usability of CCBT and efficacy over traditional CBT needs to be acclaimed.

Additionally, self-monitoring can be very useful in motivating behavior change based on reasoning that one gets to better understand daily life patterns and activities (Fogg, 2003) cited after Kaipainen (2009). That way, an individual might be intrinsically motivated as to different behavioral actions might yield a different, maybe even, better outcome. Based on that, one could assume that EMA itself is a brick in motivating behavior change, thus, also related to CBT. Furthermore, bringing about EMA on mobile devices increases the chance to reach people at a moment, where recommendations are most effective and change is most likely to occur (Morris, 2012).

Inspite of the need for much more empirical evidence for its efficacy, support by research is growing (DeVylder, 2010; Muehlenkamp, 2006) as to situate CBT as a useful treatment plan in settings where patients self-injure. Furthermore, one could assume that gamification concepts and persuasion strategies might be fruitful in the context of NSSI, too.

2.4.3 Gamification

Relatively novel and rather popular in research, nowadays, seems to be gamification. This is a concept that takes gaming aspects and incorporates them into "more serious" contexts, that are not directly related to games per se, such as education, banking, health (Groh, 2012).

Although there is much that could potentially be achieved by including gamification aspects, a lot of criticism is apparent as well:
A masters thesis dealing with gamification and its implications on serious games carved out several conflicting perspectives from different researchers like Bogost, Antin or McGonigal (Laar, 2012). Laar (2012, p. 22) wrote that in "a lot of cases, 'gamification' consists of just adding points and badges, but it is not the points and achievements that make the game". In an article of MIT Technology Review, Antin (2011) for instance stated that for "human beings, what counts as a reward is much less clear. Points, levels, or badges are not inherently rewarding. The reward, when there is one, comes from underlying psychological phenomena such as social status, reputation, and group identification".

In order not to take away too much information right from the beginning, readers are encouraged to get a taste of Chapter 3 for an illustration of related work in this field.

2.5 Discussion

This chapter aimed to introduce the reader to some background knowledge on what is known to trigger NSSI and why proper and accurate assessment of this maladaptive behavior are of paramount importance. According to research, NSSI may occur on its own as well as be comorbid with diagnoses like Major Depression or Borderline Personality Disorder (Klonsky et al., 2011). Notwithstanding, the latter seems to show highest comorbidity likelihood, which is why it is delineated in this chapter. However, the question whether the likelihood to encounter NSSI as its own diagnosis in practice is worth looking into (versus embedding it into the context of a specific disorder) is investigated by expert interviews and answered in Chapter 7.1.

Several methodologies to capture behavior and mood changes are of little avail. Hence, ecological momentary assessment was discussed, which addresses continuous monitoring of behavioral actions and emotional trajectories to a better and greater extent. Thus, it serves as a fundamental concept to document whatever behavioral patterns emerge in-between therapeutic session, exactly at the point of time where they actually occur. Moreover, a delineation of therapeutic strategies and motivational factors in dealing with NSSI was presented. A special focus was put on dialectical behavior therapy which has proven successful in helping Borderliners adopt a healthier or less harmful lifestyle. Several therapeutic approaches that are approved in Austria are incorporated during interview rounds, such as client centered therapy or behavior therapy. The therapeutic setting that is focused on is elaborated during the interview analysis and presented to the interested reader in Chapter 7.1, Chapter 7.2 and Chapter 7.3.

3 Mobile information technology in healthcare

"And now for something completely different."

— Monty Python (1971), *Monty Python's Flying Circus spin-off*

Mobile information technology is growing in the health care sector - amongst many others. Searching for the keyword 'mHealth' yields 62 pubmed-indexed articles, whilst the term 'm-health' even delivers 1134 results already[1]. Items shown range from simple text-messaging applications in the context of prenatal care (Evans et al., 2012), to self-management solutions for diabetes (Cafazzo et al., 2012), population surveillance or support for rural health workers in developing countries or countries that are way out of reach (Rajput et al., 2012; Lemay et al., 2012), to mHealth interventions that are supported by Body Area Networks (BANs) to monitor activities and promote healthy lifestyle and living (Jovanov and Milenkovic, 2011).

This chapter serves to give background information on mobile technology and health. First, terminology used in the healthcare context is defined. Second, the idea and goal of ubiquituous computing is introduced. While the subsequent section outlines several benefits and risks upon developing as well as adopting mHealth applications and pervasive computing technologies, the last section concludes with research related to keywords that appear as a center piece for this thesis, i.e. mHealth, ubiquituous computing, monitoring applications, motivating behavior change, CBT, and self-injury.

3.1 Definition and terminology

Due to the magnitude of terms one is facing in the field of IT and health care a quick outline regarding terms eHealth, electronic health record (EHR), electronic medical record (EMR), personal health record (PHR), mHealth and the interplay of social media and health is given to prepare the overall context of the thesis.

3.1.1 eHealth

Eysenbach (2001) defined the term eHealth as

> an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.

Some of the promises with respect to eHealth innovations and applications, i.e., enhancements in quality of care, reduced financial burden, secure health information exchange, improved access

[1] Search was conducted on 09/23/2012.

to care, higher degree of transparency and comparison among treatments, time savings due to diminished documentation efforts (OECD, 2010), raise a lot of concerns. In fact, particularly the aspect of cost-saving is subject to criticism, revealing conflicts in opinions and research findings.

Schweitzer and Synowiec (2010) criticize that potential benefits, however having proven in theory, are speculative in nature but have not been measured as in actual economic and financial outcome. The lack of common policy and procedures in standards and interoperability as well as the plethora of clinical systems that need to be aligned and properly interfaced in order to support, yet another new system yields widely spread adoption (and acceptance in an effort to comply with aforementioned benefits) a difficult task (OECD, 2010). The adoption of new systems that replace legacy system or interplay with existing ones requires training, thus, time as well as work effort in order to familiarize oneself with the functions of the system. Hence, it conflicts with the initial benefit of diminishing a professional's time effort upon documenting health information (Schweitzer and Synowiec, 2010; OECD, 2010).

Often, electronic health records (EHR), electronic medical records (EMR), and personal health records (PHR) are mistaken for one and the same thing. They are nonetheless related to each other, however, they do represent different concepts. Terminology given refers to (NAHIT, 2008).

3.1.1.1 EHR

Electronic health records comprise health-related information about a patient originating from multiple health care providers. Thus, the exchange of health information is a vital part of every EHR.

3.1.1.2 EMR

Electronic medical records are defined within the scope of an electronic health record. Nonetheless, the important difference is that health-related information about a patient and his treatment options, diagnostic results and tests are bound to a specific health care provider.

3.1.1.3 PHR

A personal health record is a collection of health-related information that can originate from multiple parties as in health care providers and which is under the custodianship of an individual themselves.

3.1.2 mHealth

mHealth is concerned with providing healthcare services via mobile technologies (Istepanian, Jovanov, and Zhang, 2004), i.e.,

- mobile devices - PDAs, tablets, smartphones, ...,
- sensors - EEG, ECG, respiratory sensors, ...,
- wireless communication technologies - WiFi, Bluetooth, ZigBee, et cetera.

Rather, than being a mere and isolated concept, it needs to be seen within the context of the eHealth domain. Providing health-related information on-the-go offers potential for accessing, recording and transferring data whenever possible and desired for both, the patient and medical professional, whereas the general objective is to enhance quality of care (Istepanian, Jovanov,

and Zhang, 2004). However, certain limitations and challenges have to be well considered, compare Section 3.3. By 2004, researchers have already claimed that new generations of mHealth applications will involve pervasive technology (Istepanian, Jovanov, and Zhang, 2004).

3.1.3 Social media for health

Social media and social networking sites (SNS) in healthcare provide education (on a professional as well as a patient level), support by communities that focus on patients with similar diseases and diagnoses, or communication overall. Thus, they pave the way towards disseminating health-related information and providing second opinions. Some examples of SNS are PatientsLikeMe[2], CureTogether[3], CaringBridge[4] and TuDiabetes[5]. PatientsLikeMe, among others, has a community dealing with Borderline Personality Disorder, as such. An overview is denoted in Figure 3.1. Therein, likeminded people share diagnoses, treatment information, receive support by peers and exchange information about each other's health status and progress.

3.2 Ubiquituous computing

Ubiquituous computing (UbiComp) is somewhat accompanied by the term pervasive computing. In fact, quite often both terms are found and used interchangeably (Siegemund, 2004). Korhonen (2004, p. 229) claims that pervasive healthcare "addresses those technologies and concepts that integrate healthcare more seamlessly to our everyday life, wherever we are". Basically, it means that technology is omnipresent and, thus, health care can be delivered (behavior can be monitored) at all times. Additionally, it is seen as a major driver moving away from professional-centric towards patient-centric healthcare models (Arnrich et al., 2010).
Of course, pervasive systems co-occur in a variety of different contexts and differ in the way ubiquituous computing is delivered. Some systems heavily rely on the use of hardware devices that can be attached to one's body yielding data, compare BANs, some use sensors incorporated in mobile devices, such as accelerometers, location sensors, gyroscope, temperature sensors, GPS, proximity sensors, magnetic field, pressure, humidity sensors (Android, 2012). Others offer software systems to be deployed on smartphones that observe a user's situation and environment which may be partly relying on user's input in order to deliver an ubiquituous notion.
The only restriction lies in delivering systems that are context-aware, regardless of what technology is used in that matter. That, in fact, means ubiquity is not solely reflected in goods that are considered technologically-savvy, such as PDAs, smartphones, desktop computers, but also in houses, i.e., smart homes, furniture, paint (Korhonen, 2004). Almost every object that is present in our surrounding can be used for communication purposes as long as the smart component somewhat adheres to the principle aim of the object itself. These things are called smart everyday objects consisting of "both an everyday thing and information technology that augments it" (Siegemund, 2004, p. 15).

Persuasive computing in health, is yet another concept, that is in close relation to pervasive or ubiquituous computing. It encompasses UbiComp to a certain extent, in fact UbiComp applications represent the third generation (3G) and future systems of persuasive technology by utilizing BANs, real-time mobile sensoring systems, pervasive sensoring systems (Chatterjee and Price, 2009). The objective, however, does not end with the omnipresent communication and computing but is enhanced with a focus on persuading an individual towards change in attitude, behavior, health, well-being. A framework (Chatterjee and Price, 2009) illustrating how

[2] http://www.patientslikeme.com
[3] http://curetogether.com
[4] http://www.caringbridge.org
[5] http://www.tudiabetes.org

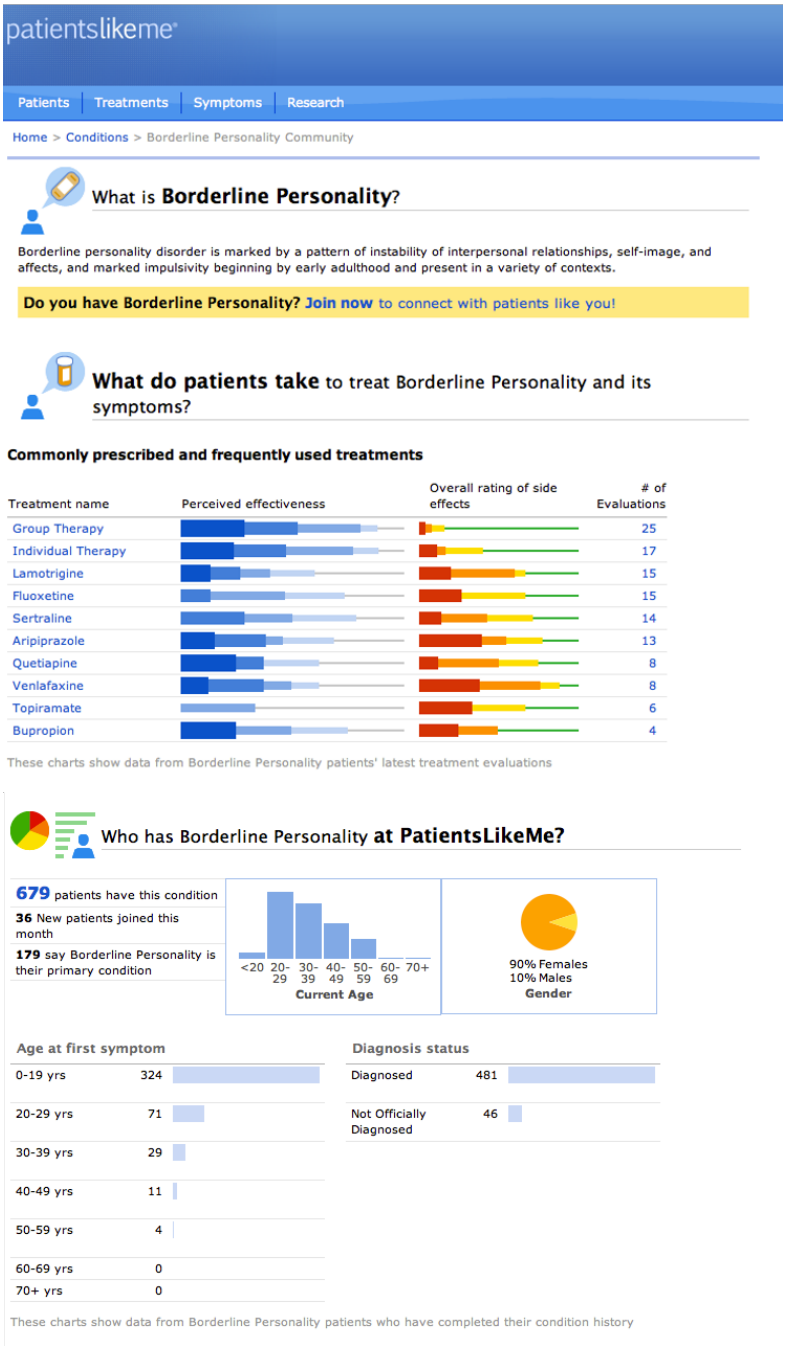

Figure 3.1: General overview of the Borderline Personality Disorder Community within the social platform PatientsLikeMe, screenshot taken from PatientsLikeMe (2013).

persuasive technology and healthcare interplay is shown in Figure 3.2. It shows three circular concepts, i.e., technology, persuasion and healthcare subdomains - that are overlapping, thus, interplaying and influencing each other. Several technological devices, respectively, technological notions follow persuasive strategies in order to affect / support / maintain healthcare goals. The dashed ellipsoids life style, disease and life cycle are directly associated with given healthcare subdomains and goals.

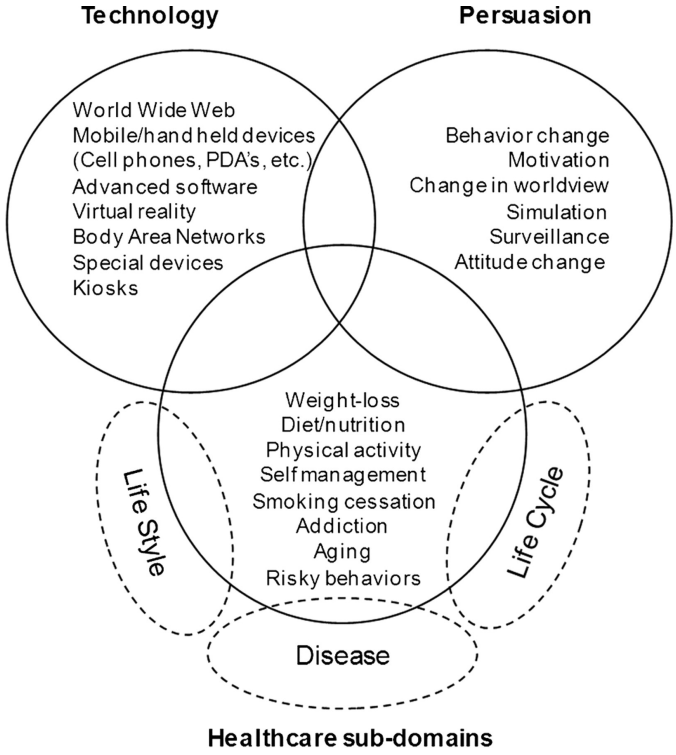

Figure 3.2: A simple framework on persuasive technology shows the overlap of three circular concepts it consists of - technology, persuasion and healthcare subdomains. Life style, disease and life cycle illustrate dashed ellipsoids that influence one's health and well-being, thus, also healthcare goals. Figure taken from Chatterjee and Price (2009, p. 172).

3.3 Benefits and risks

Some benefits and risks of using mHealth applications, in particular, pervasive computing technology in healthcare are listed in Table 3.1.

3.4 Related work

Numerous studies are out there dealing with ecological momentary assessment and cognitive behavior therapy, in general. Most of them are set in the context of mental health, stress-related diseases, binge-eating, obesity, alcohol consumption or smoking cessation. Only a subset of these consider assessing NSSI in real-time in its natural setting, with even fewer studies on CBT in that regard. Furthermore, very little, if any research at all, has specifically set its focus on a therapist's perspective. While EHRs / PHRs have been studied at great length (Walker et al., 2008; Reti et al., 2010), considering adoption and acceptance among medical professionals and patients, privacy and security considerations, the author is unaware of a project that could potentially link "behavioral trajectories" of NSSI to PHRs. Related work presented here situates the design approach and methodology of this thesis to support therapists with continuous behavioral

Benefit (+)	**Risk (-)**
higher patient empowerment	research still at proof-of-concept step
ubiquituous availability of technology	too little supporting evidence for successful adoption
disease prevention and maintaining health is key	little acceptance among professionals
more powerful health services	heterogenic environment
processing / computing power on the rise	expensive, thus, especially placing a burden on developing countries
chronic disease monitoring	research rarely presents studies with real people in real environments
motivating people for change	usability needs to be highly focused on
life style awareness	people aimed at adopting pervasive healthcare are not always tech-savvy
establish an individual profile	standards are lacking
context-awareness	smartphones: - high power consumption - limited processing power and memory - limited screen size
provide (just-in-time) recommendations	security and data privacy are fundamental
user-centered approach	potential loss of autonomy over data to device

Table 3.1: Benefits and risks upon employing mHealth applications (with a special emphasis on pervasive healthcare) are listed here without any direct relation between + and - side. Statements for pros and cons are drawn from Chatterjee and Price (2009), Arnrich et al. (2010), Siegemund (2004), Yu and Yu (2004), and Korhonen (2004).

data recorded by clients in-between therapeutic settings and offer the possibility to incorporate these data into existing PHRs.

Research on mobile applications to support mental health interventions is relatively novel. This is partly due to the sensitive environment. Supporting therapists in their activities and improving client - therapist relationships places many design and ethical concerns if technology is introduced. While therapists should not be burdened with learning to use new technology, close collaboration among analysis and design of the application is key. Their experience among working with clients is invaluable, which is why eliciting requirements via interviewing therapists becomes more reasonable. It involves information about end-user needs, i.e., the clients themselves as they are the ones responsible for willingnessly collecting data, therapists' needs and settings to ensure support in their activites. A mobile application is described that tracks a patient's mood. However, the focus was set on HCI and no further details have been given as to how technical design considerations were incorporated. (Matthews et al., 2008)

Emotional self-awareness and self-regulation are two keywords that do not only support general health but also cause action, respectively dysfunctions thereof, in NSSI (Klonsky et al., 2011). A study (Morris et al., 2010) targeted these factors and disseminated smartphones with

a designated application to capture mood, anxiety, anger, happiness and sadness by prompting several times a day. Intervals of alerts could be scheduled by the users. In addition, the software consisted of CBT mechanisms that motivated participants to apply relaxation techniques, follow visualized breathing exercises and work through rhetorical questions (with the objective to reappraise situations and behavior). Upon defining one's emotional state via the application these behavior changing suggestions could be accessed by the user's initiative. One of their findings was that mobile therapies are more likely to be used once a person is stuck in an intense emotional state. A further suggestion was made as to include mood development after entering data as well as letting participants set individual goals and give feedback upon incorporated therapeutic techniques.

A momentary assessment of adolescent and young adults to study self-injurious thoughts and behavior was performed by means of PDAs (Nock, Prinstein, and Sterba, 2009). This study was in contrast to similar research that simply relied on retrospective long-term recalls. By means of asking descriptive questions participants reported frequency, intensity, duration, and other factors several times a day, whereas two methods were combined. In addition to event-based triggering initiated by the participants, two sampled alerts were prompted at users. A clear distinction between suicidal thoughts / behaviors and non-suicidal thoughts / behaviors has been drawn. Some of the conclusions were higher intensity and duration of suicidal thoughts in comparison to lower intensity and duration of NSSI. However, the majority of the participants engaged in NSSI. Bias that is still inherent in self-reporting in a real-time setting, though yielding better outcome than paper diaries, was stated critical.

A recent paper (Morris, 2012) discusses a variety of existing software applications yielding behavioral change and suggests a transition toward using cell phones, rather, than relying on yet another desktop solution. Her work focuses on seven keypoints to effectively motivate enduring change of lifestyle and behavior. She emphasizes that self-monitoring alone is not enough, but social components, context-awareness, e.g., location, individualized messages striving to find a way out of a miserable situation together, visualizing and describing concrete loss of continuing along a maladaptive habit, etc. promise exciting and useful directions.

Laar (2012) discussed a serious game invented by McGonigal (called SuperBetter) to help people with depression. SuperBetter provides players with quests and challenges and subsequent strengths-building of different kinds until an ultimate goal is reached (SuperBetter Labs, 2012). Additionally, it features positive and negative conditions reflecting real life obstacles as some sort of game characters. The game also includes a social component, where a player designates friends as one's allies who can then follow the their journey, cheer them up or hand out achievements.

A project called Agile Life addressed physical and cognitive decline that become apparent in the elderly population (Grosinger, Vetere, and Fitzpatrick, 2012). A prototype for an Android Tablet application was designed and implemented in order to provoke higher physical activity and maintain close social circles. This was done by means of interesting and surprising chunks of information tailored to specific activities or the possibility to joining close friends in their planned physical activities. In addition, a flower garden inspired by UbiFit (Consolvo et al., 2008) reflected each activity (as a positive reinforcement) by a nourishing garden with a variety of flowers and colors.

Design considerations upon implementing EMA tools are given in Consolvo and Walker (2003). There is a difference as to selecting ways for adaequately reaching out to participants via prompts. Sound alerts may be inappropriate due to important meetings, work situations that need to be center of concentration and focus. On the other hand, tangible alerts may be overlooked. Alerts that interrupt phone calls, email writing or simple texting are a nuisance to users. The same is true if people are "beeped at" too frequently during the day. Having to answer one and the

same question over and over again leaves users with frustration. Apart from that, scheduling approaches which have been discussed earlier need to be selected. Hence, the information one expects to retrieve has decisive value as to whether event-based systems or scheduled / random sampling systems are used.

Small screen size, battery life, energy consumption, limited processing speed and memory need to be considered on developing requirements and designing smartphone applications (Yu and Yu, 2004). Lessons learned in this paper were that ignoring any of these limitations will eventually result in low usability, thus, little user perception and acceptance. A variety of design considerations in using mobile phones for spreading wellness are presented by Kailas, Chong, and Watanabe (2010).

Mobile applications dealing with self-injurious behavior, available in either the iTunes App Store or on Google Play, are more than rare. Only one tool was found specifically addressing clients in the context of NSSI.

3.4.1 iCope

iCope (ReallyAPPy, 2011) is a software designed for iPhone / iPod touch / iPad[6]. Its objective is to provide distractions and alternative methods as soon as urges to self-harm sneak up on a client depending on the intensity of one's feelings, compare Figure 3.3 taken from ReallyAPPy (2011).

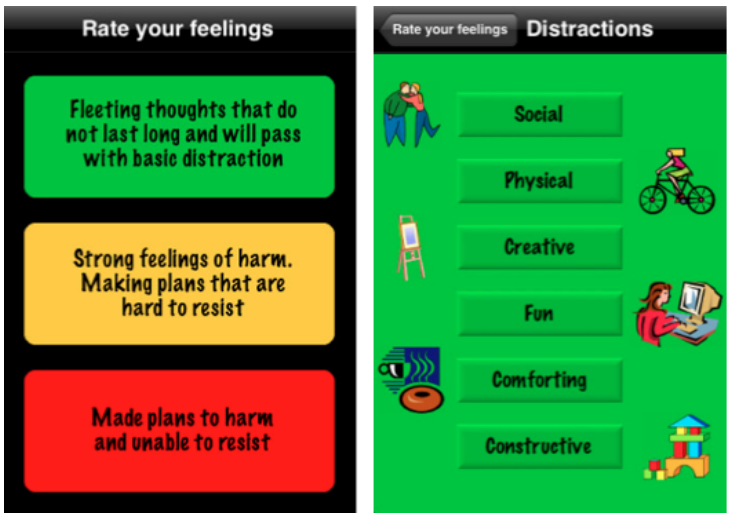

Figure 3.3: A couple of screenshots delivering distraction techniques and alternative methods to engage in, instead of performing activities to cause bodily injury. Recommendations are based on the pressing need to self-harm ranging from low to middle to high intensity. Screenshots taken from ReallyAPPy (2011).

For instance, low-intensity urges offer categories like social, physical, creative, fun, comforting and constructive providing text-based lists of recommendations for alternative activities. Mid-intense feelings result in a list of strategies to engage in that do not yield any bodily injury, while high-intensity urges lead to a choice between two types of methods, i.e., cutting or burning. Subsequently, a picture of a human's lower arm is displayed which can be virtually cut or burnt by touching the screen. Upon doing so, bandages and band-aids instantly occur at the injured

[6] iCope has been developed by ReallyAPPy in collaboration with mental health nurses and can be downloaded from (ReallyAPPy, 2011). It was released via the iTunes App Store on 12/07/2011 in the health & fitness category and is available at version 1.3.2. iOS 4.0 is required to install the application.

body location.
However, there is no evidence that a monitoring of self-injurious acts or reported feelings takes place. One cannot recover date or time of recently engaged virtual bodily injury. Distractive mechanisms and suggestions are presented as static lists only. Here, individualized messages as well as recommendations appearing by the time an urge is emerging could yield higher sucess rates. Mechanisms are not individualized, there is no support whatsoever as to what social activities (doing what, where, with whom) would be feasible at the moment. In addition, the types of injury are too restrictive. There is no data history, there is no backend for this application. The "gaming factor" is lacking.

3.4.2 MoodPanda

MoodPanda (MoodPanda, 2012) is a web application with the goal to track one's mood over time by keeping a diary. In addition, it is available as a mobile application for iOS systems[7] - an application based on Android is currently underway. It features mood tracking, reveals mood changes via graphs and features social components by offering mood maps depicting the mood of a city, country, enables sharing component of one's own mood via social networks and establishes a mood calendar designed for use in therapeutic sessions, compare Figure 3.4, taken from MoodPanda (2012).

Figure 3.4: Four screens of the mobile MoodPanda application are shown here. The main user interface defines the activities available. Apart from tracking one's mood, the application comprises a social component and offers graphs about own mood changes versus world mood as well as mood history. Screenshots taken from MoodPanda (2012).

[7] MoodPanda has been developed by Jake Greenwood and Ross Larter and can be downloaded from (MoodPanda, 2012). It was released via the iTunes App Store on 08/17/2012 in the health & fitness category and is available at version 1.0.6. iOS 3.0 is required at a minimum to install the application. An API at beta status to retrieve one's data has currently been released.

Albeit MoodPanda is not designed for NSSI, but rather deals with mental health as in mood changes, in general, its inherent design considerations could serve a basis for the mobile application targeting NSSI. These considerations involve EMA by letting users continuously track their mood and providing opportunity to reason about it as well as giving an overview on one's mood behavior over time. Paired with a social component it adopts persuasion strategies for better well-being. First, by keeping a mood diary one might better understand one's emotions and actions, thus, potentially prepare for change. This conforms to what has been stated by Fogg (2003) cited after Kaipainen (2009) in a previous section of this thesis already. Second, by support of peers (categorized into friends and other people) who can hug and comment on whatever state of mood another member is in. However, scheduled alerts and reminders of entering mood data are non-existent. Additionally, as outlined by Morris (2012), motivational aspects could brighten one's mood by intervening at a time of reported low mood situations that are not considered for the application. A further point of interest is the provision of mood calendars for therapeutic uses, albeit no evidence of acceptance or its usefulness for therapeutic workflows is given. However, this feature is available solely in the web version of the software.

3.4.3 DBT Coach

The DBT Coach is a mobile phone application following the DBT in order to coach patients who suffer from BPD with comorbid substance use disorder, read Rizvi et al. (2011). Figure 3.5 illustrates some of its core features.

Figure 3.5: Some core features of the DBT Coach. Figure taken from Rizvi et al. (2011).

Skills training is an integral part of every DBT approach, but due to its complexity and size the developed prototype incorporated only one specific skill called Opposite Action (OA). Upon identifying and rating the emotion that is associated to cause the most distress momentarily and a subsequent action urge, an OA session is started guiding the patient through the coaching process of DBT. After the skills session, emotion intensity and urge action are rated again to see if the skills had helped. The application covers psychoeducational features, however, to the author's knowledge there is no notifcation feature included to assess the user's "status" throughout the day (which is included in the application proposed in this thesis).

3.5 Discussion

To the authors knowledge there is no single Android application available that targets "behavioral trajectories" of Borderline patients, especially people who self-injure, and their interactions with their respective therapists. Although the applications presented above employ similar patterns and likewise target people with Borderline or self-injury, core features that are planned for the proposed application in this project like monitor behavior, intervene in a context-sensitive behavior, observe emotion or tension curves throughout a day are lacking.

4 Empirical research

"Procrastination is the art of keeping up with yesterday."

— Don Marquis (1927), *Certain Maxims of Archy*

Empirical research is a field mainly associated with sociology, however, it is applicable to several fields and disciplines and delivers valuable outcome (Gläser and Laudel, 2010). According to the type of measurements performed, it can be subdivided into the categories quantitative as well as qualitative research. Although both methodologies are somewhat blurry, nowadays, since they cannot be seen and applied strictly separated from each other, are sometimes even used in combination and depend on each other to prove mostly effective (Gläser and Laudel, 2010), this chapter strives to give an outline of the "classic traditional" purpose and definition of quantitative and qualitative measures that do separate each other. Unless specifically cited, the sections quantitative and qualitative measures refer to Bortz and Döring (2006).

4.1 Quantitative measures

Quantitative measures basically rely on statistical findings and measurements of characteristic values and support a plethora of tests to reject / (at best) not reject hypotheses by looking for statistical significances. Thus, one can take a list of grades from a final exam, measured heights of students, reaction time and use them as a basis to perform statistical analysis.
Scales are typically differentiated between measurements at a nominal level, ordinal level, interval and ratio - i.e., a cardinal - level. As long as the characteristics originate from a cardinal or metric scale, single items can be counted, put into relation to each other and measured during quantitative analysis. Statistical tests and analyses, which may reject or - in the best case - fail to reject a hypothesis can be used, such as *t*-test, Welch-test, χ^2-test - amongst others - depending on the underlying data material (Weiß, 2005). Traditional approaches on conducting quantitative research are questionnaires or even standardized or structured interviews (Bryman, 2012). Since gathering data is fast, they can be deployed widely spread and comparisons as well as measurements among the artifacts are highly reasonable (Bryman, 2012).

4.2 Qualitative measures

Qualitative measures are expressed in terms of linguistic measures. As a consequence, data on a nominal scale and on an ordinal scale are adaequate qualitative data measurements (Weiß, 2005). Information that is of interest to the researcher lies in opinions, different perspectives and verbal assessments (Bortz and Döring, 2006) that go way beyond a five-point-Likert scale (Likert, 1932) ranging from "strongly disagree" to "strongly agree", thus, delivering much more detail than quantitative data (Bortz and Döring, 2006). Analysis thereof (of qualitative data) could result in establishing categories of interest in regard to the field being explored. Thus, it mostly relies on content and the quality of statements than on statistical measures or numerical values, albeit, a combination with quantitative analysis / measurements can still be suitable what has already been mentioned in the introduction of this chapter. Qualitative approaches pursue generating new knowledge, generating hypotheses that are, at times, worthwile being tested subsequently, rather than testing already established hypotheses. Exploring unknown fields is much more suitable for qualitative approaches since they yield interpretation and generate new

knowledge, rather, than quantify significances. Qualitative approaches are pursued via conducting interviews - which will be focused on in more detail in the upcoming section - workshops, brainstorming, observations, protocols, (technical) reports and many more. Due to the qualitative nature collecting data is a time-consuming process, whereas quality of research depends on the art of questioning as well as on the situation both - interviewer and interviewee - are in (Hove and Anda, 2005). Although quantitative analysis may very well be based on qualitative data, it might not give the impression of a representative control sample. This is due to a small overall number of qualitative data.

4.3 Interviews

Interviews are a common methodology to collect data in qualitative research (Myers and Newman, 2007). This section gives detailed information about classification and types of interviews, the process of conducting interviews in the course of research, as well as challenges and pitfalls that occur while applying this technique. Its purpose is to prepare the reader for the method in use throughout this thesis. Unless specifically cited otherwise, Section 4.3.3 *Challenges and pitfalls* refers to Myers and Newman (2007) while Section 4.3.2 *The process of interviewing* refers to Bortz and Döring (2006).

Qualitative as in face-to-face expert interviews are the requirements elicitation technique of choice in this project. The reason for doing so is that not much information regarding mobile behavioral monitoring applications for therapists is known to the author. Especially, research in that matter about the particular field of expertise - NSSI - is limited in numbers. Thus, the outcome in terms of causal links, requirements and feedback from experts is anticipated to cover a broader scope of knowledge than standardized questionnaires could comprehend. In order to leverage discussion and understanding between the perspectives of psychology / psychiatry / psychotherapy / research and medical informatics, thus computer science, a prototypical approach while interviewing will be adhered to. These prototypical implementations are meant as informal sketches with the intention to offer a basic understanding of what both engineer and psychologist are talking about and is based on characteristics and brainstorming about boundary requirements and conditions regarding the proposed topic.

4.3.1 Types of interviews

Interviews can be categorized in a number of ways (Gläser and Laudel, 2010), some of which are:

- the **structured interview**, meaning the course of the interview is very rigid, all questions to be asked are prepared beforehand, questions are to be asked in the exact wording given as well as in the order outlined (Gläser and Laudel, 2010). This prevents respondents from talking loosely as in expressing opinions in more detail if they do not align with the purpose of the question itself (Bryman, 2012). However, the structured way of going about an interview opens the opportunity to comparison among several conversations and makes measurements more reliable and valid. Therefore, this type of interview is renown as being used in quantitative rather than in qualitative research (Bryman, 2012).
- The **semi-structured interview** is conducted by using a basic questioning guide that is prepared beforehand. Unlike the structured interview, exact wording and maintaining the order of questions is irrelevant (Gläser and Laudel, 2010). Even though questions outlined should be "processed" in the course of the conversation, the interviewee is allowed to get off-topic and talk loosely. That way some questions may even be skipped in case they have been answered by the respondent while talking freely. Therefore, it is important to let the

respondent talk and go into details of the current conversation's content rather than rigorously following through with beforehand-prepared questions (Bortz and Döring, 2006). They may be postponed until later during the interview. It is the interviewer's responsibility to ask follow-up qestions, clarify what is being said and meant by the interview partner (Bryman, 2012) which should enhance the knowledge base and avoid ambiguities (Myers and Newman, 2007) (which is especially important if differing problem domains are collaborating).

- The **unstructured interview** offers no framework at all, thus, is a completely loose strategy. A general theme is important for the conversation, however, no questions are prepared beforehand. It can further be subdivided into guided, open or narrative interviews that show specific distinctions from each other (Gläser and Laudel, 2010). An unstructured narrative interview might be initiated by a broad question focusing on the central theme, leaving the interviewee with no further restriction than to talk about this topic and his story, mentioning whatever aspects they think are of interest while the interviewer may follow-up for clarifications (Bryman, 2012).

4.3.1.1 Experts and expert interviews

There is no way one can give a solid definition of what the classic expert is like. Depending on whatever research area and topic is looked at, experts comprise varying needs, interests, knowledge and characteristics. Hence, in principle, a human being is classified an expert whenever they are involved in the field to be explored, has acquired knowledge going beyond general knowledge, is in possession of information that point to answering research questions or simply knows how to access information via networking, for instance (Meuser and Nagel, 2005). Thus, a person having gained knowledge about a disease currently being fought, is as much of an expert in their respective field as a teacher working with hyperactive pupils or a friend worrying about another friend's destructive behavior. The constant among these cases is the context, whereas people can share their different perspectives and experience on one-and-the-same topic.

Expert interviews which will be used throughout this thesis cannot be sharply divided into either category of semi-structured or unstructured interviews. In general, they are regarded as highly controversial within qualitative research, especially criticized are influential factors brought up by the interviewer (Bogner and Menz, 2005). Plus, according to Bogner and Menz (2005) they can not even be clearly seen beyond the structured interview type since Delphi-methods comprising a standardized structure are within the subset of expert interviews themselves. However, belonging to the general class of qualitative interviews (Bryman, 2012) it might be worth seeing the expert interview as some kind of a combination between semi-structured and unstructured styles.

4.3.2 The process of interviewing

An interview process is broken down into several phases, namely planning and preparation of the interview, a preliminary and entry phase, actual conductance of the interview along with adaequate taping / recording, exit phase of the interview as such, the discharge and the taking notes to conclude the process. These aspects are about to be outlined in further detail below. Unless specifically cited otherwise, this section refers to Bortz and Döring (2006).

Planning and preparation in terms of contextual matters means familiarizing oneself with the research topic as such, specifying the interviewing technique, deciding on a number of interviewers (Hove and Anda, 2005), identifying relevant interviewees and establishing an interview guide as in preparing questions to be asked. The administrative part of the planning phase centers upon scheduling time, date and location of interviews as well as planning what recording devices to use and the like. Depending on the number of interviewers taking part in the study,

up-front meetings should be held, in order to coordinate and discuss planned strategies well ahead of time (Hove and Anda, 2005).

The **preliminary or entry phase** of each interview acts as some sort of an ice-breaker. The interviewee ought to be engaged in small-talk in order to establish atmosphere that is comforting, invites to talk freely and positively influences the situation for both interviewer and respondent. Besides introducing the aim of the research, a promise for confidentiality is to be given to the interviewee, while being granted with the permission to tape the conversation.

During the **actual interview** it is essential for the interviewer to listen carefully, so, that follow-up questions can be directed towards the interviewee. A key factor is how to shape the interaction between interviewer and interviewee (Hove and Anda, 2005). While repondents may appear relatively silent, shy, not willing to share too much information on the one hand, as well as too talkative on the other hand, it is up to the interviewer to steer the course of the communication into a desirable direction that is fruitful for the research question at hand (Hove and Anda, 2005). Additionally, it should be ensured that recording devices used are indeed working properly during the conversation to avoid unanticipated loss of data. Besides the actual verbal communication, specific attention should also be drawn to nonverbal communication, such as gestures, mimics, pauses or possible interruptions.

After the official interview has ended, which is marked by turning off any recording devices, the interviewer needs to continue being focused as to many aspects or details may be revealed by the interviewee that are of importance. The interviewer ought to show his gratitude toward the interview partner for his time and effort, talk about organizational follow-up matters offering information about the research and further steps planned.

Having left the stage (Myers and Newman, 2007) the interviewer should summarize the course of the interview. Besides taking notes regarding the general atmosphere, respondent's behavior or occurring interruptions, considerable effort as well as amount of time need to be spent upon transcribing the conversation to prepare for subsequent data analysis (Hove and Anda, 2005).

4.3.3 Challenges and pitfalls

Upon conducting interviews a variety of issues and problems may arise. Research reveals that very few studies actually do address major pitfalls which are likely to occur while interviewing people and may even lead interviews into wrong directions. Several major barriers are identified in using qualitative interviews. A few of them are summarized below.

4.3.3.1 Trust and time issues and artificiality

Interviews often take place in artificial settings. Interviewer and interviewee often do not know each other, which makes it difficult to retrieve sensitive information. On the one hand, this might compromise the entire research. On the other hand, interviewers may not get to observing behavior in real-life situations. Hence, they have to trust in what interviewees reflect on past activities, usual behaviors and workflows. On top of that, the time-limit in interviews puts additional pressure on interview partners regarding collecting and expressing their thoughts and opinions on specific matters.

4.3.3.2 Level of entry

Different levels among employees / employers within the organization need to be considered upon planning interviews. While entering at a lower level might prevent the researcher from getting in touch with the higher management area, a similar outcome may be expected if the situation were the other way round.

4.3.3.3 Hawthorne effects

The interviewer does not play a detached and neutral role but rather acts as an influential factor with respect to repondents' reactions and the course of the interview / conversation as such (Fontana and Frey, 2000) cited after Myers and Newman (2007). People may change their behavior, react differently on being questioned because they are part of a study, research, observation or the like.

4.3.3.4 Constructing knowledge

An interviewer does not purely retrieve information during the conversation. Rather, they play a part in actively constructing new knowledge by asking questions an interviewee might not have considered before.

4.3.3.5 Ambiguity

Certain words comprise several meanings and every person may assign a different meaning to one-and-the-same word. Thus, words or rather language are ambiguous. This becomes even more evident when people with different backgrounds, different applicational domains are communicating. The possibility that either language is not understood, not communicated properly or even has conflicting meanings in different fields of expertise is high.

4.3.3.6 Interviews can go wrong

Research warns about the non-neutral entity role of the interviewer. Statements can easily offend an interview partner, poorly expressed questions or gestures and mimics may influence and steer an interviewee's responses into directions / opinions imposed on the respondent during the conversation. In the worst case, it may lead to interruption and in-between cancellation of interviews, unintended harm of respondents (DiCicco-Bloom and Crabtree, 2006) or poor gathering of data material which does not necessarily reflect the true nature in opinion of an interviewee.

Additionally, Myers and Newman (2007) propose a dramaturgical model for conducting qualitative interviews since the process resembles a drama being performed on stage. The conversation equals some kind of a script presented by various actors towards an audience. It, furthermore, inherits certain dramaturgical properties and includes entry and exit scenes that surround the actual performance.

4.3.4 Qualitative (Content) Analysis

One can analyze qualitative data content, be it interviews, be it observations written down by the researcher, be it video material, in both quantitative as well as qualitative ways. A quantitative analysis of qualitative content will eventually result in statistical findings, measurements as in number of occurrences and such. Qualitative analysis does not put results into numbers. Rather, it processes a text via establishing categories of interest and subsequently interpreting its output. Numerous approaches on how to perform qualitative analysis are available and well-known to researchers in the field, such as qualitative content analysis as defined by Mayring (Mayring, 2000) or grounded theory (Glaser and Strauss, 1967). Both methods employ a coding mechanism which is concerned with establishing a criteria catalogue of key points for the research. Relevant criterias can be established before even conducting the interview (deductive approach) as well as be derived from the content at hand (inductive approach). In its ideal form both approaches are completely separated from each other. Hower, in practice, a combination of both approaches is more feasible (Bortz and Döring, 2006).

Unlike content analysis by Mayring, grounded theory will be explained in more detail. It will serve as the analysis strategy of choice for three reasons. First, since little is known about the subject of NSSI, its mobile assessment and therapy, preformulated ideas of what might be important are existent, however, knowledge needs to be constructed at great length. Second, grounded theory is an inductive approach that serves the very matter to generate knowledge that is grounded in the data gathered without getting stuck in preexisting concepts (Halaweh, 2012). Third, trends of using grounded theory in the discipline of information science is apparent in research according to Urquhart, Lehmann, and Myers (2010).

4.3.4.1 Content analysis by Mayring

As has already been mentioned in above paragraph in the context of coding two basic approaches in doing qualitative content analysis are available (Mayring, 2000).

Inductive category development actively uses the underlying data material gathered in order to identify and, subsequently, iteratively refine categories of interest. As a result of the refinement process, categories can either be grouped together or divided up further and may consequently be used with respect to quantitative analysis as well (Mayring, 2000).

Deductive category application centers upon preformulating a framework as in establishing categories of interest prior to collecting data. The qualitative material is then used for looking up instances of these concepts in an iterative fashion. Thus, the data are associated with the preexisting codes (Mayring, 2000).

4.3.4.2 Grounded theory (in information science)

Grounded theory (GT) refers to a process of figuratively wading through, respectively, interpreting collected material - without further setting up restrictions to solely use either qualitative or quantitative data (Glaser and Strauss, 1967) - in order to identify new knowledge or hypotheses that are grounded by empirical data. The method originated from a dissemination called "The Discovery of Grounded Theory" in 1967 by Glaser and Strauss (1967) and has grown into a variety of definitions and uses. Upon a split among the original authors each of them developed the method further. However, the characteristics underneath grounded theory have diversified and how to follow GT depends on whose approach is being pursued (Halaweh, 2012). A prerequisite upon using the grounded theory method is to loose any prior assumptions on patterns, characteristics, attributes to be found within the data (Urquhart, Lehmann, and Myers, 2010; Halaweh, 2012). Thus, researchers need to start with a somewhat clean slate to ensure a "grounding" of new theory without any injection or interference of the actual data collected (Urquhart, Lehmann, and Myers, 2010). However, the main purpose of the clean slate is to avoid using GT as a method to agree or reject "preformulated hypotheses", but, rather focus on the essential part of using the GT method to "enhance the theory, widen its scope or in other ways improve it" (Urquhart, Lehmann, and Myers, 2010, p. 360). Coding is a fundamental step in GT (Halaweh, 2012). Adhering to the methodology of Strauss and Corbin (1990) it consists of open, axial and selective coding. This coding approach will be followed throughout the analysis of conducted interviews within this thesis:

Open. Open coding is concerned with exploring the qualitative data in order to identify concepts and ideas from it. Comparison of similar phrases and expressions among several interviews are assigned to the same concept or idea.

Axial. Axial coding is then performed on the established dimensions to find relationships, such as pre- and postconditions, causal associations, context and to establish a hierarchy among the concepts.

Selective. Subsequently, selective coding is about building up the theory by revealing the core concept, i.e., the idea which is repeatedly found in the data, refining additionally uncovered concepts and as a consequence, identify them in their respective relation to the main theme of the research.

Also, Urquhart, Lehmann, and Myers (2010) propose guidelines as to how grounded theory can be fruitfully applied in the information science discipline:

First. The first step comprises the core concept of ***constant comparison*** and is thus named likewise. Data, codes and categories are to be compared in terms of their varying instances. Thereby, they are refined and build a more stable theoretical fundament.

Second. Subsequently, ***iterative conceptualization*** centers on identifying and building relationships between categories by theoretical coding and writing up theoretical memos. In the latter, one reflects about experience gathered from the interview, impression the respondent left on the interviewer, questioning of ideas that have existed prior to the interview (Sbaraini et al., 2011). One can also reason about codes and compare memos against each other. Varying approaches in iterative conceptualization have been established by Strauss and Corbin (1990), Glaser (1992) and Charmaz (2006).

Third. Step three during grounding theory in information science is entitled ***theoretical sampling***. Its aim is to achieve saturation in the theory being developed, whereas saturation means that codes and categories should be "well represented by many instances in the data" (Urquhart, Lehmann, and Myers, 2010, p. 372). Thus, the theory as such is deepened.

Fourth. Following theoretical sampling leads towards the step of ***scaling up***. The level at which coding strategies are performed can be both helpful and hindering at the same time while looking for grounded theory. Focusing on word- or sentence-levels may reveal a plethora of details but also hamper one's ability on seeing the bigger picture (Urquhart, Lehmann, and Myers, 2010). To overcome the cost of getting lost in too much detail the positive effect of "grouping high-level categories into larger, broader themes" is mentioned (Urquhart, Lehmann, and Myers, 2010, p. 372).

Fifth. Consequently, ***theoretical integration*** concludes the grounded theory guideline. Putting the formalized and established theory into context depicts a necessary action as in comparing the theory to other theories from the same area of research. Needless to say, that the proposed guidelines yield a creative mind and are no strategy to be rigidly adhered to.

5 Requirements Engineering

"Ours is a world where people don't know what they want and are willing to go through hell to get it."

— Don Marquis (1878-1937)

Requirements Engineering (RE) is a systemic approach involving various perspectives from different stakeholders, while accompanying the software engineering process along its various phases (Phandey, Suman, and Ramani, 2010). In order to address changes and evolution of requirements iterative RE approaches are proposed. Upon doing so, not only developing but also managing requirements is critical to be performed in an incremental, iterative fashion (Phandey, Suman, and Ramani, 2010).

Unlike adhering to somewhat traditional, but, rather, rigid software development life cycles, compare the waterfall model or V-Model (Rupp and SOPHISTen, 2009), one can benefit from applying agile methods in software engineering to the RE process as a whole, more specifically, to particular RE phases (Cao and Ramesh, 2008). To that extent, permanent communication with users upon starting a new development cycle - as is common in agile processes (Cao and Ramesh, 2008) - lets requirements evolve and offers constant feedback, discussion and agreement among stakeholders.

Conforming to the "I'll know it when I see it" (IKIWISI) approach (Boehm, 2000), the combination of initial demos or prototypes with face-to-face interviews leverages a common understanding. Thereby, it is of no regard whether prototypes are mock-ups, already coded graphical user interfaces or simple paper sketches (Paetsch, Eberlein, and Maurer, 2003). The common understanding acts as a bridging mechanism as to what different parties - software developer, requirements engineer and user - are referring to (Cao and Ramesh, 2008; Boehm, 2000).

However, "stable", respectively, thoroughly documented requirements specifications are missing due to the agile methodological approach (Cao and Ramesh, 2008). Despite the fact that several companies adopted early prototyping as a successful means for agreeing upon requirements (Paetsch, Eberlein, and Maurer, 2003), it undergoes a lot of criticism. In particular, lack of formal RE documentation (Paetsch, Eberlein, and Maurer, 2003) and unrealistic expectations among users due to quick-and-dirty prototypes (Cao and Ramesh, 2008), as well as too little focus on non-functional requirements are reported (Paetsch, Eberlein, and Maurer, 2003).

This thesis mostly adheres to the RE phases as they are outlined in this chapter. However, a detailed work-trough as should be done in practice, such as managing requirements over time and iteratively validating/verifying them would exceed the scope of this project. Nonetheless, the author strives to address some of the aforementioned counts, such as IKIWISI and agile design cycles via supporting face-to-face interviews with initial prototypes in order to agree on requirements during elicitation and analysis as well as subsequent concept system design process. This approach shall justify the possibility for requirements adaptability, flexibility and change at a small scale (project) until a formal requirements specification has been established.

This chapters presents the IEEE definition of the term requirement, outlines typical requirements types and subsequently discusses the traditional RE process as in the set of phases and activities it provides. As a software requirements specification arises as an artifact along the RE process it will be discussed in theory. Then, UML is introduced in a nutshell for being used upon modeling requirements as well as Use Cases during the project's study. The chapter concludes

with a discussion of how and to what effects empirical research and Requirements Engineering intertwine.

5.1 Requirements

Adhering to IEEE (1990) a requirement is defined as follows,

> (1) A condition or capability needed by a user to solve a problem or achieve an objective.
> (2) A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents.
> (3) A documented representation of a condition or capability as in (1) or (2).

That is, not only are requirements an abstract identification of the functions a system is in need of. Rather, additional questions as to identify counts on what, why (are these aspects needed for incorporation into an existing environment, what advantages arise?), who (stakeholder analysis), when (traditional, incremental, agile approach during software development life cycle) and how (selection of available techniques, how do requirements associate?) (Westfall, 2005) are addressed.

5.2 Types of requirements

First and foremost, requirements are categorized into functional and non-functional requirements (Aurum and Wohlin, 2005). Thereby, functional requirements (F Req) describe the functionality of the system to be designed. Quality requirements or nonfunctional requirements (NF Req) (Jönsson and Lindvall, 2005) describe how or rather in what ways (Aurum and Wohlin, 2005) certain aspects of the system should be performed, such as how efficient should the system be, what are acceptable time limits during operation of the system. Apart from these common terms, requirements are classified as to who is the identifying stakeholder as well as to what is the applicable domain. Hence, user based requirements as well as business requirements, design requirements and security requirements do exist as well (Aurum and Wohlin, 2005), although the terms mentioned here do not represent an exhaustive list of all requirements available.

5.3 RE process

The process of Requirements Engineering is commonly subdivided into the stages *elicitation*, *modeling*, *analysis*, *validation / verification* and *management*. As the enumeration of phases within the RE process differs among literature this approach is geared to research by Cheng and Atlee (2007).

5.3.1 Elicitation

Eliciting requirements involves identifying the functionality the proposed or designed system has to offer, including user requirements, business objectives, aims of either the company or the software (Cheng and Atlee, 2007), as such. It is not only needed while starting off with a new project in an effort to build from scratch, but, rather, also when a software solution has already been in use but is intended to be modified due to problems, improved or enhanced in terms of new features (Nuseibeh and Easterbrook, 2000). Especially identifying system boundaries becomes important since they have a say in what aims or tasks are pursued further, which stakeholders are to be involved (Nuseibeh and Easterbrook, 2000). Hence, requirement elicitation is

a fundamental step and mostly represents the first thing to do in the RE process (Nuseibeh and Easterbrook, 2000). Several elicitation techniques are available to choose from depending on time and resources at hands (Nuseibeh and Easterbrook, 2000), as well as on aim of a sub-step that is being focused on during elicitation (Cheng and Atlee, 2007). For instance, if relevant stakeholders have not been identified, yet, one applicable approach on who to consult would be to build a network of stakeholders by starting out with a baseline and further exploration of interaction patterns (Sharp, Finkelstein, and Galal, 1999). That way, a web of stakeholders is spanned (Sharp, Finkelstein, and Galal, 1999) as a result of continuous refinement. There is no single way to perfectly and accurately elicit requirements (Hickey and Davis, 2003). Hence, although there are many methods available to choose from, there is no "one fits it all" solution (Hickey and Davis, 2003). That is just another reason of why it is paramount to think of what one needs and how one can reach this aim in the best way (Hickey and Davis, 2003). Also, misunderstandings and other difficulties in communication assign requirements elicitation a critical role. This is because large errors may be generated which in turn affect subsequent phases in the RE process (Zowghi and Coulin, 2005).
A multitude of techniques to gather requirements is available (Nuseibeh and Easterbrook, 2000). Traditional techniques include interviews and questionnaires, model-driven techniques subsume goal- and scenario-based methods, cognitive techniques comprise card sorting or repertory grids. In addition, prototyping and ethnographic techniques may be handy. A few strategies - KAOS, Joint Application Development (JAD), Interviews and CREWS - are described below in some more detail. The section JAD refers to Wood and Silver (1995), and CREWS mainly refers to Weidenhaupt et al. (1998).

5.3.1.1 KAOS

Acquiring requirements has already been labeled a strenuous and complex task (Lamsweerde, 2008). Formal methods help engineers to make them precise and unambiguous (Dardenne, Lamsweerde, and Fickas, 1993).
The KAOS methodology, i.e., Knowledge Acquisition in autOmated Specification (Dardenne, Lamsweerde, and Fickas, 1993) later on extended to Keep All Objectives Satisfied (Lamsweerde, 2008) uses a goal-based approach upon collecting requirements (Nuseibeh and Easterbrook, 2000). It incorporates multiple views that are derived from a goal model (Lamsweerde, 2008) and enables to capture and specify F Reqs as well as NF Reqs by means of meta-level concepts and formal notations (Dardenne, Lamsweerde, and Fickas, 1993).

Thereby, goals depict several objectives that have to be met by the system. These pertain to certain acquisition strategies that employ agents, actions, entities, relationships, contraints and many more. Meta-level concepts enable temporal constraints as well as pre- and post-conditions for actions to take place. By traversing through the meta-level model, domain-level concepts and subsequently real instances thereof guide a well-formed requirements acquisition model and process, compare Dardenne, Lamsweerde, and Fickas (1993).

5.3.1.2 JAD

JAD brings together information system (IS) specialists as well as business oriented people who are the stakeholders for the product to be designed. It typically results in a workshop lasting up to five days, whereas a designated person facilitates the communication. The aim is to define high-level requirements, functions and needs leaving out lower-level details, as in technical issues, with the intention of reducing typical communication errors like misunderstandings. Additionally, this method is used to overcome the challenges in terms of changing requirements after reconsiderations. JAD is a well-structured method, albeit main aims of the system have already been discussed before collaborative sessions with stakeholders take place, which distinguishes it from typical brainstorming approaches (Zowghi and Coulin, 2005).

5.3.1.3 Interviews

Interviews are frequently used techniques upon requirement elicitation (Hickey and Davis, 2003) with the main objectives to gain new information, reveal conflicts and deal with political issues. As they have been introduced and outlined earlier in this thesis, read section 4.3 *Interviews*, and are the key factor for the empirical study in this project, they are mentioned here but will not be further elaborated on.

5.3.1.4 CREWS

CREWS[1] classifies a framework for a scenario-based approach (Nuseibeh and Easterbrook, 2000). "Scenarios present possible ways to use a system to accomplish some desired function" (Weidenhaupt et al., 1998, p. 34). Within this framework they (scenarios) are well described based on the four columns form, contents, purpose, and life cycle. The latter two aspects which are concerned with the aim a scenario has been constructed for and the evolution and management of a scenario are attributed higher importance, in practice. It has been found that scenarios supported by prototypes support communication with users, rather, than utilizing abstract models. In addition, prototypes can reveal misunderstood or ill-defined requirements and scenarios.

Regarding strengths and weaknesses Zowghi and Coulin (2005) elaborated on combining elicitation methods, furthermore, declaring some of them as either complementary or alternative approaches via criss-crossing the available strategies. For instance, prototyping is seen as an alternate method to interviews and domain analyses, while it may be used complementary to group elicitation techniques, ethnography, goal- and scenario based approaches.

5.3.2 Modeling

In order to talk about the specific modeling part of the RE process, it is necessary to offer a notion of the term model. In its most basic definition, a model is an abstract representation of the real world, thus, it maps the real-world onto functions and behaviors of a proposed system (Rumbaugh, Jacobson, and Booch, 1999). Models are built in order to make the understanding of the world more feasible, also, impacts caused by changes can be tested in theory. They can be represented in formal, semi-formal or informal notation (Nuseibeh and Easterbrook, 2000), whereas the level of abstraction and detail depends on a model's purpose as well as the progress along the development lifecycle (Rumbaugh, Jacobson, and Booch, 1999).

Requirement elicitation and modeling are understood to be interdependent (Nuseibeh and Easterbrook, 2000). The main objective of the modeling phase is to represent elicitated requirements more clearly than natural language can do (Cheng and Atlee, 2007). By abandoning the informal notation of language a higher abstraction level with respect to system functionalities and aspects is reached. Thus, a transformation of user requirements into system requirements takes place serving several purposes. The model is closer to the solution domain which then enables and eases refinements in the design phase of the software lifecycle (Machado, Ramos, and Fernandes, 2005). Also, it is confirmed that it captures system requirements pretty concisely and unambiguously (Cheng and Atlee, 2007). Due to the highly conceptual and abstract level one refers to these sort of models as meta-models (Machado, Ramos, and Fernandes, 2005). By means of their language, which holds certain properties, it is reasoned that the entire meta-model itself satisfies unambiguity.
Another approach in modeling follows incorporation / combination of multiple views (Machado,

[1] CREWS is an acronym for Cooperative Requirements Engineering With Scenarios. Compare Haumer (1999) for more information on the project.

Ramos, and Fernandes, 2005). That way, several system perspectives can be merged, for instance by using Unified Modeling Language (UML).

Due to its nature UML supports activity diagrams, class diagrams, state diagrams, sequence-diagrams, hence offers to represent a functional view, as well as represents the anticipated behavior of the system, what data will be needed in an effort to design the software, thus covers what one defines a multiple view approach. Use Cases written in UML also come in handy when transformation from user requirements towards system requirements should take place. Comprising actors, relationships and activities they do accurately capture requirements users expect from the system, as such. A definition as well as characteristics of UML will be outlined in Section 5.5.

Basic models used in requirements modeling are functional, data, behavioral models (Hofmann, 2000), enterprise modeling, domain modeling; modeling of nun-functional requirements add up further to the "bag of techniques" (Nuseibeh and Easterbrook, 2000). However, in that matter it is to mention that NF Reqs are difficult to grasp, which is partly why recent research has especially focused on modeling and analysis of NF Reqs (Chung and Prado Leite, 2009). Cheng and Atlee (2007) take this concept further and mention generic solution patterns for issues inherent in modeling. Promising trends are also shown in scenario based models (Whittle and Schumann, 2000; Uchitel, Kramer, and Magee, 2003; Alfonso et al., 2004).

5.3.2.1 What is a functional model?

A functional model describes the functions a system needs to provide, sometimes in an effort to be integrated into an existing environment, whereas functions are organized in hierarchical tree structures (Hofmann, 2000). The root of a tree is the most generic function, while traversing alongs its paths down to the leaf nodes results in more specific and detailed functions of the system.
The majority of functional models combine data flow diagrams (DFD) and data dictionaries (Hofmann, 2000). Thereby, DFDs represent the hierarchy while the dictionaries show data stores and flows in-between (Yourdon, 2006). Basic components of a DFD are processes which interact with data stores by means of data flows. So called terminators represent sources and destinations of, respectively, for data. An example of what a DFD might look like is shown in Figure 5.1 (Yourdon, 2006, p. 171). The main process is the bubble labeled market research system. Data flows represented by arrows are annual reports, 10-K reports, and research data. They originate from the data sources (depicted as rectangles) corporate clients, SEC, and research organizations and subsequently contribute as input variables to the market research system process. After that, the market research system processes these information to generate market data which are in turn archived in their corresponding data store (rectangular form with only two horizontal parallel lines shown). As a consequence, the customer acts as the designated terminator by receiving the market data. He is considered as the data flow destination (Yourdon, 2006).
Hofmann (2000) states that Structured Analysis and Design Technique (SADT) is another form of a functional model that is widely cited in research.

5.3.2.2 What is a data model?

Software systems include and generate a lot of information which is why their underlying data structure needs to be specified and well-documented. It is important to know what information needs to be handled, which relationships are existent between them, how they can be accessed and the like. These things are accurately addressed in data models (Nuseibeh and Easterbrook, 2000). Due to their extensive use in the software engineering discipline, entity relationship diagrams (ERD), respectively, entity relationship models (ERM) are well-known data-models (Hofmann, 2000). An ERM illustrates the entire structure of a system at a conceptual or a logical

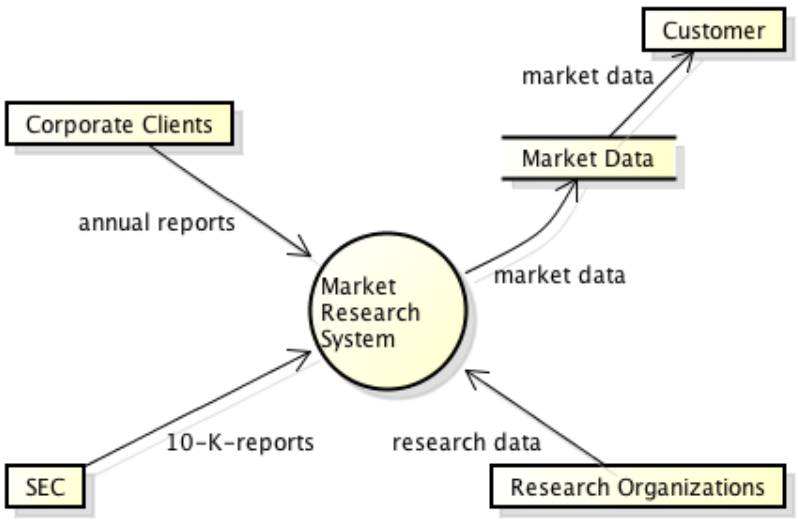

Figure 5.1: A data flow diagram centering upon a market research system is shown, whereas *corporate clients*, *sec*, *research organizations*, and *customer* represent terminators, market data reflects a data store, the arrows labeled *annual reports*, *10-K reports*, *research data*, and *market data* show data flows from and to the process labeled *market research system*. Figure taken and adapted from Yourdon (2006, p. 171).

level by providing different concepts, such as entities, relationships, cardinalities (one-to-many, many-to-many, etc.), generalization / specification, roles, attributes.

5.3.2.3 What is a behavioral model?

The focus of behavioral models is on "the dynamic or functional behaviour of stakeholders and systems, both existing and required" (Nuseibeh and Easterbrook, 2000, p. 41). Methods addressing the technique of behavioral modeling involve object-oriented methods, for instance UML, ranging down to structured methods, whereas the ultimate aim is to leverage automated analysis (Nuseibeh and Easterbrook, 2000). Additionally, one can distinguish between soft, semi-formal or formal methods, that lead to increased abstraction, also differing in precision of depicting a behavior, albeit soft methods offer adaequate methods for being understood by non-technical stakeholders. Unlike semi-formal or formal languages, soft methods lack the possibility for automating analysis (Nuseibeh and Easterbrook, 2000).

5.3.3 Analysis

This stage of the RE process includes multiple activities addressing, for instance, ambiguity, inconsistency and incompleteness (Cheng and Atlee, 2007). Other tasks involve removal of missing assumptions, resolving misunderstandings, analyzing impacts and interdependencies, performing prioritization, thus, also cost and risk analysis (Berander and Andrews, 2005) and visualizing requirements (Cheng and Atlee, 2007). Of additional importance is the negotiation of requirements. In particular, with a lot of different stakeholders, the tendency of disagreement is quite high. Resolving occurring conflicts can reveal potential for improvement and acceptance for the product itself (Grünbacher and Seyff, 2005).
Nuseibeh and Easterbrook (2000) communicate that requirement models offer an adequate starting point for the subsequent analysis since formalisms / strategies can be automated, models can be reasonably checked. These tasks already give way to the validation and verification stage.

However, many techniques mentioned in here are not supposed to be performed only once as if analysis were a static stage, but rather, need to be reviewed and redone in an iterative fashion (Grünbacher and Seyff, 2005).

5.3.4 Validation / Verification

In an effort to aggree on (or discard, if necessary) requirements they need to be validated and verified (Hofmann and Lehner, 2001). These two terms comprise an important distinction from each other. Validation asks as to whether the right requirements as identified by stakeholders have been elicitated and modeled, meaning that modeled requirements actually do meet the needs and desires stakeholders had in mind. While, on the other hand, verification is concerned with the question if the requirements have been modeled right, i.e., are the requirements models actually related to the specification (Cheng and Atlee, 2007). One way to verify requirements is by means of model checking which, in principle, aims at an automated technology to perform that step.

5.3.4.1 Verify requirements

Many areas in life, for example aeronautics or equipment in the health care sector, comprise so-called critical systems. Failures in development of these systems or failures during operational use may result in physical harm, at its worst, even threaten human life. Hence, systems are in need of real-time requirements and despite their complexity, they need to be verified with thorough care to ensure reliability. This can be performed by computer aided verification and model checking. One such approach was proposed by Alfonso et al. (2004). In order to model check and verify real-time-requirements a graphical time scenario approach was developed. Visual timed event scenarios (VTS) provide a language fulfilling two purposes. First of all, requirements can be modeled as scenarios. Secondly, the constructed scenarios comprise properties which - by walking through simulated series of events - can either confirm or reject the underlying requirement. Its advantage to time-based-descriptions by means of formal specification is greater perceivability.

A simple example of a VTS scenario, taken from Alfonso et al. (2004, p. 170), is outlined in Figure 5.2. It describes that after an event stimulus *e* has taken place, events *r1* and *r2* occur subsequently. The dashed line between *response1* and *response 2* labeled ¬ *[20,100]* describes that responses *r1* and *r2* are separated by a time interval. In addition, this time intervall shall not lie between 20 and 100.

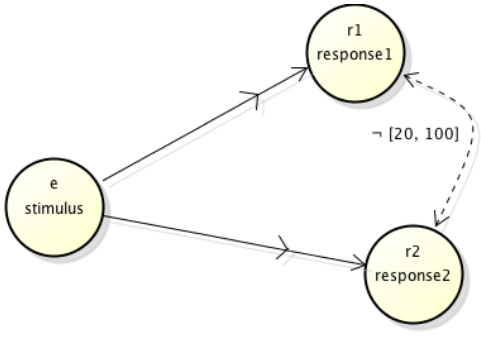

Figure 5.2: A VTS scenario describes event responses *r1* and *r2* taking place subsequently to an event stimulus *e*. The responses are separated via a predefined time interval that ought not be within 20 and 100 given time-units. Figure taken and adapted from Alfonso et al. (2004, p. 170).

The VTS patterns in Figure 5.2 show a scenario following a negative approach. This means, if an event-sequence satisfies the negative scenario, the requirement is violated, as a consequence.

If the available event-sequence does not satisfy / agree with the depicted VTS it successfully confirms / meets the requirement. If a requirement is not fulfilled a system that produces the related event-sequence would be rejected.

Adhering to examples given by Alfonso et al. (2004), two event-sequences are constructed in order to be able to work through a basic scenario.

$$\begin{array}{lcccccccc} s1:\ldots & e & a & r1 & c & d & x & r3 & r2 & \ldots \\ & 5 & 10 & 22 & 59 & 81 & 104 & 136 & 137 & \end{array}$$

$$\begin{array}{lcccccccc} s2:\ldots & e & z & y & x & r1 & a & r2 & r3 & \ldots \\ & 18 & 44 & 45 & 46 & 52 & 56 & 73 & 80 & \end{array}$$

Herein, looking at the temporal distance (in sequence s1) between responses r1 and r2 after an event stimulus e has already occured, distance $d_{s1} = 137 - 22 = 115$. Therefore, the event sequence s1 satisfies the VTS scenario shown in Figure 5.2. Likewise, event sequence s2 needs to be analyzed. The temporal distance $d_{s2} = 73 - 52 = 21$, hence, violates the temporal restriction illustrated in Figure 5.2. As a consequence, a system producing event sequence s1 would be rejected, while system yielding event-sequence s2 would prove successful upon conforming to the presented negative scenario.

5.3.4.2 Validate requirements

Unlike formal or automated requirements and software verification, the validation of requirements often involves the customers themselves. A couple of techniques have been proposed by various researchers (Hofmann and Lehner, 2001; Rupp and SOPHISTen, 2009; Denger and Olsson, 2005) as to how such a validation can be carried out.

By means of peer reviews, audits, walkthroughs and scenarios, inspections (Denger and Olsson, 2005), prototyping and simulation requirements can be validated (Hofmann and Lehner, 2001; Rupp and SOPHISTen, 2009). Additionally, requirements-based-testing is a method to test the quality of requirements, albeit their natural language specification. Level of abstraction as well as level of formality of these approaches can vary (Rupp and SOPHISTen, 2009). Validation provides an important outcome in terms of acceptance tests (Denger and Olsson, 2005), and, further, yields a basis for verification processes (Rupp and SOPHISTen, 2009).

Pros and cons of aforementioned validation and potential verification strategies are listed in Table 5.1 and refer to Rupp and SOPHISTen (2009) and Hofmann and Lehner (2001).

keyword	pro	con
peer review (Hofmann and Lehner, 2001)		
	* provides a common understanding * mentoring benefits * knowledge transfer	* expertise of the application domain and specification standards needed
audit (Hofmann and Lehner, 2001)		
	* different stakeholder perspectives	* effort in time and preparation
walkthrough and scenario (Rupp and SOPHISTen, 2009, pp. 295–296)		
	* issues can be resolved quickly * common understanding	
		* focus can be set by moderator * skills to find right balance in moderation * no re-tests, re-inspection of identified issues
inspection (Rupp and SOPHISTen, 2009, p. 297)		
	* leverages finding issues * efficient due to formal process	
		* high costs and time effort * duration of inspection is a factor * skills and experience necessary for inspection lead
prototyping and simulation (Rupp and SOPHISTen, 2009, p. 298)		
	* easily understandable / imaginable for users * focus is on look-and-feel * facilitates discussion	
		* effort in time and work * risk of unnecessary detail

Table 5.1: Techniques for verifying and validating requirements are outlined including their specific pros and cons. Information presented refers to Rupp and SOPHISTen (2009) and Hofmann and Lehner (2001).

Another aspect in validating and verifying software requirements is quality assurance (QA). To that extent several quality metrics are at hand to engineers in that field to measure quality as well as identify potential risk factors on a quantitative basis (in order to gain objective reasoning) (Rupp and SOPHISTen, 2009). One of the many metrics available is concerned with ambiguousness and relates to the power of linguistic expression (Rupp and SOPHISTen, 2009). Thereby, it is noted whether comparative words offer a point of reference (denoted PoR), all the terms used are defined (TDef) somewhere within the specification and whether "process words" are unambiguously (denoted PWo) as well as completely defined (p. 319). A metric proposed by Rupp and SOPHISTen (2009) is shown in Equation (5.1), whereas *u, v and w* are weighting factors that sum up to the numeric value of 1 but are defined as matters to the project or company, NoS denotes the number of sentences a specific requirement is expressed with.

$$unambiguity = \frac{u * PWo + v * PoR + w * TDef}{NoS} * 100 \qquad u + v + w = 1 \tag{5.1}$$

Upon walking through a theoretical example, if Equation (5.1) yields a value of 75%, 25% of specified requirements are at risk of being either misunderstood or not adhering to initial requirements set by customers. Further metrics involved in QA are classifiability, completeness, identifiability, sortability, non-redundancy (Rupp and SOPHISTen, 2009).

5.3.5 Management

As requirements engineers need to face the fact that requirements are constantly going to change and will be used later on for a variety of different purposes or perspectives in the scope of the project, management of requirements becomes fundamental. The establishment of a well-defined RE concept is a much needed artifact in this context and ought to be set up prior to elicitating any requirements, at all. Thus, the concept aims at being a companion and guide throughout the entire lifecycle of a requirement (Rupp and SOPHISTen, 2009). Amongst others, it contains requirements uniquely identified by for instance, Object Identifiers (OID), relationships towards other requirements, relevant stakeholders and roles as well as their permissions to create, alter, view requirements, meta-information about requirements, e.g., state, maturity, requirements history and version management, definition as to what states are reachable for specific requirements as well as to how these states can be reached. Details can be found in Rupp and SOPHISTen (2009). Different requirements management tools are available for support and encouraged to use, rather, than relying on common tools for office management.

Requirements traceability is, yet, another key term that is attributed paramount importance in the scope of managing requirements. In order to make clear that requirements depend on and interplay with other requirements, links need to be established (Hofmann and Lehner, 2001).

Gotel and Finkelstein (1997, p. 170) state that requirements traceability is

> the ability to describe and follow the life of a requirement in both a forwards and backwards direction (i.e., from its origins, through its development and specification, to its subsequent deployment and use, and through periods of on-going refinement and iteration in any of these phases). It is considered the primary technique to help with many project-related activities, like ensuring that systems and software conform to their changing requirements, but is commonly cited as a problem area by practitioners.

Research (Hofmann and Lehner, 2001) additionally identified tracing of artifacts and tracing of arguments in the context of requirements traceability. While artifact tracing is mainly concerned

as to what documents originating along specific phases of the software process are interlinked with requirements, the tracing of arguments centers on decisions being made as to why requirements are changing, why they are existent (Hofmann and Lehner, 2001). Thus, the latter aims to facilitate a common understanding among different disciplines (Hofmann and Lehner, 2001), unlike the former that intends to build a relationship structure for finding associated documents.

5.4 Software Requirements Specification

A Software Requirements Specification (SRS) is an artifact emerging and evolving throughout the RE process and basically comprises a description of the anticipated system in terms of "what does the system do?", "what does it not do?", "how are these functions enabled?", "how is the system incorporated into existing business processes and interfaces?" (Abran et al., 2004). That way, functional as well as non-functional and boundary requirements are outlined in natural language. A combination with formal or semi-formal notations (Abran et al., 2004), e.g., via UML that is introduced in the upcoming section, is used quite often to make the specification as clear, precise and unambiguous as possible.

SRS is a standard that has been introduced by the IEEE Computer Society (IEEE, 1984). Templates are available in several flavors and depend on a company's policy as well as on the project at hand (Le Vie, 2010). Here, a specific template (Stellman and Greene, 2005) is introduced that includes the following information.

1. **Introduction:** this section comprises information regarding purpose, scope, system overview and references of the project and the document themselves.
2. **Definitions:** terms being used are to be defined, e.g., by support of a glossary.
3. **Use Cases:** all Use Cases are numbered, described and listed in this section in a tabular form.
4. **Functional requirements:** each functional requirement is given a number and name, may link to Use Cases, other requirements and is described in detail in this section.
5. **Non-functional requirements:** compare above with respect to non-functional requirements.

Ten aspects (Le Vie, 2010) indicate as to what defines high-quality in a SRS, apart from documenting what the user really wanted. These characteristics involve completeness, consistency, accuracy, modifiability, ranking, testability, traceability, unambiguity, validity and verifiability. At least *correctness, completeness, ambiguity, consistency* as well as *verifiability* should be thoroughly tested in order to propagate QA at an early stage during the RE process (Denger and Olsson, 2005).

A simple form of a SRS comprising a Use Case based approach, supplemented with UML diagrams, will be elaborated in the course of this project. Since the scope of the project, as well as definitions are anyway presented in this thesis, a SRS-outline in here will focus on Use Cases, functional and non-functional requirements solely. These can be read up on in Chapter 7.1, Chapter 7.2 and Chapter 7.3.

5.5 Unified Modeling Language

The UML originated as a graphical modeling language intended for a wide range of purposes. Since then it has been adopted by the Object Management Group (OMG) (Rumbaugh, Jacobson,

and Booch, 1999) and became an international standard ISO / IEC 19505 (Object Management Group, 2011). Many authors have collaborated, thus, UML is constantly evolving, and, as of today, available at version 2.4.1 as most recent official formal specification (Object Management Group, 2011). It offers an object-oriented methodology / view and provides requirements as well as system and software engineers with a range of tools to visualize, analyze, model business processes, requirements (Rupp and SOPHISTen, 2009), software, certain aspects, thereof, and the like (Object Management Group, 2011). Common UML diagrams used in RE are (Rupp and SOPHISTen, 2009):

- **Use Case Diagrams** show the view on a system and comprise certain boundaries. Scenarios and functions to be performed within this scope are initialized by actors / other systems.
- **Activity Diagrams** illustrate various activities being processed without offering temporal information.
- **Sequence or Interaction diagrams** show interactions and communication occurring between systems / interfaces / users depending on the context in question. The temporal component is inherent in these types of diagrams due to chronological order of communication. Interactions are performed by means of asynchronous and synchronous communication. That way "blocking-modes" as well as concurrent sending of messages and objects are enabled.
- **State-Chart Diagrams** identify states to be inherited by data as well as events triggering a transition from one state to the other.
- **Class Diagrams** or ERMs aim to illustrate objects / classes, attributes they are comprised of as well as their interrelations with each other. It is a much more abstract concept on software requirements than a Use Case Diagram, and offers great support for system developers and architects.

Glinz (2000) identified several deficiencies upon using UML as a tool to visualize aspects throughout the RE process, whereas an alternative to overcome these issues is yet to be proposed. However, UML is widely accepted in the software engineering discipline (Glinz, 2000). Hence, it has been considered as an appropriate tool to support the RE process by modeling and visualizing requirements as part of aforementioned SRS throughout this thesis.

5.6 Discussion

The association between qualitative research - in particular, the use of GT - and requirement analysis is well described in research (Halaweh, 2012). By analyzing gathered interviews, questionnaires or observational data grounded theory is capable of deriving sound requirements. Furthermore, research (Halaweh, 2012) suggests that barriers in the RE process such as poor development of requirements due to misunderstanding, poor communication between people coming from different problem domains can be overcome. Thanks to the reiterative coding approach of GT depicted in Figure 5.3, identifying and refining requirements during qualitative analysis is leveraged.
A similar workflow is proposed by Urquhart, Lehmann, and Myers (2010) who establish guidelines upon conducting grounded theory in building information systems, compare Chapter 4.

Hence, a lot of positive attention has been drawn to combining qualitative research in identifying socio-technical system aspects. However, certain drawbacks have been reported. GT leaves low-level aspects of the system - as in technical requirements - untouched and rather focuses on a

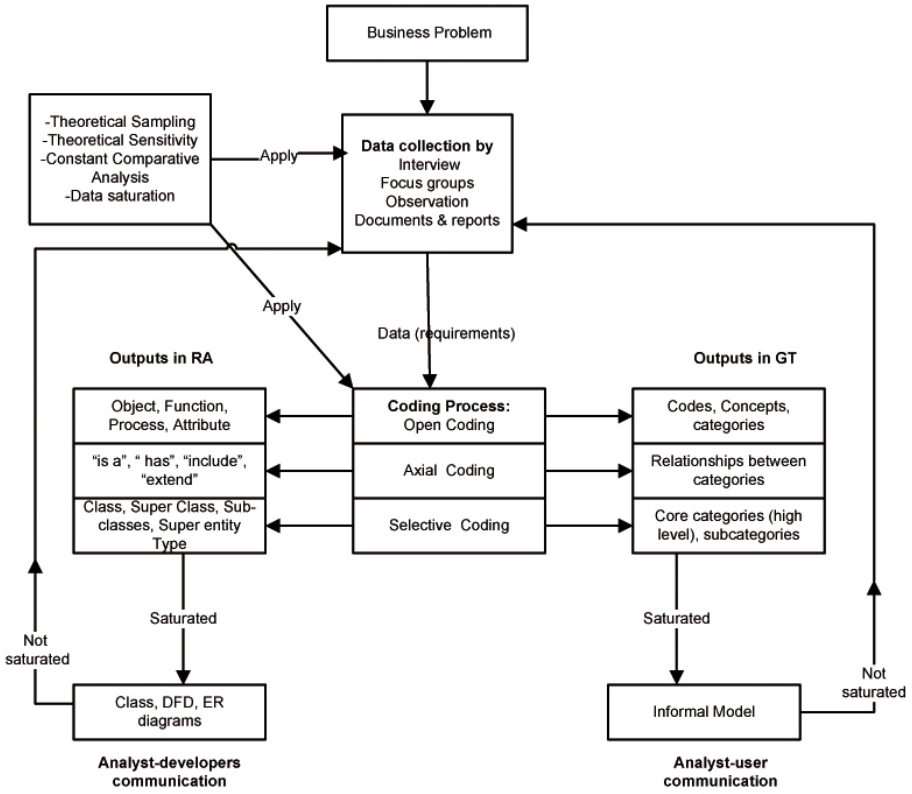

Figure 5.3: Grounded theory methodology interplays with analysis of requirements. Data input comes from interviews, focus groups, observations, documents and reports, is then susceptible to a coding process which, subsequently, delivers input for further communication with either the user or a developer. Figure taken and adapted from Halaweh (2012, p. 29).

user-centered view. Thus, a focus on user requirements rather than on system requirements is set (Halaweh, 2012). In addition, (Urquhart, Lehmann, and Myers, 2010) criticize the fundamental application of grounded theory. Although growing trends on using GT in information system studies are observed, the key feature of GT - that is to generate new ideas and hypotheses - is depreciated. The majority of existing research uses GT as a way to perform coding on data, solely, thereby disregarding the establishment of new theories (Urquhart, Lehmann, and Myers, 2010).

This project seeks to address both points of criticism by its inherent need to gain new knowledge about NSSI and its relation to therapy and utilization of mobile technology. Preformulated assumptions will not be tested by applying GT, but rather be used as a basis to enrich the level of knowledge thereupon. Additionally, apart from gaining insights into user needs, system requirements as in technological limitations and NF Reqs will be identified and addressed in designing the smartphone solution.

6 Research Design

"Being a scientist means living on the borderline between your competence and your incompetence. If you always feel competent, you aren't doing your job."

— Carlos Bustamante, *UC-Berkeley*

This chapter deals with the empirical study that is being conducted in the course of this thesis. It is based on expert interviews in order to delve deeply into the area of NSSI and BPD, to understand typical therapeutic workflows that come with it and to conceptualize what a mobile "electronic diary" prototype might look like. Sections outlined are the design, selection criteria, and instruments used within this research project.

6.1 Design

The overall design of the research is divided into several steps. For a visual impression please see Figure 6.1:

First, a review of the literature is performed.

Second, potential interview partners are queried (based on selection criteria described in Section 6.2) and invited for participation in this project.

Third, an initial prototype which is informed by available research is developed.

Fourth, an interview guide and a demographics questionnaire is prepared to support the process of interviewing experts.

Fifth, 18 interviews total are conducted, audio recorded, then transcribed and analyzed. This entire step (plus all sub-steps) employs the Grounded Theory (GT) methodology combined with the IKIWISI approach (using a prototype to support RE). These were delineated in more detail in Chapter 4 and Chapter 5. Short recaps are given along detailing the methodology in here. Additionally, it is to mention that the sub-steps below reflect an iterative course of action.

- **a.** interviews are divided into four stages, compare *The Horizontal Timeline* in Figure 6.1 and its textual description in Section 6.1.2.3:
  1. *pilot phase,*
  2. *interview rounds I,*
  3. *interview rounds II, and*
  4. *interview rounds III.*
- **b.** interview results are analyzed after each stage is completed.
- **c.** potential new interview partners are queried and relevant research is uncovered once analysis results suggest so, compare *the circle* in Figure 6.1 and Section 6.1.2.1.[1]

[1] This comes with the specific characteristics of using GT methodology in the discipline of information science which relies on iterations in terms of data gathering AND analysis. Thus, it is even feasible and likely to add further sources to the previously determined network of stakeholders to be interviewed if previously elicited requirements point into that direction (Halaweh, 2012).

d. after each stage software requirements are derived from newly gathered information, compare *the pyramid* in Figure 6.1 and Section 6.1.2.2..

e. software requirements from each stage lead to identification which features of the prototype need to be removed and how these features are modified respectively what aspects are added for this feature to reflect experts' feedback on the previous version of the prototype.

f. Modified features are incorporated into the prototype so as to present a new version to interview partners in the next interview round, compare *the pyramid* in Figure 6.1 and Section 6.1.2.2.[2]

g. questionnaire and interview guide are modified after each stage or when deemed necessary. That means, that newly emerged matters and obtained results from one (a previous or current) stage are used to ask more specific questions around in subsequent interviews, compare *the pyramid* in Figure 6.1 and Section 6.1.2.2.

Sixth, Interview results are wrapped up and written down in the thesis.

Seven, final requirements (functional, non-functional, usability) are established based on the interview analyses.

Eight, Use Cases and further design considerations for the proposed Android application are established.

Nine, interview partners obtain a copy of their respective transcript and are invited to comment or clear their interviews for quotes.

Ten, an explicit "code-freeze" date was set by the author herself to explicitly mark the end of the coding stage. This is done to prevent further delays upon completion of the project.

Eleven, several "left-over" core features of the framework (Android application and proof-of-concept RESTful webservice to demonstrate network communication) are implemented - depending on the remaining time until "code-freeze" - and conclude the research design, thus the thesis.

6.1.1 Interview details

During the course of the empirical research 18 experts were interviewed in total, see Table 6.1. Age groups were established based on the actual age of interview partners by the time the interview took place. They were derived in a way that at least two persons fall into each group, whereas every age group covers an interval of 10 years. Besides using alias references like Ms. A, Mr. D, et cetera, these age groups were introduced to further disguise a person's identity. Data collection was done from mid August until the beginning of April, interviews lasted from 35 minutes up to 1 hour 45 minutes, with an average duration of about 62 minutes per interview overall. Due to time conflicts one expert came into the interview process rather late, that is by end of June. Although the interview phase had already been completed, the author decided to meet up with this person because both were eager to share / hear about each other's thoughts and express ideas. Almost all interviews were audio recorded and afterwards transcribed accordingly. If audio recording was not feasible, notes were taken during / after the interview, important discussion points and key facts were written down based on these notes and memory

[2] To recap, the reason for doing so is to support discussions about requirements. It is assumed that one can better express required functionalities and features if presented with some sort of visualization what a system might look like or do.

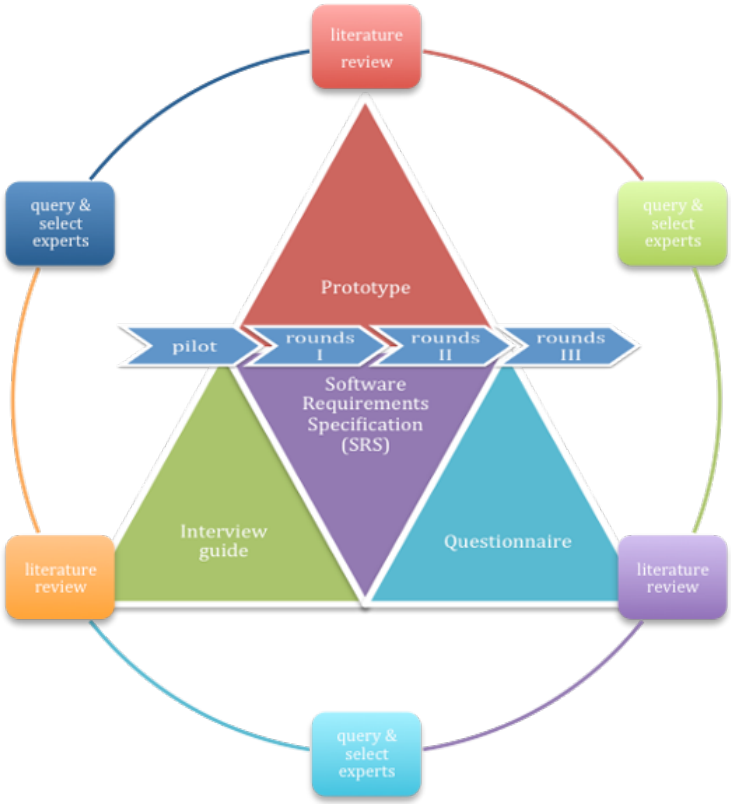

Figure 6.1: The questionnaire, interview guide and the prototype constitute the fundamental edges of the triangle. Their initial establishment has been informed by a literature review prior to a pilot phase as the kick-off of the entire interview and research process. Literature review as well as querying and selecting experts for interviews accompany the entire empirical phase. Following the principle of Bandura's Social Cognitive Theory that mentions triadic reciprocity of several factors for human behavior, cf. Redding et al. (2000), the three artifacts (questionnaire, interview guide and prototype) are reciprocally linked to each other. That is, changes in (not necessarily the questionnaire, but) the interview guide and its subsequent analysis will inform modification of the prototype. Upon adhering to the research process (which is illustrated by the overlay of the horizontal timeline - pilot, rounds I, rounds II, rounds III), analysis and refinement of each artifact takes place (in an iterative fashion). While running through the defined research steps, the refinement traverses towards the middle of the pyramid / triangle. As soon as the research and analysis process has come close to an end a final Software Requirements Specification (SRS) will result as the final artifact of this project.

upon completion of the interview.
12 out of 18 experts did actually see the prototype during the interviews, see Figure 6.2 for a distribution over each interview stage. The remaining experts did not see the prototype mostly due to very strict time schedule as well as an unfavorable ordering of questions in the interview guide (which accounted for little interviewing experience from the perspective of the author at least at the beginning of the project) or rarely due to lack of interest.

6.1.2 Visualizing the research design

To help readers understand the iterative process of the empirical phase, a graphical description of the line of action is illustrated in Figure 6.1. The three upcoming paragraphs *The circle*, *The pyramid* and *The Horizontal Timeline* further elaborate on its components and how they are linked to each other.

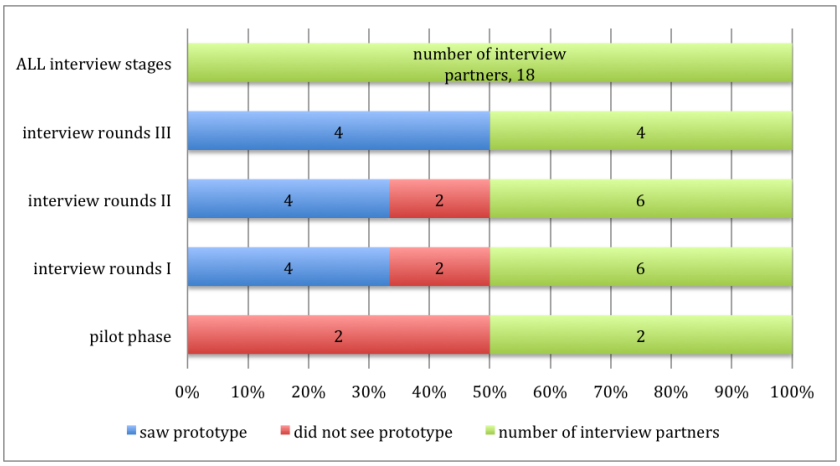

Figure 6.2: Distribution of interview partners who saw the prototype versus those who did not see the prototype over each interview stage. The entire number of people interviewed in each stage is given in green to enhance readability and understanding.

6.1.2.1 The circle

Review of the literature is one of the first tasks upon starting off with this thesis and becomes a continuous effort over the course of this project. The same is true for querying and selecting interview partners for participation in the interview process. (As noted above, the GT methodology makes it possible to iteratively expand the web of stakeholders throughout the entire interviewing process.) Hence, these two tasks build the surrounding environment of the empirical stage and the results and artifacts that come along with it and form a big circle containing everything else.

6.1.2.2 The pyramid

Inspired by Bandura's Social Cognitive Theory, compare Redding et al. (2000), which employs triadic reciprocity, the research is depicted as a pyramid or triangle. Its edges are constituted by three major artifacts, compare Figure 6.1 - *questionnaire*, *interview guide* and *(initial) prototype* (a description follows in subsequent sections of this chapter). These are regarded the groundwork of the research process, which is illustrated as the overlaying horizontal timeline - *pilot*, *rounds I*, *rounds II* and *rounds III*. The initial fundamental corners of the pyramid have been informed by literature and established prior to conducting (and refined during) the pilot phase. Upon traversing the research process (horizontal timeline) each artifact will be analyzed and refined. Additionally, the triadic reciprocity assures or shows that changes in one artifact subsequently trigger a modification in the other two, thus, they are linked and intertwined. Working through the research process will further push the development of the artifacts towards the middle of the pyramid. As soon as the research and analysis process has come close to the end a SRS will result as a final artifact (in combination with an evolved prototype) of this project.

6.1.2.3 The horizontal timeline

The pilot phase includes ***two interviews*** with (recent) psychology graduates and is fed with an already established interview guide, questionnaire and an initial prototype (which is of limited actual capabilities). Neither does it offer real background functionality, nor does it archive any data entered by the user. Its sole purpose is to give the user some sense of interaction and graphical interface. However, it comprises several concepts of the system to be designed. Information as to what data might be of interest for researchers or during therapeutic activities is drawn from the available literature. The prototype is designed as to the end-user, that is in fact the person pre-

senting with self-injurious behavior, is carrying the smartphone (having the prototype installed already) around as they go about the day in order to collect the data a therapist might be working with. As the study progresses throughout this thesis, the prototype will evolve, thus, replacing mock-ups and random test data by real functionality and input data towards a repeatedly more sophisticated prototype (informed by interviews and requirements analysis).

Interview rounds I centers on conducting interviews with ***six experts*** adhering to defined selection criteria, compare Section 6.2. Analysis of these conversations will yield modification concerning the interview guide as well as the prototype. Furtheron, it will help build up the emerging theory upon the focus / questions supporting this thesis.
Interview rounds II deals with interviewing ***six experts*** and leads to modification of the interview guide.
Interview rounds III handles the last block of ***four interviewees***. An overview of all experts interviewed in the course of the research is given in Table 6.1. Analysis of these conversations will lead to finalizing the established theory on mobile technology and NSSI in order to support therapeutic activities. Actual outcome in terms of artifacts will be a completed SRS as well as a prototype. The latter will include functionality and real data instead of test data and mockups and will conclude the project.

Alias	Gender		Age group	Function	Area of expertise	Country	Stage
	F	*M*					
Ms. A	✗		25-34 y	psychologist	currently education at Department of Pediatrics and Adolescent Medicine	AT	P
Ms. B	✗		25-34 y	psychologist	clinical psychology, job life rehabilitation of people with (chronic) mental illnesses	AT	P
					Sum experts in stage P	*n=2*	
Ms. C	✗		55-64 y	psychologist, psychotherapist	-	AT	R_I
Mr. D		✗	45-54 y	psychiatrist	BPD, depression, addiction, perinatal psy.	AT	R_I
Ms. E	✗		45-54 y	psychotherapist	-	AT	R_I
Mr. F		✗	55-64 y	psychotherapist	-	AT	R_I
Mr. G		✗	45-54 y	psychiatrist, psychotherapist, working in education	drug therapy, BPD, autistic disorders	AT	R_I
Mr. H		✗	45-54 y	psychotherapist	BPD, dissocial personality disorder, addiction	AT	R_I
					Sum experts in stage R_I	*n=6*	
Ms. I	✗		35-44 y	psychologist, psychotherapist, working in education	personality disorders (especially BPD), panic and anxiety disorders, attention deficit disorders, disorders in toddlers and pre-school aged children	AT	R_II
Mr. J		✗	35-44 y	psychologist, psychotherapist, working in education	compulsive disorders	AT	R_II
Ms. K	✗		35-44 y	psychologist, psychotherapist	burn-out, job problems, mobbing, anxiety disorders (panic), previously Borderline, bipolar disorders	AT	R_II
Mr. L		✗	N/A	N/A	N/A	AT	R_II
Ms. M	✗		35-44 y	psychologist, psychotherapist	DBT, skills trainer	DE	R_II

Alias	Gender		Age group	Function	Area of expertise	Country	Stage
	F	*M*					
Ms. N	✗		45-54 y	psychiatrist, psychotherapist	addictive disorders (also, DBT-skills trainer)	AT	R_II
					Sum experts in stage R_II	*n=6*	
Ms. O	✗		45-54 y	research scientist, director of Cornell Research Program on Self-Injury and Recovery (PhD in developmental psychology)	self-injury, emotional development, resilience, connectedness, recovery	US	R_III
Ms. P	✗		N/A	psychologist, psychotherapist, working in education	personality disorders	AT	R_III
Ms. Q	✗		25-34 y	psychologist, psychotherapist	therapeutic climbing	DE	R_III
Mr. R		✗	45-54 y	psychotherapist	children and adolescents	AT	R_III
					Sum experts in stage R_III	*n=4*	
					Sum experts total	*n=18*	

Table 6.1: An overview of all interview partners (plus demographics) supporting the Requirements Engineering process throughout the research. Interview partner's real names are replaced by aliases to disguise identities. Age groups cover intervals of 10 years and were derived from their actual age by the time interviews took place. Column country shows whether people involved in this project reside in Austria (AT), Germany (DE) or the United States (US). The research design is divided into the stages pilot (P), rounds I (R_I), rounds II (R_II) and rounds III (R_III).

6.2 Selection criteria

Interview partners from the pilot phase and subsequent stages (rounds I, rounds II, rounds III) resemble each other in their field of expertise or education. That is, they have studied psychology, medicine, psychotherapy or underwent a comparable follow-up postgradual education. This ensures that pre-testing the interview guide (and established initial prototype) is feasible of picturing how easy / hard / understandable it is for therapists with practical experience to answer the questions as well as their applicability and usefulness.

For the pilot (fairly recent) psychology graduates have been recruited belonging to the social network of the author of this thesis. Recruiting interview partners regarding the research stages rounds I, II and III employed querying the Internet as such, especially platforms focusing on introducing a pool of psychotherapists and psychiatrists available[3]. Additionally, the extended social network of interviewees was useful for gaining further contacts in that field.

Interview partners met the following criteria in order to qualify as an expert within the interview process:

- current position at a private practice, hospital, other medical institution is psychologist, psychotherapist or psychiatrist,
- professional experience in the field of NSSI is present, i.e. they have worked respectively are currently working with clients who injure themselves, and
- self-injurious behavior is limited to people deliberately harming their bodies' tissues by cutting, biting, burning themselves, picking at wounds, pulling out hair, self-battery (e.g., punching oneself, hitting the wall with one's head), ingesting toxic substances and inserting objects under one's skin.

A former criterion that specified work location to be Vienna had been dropped (due to issues in recruitment), which is why interview partners from Austria, Germany and the United States were chosen. The criterion to look for psychotherapists who engage in some sort of behavior therapy (especially DBT) was added for rounds II and rounds III (since the output from rounds I considered it the target group that could actually benefit from the app to be designed). In addition to that, talking to researchers in this very field was encouraged and has, thus, been rendered important by the author herself.

6.3 Instruments

The design of the empirical study centers on three core instruments which are a demographics questionnaire, an interview guide and a prototype (which is constantly refined along with the study).

6.3.1 Demographic data

Each interviewee is asked to provide name, age, gender and (academic) education. In addition, current job position / function, entry date or period of time this position has been hold accountable for, and area(s) of expertise - if applicable - are collected. Apart from name and location of their affiliation, five items are presented in order to reveal the type of institution one is affiliated with and whether EHRs are in use. Additionally, date, time and location of each interview

[3] Platforms queried involved http://seelischgesund.info, http://www.psyonline.at, http://www.arztverzeichnis.at and http://www.oegvt.at.

are documented. An overview of experts' demographic data can be looked at in Appendix A, Section A.1.

6.3.2 Interview guide

The guide is the heart of each interview as such and consists of several core talking points. While it is not necessary to spell out every question that is contained nor to adhere to the order outlined in the guide, it proves useful to steer the conversation and prevents neglect of information to be asked, compare Section 4.3.1. Besides demographic information, which were gathered by disseminating a short questionnaire before the official start of the interview, compare Section 6.3.1, following core categories have been established and talked about:

- basic experience with NSSI
- monitoring of self-injurious behavior (general requirements)
- monitoring of self-injurious behavior and support by IT (mobile requirements)
- prototype walkthroughs
- therapy and motivational strategies
- causal relation between self-monitoring and motivating alternative coping strategies

It is to say that the themes outlined in here are presented to interview participants in the pilot phase. Discussion and analysis of feedback from these interviews has lead to modifications of the interview guide as such, compare Section 7.1.1. For interested readers, the entire set of interview guides covering interview rounds I, II and III is included in Appendix B. Also, most interviews have been conducted in German which is why core categories and questions have been translated to English afterwards for the sake of incorporation into this thesis.

Interviews are estimated to last between 1 and 1.5 hours. However, actual duration depends on respondents' time schedule and the ability to prolong the interview situation regarding for instance, power of concentration.

6.3.3 Prototype

The prototype (drafted from literature review) that will be presented to interview partners is deployed to a Samsung GT-S5300 smartphone using an Android Firmware version of 2.3.6 (Gingerbread) based on Linux kernel 2.6.35.7. Interviewees are encouraged to think-aloud and give feedback while (or after) the prototype is presented and explained to them. That means that strengths and weaknesses, missing information and data to be documented are uncovered. It should furthermore encourage therapists to express whatever opinion or information they need in such a system with the objective to get as most support for their therapeutic activities as possible.

Figure 6.3 shows emulator screenshots[4] to illustrate the design of the preliminary prototype that is presented to the interview partners within the pilot phase, as well as stage I, i.e., the first

[4] Several images have been copied from various sources in order to place them within the application, thus, make it more appealing. The orange ribbon reflects self-harm awareness and is taken from http://en.wikipedia.org/w/index.php?title=File:Orange_ribbon.svg&page=1. The stats picture within the menu options functionality is taken from http://derekmaul.files.wordpress.com/2012/02/statistics.png. The trophy picture regarding the achievements functionality is taken from http://www.mtsv-maedchenfussball.cms4people.de/pokal_347_460.jpg. In order to build graphs and diagrams within Android the AChartEngine software library has been used (achartengine.org, 2012).

"block" of experts to be interviewed. The letters given in parentheses refer to the corresponding screen in Figure 6.3. The author emphasizes once more that the prototype depicted at this point is an initial prototype to be presented in pilot phase and interview rounds I. Upon traversing through the interview stages it will evolve to a prototype covering a more coherent picture of a useful application and will be enhanced in actual functionality.

Based on the main screen of the application (A), users can trigger several functions, whereas the prototype pursues five general objectives:

First, there is the assessment of behavior, mood and behavioral changes by documenting urges (B) and acts (C) regarding NSSI. These are based on events initiated by the user. Their functionality is limited to the smallest extent possible. Thus, users can click buttons, enter data and change values in provided progress bars, however, upon confirmation by the user changes are not stored anywhere, yet.

Second, users are beeped at several times a day to record their mood and emotional state via prompts (D). This approach is solely time-based and initiated by the system, whereas the user can set appropriate time intervals allowing to be bothered within (F).

Third, users can view their "progress" by means of charts (E) generated on SI urges and acts as well as on mood changes throughout a period of time (e.g., a week). These graphs are filled with random data, every time one initiates this very function.

Fourth, the data that has been collected is residing on the phone and can be manually uploaded to the EHR of the therapist the app is associated with. Upon triggering this function a circular progress bar is shown to the user in order to give feedback on what is happening, respectively, how long this exact operation will still take place. At the moment, this progress bar is appearing for a couple of seconds in order to illustrate the behavior, without actually performing any action in the background.

Fifth, further settings allow to view statistics on how many prompts have been answered (received), how many urges have been documented. In addition, game levels appear to tell what level of motivational strategy one is in, which are changeable (G). Upon selecting one of the three levels provided, an urge either yields no action (level 0), a distraction strategy by starting angry birds given the user's consent and availability on the phone (level 1), as well as a motivation towards alternative behavior, such as doing sports (level 2).

6.4 Discussion

This chapter outlined the research design of this project, that is relying on a Grounded Theory methodology coupled with an IKIWISI (I'll know it when I see it) approach. The qualitative design of the study allows for rich and detailed information to be gathered, whereas 18 experts in total are interviewed. To that extent, a prototype had been drafted from literature reviews to document NSSI urges or thoughts and actual behavior (based on events) as a means of EMA. Additionally, it cared for the incorporation of randomized emotional prompts (based on points of interest throughout the day triggered by the system within a individually set time range). Progress reports were demonstrated by visual graphs that illustrated behavior and mood changes over time. Motivational factors and interventions like replacing strategies or self-worth enhancements were presented upon documenting NSSI thoughts. The functionality to upload one's data to a PHR residing at a therapist's office was included. Upon presenting interview partners with this prototype, refinements and modifications are made as soon as new requirements had been established. This process is reflected in the upcoming chapters.

Figure 6.3: Several screens regarding the developed initial prototype are illustrated. (A) is the main screen of the application, (B) lets users document self-injurious urges, (C) records behavioral acts and is subsequently presented to the user with the emotional assessment screen (D). (E) displays a mock-up what graphing one's emotion might look like. (F) delineates how users can actively set time intervals for mood prompts to be displayed. (G) shows a documentation of the achievements a user has received upon using the application and at which "game"/therapy level he/she is at. The picture of the cell phone acts as an underneath layer for the incorporated emulator screenshot and has been taken from http://www.xda-developers.com/wp-content/uploads/2011/03/Samsung-Galaxy-S-4g-release-date.jpg?f39ce1.

7 Results

"It killed me inside and I thought I was gonna actully [sic!] die."

— Amanda Todd (2012), *Card from her YouTube-Video*

Numerous pages of data material have been collected throughout the four stages of the empirical study. The author decided that presenting results per interview stage best reflects the progress that was made, as well as the knowledge gained throughout this project. Hence, this chapter is divided into four different sections pertaining to their respective interview stage. It starts off with:

- pilot phase and interview rounds I in Section 7.1,
- subsequently follows with interview rounds II in Section 7.2, then moves on to discussing
- interview rounds III in Section 7.3, and finally concludes with
- prototype details as in Use Cases, design considerations, framework information in Section 7.4.

Furtheron, the author states that codes, descriptive instances or properties of sub-categories are linked to the person who mentioned them via their alias. If no alias is given, the respective aspect came up during several interviews and is, hence, not explicitly stated.

7.1 Results - Pilot and Rounds I

This chapter outlines the results that have emerged upon analyzing interviews from the pilot phase and interview rounds I. Besides delineating and reflecting on codes and concepts that are grounded in the data collected, a list of preliminary requirements is derived from them. Subsequently, a sample mapping of these requirements to features and implications for the prototype (which is presented to interview partners alongside the empirical research) is given. The chapter concludes with a discussion about the knowledge that was constructed and shares research findings that have been pointed at by interview partners, thus, discovered in interview rounds I.

7.1.1 Pilot phase

The main aim of the interview pilots was to test the interview guide as well as the short demographic questionnaire it is paired with. On the one hand, the test should give a clear picture if the questions are comprehensible, neutral enough so they do not affect the interviewee's answer and in fact feasible to be answered. On the other hand, it serves as a training for doing an actual interview and to test if the recording devices are appropriate for the situation and can be handled adequately. Additionally, it proved useful as to explore whether the established core categories were addressed in a coherent matter and where questions relied on too much level of detail (for an initial interview stage). If feasible - depending on the respondents' experience with / understanding about NSSI - it is also an attempt to gain first insights into self-injurious behavior from a (theoretical) psychological perspective. A walkthrough with the prototype is conducted, whereas interview partners are encouraged to express their opinion on level of usefulness, benefits and risks associated with it. Thus, apart from carrying out a pre-test, recommendations

and reflections are sought to be collected, regarding interview guide / questionnaire and the prototype.

Two interviews have been conducted in this initial stage of the study. Participants were psychology majors, respectively, recent psychology graduates. They have been recruited from the author's social network. One interview has been recorded by means of a cell phone in order to transcribe the audio contents afterwards. The second interview could not be audio taped due to strong background noises. Instead, notes were taken during and subsequently after the interview. Then, the main talking points were written down based on memory recall and represent a theoretical memo on its own.

Analyzing key points discussed at this stage of the empirical study yielded some modifications of interview guide / questionnaire. Instead of documenting the interview location - which is the location of respondents' affiliation in the majority of cases and kept track of anyway - the exact time of the interview is noted. An item depicting what type of institution interviewees are affiliated with has been added.

The order of of core talking points has been shifted in the interview guide based on the fact that - besides some discussion in literature - not much is known about therapists' methods and approaches in fostering a therapeutic alliance with their patients to fight NSSI. Therefore, it is deemed important to assess the general therapeutic workflow and approach, probable stages throughout therapy, prior to getting into too much details. Utilization of electronic or other documentation tool ought to be established as much as its interplay with therapy. Therapy, respectively, treatment and goal setting, respectively, motivation towards alternative behavior are understood to intertwine. However, for the sake of breaking the complex topic down into smaller pieces they are dealt as separate things. This allows for the motivation category to become optional, thus, be postponed towards probable follow-up interviews. As a result, at this stage, the focus of interviews can be set on available therapeutic strategies, evaluation of success and failure thereupon, which have been experienced during meetings, as well as how to prepare an electronic behavioral diary by means of a cell phone. In addition to this, several questions have been added addressing both therapists' approaches as well as their experience with treatment over NSSI. Another important question has been included that asks about necessary criteria in order to request maintenance of a behavioral diary.

Table 7.1 describes the so established various themes in the interview guide and gives a short description on the focus of each theme. Furthermore, it lists the number of questions asked within each category as well as the quantity of open and closed questions presented with specified items. The entire interview guide as it is used during interview rounds I can be looked up in the appendix of this thesis. Further refinement takes place in the course of the ongoing empirical study conforming to the methodology of the utilized Grounded Theory Method. However, additional modifications concerning the interview guide will not be appended to this thesis.

Theme	**Description / Keywords**	**Num of questions**	
		Open	*Closed*
introduction	definition of NSSI within the thesis and expert experience	5	2
treatment / therapy	structure of therapy, IT support, behavioral diaries	5	1
goals / motivation (optional in rounds I)	goal setting, motivational strategies, intervening access points	4	0
prototyping	electronic diary, thinking-aloud about, missing information, what is good to record	2	2

causal link: Ecological momentary assessment (EMA) / self-monitoring - alternative behavior	existence of causal relation (y/n) + reasoning	1	1

Table 7.1: This table describes the core themes of the interview guide which has been established as such during interviews from the pilot phase. A basic description on what the theme is about is offered in column 2, while column 3 states the number of open versus closed questions in each category. The interview guide is used in interview rounds I and will then be further refined. The concept *goals / motivation* is regarded optional for this stage of the study and may be postponed depending on time limits and progress of the interview.

7.1.2 Interview rounds I

The distribution of approaches and methodologies used in practice by psychotherapists interviewed in rounds I is delineated in Figure 7.1. During interview rounds I therapeutic approaches have not been narrowed down to a specific method. That's why the largest portion of experts interviewed belong to the school of client-centered psychotherapy (n=3; 50%). The remaining half was accounted for by the cohorts of behavior therapy (n=1; 17%), systemic psychotherapy (n=1; 17%) and art therapy (n=1; 16%). Throughout stage I of the empirical research, it became clear and was attributable to several recommendations, that one should focus on one specific therapeutic approach. That way, a mixing bowl of existing therapeutic approaches and their imaginations and desires for an app design is avoided. Behavior therapy is said to be closest to the preliminary concept of the mobile diary due to its manualized and structurized methodology. Henceforth, interview rounds II centers on talking to experts in behavior therapy (especially DBT) as well as skills-training (which holds an important part within DBT).

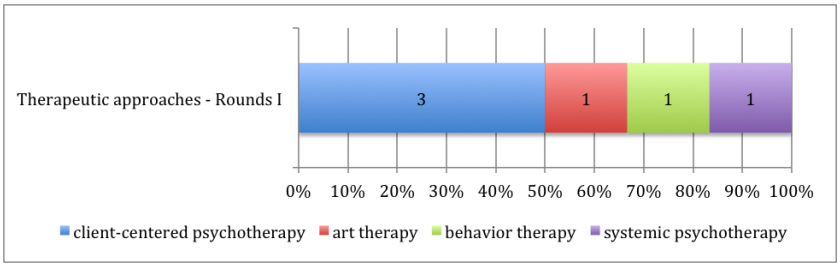

Figure 7.1: Distribution of therapeutic approaches found to be used by experts interviewed during rounds I.

7.1.2.1 Codes and Concepts

The coding stages, respectively, the analysis of interviews of the entire research was done using the HyperRESEARCH software[1] (version 3.5.1, ResearchWare), that was specifically designed for supporting researchers upon doing qualitative analysis. More than 600 different codes were obtained after the initial phase of the coding stage. These codes were then placed into 35 concepts which described similarities as well as differences among the coded instances. Some examples of codes (and coded instances) that have been assigned to broader concepts or themes

[1] http://www.researchware.com

are shown in Table 7.2. An alias is given if the code was linked to specific interview partners, these references are lacking if the topic came up during several interviews or if the respective reference was difficult to pin-point among the amount of data collected.

Alias	Code or descriptive instance	Concept
Ms. C	Takes an interest into why "some people are not angry at all yet do then, however, hurt themselves".	triggers
Ms. E	Talks about a "tension that is built up that can only be got rid of by cutting".	positive function of NSSI
Mr. D	Mentions social components of an app as a means to positively reinforce a desired behavior.	reinforce desired behavior
Ms. B	intervening point in time as soon as urge occurs	app as means of intervention
Mr. H	holistic view of a person as a client-centered item	psychotherapy
Ms. C	Triggers as well as comforting conditions are "not that easily identifiable".	inherent therapeutic problems
	NSSI serves to regulate emotion.	positive function of NSSI
Ms. A, Ms. C	some sort of cognitive restructuring	app as means of intervention
Mr. H	"I am working at the juvenile department of correction [...] and in the department of correction for women [...]."	therapeutic setting
Mr. H	negligence or (family) violence during childhood	being at risk
	Sees NSSI as a possible symptom in people with Borderline Personality Disorder most frequently.	typical comorbidity
Mr. D	game-character-like psychoeducation	app as means of intervention
	"client-centered psychotherapy", "systemic therapy", "behavior therapy"	therapeutic approach
Ms. A	Regards triggering situation / conditions for a behavior important	behavioral documentation
Mr. G	"Joylessness - anhedony - and weariness are torturing. So, self-injury may be a possibility, to feel oneself, in order to feel a little bit, if anything at all."	positive function of NSSI
Ms. E	"Adolescents, who reinforce it [the self-injurious pattern] within their school class. There is one cutter and all of a sudden after half a year, there are five others, where it is more about the imitation."	susceptibility and peer pressure

Table 7.2: Some sample codes and associated instances that have been assigned to their respective broader concept.

A few concepts (or themes) that emerged throughout the coding process (open, axial, selective) of interview rounds I are introduced in the remainder of this section. *Acceptance of app (in general)*, *progress diagrams of the app*, *behavior documentation via the app* were chosen as themes to give the reader a hint on what is going on and happening with the data collected. Also, this is to demonstrate the transition from emerging concepts (and their corresponding dimensional properties) to basic requirements that have been drafted at this stage. These requirements are used to inform refinement of the initial prototype that will be used to support conversations with interview partners in rounds II. Interested readers are referred to Appendix A to get a grasp on

remaining concepts from rounds I, which can not be discussed in this section due to too much level of detail with respect to the research stage.

Concept: Acceptance of app (general)

This specific concept of usefulness and acceptance of such an a app in general was perceived both positive and negative. Compare

- Table 7.3 for an overview of the list of sub-categories and their respective properties that describe a concept, and
- Figure 7.2 for detailed information about sub-categories where a range of properties was found in the data material. To better reflect the dimensional range, these categories are illustrated as sliders. Furtheron, dimensions comprise two extrema, which are depicted as the end-points of the corresponding sliders. Along this range lots of properties were found in interviews which is why only their end-points / extrema are given.

Among positive aspects interview partners mentioned the possibility to see differences in patients' behavior and emotions serving two functions. First, it is a means for patients to see and realize that not all they do or feel is bad. Second, frustration of psychotherapists can be avoided upon seeing that patients are not stuck in stagnation (as is often argued by patients). Additionally, capability to intervene at a certain point in time is considered positive, general perception of the app being a helpful tool is existent. On the other hand, negative perceptions of usefulness are attributed to specific concerns, which become clearer in this section.

> *From my point of view there are two problems. One problem is, there are people, who perhaps use it [the app] as some sort of war-game, where they say, I'll play a little bit with it and then I'll cut myself a little bit [...] and now let's see, if we can make the curve grow a bit bigger even - in such a way, that it becomes a positive reinforcement [...] Self-injurious behavior is of manipulative character. [...] Drug addicts use that quite often 'yes, if you don't give me this [what I want] now, then I'll show you where- [...] If I self-injure, I think I won't take my cell phone to say 'now I gotta document it'. It is more likely, that they will be able to do that only later [after the self-injurious act], once the crisis is over.*
> *(Mr. H)*

Besides the mentioned high-score-effect and manipulative stimuli that may occur in using such an app, there is an innate risk of avoiding discussion of "dangerous", triggering situations / surroundings and underlying problematic symptoms.

> *There is this patient of mine who [...] has a drinking problem and a problem of using tranquilizers. [...] documented exactly, how much she drank, when she drank or when she took pills and so on. In her case it would have been easy to focus on that, avoiding any other conversation, such as what her relationship looks like or her satisfaction regarding her professional life [...] It would remain on the surface, without a chance to reach the underlying [problem], you know. She could block all that fairly easily. [...] We wouldn't be able to see [the underlying problem].*
> *(Mr. G)*

General Acceptance (app)			
Sub-category	***Description***	***Property***	***Alias***
technology savvyness	*note: acceptance depends on user's level of tech savvyness*		
perception on usefulness			
	NEGATIVE		
		- high-score-effect - war-game-(ab)use - reinforcing manipulative stimuli / behavior	Mr. H
		avoidance of discussion of underneath problems	Mr. G
		skepticism regarding benefit and practical usage of diary-like-documentation with respect to self-injurious behavior	Ms. A
		no benefit and useless because already existent	Mr. F
	POSITIVE		
		interesting idea in general	Mr. G

Table 7.3: The concept of perceived usefulness of the app in general, which offers several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-categories. Sub-categories where readers are referred to another table for detailed information about properties are listed to illustrate and keep alive their relationship with the concept.

Concept: Progress diagrams of app (general)

Progress diagrams were considered beneficial for both patient and therapist, compare Table 7.4. Additionally, it gives the patient (end-user) some sort of self-monitoring tool. However, emotional trajectories were plotted separately from charts depicting progression of self-injurious thoughts versus self-injurious acts. This yielded skepticism to a certain extent but did also give way for something new and positive to emerge:

> *[...] the overlay [...] of mood parameters and, well, injury [parameters] [...] would be exciting, in terms of psychiatric usage. What does it say about correlation? (Mr. D)*

An overview on dimensional properties with respect to the concept of progress diagrams can be seen in Table 7.4.

Concept: Behavior Documentation (app)

The context-sensitive documentation of behavior, i.e., entering an event at the time and place where it occurs, is somehow related to the acceptance, perceived usefulness of such an app in general, as well as to benefits regarding the specific behavior. Several interview partners mentioned the benefits and successful application of behavioral diaries with respect to alcoholism (Mr. D), depression (Ms. A), sleeping problems (Mr. D), eating disorder or ablutomania (i.e., compulsion to wash) (Mr. F). These experiences are supported by literature, which states useful application of diaries (and EMA) in eating disorders, depression, migraine, pain or stress-related diseases et cetera (readers are referred to Yoshiuchi, Yamamoto, and Akabayashi (2008) and Burton, Weller, and Sharpe (2007) for a starting point). What is important to know includes, for

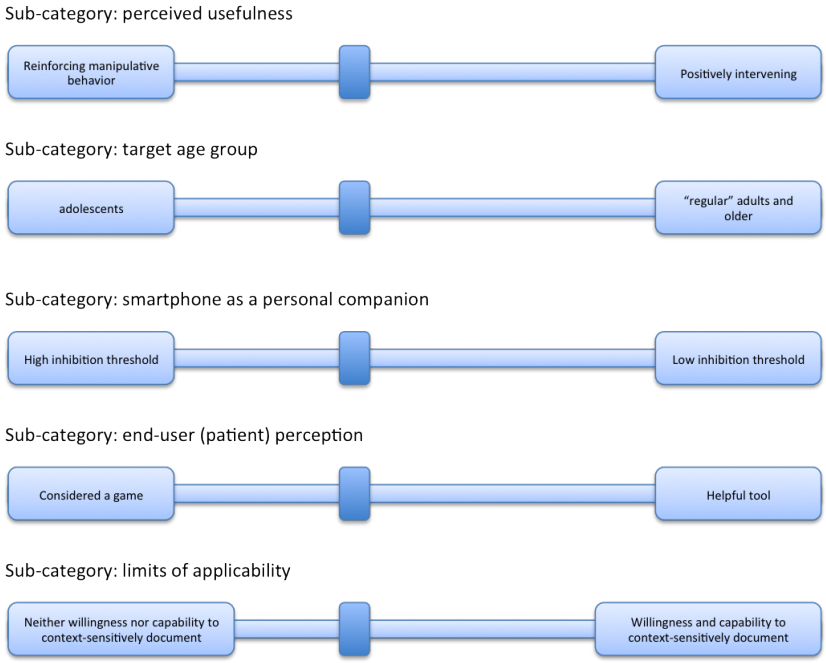

Figure 7.2: Sub-categories that belong to the concept of perceived usefulness of the app in general. Each is depicted as a slider to better represent its meaning as dimensional ranges. That is, both ends of a slider (dimension) are corresponding extrema. Properties along this range (from one to the other extremum) were found in interview data material.

Progress diagrams (app)		
Sub − category	*Properties*	*Alias*
positive perception of diagram from *therapist* perspective	- skip frustration resulting from perceived stagnation of a patient's progress - reflection on ups and downs	Ms. C
positive perception of diagram from *patient* perspective	- shed light onto the fact that not all things are necessarily bad - reflection on ups and downs	Ms. C
negative perception of diagram		
	skepticism about the underlying meaning	Mr. G
	loss of possible correlation patterns due to non-overlay of mood and self-injurious behavior	Mr. D
	skeptical about additional benefit or reinforcement of progress diagram once motivation to keep electronic diary has been established	Ms. E
structure or content		
	monitoring of decision processes	Mr. G
	overlay mood and self-injury	Mr. D

Table 7.4: The concept of progress diagrams of the app offers several sub-categories. Each sub-category further consists of properties that describe it, respectively, belong to it.

instance, the emotions and cognitions that come with a specific situation. What does the person think about a situation? Why is it making them uncomfortable or feel stressed? In particular, describing a physiological tension is interesting for Borderline patients, who struggle identifying inner (i.e., emotional) tension or thoughts.

> *Each person has got a basal fundamental tension, a muscular tension. This muscular tension shows an increased level in people with Borderline Disorder, plus, an additional intense tension does often add up to that. Actually, all these states of tension correspond to emotions, but people are not capable to identify them. They only sense the physiological change, what is noticed as tension.*
> *(Mr. G)*[2]

Simultaneously, on the other hand deriving the success of these disorders and transferring it towards the maladaptive behavior of self-injury is questioned. Furthermore, focusing or not focusing on self-injurious behavior (as well as attempting to take a maladaptive but working coping strategy from the patient's point of view) is crucial and (presumably) determined by one's therapeutic approach. Compare the following tables for a summary of the codes and properties collected from interview data:

- Table 7.5 outlines concerns as well as approval and information on what makes sense to monitor and document, and
- Figure 7.3 details information about sub-categories where a range of properties was found in the data material. That is, these dimensions comprise two extrema, which are represented as the end-points of the depicted slider (dimension). Along this range lots of properties were found in interviews.

Figure 7.3: Sub-category "State-versus-Trait" which belongs to the concept of behavior documentation within the app. It is depicted as a slider so as to better represent that it contains a dimensional range. Both ends of the slider (dimension) are corresponding extrema. Properties along this range (from one to the other extremum) were found in interview data material.

7.1.2.2 Drafted Requirements

The following requirements have been drafted after analyzing interview data into more abstract concepts and themes. This list is certainly not considered comprehensive, but will be adapted and refined throughout the upcoming research stages of interview rounds II and rounds III.

[2] On a sidemark, exactly this interaction between physiological change, emotion and cognition (regardless of whatever "state of health" one is in) is largely addressed in the field of emotion research that developed a set of different theories. Some of them - like the James-Lange theory - are emphasized in Sendera and Sendera (2012) (which I personally would like to mention in here, as well). For instance, in 1884, William James wrote about a bodily change causing an emotion "If we abruptly see a dark moving form in the woods, our heart stops beating, and we catch our breath instantly and before any articulate idea of danger can arise." (James, 1884, p. 196). This has lead to big amounts of skepticism and all sorts of varying interpretations. One point of criticism was that emotions would then be forced to discern as soon as any bodily change has faded (Sendera and Sendera, 2012). However, more than a century later Reisenzein, Meyer, and Schützwohl (1995) tried to set the record straight as far as discussion on James' interpretation are concerned. They said that "within James's theory, one can say both that bodily changes cause and temporally precede emotional feelings, the temporal overlap of these events notwithstanding." (Reisenzein, Meyer, and Schützwohl, 1995, p. 760).

Behavior documentation (app)		
Sub − category	*Properties*	*Alias*
Date and time	- automatically save time in the background - entering time of event manually later on (optionally) - skeptical because reduction in retrospection bias clashes with the fact that sometimes documenting an event at its time and place of occurrence is neither practical nor predicted possible	Mr. D
Event documentation	backwards-entering (entering after event had taken place);	Mr. D
"State-versus-Trait"	*author's note: please have a look at Figure 7.3*	
Protocol information		
	frequency, method, triggering situation, triggering conditions	Ms. A
	time of day	Ms. A, Ms. C, Mr. D
	location where event occurs, alone or in company	Ms. C
	emotion and cognition before and after event	Ms. A, Ms. C
	physiological change or tension	Mr. G
Protocol steps and order	situation, emotion, cognition, interpretation of situation, behavior, reality check, modified behavior after reality check	Mr. F

Table 7.5: The concept of behavior documentation within the app, which offers several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-categories. Sub-categories where readers are referred to another figure for detailed information about properties are listed to illustrate and keep alive their relationship with the concept.

Req 1 ***Add an entertainment factor.*** Apps are more likely to be used if they promise to award the user with some fun or entertaining experience. One interview partner, for instance, mentioned, that psychoeducation with regard to myths of NSSI could be used as some sort of a quiz. That way, the patient would learn about their very own misconceptions and self-perception, thus, gain some acceptance and self-worth even if doing something harmful. On the other hand, they would experience some sort of entertainment while having to deal with (and enter) one's maladaptive coping mechanisms.

Req 2 ***Prepare for analyzing correlation.*** A possible (and explorable) correlation between emotion and mood changes and self-injurious acts might be worth looking further into.

Req 3 ***Expand on emotional scales.*** Anger (at oneself, another person or complete lack thereof) and dissociation are frequent emotions to be encountered in self-injurious patients.

Req 4 ***Do not toss therapeutic approaches into a mixing bowl.*** Put the focus of the app on a well-structured and manualized therapeutic strategy as in behavior therapy. Bringing together all kinds of approaches will end up being too broad of a frame to design an app on top of it. This is, for instance, undermined by further interviews' results that state diary cards to be seldom used in client-centered psychotherapy.

Req 5 ***Emotion and Cognition.*** The differentiation between what one feels (emotions) and what one thinks (cognitions) about a certain situation are important. Consider emotions and cognitions of utmost conditions during documenting maladaptive behaviors.

Req 6 ***Triggers vary individually and are often diverse yet unknown.*** The description of a situation itself does not help identify an approved trigger. The links towards one's interpretation of the situation are what is of interest to the therapist.

Req 7 ***Frame in context of a specific diagnosis.*** Self-injurious behavior is a typical example of being comorbid with Borderline Personality Disorder.

Req 8 ***Avoid high-score effect.*** High-score lists and the like tend to be risky to reinforce self-injurious behavior. This includes aspects within a game that are likely to yield high-score effects linked to harming oneself. For instance, gamification aspects like earning a ribbon each time an urge or a self-injurious act is performed, thus, documented might be regarded potentially dangerous.

Req 9 ***Emotional black and white.*** People with BPD struggle identifying (and classifying according to intensity) emotions. BPD comes with ambivalence in any area of life, emotions, situational interpretations, cognitions etc. are considered either black or white. Providing patients with the opportunity to classify intensity of a variety of emotions might enable reflective process of thinking.

Req 10 ***Time, location and company.*** Upon documentation of date and time, location (e.g., at home, at work, at school) and company (e.g., is one alone? in company?) psychotherapists may detect patterns of triggering situations or conditions.

Req 11 ***Providing patient's data to therapist.*** In order for a therapist to detect patterns, they need all the information being collected by the patient.

Req 12 ***Intervening point.*** Interventions are considered useful when they occur at a point in time where tension is being built up and an urge to self-injure occurs.

Req 13 ***Intervention.*** Successful interventions are highly individual and variable. Their success depends on the person, what they like, what they enjoy doing, what offers an adequate stimulus that is striking enough to not go through with a self-injurious act but rather act as a working alternative. That means, they need to be tailored to the person.

Req 14 ***Provide alternatives.*** Typical alternatives mentioned instead of performing NSSI are snapping a rubber band on one's arm or wrist (Ms. E), "put your hand into ice-cold water" (Ms. A), "going for a run" (Ms. A), relaxation techniques.

Req 15 ***Motivation and reward.*** Motivators - that work for a person - are highly individual and variable. Social aspects like comparisons within a community which uses the app could work as positive reinforcement (Mr. D).

Req 16 ***Event-based versus system-based sampling.*** The event that is responsible for information to be entered within the app can be based on two concepts. Event-based means a person initializes the documentation of an event themselves at the time and place of its occurrence. (Additionally, entering information backwards needs to be possible to a certain extent, since the ability of a person to document self-injury at a time of high tension is unlikely.) System-initiated monitoring relies on prompting the user with questions or items to be answered without the necessity of the actual occurrence of an event. Thus, end-users are beeped at multiple times during the day, whereas this gives an overview on patterns and changes in mood, tension or behavior that may otherwise not be noted by the diary.

Req 17 ***Tension.*** Some patients may only notice emotions as some kind of physiological change, that is noticed as a tension that goes way beyond a normal (basal) muscular tension.

7.1.2.3 Mapping requirements to prototype

A list of drafted requirements has been given in the section above. But what happens to the requirements in terms of designing the prototype? How are requirements mapped to prototype features as such? Table 7.6 attempts to address these questions by outlining the mapping process from requirements to prototype aspects:

- ***Column 'Req'*** The numbers refer to the corresponding requirement as shown in the previous section and illustrate the link to prototype features.
- ***Column 'Dropped'*** outlines previous features from the initial prototype which were rendered somewhat irrelevant or inappropriate (once mapped to drafted requirements).
- ***Column 'Added'*** delineates the modification regarding the corresponding requirement and old prototype functionality that feeds into refinement of the prototype for interview rounds II.

Req	**Prototype feature**	
	Dropped	*Added*
1	*compare Requirement number 15*	*compare Requirement number 15*
2	Two types of progress diagrams were drawn separately. One showed changes in mood (happy, sad, anxious, mad) over time, the other one illustrated self-injurious behavior versus self-injurious acts over time.	Each mood should be overlayed with the act of self-injurious behavior. Mapping of mood to a mood-NSSI-chart happens on a 1:1 basis. That is, each emotion is accounted for by a separate chart.
3	The list of emotions provided included sadness, anger, anxiousness, relief plus some sort of simply drawn graphical mood drops.	Primary and secondary emotions people with BPD are facing are added, for instance, guilt, emptiness, loneliness etc. The graphical mood drops were removed due to visibility and understandability issues.
4	Interventions were of types cognitive strategy, enhancing self-worth or acceptance as well as replacement strategies. No tailoring towards a specific therapeutic approach had been undergone since the initial rounds of interviewing therapists did not involve a defined therapeutic methodology.	The prototype is considered to integrate skills-training, which is a fundamental part of DBT, and, thus, specifically targets the one therapeutic approach, i.e., behavior therapy, that has been found most likely to deal with diary cards and manualized structures. Besides training during times of less tension, acquired and identified skills will also be used for interventions.

5, 6	Documentation of an urge involves describing the reason, the situation that led to the thoughts of performing NSSI.	Not only the situation, but also the interpretation of why this situation was perceived as "emotionally loaded" is important. Questions regarding "what do you think about the situation" and "what do you feel about the situation" (via emotional scales) have been added. This "component" asks the patient to think about a situation, analyze it to figure out what was going on before NSSI occurred.
7	Self-injury was regarded as a fully-fledged syndrome by itself. Thus, the focus was very much on every detail of the self-injurious act and behavior itself, less on surrounding emotions (whereas specific emotions would then account for a diagnosis or disease that is regarded a comorbidity, since NSSI is at most a symptome, for example) or additional disease-related characteristics.	It is attempted to embed self-injurious behavior in the bigger context of BPD. Thus, primary and secondary emotions associated with BPD as well as the ambivalence occurring in Borderliners is addressed.
8	Patients could earn ribbons for entering data into the diary (which is mostly about self-injurious urges and self-injurious acts).	The incentive of earning ribbons could be either totally dropped (since instead a picture of balance targeting ambivalence has been included) or work as a reward for various decision processes or frequency of performed skills-training.
9	Defined emotional states can be classified according to their intensity by means of continuous scales similar to the Visual Analogue Scale (VAS). The intensity is set by sliding a knobble to one's perception of intensity. Additionally, scales are emphasized by background color ranging from green to red. This color scheme depicts lowest intensity of a feeling in green and increases gradually in color towards highest intensity of a feeling in red. Two emotions that are considered to become gradually more positive (towards reaching higher intensity) are designed with a color scheme ranging from blue to green.	The structure of having scale-oriented emotion documentation remains the same.
10	-	Time and location should be automatically archived (without requiring manual user entry) once an urge or an act is documented. The condition of whether one is alone or in company while being struck by an urge has been added.

11	Patients can initiate transfer of their collected data manually as soon as the device is connected to WiFi. Upon clicking the button the user is prompted with feedback to simulate the upload process. In fact, at this stage, no data transfer occurs.	The concept or feature remains unchanged. The real functionality will be added at a later stage of design.
12	Depending on whatever stage of therapy is set up in the app, a reminder or pop-up occurs on the screen as soon as a user has documented an urge.	The intervening point remains the same.
13	The stage of therapy (setting within the app) defines what type the intervention is made of. For instance, stage 1 prompts the user with a distraction strategy like playing AngryBirds during moments of high tension. Stage 2 targets a users negative perception on themselves by displaying a positive statement saying they are worthy of being loved.	However, literature states that in moment of high tension training can not occur. That's why additional skills training during periods of lowered tension is considered.
14	*compare Requirement number 4*	*compare Requirement number 4*. Additionally, it is regarded important to include skills (which will be taken from various skills-training categories) that have proven to be successful for a specific patient.
15	The awareness ribbon for self-harm (orange ribbon) was first thought of as a motivator. Like a gamification aspect, the idea was to reward the patient with a new orange ribbon upon entering an urge or an act.	Since people with BPD have difficulties with facing emotions be it of either positive or negative nature, reinforcements and motivators to enter data need to address these characteristics. Positive or negative reinforcement (praise or punishment) could raise potential issues. Hence, the idea of receiving orange ribbons like trophies could yield a high-score effect. An image was added showing a set of scales that should reflect the balance (also the ambivalence) in patients with BPD. Two little munchkins are underneath the scale holding it up. Doing some skills-training makes the blue munchkin grow, while every decision to postpone or not postpone acting on an urge makes the yellow munchkin grow. These munchkins' sizes determine the state of balance the scales are in. The task for the patient is then to regain balance with the set of scales.

16	The intention of enabling system-initiated monitoring of mood (changes) during the day was existent. However, the initial prototype did not incorporate real emotional prompting functionality, but rather the setup of a starting point. The user could apply an interval during the day when they were ok with being beeped at.	In addition to the "bothering-time-setup", the app triggers so-called tensional prompts at random times during this interval that occur as app-specific notifications. Therein, users are asked to rate their tension and emotions (anger, happiness, emptiness, shame/guilt) by means of color-coded scales. The selection of these feelings was deliberate, since some of them are listed as primary feelings with respect to BPD. Additionally, the scale of happiness seeks to make patients understand that not all their feelings be necessarily negative or bad, but also positive or joyful.
17	-	Upon documenting an urge of self-injury the physiological change can be entered as well. Additionally, emotional and tension prompts will include a color-coded scale to rate their tension regularly during the day.

Table 7.6: Each requirement (identified by its number) is mapped to a certain aspect or feature of the prototype as such. The mapping process accounts for a previous prototype feature that has been rendered irrelevant *(column 'Dropped')* as well as its refinement based on the specific requirement *(column 'Added')* for the purpose of presentation in interview rounds II.

7.1.3 Discussion Pilot and Rounds I

This chapter was to outline the results gathered from experts throughout pilot phase and interview rounds I. NSSI is not a disorder to be diagnosed by means of DSM-IV or ICD-10, but rather occurs with several comorbidities. However, it is listed as a criterion for Borderline Personality Disorder, which is why NSSI is put and regarded within the broader context of BPD in this project. Putting the pieces of NSSI and BPD together, the manualized structure of DBT is thought of while designing the smartphone application.

Analysis results from pilot phase and interview rounds I suggest that the proposed Android app needs to target DBT as specific treatment approach. Up to that point, the author was unaware of the direction one was headed to. Furthermore, interview partners pointed out that research in that matter had already been undertaken and published, namely the DBTCoach. It is left to mention that this research was discovered after completion of interview rounds I only, i.e., the current stage of the empirical phase. For the sake of clarity and comprehensiveness, it was however already described in Section 3.4.3 along with work that is relevant in comparison to the proposed application.

7.2 Results - Rounds II

The set of codes which was obtained during pilot phase, interview rounds I and interview rounds II grew up to 919 codes after merging all analysis results available. These were derived from interviews after the open and axial phases within the coding stage (remember, Grounded Theory methodology) of the research. The current chapter illustrates the modified prototype (after incorporating findings from interview rounds I), refines requirements that were also drafted in the previous chapter, compare Chapter 7.1, and gives an overview on the Use Cases involved in the process of designing the app.

7.2.1 Prototype

The prototype that has been presented to interview partners in rounds II is shown in Figure 7.4. Following ten screens labeled A to J emphasize some of the core features included:

A the main screen or entry point of the app representing buttons 'urge', 'act', 'skill', 'graphs' and 'upload' which trigger corresponding functionality. At the bottom one sees a scale that is held up by two little munchkins which are planned to grow and shrink, thereby (un)balancing the scales upon defined user interaction with the app.

B user can enter their urge. The first part of the urge documentation asks the user to rate their tension, to enter a description about situation, thoughts and bodily sensations. Furtheron, users are advised to check or uncheck whether they are in company, drinking alcohol or taking drugs.

C prompts the user with a list of Borderline-associated emotions to be rated according to their intensity, which is the second part of the urge documentation and thus related to it.

D users are presented with a skill and a decision of wether to postpone or not postpone acting on their urge. This is considered the last action when documenting an urge.

E user can enter details about their self-injury whenever they have acted out. The first screen of the act documentation asks about type, severity, tool used and number of wounds inflicted within one episode of self-injury.

F shows the overlay of the progress curve of a specific emotion versus self-injurious acts.

G delineates the feedback to the user whenever they manually hit the upload button.

H shows the cell phone dashboard with a notification that was triggered by the app.

I the notification section of the cell phone is opened up. One can see the orange self-injury awareness ribbon, which is the icon of the prototype, title and sub-title of the notification per se and the time the notification was issued.

J illustrates the screen a user is actually prompted with to rate their tension and feelings multiple times per day.

7.2.2 Codes and Concepts

After merging the separately analyzed interviews (and their results) 919 different codes were obtained that had then been placed into 48 groups. Constant comparison - which is a dedicated stage within the GT method - led to comparison of similar codes and concepts, adding, merging, recoding, thus, further refinement and modifications of codes and groups. Eventually, 667 differing codes were established and put into 50 different groups or concepts.

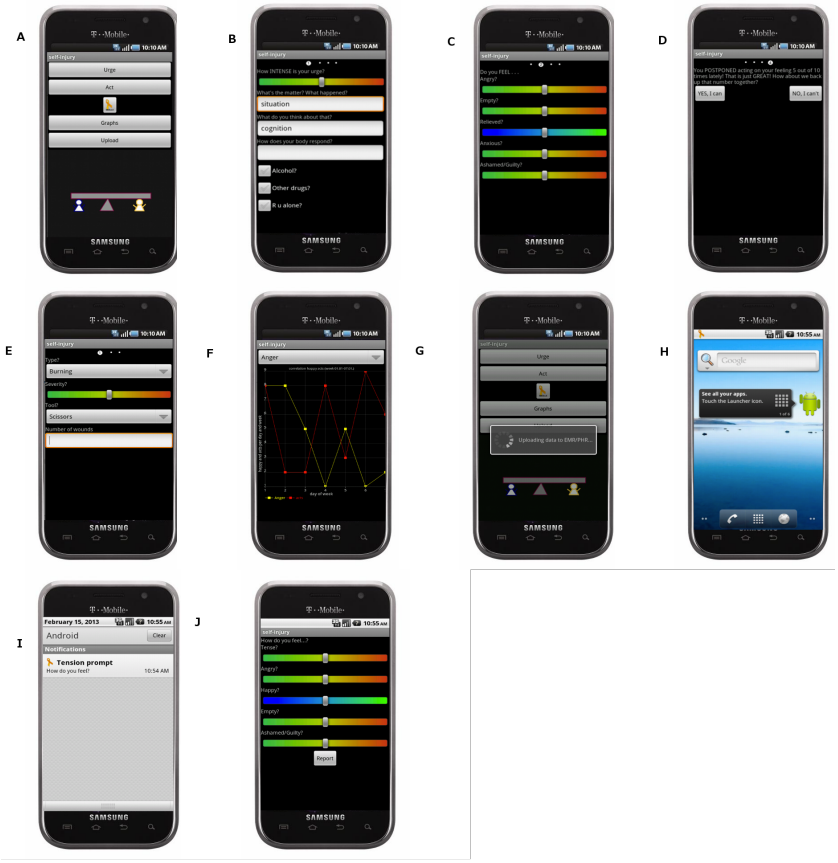

Figure 7.4: Evolution of prototype after analyzing pilot phase and interview rounds I. This prototype is used to support interviews during rounds II. (A) is the main screen of the app, (B) is to enter an urge, (C) prompts the user with a list of Borderline-associated emotions to be rated according to intensity, (D) presents the user with a skill and a decision to either postpone or not postpone acting on their urge. (E) illustrates the screen to document an act, (F) shows the overlay of the progress curve of a specific emotion vs. self-injurious acts, (G) denotes the upload screen. (H) shows the cell phone dashboard with a notification triggered by the app, (I) shows the content shown within the notification section of the cell phone, (J) illustrates the screen the user is actually prompted with throughout their day.

7.2.2.1 Concept: Achievement & Reward & Positive Reinforcement & Motivation

In 11 out of 14 cases the topic of providing achievements / rewards or some kind of positive reinforcement and motivation for the patient came up during the interview. Nonetheless, questions have been targeting this aspect, but clearly one could mark this as a trend that motivation is key for therapeutic interactions (and especially an app like this).
One interview partner (Ms. M) specifically addressed the need for a rewarding system while interacting with the app. During reflecting on current different research approaches and the various types of reinforcement (or punishment in that matter), she stated that punishment might not be the "weapon" of choice. Also she mentioned findings regarding better learning effects by support of positive reinforcement rather than punishment. These results are supported by recent research by Lin et al. (2006) and Grosinger, Vetere, and Fitzpatrick (2012) who associate negative reinforcement[3] with possible frustration among users. In Grosinger, Vetere, and

[3] Rewards and achievements in the "gamification sector" are classified into several categories like positive / negative reinforcement, punishment and extinction (Morgan, 2012). Additionally, in the area of psychology negative reinforcement is the *reduction* of an unpleasant, maybe even aversive, stimulus and not regarded a punishment (*addition* of an unpleasant, maybe even aversive stimulus) per se, compare, for instance, Sendera and Sendera

Fitzpatrick (2012) a developed Tablet prototype specifically stated the intention to only use positive reinforcement (upon motivating older adults to be more physically active) in order to avoid frustration or even unwillingness to work with the software per se.

That is why it was decided to expand and strengthen requirement no 15 named "Motivation and Reward" towards an entire "Reward system" providing it with deeper and more detailed information about what types of rewards may be useful and appropriate for a "Borderline diary app" (compare upcoming Section 7.2.3). For instance,

> *one could, perhaps, do that with a person, that one fills up with stuff. So that the gestalt is strengthened but also made more sensitive. Would also be a good reward. (Ms. M)*

Another example might be the use of a *"token system, meaning collecting points" (Ms. M)* upon doing skills-training regularly, for example, or doing one's homework as in writing a diary card each day. These aspects enhance the idea of incorporating a social factor (which has been brought up by one interview partner (Mr. D)) like a community to cheer on each other and share rewards or achievements along the way as such. Also, this would be in line with recent research regarding sharing entered health data from an EHR / PHR, respectively, their modification into achievements in a social platform to possibly build up a comparative health behavior. For details please refer to Baranyi, Lederer, and Grechenig (2013).

Additionally, a summary of interviews' results dealing with this topic can be found in Section A.3 of the Appendix.

7.2.2.2 Concept: Regular user prompts

The perceptions about including tension prompts are charted as an overview in Figure 7.5.

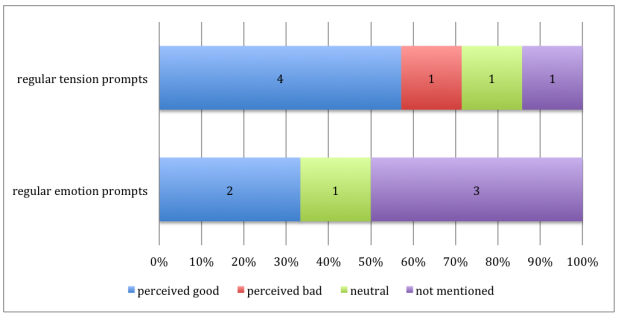

Figure 7.5: Perception of emotion versus tension prompts.

One interview partner explicitly mentioned the tension protocol (Ms. M). Besides rating the tension on a range from 0% to 100% in steps of 10%, the protocol includes textual description of situation, thoughts, emotions, body sensations and applied skills. Another interview partner again mentioned the target group's difficulty to identify and rate emotions until they have actually learned to do so (Ms. N). She was more focused on giving information like body sensation or pain (within the tension prompts), for instance. Since these few cases do certainly not answer the question about actual content of tension prompts, this particular aspect will be presented to interview partners in rounds III. One has to take into account that a majority of interviewees (coming from interview rounds I and pilot phase) reported that a trajectory of emotions over

(2012). Hence, in the case of Lin et al. (2006) one should rather speak of punishment, rather than of negative reinforcement. (Fish are small and possibly crying or unhappy if a designated number of steps is not achieved.)

time would be a good start. But this population did not reflect the exact search query of designated experts which is why it does not yield instant integration into the prototype. This is due to the fact that the "net of stakeholders and experts" could only be refined and adequately identified after already having talked to colleagues coming from several different therapeutic backgrounds (meaning different therapeutic approaches). Also, by then, the target group of people with Borderline Personality Disorder had not been found and identified. Momentarily, it seems, that asking users to rate given emotions on specified scales might be too restrictive. Hence, a work-around could be to ask them to give a reason as to why they are experiencing the reported tension. That way, they could verbally express whatever situation or feeling or thoughts are running through their head.

Number of tension prompts. Limiting the number of per-day-tension prompts may be well worth considering in order to not bother the user too much. The *number of tension prompts* was discussed in several interviews, compare Figure 7.6. There was no trace of opinions on number of per-day-tension prompts in six interviews, whereas three of them (interview partners) had not seen the prototype per se. That might explain why this particular item was not covered in such a large portion of interviews. Two experts said that 3-6 tension prompt per day were ok, two others considered prompting the user each hour or every two hours positive (at least for the initial period, e.g., two weeks, of therapy). One interviewee specifically mentioned the need to set the number of tension prompts on an individual basis. Those interview partners who are designated being neutral did neither criticize nor confirm the number of tension prompts (mostly presented as "5 or 6 tension prompts per day") mentioned by the author upon explaining the prototype.

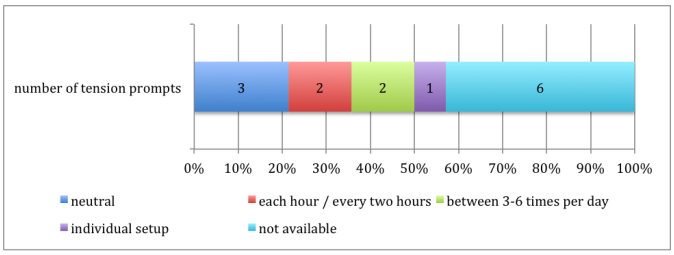

Figure 7.6: Expert opinions on number of tension prompts per day users should / could receive with their app. Three people seemed rather neutral given the limit of tension prompts, two could consider prompting the user each hour or every two hours. Two other experts talked about 3-6 tension prompts per day, and only one interviewee said that the number should be set up on an individual basis. No results regarding the tension prompt number were found in six interviews, whereas three of those are attributed to the fact that they had not seen the prototype (due to various reasons).

7.2.2.3 Concept: Skills and their functions

Purpose and use of skills within a mobile application is reflected by identified categories in Figure 7.7. About 78% (n = 11) of the interview partners perceived interventions by means of skills - being an integral part of DBT - as a valuable asset for such an app. Additional functions of skills were attributed to educational and practicing functions. To make patients aware of the skills they already have at hands (educational feature) but are not aware of their actual function was addressed by about 28% (n = 4) of the interviews. Skills training came up as important for integration into an app in about 42% (n = 6) of the conversations.

One interviewee specifically addressed the need to apply skills (or do skills training) even together with a therapist to avoid or professionally deal with unintentional sudden emergence of flashbacks or increase in level of tension.

> *In principle, one can say almost all individuals like vanilla flavor, that there is something soothing and relaxing to it, but that's nonsense because I had this pa-*

> *tient once, who - there, I tried that [sensoric skill] - within the awareness [module of skills-training] and all of a sudden the patient was gone. I mean, she was dissociated but was at such a low level of tension before, so that awareness training is possible. So, I had the vanilla flavor and was deemed to investigate for hours what had happened. [...] That way it is not an awareness exercise if you feel worse afterwards than if I had done nothing with her. [...] One should be extremely cautious because then [by using the app] the patient is all by himself, I mean, if you don't pay attention.*
> *(Ms. N)*

Coming back to the topic of using skills as interventional mechanisms requires one to take a deeper look, compare Figure 7.7. Interventions become activated on either of three preconditions:

a) a patient is faced with an urge to self-injure and documents that, and

b) regular user prompts detect a rise in level of tension

c) patient feels an upcoming crisis upon them and wants to prevent this situation altogether.

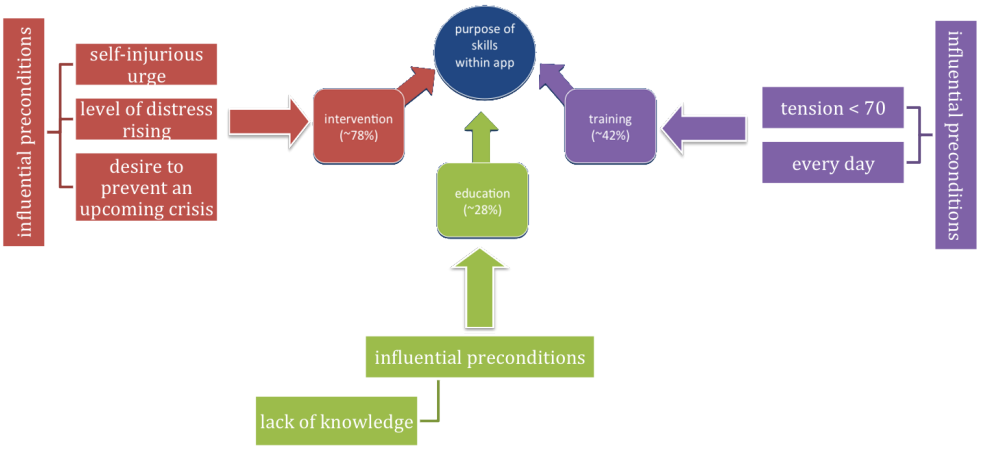

Figure 7.7: The aims of including and applying skills within the app are shown in relation to their corresponding influential factors or preconditions, each one of them yielding a specific skills-action.

7.2.2.4 Concept: Content NSSI Urge

The importance of documenting the location one is at, for instance at home, while facing an urge has only been mentioned by two experts which is why this parameter is rendered negligible. Location-based services could have been used for this purpose but are now not further considered. Four interviewees specifically talked about identifying day time patterns, like a person may be more likely to injure in the evening or at night. One person reflected on the fact that one might not be able to document an urge during its occurrence. So, they should be given the possibility to add an urge and defining the time afterwards. Time will automatically be stored in the background - with the option for the user to enter the time manually as well to take into account later reporting. Also, it turned out, that the time that passes between an urge and a definite act is good to know about. Three out of 14 people specifically talked about identifying whether the person was alone or in company. It did not seem applicable for one expert who is mostly working with people in jail. The remaining six people who have actually seen the prototype in action did not show any reluctance to documenting that. One interview partner had this idea to

keep track of decisional trees whether one really needed to injure or not. The author considered that particularly useful to add in the prototype, given that Borderliners always have two diametrical options in their head. An interview partner at stage rounds II specifically emphasized that she liked this decision item for patients to think about. A large portion of interviewees stressed that besides a situation it is important to find out why this situation is particularly difficult or triggering for a person (n = 7). From an objective viewpoint, a situation may be something simple as another person passing by, smiling. But at the same time this may trigger some sort of cognitive process or flashback that reveals more about triggers themselves. A situational interpretation does not only include one's cognitions but also the emotions that come with them. Particularly, Borderliners, having difficulties identifying emotions, are rather likely to give information about bodily changes which are said to correlate or yield emotional or cognitive output.

Vulnerability factors. Identified *vulnerability factors* were intake of antibiotics or drugs or alcohol consumption - or even premenstrual syndrome - (so called biological factors) during the time frame where an urge occurred (Klonsky et al., 2011). In addition, the diary card in Bohus and Wolf-Arehult (2013) also includes vulnerabilities like lack of sleep, poor physical activity or dietary intake. On a sidemark, these are also known as the skill "ABC-Gesund" and are a relevant marker to keep track and reflect on as one interview partner pointed out. The absence of these factors - like enough sleep, for instance - increases the likelihood of experiencing injuring urges (respectively of managing difficult situations badly) according to experts (Ms. M) and literature, compare (Bohus and Wolf-Arehult, 2013; Klonsky et al., 2011). Users are advised to identify their vulnerability regarding these two aspects in the prototype. Vulnerability factors, are btw, different from risk factors that place-at-risk people for engaging in NSSI by exposing them to traumatic or violent situations or invalidating environments, in general.

Urge intensity. Rating the *urge intensity* had been included in the prototype from the very beginning. None of the interview partners criticized this part, however, there were almost no findings (only one expert said) that it is important for psychotherapists in practice. That is, only one person stressed it as something useful or important to know. Still, it might be of benefit upon doing a follow-up study where one could focus on the intensity stages where urges can be resisted for example. For instance, certain intensity ranges are highly likely to result in injury, while others still carry with them a chance to not injure. The same situation might apply for a possible causality between urge and skills. Some intensity states might respond to particular skills only. That way, it would also make sense to think of the urge intensity as the level of tension which is rated in a system-based sampling fashion in the prototype. Intensity of an urge was also a measured item in Nock, Prinstein, and Sterba (2009). Additionally, one can find items to rate urge intensity in diary cards used in DBT or DBT-A, compare, for instance, Klonsky et al. (2011). These reasons undermine its maintenance in the prototype.

Issues with emotional identification There are conflicting opinions on including emotions and rating them on a pre-defined scale. Negative statements are attributed to the fact that Borderliners cannot express or identify their emotions the way Non-Borderliners would be able to. The situation that their emotional instability und inability to talk about their feelings or moods or emotions is part of why they are struggling is a valid argument. Positive statements go as far as offering the opportunity or at least finding out if there would be a learning effect with respect to rating emotions for Borderliners after a while. One could also think and work out details of when to start working with the prototype in therapy, in general. Some people argued that therapy is needed previous to that, and until they have not learned to express emotions to some extent, the app would neither be useful nor applicable for them. Both sides are understandable and do make sense in the author's opinion. As a matter of fact, and what has been said with several aspects of the app, one should not remove these details altogether without doing some testing around it. However, identifying emotions prior to an urge or act is regarded useful and important when trying to analyze triggering conditions.

An important focus for documenting an urge was the definition and entering of emotions. Interviews revealed that identifying emotions that lead to an urge are critical, on the other hand, there are certain drawbacks among the target group. Clearly, Borderliners have issues regarding emotional identification (it has been stated in this thesis several times already) and may not be able to rate emotions given. Another question is what sort of emotions they are experiencing anyway, which might differ from basic emotional states like happy or sad in some finer detail. Considerations and interview results about entering emotions and emotional states are discussed in Section 7.2.2.7 below.

Make doing skills an obligation for user. One interview partner wanted the app to oblige the users to doing the skills, which are prompted. If the skill triggered were not actually done and confirmed by the user, it would result in some sort of app-freezing. Interestingly, this is the exact same thing that another expert mentioned as "counter-productive". She wanted to make sure the app does not freeze if a prompted skill was not carried out or confirmed or for instance a given emotion was not rated on its respective scale. The majority of experts, however, stressed that doing and prompting skills should be in focus of the app. That is, people often forget about skills they already have at hand according to one expert, so this could be a good reminder. Documenting an urge is considered to be the entry point where one could theoretically still decide whether to go through with injuring or not. That's why prompting the user with skills (that have worked in the past) at that point in time should be a good starting point. The word "skills" has appeared 95 times in these 14 conversations. Each expert from interview rounds II (n = 6) somehow talked about the importance of including skills in the app, which is a very strong indicator of where a focus for an app for self-injuring people and Borderliners should be.
The inclusion of skills upon documenting an urge (as well as their relevance and causal relationships with other prototype aspects) has already been talked about in this thesis, in detail. It is, hence, not further outlined in here any longer. But the reader must be aware of its utmost importance, i.e., skills have evolved to be rather of a core concept for the entire app after having talked to 14 experts in the field.

7.2.2.5 Concept: Content NSSI Act

Figure 7.8 divides feedbacks from interviews about the content of documenting an injury into categories negative, skeptical and rather skeptical. Participants who are grouped as 'data not available' have neither seen the prototype (due to lack of time, for instance) nor did the topic of the details of a self-injurious act come up in one or another way during the conversation. Trend data do suggest, though, that a large portion of experts thinks the current documentation for the prototype is too detailed.

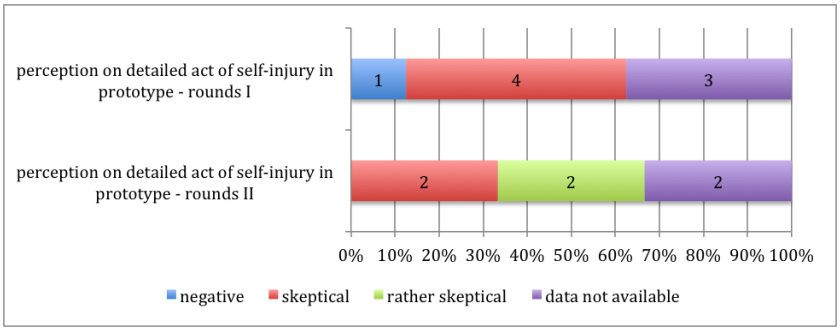

Figure 7.8: This chart details interview partners' perception on the level of detail regarding documentation of self-injurious acts.

Here is a quick snapshot of why interview partners were skeptical about too detailed description of self-injurious acts:

I think of it as dangerous. I mean, the patients would probably like doing that a lot [describing what they did to themselves exactly]. [...] They get upset, of course, if we sometimes don't pay too much attention [to what they are doing], well, but yes, they get an explanation why we are not doing it. It doesn't make sense to support something that is dysfunctional.
(Ms. N)

Well, I believe, it's not so much about top-scoring [documenting number of wounds for example]. That's what is a little bit dangerous here. There are indeed people, who are actually proud [of their self-injurious behavior].
(Mr. H)

I: So, you are saying, the focus should be on mood curves and emotions or something like that, so that for example the entire behavior with respect to self-injury should be rather minimized when thinking about documentation? IP: I'd agree on that, yes, because if these people rather cut / carve or run with their head against the wall or stub out cigarettes... [on their tissue (memo: exact form of self-injury is rather irrelevant)]
(Mr. G)

Hm, don't know whether the bodily location is so important. I think that they do have the same one(s) anyways.
(Ms. C)

Body location of injury. Marking the *spot of an injury via a body scheme* was neither investigated very deeply nor was it mentioned more than twice during interviews by experts themselves. These two people mentioning bodily location did not feel that it is very important to know. Firstly, because the spot where a person injures does rarely change (Ms. C), secondly, because of the profession of the therapist (Ms. N). Bodily location becomes important when the personnel one is talking to is a doctor or the injury requires medical intervention. Other than that, the general theme of not focusing too hard on a dysfunctional behavior (not exploring it in such detail) was more prominent, leading the author to the conclusion that bodily location is not a necessary item to record. In light of one expert, who had this idea to develop a VR app where a patient could perform injuries in a virtual environment with a smartphone, it might serve a function to release tension in patients after all. But, there, it is to note, that bodily location would not serve as some sort of documentation of an act of NSSI, but rather be included during documenting an urge with the aim to provide a vent. These considerations are, however, theoretical in nature and could not be supported by the interviews conducted throughout this thesis. It might be worthwhile considering this concept for a study trial though.

Take and upload foto of wounds. By using Android's camera service from within the app, one could enable *taking fotos of a wound* and then uploading it to an EMR (along with the rest of the data collected). Opinions on that matter vary. One expert said that wound inspection happens on terms of therapists individually (Ms. I) (as well as depends on the underlying profession). That is, in general, she thought of it as imperative for the therapeutic process, for instance, to see whether the patient gave a correct picture of the actual situation. The other reason was psychoeducational, so as to teach patients how to adequately cater for their wounds. Another expert seconded this opinion, but rejected to have patients take a foto of their wounds and upload them to the EMR (Ms. K). From her perspective, there was no reason or positive argumentation for digitally providing a picture. An interesting idea had been suggested by an interview partner from interview rounds I, where one could build some sort of a Virtual Reality (VR) environment

around an episode of injury (Mr. D). The cell phone would then provide the VR app and be used to simulate the "cutting" process. The VR app would then show a designated tool to be used, and upon simulating cutting one's hand the app would show physical consequences of blood at the simulated bodily location. It does not serve the same purpose or concept of taking a foto of a wound, but resembles documenting and confronting oneself with an act to some extent.
In principle, there seems to be too little evidence to mark taking and uploading fotos of a wound as a requirement for the proposed app. Partly, also because one can never (i.e., without testing it in a designated study) fully comprehend if it does not act as a trigger to injure more. Hence, it is not considered for this app.

Number of wounds per episode. Overall, the aspect of letting the patient enter *number of wounds within a self-injurious episode* was not found in 8 out of 14 interviews. Several reasons for that can be established. Firstly, this question was not specifically addressed in the interview guide. Secondly, some interviews were on a strict timeline, which is why the prototype could not be presented. Thirdly, several interviews took a turn to focus on more pressing features that were of relevance to experts than talking in such detail about documenting acts of NSSI (which is perceived negative or at least with skepticism in many cases, anyways). Of the remaining six people who commented on the number-of-wounds item, only two experts seemed ok with it. One expert was uncertain, if documenting the *number of wounds* inflicted in an episode of injury is important (Ms. C). On the other hand, she did not have anything against it. The majority of four people were rather reluctant.

7.2.2.6 Concept: Medication and therapy reminder

Only one interview partner stated that medication does help in people who injure themselves (Ms. I). Releasing medical intervention regarding antibiotics treatment may or may not yield self-injurious behavior again depending on psychotherapy and patient's status as a whole. Another interview partner outlined that medication is of limited success in Borderliners (Mr. G). Basically, because one can only treat specific symptoms, possibly reducing aversive symptoms, but in general, he mentioned Borderline to be a diagnosis, that is to be treated with psychotherapy. From the additional material of another interviewee, it was found that medication has its limits in treating self-injury (Mr. D). (As was discussed with Mr. G medication may become very useful in eliminating certain symptoms like depressive states, but is not evidence-supported to treat / eliminate / heal self-injury.) All in all, a feature to *remind patients about antibiotics intake* did not seem to be too relevant. Especially, when thinking of core principles like skills and other psychotherapeutic interventions and means which were required to be more in focus.

Therapy reminder. Introducing a *reminder about an upcoming doctoral visit or therapy session* in the app was addressed as a feature request (Ms. I). The author found this topic reasonable since another interview partner mentioned absence and no-shows to therapy sessions as one of the recurring therapy problems with Borderliners (Mr. J). Yet another expert did not seem too fond of using a therapy reminder (Ms. M). One interviewee did not exactly cover this topic. But in line with the conversation therapeutic compliance and patient's progress in terms of **no-shows** to therapy sessions was mentioned and perceived as a good thing (Ms. K). Therefore, it is the author's assumption that - from her perspective - a therapy reminder might negatively impact a person's decision to be absent from therapy. This behavior, however "bad" for therapy as such, might uncover other factors that ought to be considered and that even lead to higher therapeutic progress in the patient. Introducing therapy reminders seemed to be unclear, or at least, not supported enough by evidence in interviews (in terms of numbers of approval) to definitely add it as additional prototype feature.

7.2.2.7 Concept: Emotional scales

The perception on providing defined emotions being rated on specified scales regarding the target population of Borderline patients is illustrated in Figure 7.9. It is to mention, that this figure shows results from pilot phase, interview rounds I and rounds II.
Three out of six interview partners from rounds II mentioned explicit skepticism regarding the emotional list, which is basically a set of emotions that are to be rated on a specified scale. They expressed concerns about Borderline patients not being able to identify, express their emotion (even less rating them on a scale) and mentioned the pressure upon having to do so. One of these three was not per se against this proposed emotional list, but addressed the need to have the patient learn all the emotions first. Yet, another therapist talked about usefulness of integrating emotion protocols. These, however, have the goal to lead the patient towards learning and identifying an emotion step-by-step. This is why his feedback was categorized as rather skeptical. Then, on the other hand, and this is stated by literature and several conversations as well, it is important to assess feelings and emotions. Because they provide a better picture of how a situation is perceived.
The two remaining therapists did not explicitly address the emotional scales as critical and did seem rather positive and open for that option. One interviewee mentioned the possible bias of the underlying color scheme, that was on the one hand not coherent throughout all emotional states. On the other hand, he talked about the association of people with colors, who may not be able to see the color red (in the prototype reflecting a feeling like anger to its highest degree) as something "bad". That is, they might link it to the idea of blood or bleeding, which ultimately is perceived good and something that one might want to pursue. One interview partner from rounds I looked at these "emotion reports" in a more positive way. So, he said, that one might work with the question in mind if they were to yield a teaching effect. Since every urge or act involves a variety of feelings to think about, it might trigger a reflection process to think about what feeling might actually have been responsible for an urge. These findings suggest that one should not take these emotion reports for granted especially because of the very characteristics of Borderline Personality. But simultaneously removing them without doing some sort of testing around it might lead to loss of potentially interesting or pursuable information (research questions). One person was classified as having a negative perception. Particularly, he criticized loss of information of not being able to verbally express feelings et cetera. The negative perception does, however, not only relate to the emotional scales per se, but rather to the app in general.

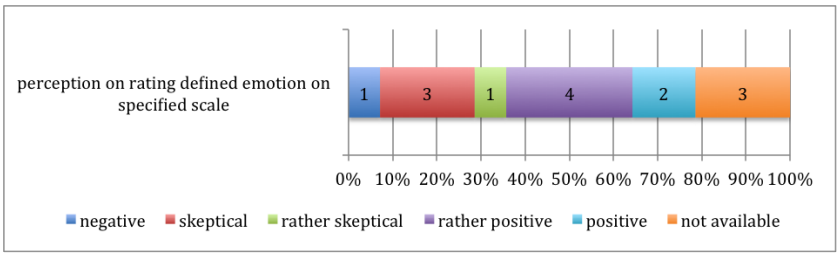

Figure 7.9: Perception of experts on rating emotions from a pre-defined list on a given scale. A definite statement cannot be determined. Five interview partners looked at it rather skeptical, while six interview partners thought of it as more or less positive. Analysis did not yield any designated opinions about these emotional scales in three interviews.

7.2.2.8 Concept: Data security and privacy

Four out 14 interview partners (including interview rounds II, rounds I and pilot phase) specifically emphasized the importance of data security and privacy during the interviews. They were concerned about data access from third parties, loss of cell phones (which is likely in 30% of Borderline cases according to one source) with sensitive information, security issues during

transfer of data and privacy in terms of sending the right data to the right patient. Security and privacy measures are critical to be designed and implemented when developing and using such an app. Still, the number of interviewees mentioning security and privacy as one of their major concerns is interesting, since the author did not ask any question related to that. It tells us that there is a lot of awareness and sensitivity regarding securing data privacy and access, which is remarkable and very much appreciated.

7.2.3 Functional Requirements

Analyzing interview results stemming from pilot phase, interview rounds I and interview rounds II led to further refinement and evolution of previously acquired requirements, compare Section 7.1.2.2. That is, all requirements from the previous chapter have been refined and modified to a certain extent. To help the reader understand more easily in what ways given requirements were refined, they are each assigned a status given in square brackets:

A **(added)** These requirements were not existent before and have been added to the catalogue after figuring its need upon completing analysis of interview rounds II.

M **(modified)** The requirement has been refined or modified.

R **(remains unchanged)** The description of the requirement may have slightly been improved in expression, but remained the same regarding its actual content.

X **(removed)** This requirement existed before but has been removed, reasoning is included in each label.

Req 1 ***Add an entertainment factor.*** [Status: M (modified)]
To make using the app more appealing and desirable entertainment aspects should be considered. This is to motivate a patient to do protocols, do his homework and, in fact, work with the app, thus, this requirement is linked to *Req 15 Reward, Motivation, and Gamification*. That way, it does have a huge impact on the acceptance of the software for therapy by patients. However, building an entertainment factor should be thoroughly thought through and researched on which is not possible in the scope of this project. It should, though, be clearly marked for further directions in this project.

Requirement labeled *Req 2 'Prepare for analyzing correlation'* is split up into two parts. The original requirement about providing a picture to analyze possible correlation is removed, whereas reasoning is given in the respective bulletin section. The second part is linked to the original requirement and labeled *Req 2a 'Curves for self-monitoring'* to keep some sort of association between concepts that belong together.

Req 2 ***Prepare for analyzing correlation.*** [Status: X (removed; note: not feasible at this point)]
Preparing the mood and injurious behavior curves to make correlations or analysis thereof apparent and possible does not seem feasible at the moment since there are too many uncertain variables like individual factor of a target population, its working patterns. On top of it all, before actually rolling out a study to test the application, it still seems unclear which emotions are relevant to keep track of, as well as to what extent Borderline patients are even remotely capable of identifying their emotional states. That is, this question will remain unresolved as long the fundamental basis of emotional identification and rating is still somehow in the dark. This requirement is, thus, postponed to possibly reconsider as a future step within further development of the application. It will, however, not affect the outcome of the thesis project at hand.

Req 2a ***Curves for self-monitoring.*** [Status: M (modified)]
Up to now, progress diagrams showed an overlay of specific emotions to be selected and self-injurious acts over a given period of time in the past. The basic idea is regarded to be kept as is, but, plans to replace specific mood curves with the renown tension curve (renown among the target population) are considered. These curves are not to be removed per se for the author argues that they may / might serve a self-monitoring function, which has been addressed as one probable aspect to motivate behavior change in the introductory chapter.

Req 3 ***Expand on emotional scales.*** [Status: M (modified)]
What sort of feelings the emotional list is made of will be determined after analyzing interviews from rounds III. As a reason for doing so, one should mention that at this point in time, there are still uncertainties of how to go about emotions in people with BPD, in general. Nonetheless, it is unclear, if a tendency to a specific direction will arise after going through all interviews available within this project. A fallback option that might be considered in this case may be to rely on the already established DBT-A diary card content regarding emotional aspects, compare Klonsky et al. (2011).

Req 4 ***Therapy method.*** [Status: M (modified)]
The therapy method of interest is behavioral therapy, especially DBT. The app should follow parts of its structurized manuals like behavior documentation and skills training.

The following two requirements, namely Req 5 and Req 6, belong together and are thus not covered separately in Table 7.7. Nonetheless, they reflect two separate requirements. Requirement labeled *Req 6 'Triggers are individual'* has been revisited, then modified, so as to give a situational interpretation (including emotion, cognition, bodily response about a situation). To better reflect the changes, it has also been renamed.

Req 5 ***Emotion and Cognition.*** [Status: R (remains unchanged)]
Emotion and cognition still need to be seen as separate aspects because what a person thinks about a certain situation and what they feel about it as a consequence do not necessarily align. This requirement somehow resembles requirement labeled *Req 6 'Situational interpretation as triggers'* and is thus, linked, to it.

Req 6 ***Situational interpretations as triggers.*** [Status: M (modified)]
A situation itself is rarely the point nor the trigger (this has been agreed on and addressed by many therapists interviewed). The conditions that are relevant and that trigger high tension, thus, often dysfunctional behavior are a patient's interpretation and individual view on a specific situation. Emotion, cognition, and bodily responses upon being confronted with a situation shall be documented.

Req 7 ***Frame in context of BPD.*** [Status: M (modified)]
Self-injury shall be addressed in the context of BPD, as has been established in a previous chapter. The app addresses this requirement following certain stages and protocols that are inherent in the therapy method of DBT and specifically target BPD. For instance, rating one's tension is closely linked to people presenting with BPD. Also, the description of bodily responses and difficulties rating and even identifying emotions is Borderline-specific. Another aspect targeting BPD is attributed towards the provision of two ambivalent decisions to self-injure or not self-injure after an urge has occurred. (Borderliners are commonly known as being ambivalent, simultaneously experiencing diametrically opposed schemata as it is called by experts. For instance, one can think of it as being proud of having gone through with something - perhaps a dysfunctional behavior - and as a

consequence of being proud, also feeling ashamed because of it. (Sendera and Sendera, 2012))

The previous requirement labeled as *Req 8 'Avoid high-score effect'* belongs to the bigger concept of reward, motivation and gamification and is, hence, shifted to requirement listed as *Req 15 'Motivation and Reward'*.

Req 9 ***Emotional black and white.*** [Status: M (modified)]
It is unlikely that Borderliners will be able to classify and rate several emotions among their intensity. On the other hand, experts do not know, if it could start a process of reflective thinking or what it would actually do with BPD-patients. Hence, the author decided to mainly leave the structure of these emotional scales, as is, with some slight modification. Scales will be set with a range from 0 to 5, represented by six-point items (0: not at all, 1: a bit, 2: somewhat, 3: rather strong, 4: very strong, 5: extremely strong) based on the DBT-A[4]. The author argues, that diary cards that have been developed for DBT-A also require patients to rate their emotions on a scale of 0 to 5 (like presented just above) in the modified version by Klonsky et al. (2011). It is to state, however, that the number of emotions to rate is fairly smaller than in the proposed app.

Req 10 ***Time and company.*** [Status: M (modified)]
A previous paragraph already discussed that the location was not perceived too important by the majority of the experts interviewed. Therefore, it was removed from the requirements list. Users of the app are, however, still required to give information about whether they are alone or in company, respectively, optionally enter the time for when an urge occurred.

Req 11 ***Providing patient's data to therapist.*** [Status: M (modified)]
Although interviews did not indicate a removal of the upload button, which lets the patient manually upload their data while on WiFi, the feature is changed in favor of a more real-time setting. That means, that as soon as a patient has interacted with the app (entered an event or answered a tension prompt, for example), these data will automatically be uploaded to the therapist. The advantage of this is that a therapist can instantly see what is happening with their patient and tailor achievements to the individual based on recent results reflected in the PHR.

Requirements labeled *Req 12 'Intervening point'*, *Req 13 'Intervention'*, and *Req 14 'Provide alternatives'* have been revisited and were due for modification (to reflect results of interview analysis). The latter requirement was removed as such and merged into *Req 12c 'Intervention'* since their content was centering around the same topic. The remaining requirements are subsumed as a single requirement with a number of sub-categories.

Req 12 ***Skills.*** [Status: M (modified)]
Skills are classified into four or five different categories. Each of the latter targets a specific criterion within the classification of BPD and aims to improve it.

Req 12a ***Modules.*** [Status: A (added)]
Skills shall be provided for each one of the five modules: emotion regulation, stress tolerance, self-worth, awareness, and interpersonal skills.

[4] The DBT-A is known as Dialectical Behavior Therapy specifically targeting adolescents with BPD who are, additionally, suicidal (Sendera and Sendera, 2012). It has been developed by Miller, Rathus, and Linehan (2007).

Req 12b ***Intervening point.*** [Status: A (added)]
Skills intervene and disrupt the user's regular process by providing alternative routes to cope with a situation. Intervening point is classified into two 'directions': a) An intervention shall prompt the user for alternative action as soon as an urge to self-injure occurs. b) An intervention shall prompt the user for alternative action after a tension level has been reported (which happens repeatedly throughout the day by means of notifications).

Req 12c ***Intervention.*** [Status: A (added)]
An intervention is closely linked to the level of tension reported by a patient. A tension level of 70% and higher requires stress-tolerance skills, i.e., the emergency suitcase, to come into effect. A tension level ranging between 60% and 40% shall trigger interventions from the modules emotions, interpersonal skills, self-worth, awareness. The module awareness is the core module, thus, the focus for lower tension levels, that is, levels below 40% refer to all skills modules except distress tolerance.

Req 12d ***Skills protocol.*** [Status: A (added)]
Stress protocols or stress lists are handed out to patients during therapy, presenting them with a list of categorized skills and their corresponding names. A stress protocol shall be readily available for access from within the app.

Req 12e ***Stress tolerance.*** [Status: A (added)]
The app shall enable the patient to identify three to four skills as their individual stress-tolerance skills, i.e., the emergency suitcase. This category contains skills that prove successful and are working for the patient, are, thus tailored to one's hobbies, beliefs, likings. These skills are not to be trained, but rather, quickly applied in times of high tension (i.e., point of no return, tension level of 70%).

Req 12f ***Skills training.*** [Status: A (added)]
Patients are encouraged to do skills training. This usually happens in group sessions alongside individual therapy. Upon doing skills training the app shall enable a person with options to declare what skill was trained, when it was trained, for how long the practice was going on and if it is a helpful and working skill for the patient (thus, will be marked as an appropriate intervention).

Requirement labeled *Req 13 'Intervention'* has been reframed to more closely match its meaning.

Req 13 ***Mind individual content.*** [Status: M (modified)]
Content within the app is highly individual, thus, ought to be tailored to the patient. Content that needs to be tailored by the therapist to reflect needs and beliefs or hobbies of the patient involves: a) number of tension prompts repeatedly targeting the patient, b) specific storylines targeting sub-obstacles and sub-goals tailored to the patient. Content that is tailored by the patient themselves is: c) entering specific working skills (name and description) that belong to designated categories.

Requirement labeled *Req 14 'Provide alternatives'* has been rendered irrelevant since it is already included in the requirements dealing with delivering all sorts of skills. It is, therefore, removed and marked as such.

Req 14 ***Provide alternatives.*** [Status: X (removed; note: duplicate)]

Req 15 ***Reward, Motivation, and Gamification.*** [Status: M (modified)]
Giving incentives and rewarding patients for desirable behavior, respectively, for making small steps along a desirable path towards better and healthier behavior is important.

Nonetheless, rewards, motivation, and incentives are a broad topic belonging to the concept of gamification research. Therefore, it cannot be broadly accounted for within the scope of this thesis. However, a few considerations and thoughts shall be made and included in here. Relying on a picture of scales that go in and out of balance and need to be eventually balanced again by the user may or may not work as a motivating achievement for Borderline patients. In fact, the author believes that it may get boring and even frustrating after a very short while since all one has to do is repeatedly keep the scales in balance. Instead, the author thinks of including a basic storyline about the patient themselves. Providing a basic storyline that can be individually modified and handled by the therapist so that it suits the very personal characteristics of a patient is attributed to successfully cover the requirement to tailor content - specifically achievement - to the very patient.

Req 15a ***Avoid high-score effect.*** [Status: A (added)]
Since earning a ribbon or alike for entering an urge (or an act) to self-injure is potentially dangerous and likely to boost dysfunctional behavior further, it is redesigned. Motivation and rewards are considered important, a reward or incentive or gamification aspect, however, should be based on a desired / functional / new behavior like a decision to postpone self-injury or a practice session of a skill.

Req 16 ***Event-based versus system-based sampling.*** [Status: R (remains unchanged)]
At its core, this requirement remains the same. The app shall provide event-based as well as system-based sampling. Event-based sampling involves documentation of self-injurious urges and acts, while system-based sampling relies on user reports in reply to tension prompts. The latter part of this requirement is, thus, also linked to Req 17 (a,b,c).

Req 16a ***Specifics of documenting self-injurious acts.*** [Status: A (added)]
Due to the many discussions with therapists regarding the details of documenting self-injurious acts, the items *'severity (as in bleeding intensity, for example)'* and *'number of wounds during one episode'* are removed from the equation. If items *'method of NSSI act'* and *'tool used to injure oneself'* are kept for the prototype, will be analyzed and determined as soon as the remaining results from interview rounds III are in. Including additional features like using a body scheme to mark the spot an injury was inflicted on, as well as the option to take a picture of a wound were seen rather skeptical than enthusiastic, in general. Therefore, they are not considered a requirement for the proposed application.

Req 17 ***Tension.*** [Status: M (modified)]
Although certainly not being pointed at or criticized by interview partners, the repeating tension notifications prompting the patients to report their tension as well as emotional state are going for a make over. Various literature as well existing interactive desktop or CD-ROM software solutions suggest that the emotion of *tension* as such is - without doubt - essential to keep tabs on, compare for example Sendera and Sendera (2012) or Bohus and Wolf-Arehult (2013). Tension curves showing its trajectory throughout a period of time, e.g., a day, are often documented. The reason for doing so is - amongst others - to educate patients about their state of tension as well as to illustrate at what point a level of high-tension is reached where emergency skills need to be readily available to be applied. It is believed that the core interest lies in the tension, which is why the author has decided to drop reporting on further emotional scales, but rather to add text fields, wherein a reason (situation and its cognitive, emotional and physiological interpretation) for this tension can be given. This is believed to be in line with research mentioned in here.

Hence, requirements labeled *Req 17 'Tension'* has been refined and divided into following three sub-categories. That way, it is also partly merged with a refined requirement previously labeled as *Req 16 'Event-based versus system-initiated monitoring'*:

Req 17a ***Structure of how a patient reports their tension.*** [Status: A (added)]
A tension is rated in steps of tens, whereas the entire scale ranges from 0 to 100 (unit is percent). A tension of value 70 is referred to as point of no return. This is the point where only stress-tolerance skills are to be applied and considered worthwhile or helpful.

Req 17b ***Content of Tension Prompts.*** [Status: A (added)]
As stated in the section above results from interviews do not point to a certain strategy regarding an actual, beneficial content of tension prompts within an app like this. A fall-back option to prompt the user with a free form text field to enter situational interpretation besides rating their tension level may become feasible. To give a better picture of the requirement regarding content of tension prompt, this aspect will be brought to interview partners in rounds III for further investigation.

Req 17c ***Frequency of Tension Prompts.*** [Status: A (added)]
At an initial stage, tension prompts should be answered by the user on an hourly basis. Afterwards, the number of prompts should be set by patient or therapist or both and tailored to the patient's needs and progress. The default value of tension prompts is set to *six*.

Req 18 ***Provide picture to therapist after injurious episode.*** [Status: A (added)]
This topic was mentioned and investigated with several interview partners. But this requirement was not found to be supported by enough evidence in interviews. Few experts asked acknowledge the fact, that it is important to look at wounds during a therapy session to check for medical emergency, appropriate catering for wounds as well as comparison with the way the patient described their injuries. Receiving a picture of the wounds, on the other hand, is not perceived to add any benefit. Furthermore, willingness and capabilities to even look at wounds is very much dependent on the therapist. Therefore, providing the app with a feature to document (and upload) pictures of deliberate injuries is not pursued further.

7.2.3.1 Mapping requirements to prototype

This section delineates the process of how requirements are mapped to prototypical features. In Table 7.7 one can read up on what features have been dropped from the prototype in order to be exchanged or enhanced by something else:

- ***Column 'Req'*** The numbers refer to the corresponding requirement as shown in the previous section and illustrate the link to prototype features.
- ***Column 'Dropped'*** outlines features from the previous prototype which were rendered somewhat irrelevant or inappropriate (once mapped to drafted requirements).
- ***Column 'Added'*** delineates the modification regarding the corresponding requirement and old prototype functionality that feeds into refinement of the prototype for a final evaluation during interview rounds III.

Req	**Prototype feature**	
	Dropped	*Added*
1	*compare Req 15*	*compare Req 15*
2	*compare Req 2a*	-

2a	Each mood curve maps to the injurious behavior curve, whereas each emotion is drawn as a separate chart.	The mood curves as such remain in the system. It is considered to replace mood curves with tension curves, however, since tension seems to be a much more reliable and important item in therapy with Borderliners (note: Borderliners have an inherent problem to identify emotions as such, which may render a self-monitoring tool, that is based on emotions, irrelevant).
3	The emotional list included feelings like angry, empty, relieved, anxious, ashamed / guilty and a few more. This emotional list is not completely dropped, but will undergo further investigation.	The prototype temporarily includes emotional aspects as they are stated in the DBT-A diary card, compare (Klonsky et al., 2011), until a tendency from analyzing all interviews within this project can be unveiled.
4	Skills and skills training had only been thought of in theory.	Skills and their training which plays a big part in the DBT are added features within the app.
5, 6	Situation, emotion, cognition and bodily reaction had been incorporated.	*remains unchanged*
7	Self-injury was regarded in the context of BPD, thus, ambivalence and emotions targeting the specific disease were thought to be included in the prototype.	*remains unchanged*
8	*compare mapping of Req 15, 1, 8*	*compare mapping of Req 15, 1, 8*
9	Emotional scales were not linked to specific values or intervals. That made it difficult for patients and therapists to draw any conclusion (besides underlying color scheme). Emotional scales were, therefore, enhanced.	Emotional scales are based on six-point-items as identified beneficial after analyzing interviews and as discussed in one of above sections.
10	The factor whether a user is in company or all by themselves when documenting an urge had been accounted for already. Automatically documenting time and location in the background was considered in theory only, up to that point.	The time upon documentation of an urge and an act is automatically recorded in the background. That way, the phone also archives information about the time that has passed between an urge and an act which is sometimes a matter of interest according to literature (when analyzing most recent "therapy-harming-behavior") (Bohus, 2002). In addition, the user can enter time of occurrence manually. (This is especially important in cases, when the user documents an event later on.) Using location-based-services to obtain information about the user's location is not included in the prototype.

11	The upload button lets the user decide when to manually upload the information collected on their phone. This has certain drawbacks like in a case when a cell phone gets lost (and with it all data). Therefore, the upload button is removed.	The upload feature is inherently included in the app. As soon as values are entered into the app, these data will be automatically transferred to the designated PHR. The therapist can then design achievements that are tailored to the individual and react to changes in a more real-time setting.
12	-	Please see *Req 12a, b, c, d, e, f* for details regarding skills within the prototype.
12a	Up to now the inclusion of skills modules has only been thought of, but was not actually reflected by the UI design.	The five skills modules - awareness, emotion, self-worth, interpersonal skills and (di)stress-tolerance skills are represented by designated pictorial icons. Each one of these categories is holding a few sample skills belonging to this very category.
12b, 14	A static external intervention is shown just before the user is asked to decide whether or not to postpone injuring.	An intervention will be delivered to the user as soon as they are documenting an urge (before a final decision to injure or not injure has taken place). The second intervention point depends on a user's tension reports. Based on the tension level, skills from pre-specified skill sets will be brought to the user's attention.
12c	Upon confirmation of the user's tension level, tension value and associated respective emotional values would have been sent to the EMR / PHR without intervention.	Upon calculation of the tension interval the user reports to be at, the system triggers skills from pre-defined skill modules; compare Figure 7.19 for a more detailed workflow.
12d	-	Including the entire list of skills available is not feasible for a prototype of this app. However, a few samples have been taken from this list and are presented to the user within their corresponding skill categories. Additionally, the paper protocol requires the patient to identify whether a skill is known, available, to what extent it is helpful et cetera. Within the app the user is encouraged to do the same thing with respect to the skills present on the phone.

12e	-	(Di)stress tolerance is a separate skills module within the app. Declaring a skill as part of a (di)stress-tolerance skills is accounted for in the skills protocol section within the app, as well. To ease lookup of (di)stress-tolerance skills, these skills are listed in the corresponding module as well. No more than four skills should be determined as (di)stress tolerance skills.
12f	-	The stress protocol is aimed to enable documentation of date and duration of a skills-training.
13	-	The individualization of the prototype has not been included at this point since other core features are still being designed and worked on. (These will not be reflected in the prototype until the surrounding context as in the main categories are resolved.)
14	*compare Req 12b, 14*	*compare Req 12b, 14*
15, 1, 8	The picture of the scales that turn to be in and out of balance is removed as motivational feature.	A basic storyline is set up for general use of the app. Additionally, a therapist can tailor the story and its obstacles and challenges to the needs of the patient. As soon as one obstacle has been overcome, that is, a specific goal has been met, an individual achievement by means of a YouTube video (that can be accessed from within the proposed app) showing a patient's favorite band or movie trailer or alike will be generated for the patient and pushed to their app.
15a, 1, 8	Earning ribbons was considered to possibly trigger a high-score-effect among the target population. The solution from the prototype at its previous stage was to provide the user with a scale that went in and out of balance upon various functional and dysfunctional user interactions and data entries.	To avoid a potentially dangerous high-score-effect ribbons or alike - gamification aspects, in general - can not be earned by entering self-injurious urges or acts. Instead, a user collects points or badges or ribbons upon doing skills-training as "ordered" by the storyline that is given by the therapist (and displayed as a motivational factor in the app, compare its "generalization" - mapping of Req 15, 1, 8 - just above).

16	The app triggered notifications prompting the user to report their tension at random intervals during their "bothering-setup-daytime". In addition, the system provided possibilities to enter events like urges and acts by the patient (which has been the core of the app from the very beginning).	The tension prompts "beeping" at the user at random times during the user's day (as set up in their preferences) as well as the event-based documentation of urges and acts remain. Further details regarding the content of system-based prompts (and their respective prototype feature) are given in requirements labeled *Req 17 (resp. 17a,b,c)*.
16a	*compare mapping of Req 16 above*	The part to document self-injurious acts will no longer contain the items *'intensity'* and *'number of wounds'*. The remaining parameters are open for discussion in interview rounds III.
17	Emotional and tension prompts included color-coded rating scales. The scales themselves were not linked to specific values or a pre-defined score.	Tension prompts were slightly redefined; see *Req 17a,b,c* for details.
17a	Rating scales are supported by stepless (seamless) color-coded SeekBars. These are rendered impractical, since patients are encouraged to rate their tension in exact intervals of 10%. Also, the color-coded layer was perceived as being too left-centered which could give the wrong impression for a patient.	Patients are asked to rate their tension at the beginning of each (group) session, whereas the unit is % and the rating scale ranges from 0 - 100 % in intervals of 10. Hence, rating scales (i.e., SeekBars in technological slang) provided are modified to present the patient with the possibility to exactly define their tension level in steps of 10%. The intervals are made apparent in the design of the SeekBar. In addition, the color code underneath was kept, which ranges from green to red, whereas the transition to a reddish color exactly happens at 50%.
17b	Besides tension, the notifications users are prompted to reply to, included emotions. Discussion with interview partners indicated that in therapy features like situation, emotion, cognition and bodily changes are important to assess together with a patient's tension. This is due to educational reasons, so that patients learn to understand why they are feeling tense and how this tension is shown in terms of physiology.	Up to this point, interview results did not reveal much about the actual content of tension prompts within an app. That is why this aspect has been postponed and specifically be presented to interview partners in rounds III for investigation. A backup-plan might be to drop the emotional scales provided, in favor of including a text area that lets the user enter situation and interpretation thereof (emotion, cognition, bodily sensation) on their own terms.

17c	The default number a user is prompted to report his tension is set to six initially.	The default number of tension prompts throughout a day remains the same. In addition, therapist and / or patient may set the number of tension prompts to a level that is more appropriate for the individual user. If possible, the time of an upcoming tension prompt will still not be predictable for the user to no fake his response beforehand.
18	-	*This requirement was investigated during several interviews, but rendered irrelevant for the prototype and is, hence, not further pursued.*

Table 7.7: Each requirement (identified by its number) is mapped to a certain aspect or feature of the prototype as such. The mapping process accounts for a previous prototype feature that has been rendered irrelevant *(column 'Dropped')* as well as its refinement based on the specific requirement *(column 'Added')* for the purpose of presentation in interview rounds III.

7.2.4 Minor modifications within the prototype

Lack of time to include and modify all requirements, which were outlined in this chapter, is responsible that only minor modifications of the prototype from interview rounds II were performed before interview rounds III started. It is, however, clearly stated that identified requirements will indeed affect the final outcome of this project. But the final prototype will only be presented after completing interview rounds III. Since one expert to be interviewed in interview rounds III resided in the USA, video material in combination with an audio track was set up and provided to her since presenting the prototype was rather unlikely during the interview (which was done via skype). The video shows minor modifications that could be done in the short timeline between rounds II and rounds III. In particular, requirements labeled *Req 9 'Emotional black and white'* and *Req 17a 'Structure of how a patient reports his tension'* were included. Also, requirements labeled *Req 12, 12a, 12d, 12f 'Skills'* were included in the minor prototype modifications (they are not shown in the upcoming excerpts below at this point). The video material may be provided to interested readers upon correspondence. Excerpts from the video material are illustrated in form of screenshots, compare Figure 7.10.

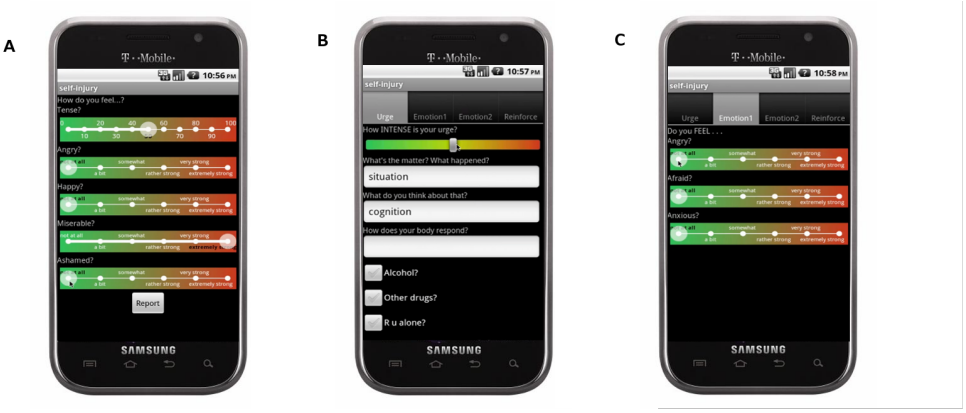

Figure 7.10: Minor modifications of the prototype in-between interview rounds II and rounds III. A) shows the redesigned tension prompt, whereas tension level can be set at an interval of 0% to 100% and emotional scales are based on six-point items. B) illustrates the redesign upon entering individual events (use of a tabbed layout for better orientation within the app, whereas swipe gesture navigation is enabled). C) is an example of the redesigned emotion set which is based on six-point-items. Also, the color scheme has been revisited to eliminate left-centered color transitions.

7.2.5 Discussion Rounds II

Up to this point, pilot phase, interview rounds I and interview rounds II have been completed. That way, 14 experts were interviewed and consulted with their expertise about treatment options in Borderline Personality Disorder and self-injurious behavior and their opinions on the designed prototype.
Several focal points regarding usefulness and purpose of the prototype were outlined. Among these, one could mention the need to have tension reports aligned with the way tension is discussed and handled in therapy and group sessions (not necessarily restricted to Borderliners). That is, tension is always rated in steps of 10 on given scales from 0%-100%. Another important aspect is that the plan to monitor an act of NSSI in proposed detail may very well yield unanticipated negative effects. On the other hand, one cannot know for sure until proven or trialled with the target population per se. But given the nature of the interviewing process - based on experts' similar tendencies and reactions, it is most valid to remove items where the majority warned of possibly triggering side-effects. As a matter of fact, keeping an eye on suicidality is of utmost importance with Borderline patients. So, while the introductory chapters focussed a lot on NSSI (to recap, nonsuicidal self-injury), this definition is in conflict with the diagnosis of BPD to some extent. This, in turn, does not suggest that Borderliners are always suicidal or always harm and injure in a suicidal context. Nor does it mean that the initial idea of solely focussing on NSSI is wrong. Rather, it should be seen as a message for project progress, tosses and turns along the research as well as an evolution and extension of the concept and a steady increase of the learning curve, where a target population was formed along the line without having been set in stone from the very beginning.

Some requirements came to effect which may or may not be supported by a large portion of interview partners. In fact, they may even be far off from building a majority in terms of numbers. But, as long as their reasoning and expertise followed a coherent line which made more sense given the specific context, target population and concept of the app (than for example an expertise which was by no means less coherent or made less sense, but was embedded in a therapeutic approach that is out of focus for this project), they were, nonetheless, considered valid and included.

The next chapter will attempt to round up the picture and concept for the proposed application by delineating opinions and expertise of three more experts. One of them being a researcher in the field, the others being psychotherapists in practice and education. They represent the interview partners from rounds III and helped with further refinement of the prototype and its possible action, interaction, benefit for therapy support.

7.3 Results - Rounds III

This chapter presents the final stage of the research process - interview rounds III - and wraps up the results, which have been obtained during the course of this project. Its core points are the discussion and outline of newly emerged or enhanced concepts and themes. In line with the two previous chapters, functional requirements will be established, whereas the mapping of prototype constructs based on the so established requirements will be outlined, as well. As usual, the chapter wraps up with a short discussion on what has been the focus of this current chapter and the knowledge that has been gained up to this point.

7.3.1 Codes and Concepts

Open, axial and selective coding (remember, Grounded Theory methodology) after interview rounds III enhanced the code list towards a number of 753 codes that were grouped into 51 different concepts. Describing every one of them would be overburdening for readers. Hence,

the 51 final concept groups are only listed for matters of completeness and can be looked up in Section A.5 of the Appendix.
Nonetheless, what has to come are two of the most important concepts. All along this project, these have been *'Concept: Content NSSI Urge'* and *'Concept: Content NSSI Act'*. Hence, skipping them in the final empirical results chapter would leave these core aspects unfinished. Several more themes are outlined below if they are considered to add valuable knowledge to results already presented in Chapter 7.1 and Chapter 7.2.

7.3.1.1 Concept: Content NSSI Urge

In general, the items that had been prepared upon documenting an urge did not reveal much skepticism. However, several interview partners had a lot of constructive comments on what could be included and helpful for the patient.

Pro and contra list. DBT, in principle, makes use of so called *pro versus contra lists* regarding problematic behavioral patterns that are to be changed, compare Bohus and Wolf-Arehult (2013). In there, advantages and disadvantages of maintaining the specific behavior are classified in short-term and long-term aspects. This schema is usually also applied to the domain of skills usage. Several interview partners came up with this exact topic (including pro / contra lists for maintaining self-injury). Having prepared a list of short-term and long-term consequences regarding self-injury by the patient, it can "pop-up" at the point of an urge to a user's advantage, thus, act as a very personal intervention (Ms. P, Ms. Q, Ms. M). Thereupon, it was mentioned that it is not just enough to display like "think about your pro / contra list" but have them see whatever notes they had written down in each respective category (Ms. M). One expert said it is important to make apparent to users or patients that they have a choice (to injure or to try to radically accept a difficult situation) (Ms. O). Her statement, in fact, covers both the relevance of having the user decide between two options that are completely different, and the effect of showing them - in writing - the (positive / negative) outcome / consequences they had established before, so as to have them make a decision based on their individual thought process.

Access channels and "stuck states". In a previous chapter, we learned that skills are classified into certain modules in the context of DBT. Additionally, one can distinguish between skills targeting actions, thoughts, the body or the five senses. This differentiation is useful because depending on the person and their level of tension certain "channels" are no longer accessible. A popular example is, that during high moments of tension people sometimes "get stuck" and start to dissociate (i.e., they are not with themselves any longer, it is like they watch themselves as if they were another person), so that a skill targeting the "thinking-mode" (like doing a crossword) is not helpful. Rather, people in "stuck-states" (Mohl, 1996) cited after Bohus and Wolf-Arehult (2013) do need "heavier" skills ("harder / stronger" cues) that can bring them back to reality. Furthermore, some skills are highly specific to certain situations (Ms. Q). For instance, while being at work, it seems unlikely to take an ice-cold shower. This is notable in light of one interview partner, who reasoned that a decisional tree could be displayed to the user (regarding where one is at) in order to determine accessible skills that are at reach (before these "beep at" the user) (Ms. Q).

Feedback before / after decision to injure. As far as *feedback* is concerned - after the user had made a decision - it was suggested to use motivational interviewing techniques for verbal support (Ms. O). This is because displaying the same text over and over again may be pretty lame and downing from a user's perspective. An app should respond to the user in a contextually-sensitive way so as to not upset them. But, then again, and this was also mentioned by this very same interview partner, "one would have to get pretty sophisticated with the text and the motivational interviewing strategy" (Ms. O) which does not seem feasible for an initial concept like this one and within the remaining time. Another person rather emphasized her opinion to leave the app being objective and just be focusing on, "are you injuring yourself? yes, no, what skills have

helped?" (Ms. P). Every other kind of feedback might yield unanticipated reactions, especially with Borderliners. One expert walked through a scenario, saying that in order not to be totally unrealistic one might not even think about giving feedback after a decision to injure (Ms. Q).

> *"Patient is sitting on their bed, holding a razor blade and - in theory - somehow still walking through the program, until reaching this point of 'do I injure? do I not injure? yes, I injure myself' and then they cut and the device is somewhere else. By that moment, they have simply given in to the battle."*
> *(Ms. Q)*

7.3.1.2 Concept: Content NSSI Act

Newly emerged codes said that detailed information about an act of injury may be 'clinically useful but potentially triggering', but also 'possibly therapeutic in a way' as well as make the user 'move back into witness mode upon documentation' (Ms. O). Statements that were linked to a higher degree of skepticism and even negative perception indicated that 'pictures of wounds are dangerous, but talking to clinicians and therapists is recommended', 'severity, instrument, etc. might act as positive reinforcement to self-injury' to 'no use in asking details about an episode of NSSI' (Ms. O, Ms. P, Ms. Q, Mr. R). That is, all four experts interviewed in rounds III agreed that there might not be much benefit, therapeutically, to know these details about a self-injurious act (rather yet one more positive reinforcement to stay with the dysfunctional behavior).

Trial recommended. A researcher in the respective field of NSSI explicitly stated that although the detailed documentation about an act might be triggering and dangerous, in her opinion, taking these items out altogether should not happen before a trial took place (Ms. O). In fact, several other interview partners also referred to considering a trial with the prototype because one can always make assumptions but does actually never know for sure what does trigger a person and what might be of help or benefit.

Method of self-injury. Hence, altogether, the author classified six experts to be ok with leaving the *method of a self-injurious act* as an item to be collected within the app. Seven other experts were classified to support removal of the method from the prototype[5]. Although three of these thirteen interview partners did not explicitly agree or disagree on including method or instrument in the prototype, their overall perception on getting detailed information about self-injurious acts was used to put them in their respective categories.

Tool used to perform self-injury. The situation is slightly different regarding the item *'instrument'*. There, five experts were classified as pro 'leaving in the prototype', while seven experts were pro 'removing from the prototype'. One interview partner talked about method, but not instrument with respect to NSSI. Keeping in mind, that there is no overall agreement on whether or not detailed self-injurious acts are indeed triggering or might even have a somewhat therapeutic benefit for the patient (and one can not know for sure unless a trial is performed), they (items 'method' and 'instrument') are not removed from the prototype.

Suicidality. Nevertheless, since suicidality is big enough of a factor in BPD (Ms. A, Ms. P), and one expert actually stated that patients do not remember if they had suicidal thoughts[6] (Ms. P), it is added as an item concerning a self-injurious act. The author, however, mentions that one interview partner was concerned about regularly asking about one's suicidality (Mr. R). His reasoning was that when you ask someone "are you sad?" a lot, they will eventually become sad

[5] This topic was not found in interviews with the remaining five experts. That is, their opinion could not be derived per se from the overall conversation.

[6] To recap, one of the author's statements to undermine the value of the project as such was reducing recall-bias by giving information about behavioral trajectories in-between therapeutic settings.

because their thoughts center around that question all that time. A similar thought was expressed by one person from rounds II who was concerned about asking "have you injured today?" too often (Ms. N). Thus, both second the opinion of a previous interview partner who said "we tend to create what we focus on" (Ms. O).

Document an act at time and place where it occurs unlikely. Furtheron, the timestamp when the "act-documentation" is initiated is archived in the background and, as with the documentation of a self-injurious urge, the user can manually enter the time when they injured themselves. Also, the time that passes by between a thought to self-injure and acting upon it is relevant to know (Ms. K) and can be entered by a user themselves. The redundant informational input regarding time of occurrence and time in-between urge and act covers situations where an urge to injure had not been recorded previously.

7.3.1.3 Concept: Data upload

One concept labeled 'Data upload' was added to the themes of the project. It revolves around legal considerations of continuous versus manual data upload as well as legal implications. The latter arise based on the introduction of a new way of data retrieval. Since mobile applications are best suited for continuously uploading collected data on-the-go, therapists are given the option to see real-time data of their patient's behavior, in principle. On the one hand, this may be a desirable effect. On the other hand, it poses problems keeping up with obligations faced by therapists. As soon as suicidality becomes apparent and comes to a therapist's knowledge (and suicidality is not uncommon among Borderliners), they are obliged to react and do something about that. Patients at ambulatory care may report being suicidal. Having the therapist read it up in a recent data upload stream will make them worried, whereas they might not even be able to reach the patient, in a worst case scenario. This aspect is an interesting thought process that was brought up by one interview partner (Ms. Q) and needs to be revisited before an app like the one proposed in here can officially go live. This statement was supported by another expert (Mr. R). He also claimed that having an overview, like once a month, or looking at the data together with the patient during a therapeutic session would be more suitable. Overall, he regarded an app like that more useful in in-patient, rather than out-patient or ambulatory, settings.

7.3.1.4 Concept: Motivational system

In 14 out of 18 interviews total one can find the topic of motivation, which positions it as a key acceptance factor. Implementing motivational strategies to actually get a user to work with the system is, therefore, paramount to be considered during app design and implementation. See Figure 7.11 for a graphical illustration of opinions on the motivational system. Two experts agreed in their opinion to not necessarily include any achievement or reward, or were at least suspicious about it (Ms. P, Mr. R). Their reasoning was based on the aspect that intrinsic motivation is more important and a much better factor for likely success. However, they did mention strategies that are considered motivating.

The concept 'motivational system' is a very broad one, which is why it is broken down into smaller pieces like 'balancing scales'. Although the concept of using balancing scales as a motivation / entertainment factor was replaced in Chapter 7.2, compare particularly requirement labeled *Req 15 'Reward, Motivation, and Gamification'* some perspectives on it, which were collected during interview rounds III are not to be held back. Nonetheless, its (balancing scales) actual positive outcome in terms of motivation for patients is questioned and can be seen as a confirmation for its removal, or rather, replacement by the sub-concept 'storyline' that follows. The remaining two sub-concepts discuss 'positive reinforcement', 'token collection' and 'music' as rewards within the app.

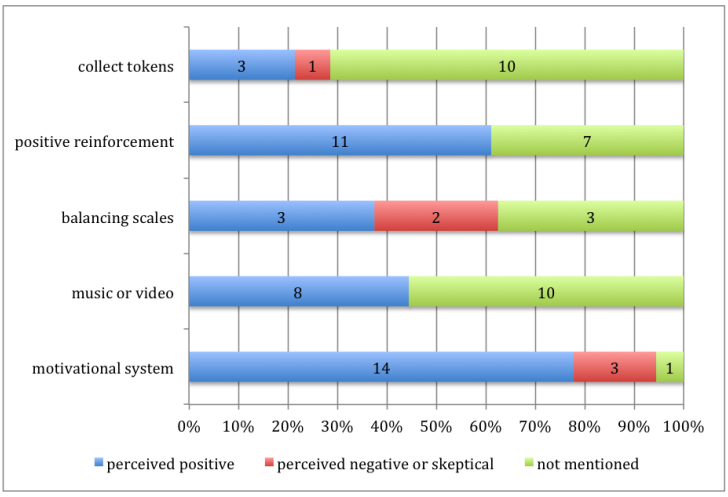

Figure 7.11: The topics that stood out with respect to a motivational system for the app. Shown are relevant distributions according to positive or negative / skeptical perception. It is stated that the concepts did not apply to every conversation, which is why the sum of opinions of each concept does not add up to the total number of interviews (n=18).

Sub-concept: Balancing scales Starting from interview rounds II onwards, the prototype featured balancing scales which are often used for depicting patient - therapist relationship and therapeutic processes with Borderliners, compare Sendera and Sendera (2012). Going through with an act of self-injury could bring the scales out of balance, while doing some skills training could then establish balance again. This balancing process would be reflected by the (modified) schematic picture of the scales and was thought to deliver some sort of entertainment factor, thus, motivate the user / patient to work with the app. People interviewed in rounds II and two experts from rounds III, that is 8 people in total, had the chance to comment on the balancing scales (required they had actually seen the prototype), compare Figure 7.11 for a graphical overview.

While it was perceived rather positive and compared to some sort of bio-feedback device for the patient during interview rounds II (Ms. K, Ms. M, Ms. N), interview rounds III revealed a different perspective. One interview partner reasoned that from a Borderliner's perspective going through with self-injury would not match with being out of balance (as would be presented with the scales) (Ms. P). In fact, in their minds, self-injury is a means to regain balance. That way, striving to reach balance again with the scales picture, although they are not out of balance per se would be somehow unreasonable.
Another interview partner mentioned that it might yield the complete opposite and rather down-regulate a person's motivation (Ms O). This is especially true, if nothing changes for a while and one is constantly out of balance. She suggested the scales could rather reflect the degree of positive versus negative states of mind, but then again, emphasized to rather attract a user's attention to any success worth having, as little as it may be.
Thus, experts' opinions from rounds III strengthened the decision to replace the balancing scales picture as discussed in Chapter 7.2, compare Section 7.2.2.1 and Requirement labeled *Req 15 'Reward, Motivation and Gamification'*. As a result, the last two experts (Ms. Q and Mr. R) did not see the balancing scales in the app any more because the prototype was developed and refined in parallel to the interviewing process whenever feasible.

Sub-concept: Storyline and individual goals In place of the balancing scales an overall storyline is chosen, whereas the basic agenda is pre-defined but can be modified and individualized for the patient by their respective therapist. The basic storyline may be divided into as many sub-goals as desired which pertain to certain skills and skills modules. That way, it follows the

positive example of the game SuperBetter (SuperBetter Labs, 2012) which has been described previously in this thesis and aims to increase motivation and bring about some sort of an entertainment factor for the user themselves. An example of a basic storyline may be:

> *You want to climb up a mountain. Make it to it's very top. But you need to overcome some obstacles to get there.*

The proposed application is set up with such a basic storyline per default, can however be modified by the therapist according to one's needs via a specific service provided within the webservice. Several sub-goals within this storyline can then be introduced which are linked to some sort of a homework assignment. This homework assignment may target, for instance, practicing skills from either skills-module that is available. Please see Figure 7.12 for a graphical illustration, thus, a better understanding of this concept.

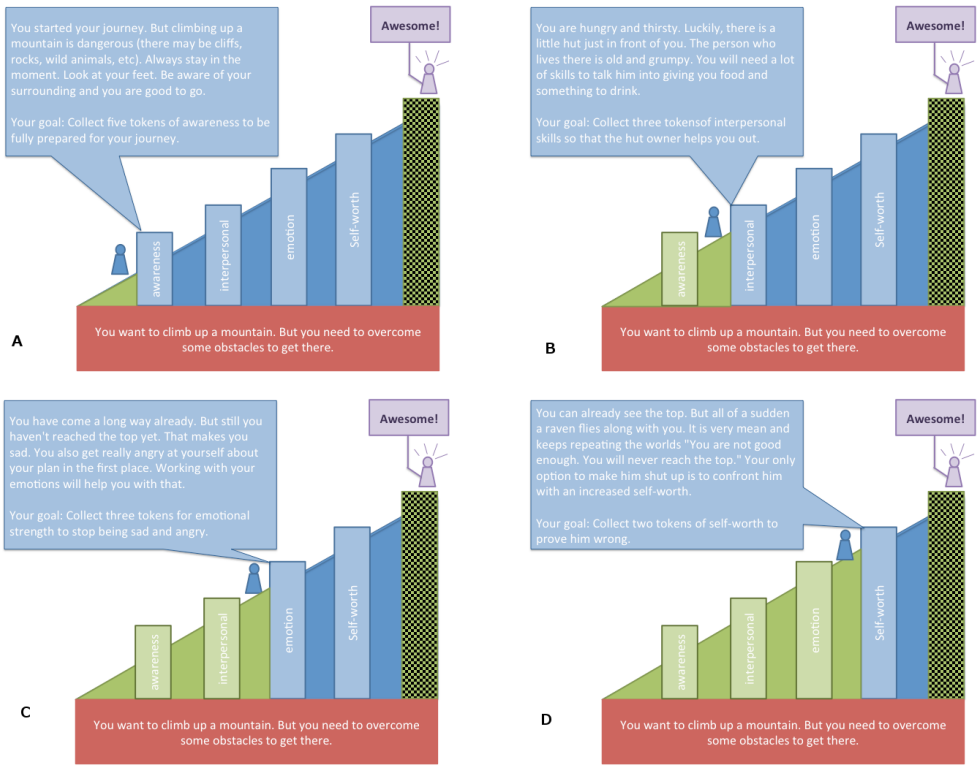

Figure 7.12: A graphical representation of the concept of the storyline and its sub-goals. A) reflects the sub-goal about awareness, B) is the sub-goal on interpersonal skills, C) is an obstacle requiring emotional skills and D) is a sub-goal to increase one's self-worth.

In addition, the sub-goal describes an abstract situation which would require this specific skills-set. Thus, working through these sub-stories aims to achieve two things. First, to educate the patient / user as to why these skills are important or need to be trained. Second, to deliver some sort of motivation and entertainment upon working with the application. On top of that, the overall requirement to have content tailored and individually filtered for the patient is satisfied since the therapist takes over assigning the storyline and corresponding sub-goals (and homework assignments). Yet, the examples given in Figure 7.12 are not set in stone. Additionally, a therapist may assign a mix of several skills-modules within one sub-goal. The names of the "obstacles" (corresponding to the core skills category that is targeted) are, hence, for purpose of demonstration only and are not to lead to false impressions that each first sub-goal were to be called 'awareness' or whatsoever.

At the moment, the storyline and its individual goals are given as textual descriptions in the bottom part of the main screen of the application. A switch towards a graphical solution which is likely to be more appealing to users is kept in mind for future reference.

Sub-concept: Positively reinforcing Coming back to the notion of making-the-user-aware-of-any-little-success-they-had (Ms. O) kind of goes into the direction of "cheerleading" (making one aware of something good that happened, like reaching a small personal goal, for instance) which was stated by another expert as well (Ms. P). One person in interview rounds III reflected on inclusion of game aspects, like collecting points, reaching a new level, including a jump-and-run, or simply playing one's favorite music, for instance (Ms Q). One expert pointed the author towards a researcher named Matthew Selekman who employs positive trigger logs and focuses on strengths people already have inside them (Ms. O) (Selekman, 2009). This entire concept revolves around the notion of well-being and having people pay attention to whatever positive things have happened or are happening to them / with / around them. One specific example or idea she had to incorporate was have users identify favorite music or songs during the initial phase of working the app. Then, whenever one would feel pretty low or stressed out one could prompt the person by playing their favorite music (Ms. O), which is exactly what Ms. Q had said. The fourth person in interview rounds III also headed to the direction of positive trigger logs, putting in center the positive progress which was made along the line (Mr. R). For instance, this progress could be focused on previously set goals or either on the skills modules that are inherent in the DBT, like "how far did you get in the awareness section? what skills did help you make progress in that area?". Upon asking if it is considered useful to have real-time-data and have the therapist define individual achievements for individual goals the last interview partner seemed rather reluctant (Mr. R). He could, though, imagine to send them a short message, to text something like "awesome!", "well done!" once a goal was achieved.
A positive message will be presented to users whenever they have successfully resisted an urge. Lots of ideas have been generated and collected of what one could use for positive reinforcement, if it were not a plain text message. One interview partner could imagine having a smiley (Ms. P), another one felt that a little figure could hold up a sign with a positive succinct message (Ms. N). Another one referred to the metaphorical picture of having a very narrow road in front of you upon going a skills way instead of a convenient and broad path that has been known for a while. If a person were one step further or had any little success worth having, there could be a picture of a road that would suddenly become a little broader (Ms. P).
Overall, 11 out of 18 people mentioned positive reinforcement or could imagine having some sort of positive reinforcement included in the app, compare Figure 7.11.

Sub-concept: Collect tokens Among the 14 experts who perceived a motivational system relevant and important for the application, four interviews revealed the topic of collecting tokens. Three of out these four times, collecting tokens was perceived a good thing, whereas the fourth person was skeptical that collecting tokens for a documentation of a self-injurious act or urge would yield a high-score effect for unintentional behavior, compare Figure 7.11.

Tokens versus high-score effects in self-injury. The potential danger of achieving a high-score effect when earning ribbons or awards each time a self-injurious urge or an act is documented has already been discussed in the previous chapter. That is why the initial concept had been modified up to this point so as to collect points or tokens for practicing skills - as given in a storyline that is "ordered" by the therapist.
What is still questionable is the smallest level at which a user can earn points. For instance, one possibility would be to use each single skill - which was practiced during a training session - as an equivalent for one token. Another one would be to say that each training session yields one token.
For instance, a therapist "prescribes" a storyline which assigns the user to practice three skills

from the awareness module and two skills from the emotion regulation module. As soon as the user has reached this sub-goal, the therapist would hand out a new assignment (possibly with a new sub-goal story). It is a valid assumption to reason that a user might not always work through the described sequence in one go. Rather, they might practice awareness skills on one day, then rather focus on working through skills from the emotion module the other day. In case, tokens would be awarded on a training-session basis (requiring the user to have done exactly three awareness skills and two emotion regulation skills) may lead to frustration. Because then, the user would have worked on their skills, but still be punished for not doing it in the given order. That, in turn will have a negative effect on an actually desired behavior (namely, the practicing of skills). That is why, to the author's opinion a token collection needs to be based on the skills level. So, each skill practiced rewards the user with a token. In addition, the user may obtain tokens when they work through skills upon reporting tension or documenting an urge. No tokens are awarded when decisions to injure or not injure are made. That is, the core focus is on whether skills are applied / practiced or not.

In terms of gamification criticism. The author states that the criticism that was passed on gamification in terms of collecting points by Bogost or Antin, compare Section 2.4.3, is used to shape game-like aspects for the app proposed in here. Simply adding up points may likely not be enough. For that reason, points or tokens that can be collected yield further (inter)action with the software (e.g., storyline sub-goals as levels) and reality. Hence, a big aspect, was to find a way of linking the virtual token or point collection with real life, so as to make use of and, thus, maybe strengthen the client - therapist relationship as suggested by an expert (Ms. Q). For instance, upon collection of a designated number of tokens one could do something fun or appreciative with their therapist. Game-level mechanics could additionally ensure that upon achieving a small sub-goal another level can be targeted at.

Social community support. Social factors and the impact of support by peers are not to be underrated. Therefore, social community support as had been brought up by an interview partner in an initial interview stage (Mr. D) should be considered as well. To that extent, the Borderline Personality Disorder community at PatientsLikeMe, compare its introduction in Section 3.1.3, may be integrated to interface with the mobile prototype that is proposed in this thesis. Theoretically, the application could include a feature to share each token-collection, the achievement of a sub-goal or simply any little success worth having to the social community. Other peers could then like / comment on the achievement, thus, work as the social community support. Comments and 'likes' could possibly be included and interactively displayed in the app itself.
These aspects are thought to strengthen a user's motivation to working with the app, while potentially reaching a higher state of well-being and aim to leave the user with a little more than simply adding up badges. That way, it follows a similar concept to build a comparative health behavior by "collecting" health data from different sources like PHRs, thereupon generating individualized achievements and sharing them via social communities as stated by Baranyi, Lederer, and Grechenig (2013).
In the course of this thesis, the social community factor is a theoretical consideration. Neither is it feasible to develop this feature in time, nor is the additional work effort justified in this project's scope. However, it is, indeed, regarded useful and a strong social support indicator which should definitely be worked on in future steps.

Sub-concept: Music Music as a motivational factor and as a skill (e.g., listening to one's favorite music, watching a video) was found as a topic among eight interviews (Ms. E, Ms. I, Ms. K, Mr. L, Ms. N, Ms. O, Ms. P, Ms. Q), compare Figure 7.11. It can thus be seen either as an intervention or as a reward for having achieved a sub-goal (to recap, a sub-goal is a challenge embedded in a storyline), for example. As with other skills and rewards, whether playing a favorite song is of benefit for a user depends largely again on whatever they fancy or whatever

works for them.
One expert mentioned it in the context of designing an intake-screen upon starting the app for the first time (Ms. O). Whenever the user would feel low in mood or tense for that matter the app could suggest playing their favorite song. The remaining seven interview partners also discussed it as interventional means to calm down, distract or soothe oneself.
Seeing that many experts mentioned it as an example for working skills (for certain people), it is considered for inclusion in the app. However, it is not the most top priority and not seen as an obligatory core feature. Thereupon, two ways of including music or video playback in the app are feasible. One would be to have the song readily available on the phone, whereas the other one would be to stream it via the Internet, e.g., youtube. Since youtube offers relatively easy incorporation in Android applications with support of designated libraries, compare Section 7.4.7.1 in the upcoming chapter, it is reasoned as the method of choice.
Furthermore, for video playback can be seen as both a reward and a skill it can be delivered in two ways:

First, among entering working skills - done by the individual - one can determine a favorite song by entering, thus, archiving a search query which will in turn be forwarded to the youtube API (to deliver the corresponding video link for display within the app).

Second, the therapist can provide youtube links (which may be any video link) to the user based on recent goal achievement, for example. That way, the therapist would archive the video link in the patient's EMR / PHR profile, which, will in turn be delivered to the patient's phone and will be accessible from within the app (on an individual basis). Furtheron, the provision of a youtube link would allow for the therapist to record an achievement video or a motivational message (even something simple as just showing their face, hearing their voice might have a positive impact (Ms. E, or partly Ms. Q) himself, thus tailor the message even more to their patient. Additionally, it would embed the therapist into the user(/ patient)-app-therapist "process / relationship" to a greater extent as the relationship between client and therapist seems to be the driving force anyway. Another advantage could be that this may even diminish the negative perception of having the app work as an isolated therapeutic tool all by itself.

7.3.1.5 Concept: Skills

The importance of incorporating skills for education and intervention has been established in the previous chapters. Four more interviews from interview rounds III did not change any of that for all of them agreed that skills are at heart of an app like this. Altogether, each conversation during interview rounds II and rounds III acknowledged the fact that skills are a center-piece within DBT, thus, also the app. (The topic even came up with experts during interview rounds I, although, skills building as it is used in DBT is not their main direction.)
One part that is relevant for the design of the app is that one needs to teach it one's working skills. Meaning, furtheron, establishing skills is a highly individual process and can not be generalized. That was emphasized by all four interview partners in rounds III (Ms. O, Ms. P, Ms. Q, Mr. R), once more.
What was kind of new is that skills are not only tension-, but also situation- and location-specific. That is why one interview partner even suggested to include a decisional tree asking about one's location before filtering and displaying skills (Ms. Q). Furthermore, the concept of making skills adaptive to the reported tension was repeated in interview rounds III (Ms. P, Ms. Q).

Emergency contact. If several available skills have been tried but were unsuccessful in resolving a tense situation, emergency telephone contact with a friend or the therapist could yet be another strategy.
The DBT respectively the people that follow its guidelines establish rules as to when it is ok and

feasible to call a therapist for help. For instance, time slots and conditions that allow a patient to call may be agreed upon in a contract, whereas as a common rule (phone) contacts are prohibited after a parasuicidal or self-injurious behavior was performed (until 24h after). (Bohus, 2002)
Overall, the topic of providing emergency contacts from within the app was rarely found in interviews. Only three out of 18 interview partners explicitly mentioned an option to either call a friend or the therapist based on either of two conditions (Mr. D, Mr. J, Mr. L):

a. a person has *reached a tension level of 100*, or

b. person is in the *middle of a crisis*, where skills turn out to be not helpful and pre-specified conditions regarding agreed upon time-slots (between therapist and patient) are met.

One expert in interview rounds II mentioned that a possibility to send a text message to the therapist might be useful. One expert from interview rounds III did not explicitly mention an emergency call option either, but is still classified as to support such a feature in the app (Ms. Q). This assumption made by the author is based on the expert's concern to read about a patient's tension level of 100 over recent days or their suicidal thoughts and no possibility to reach them. An optional feature to call one's emergency contact that could pop-up within the app once a level of 100 is reached or which could additionally be initiated by the user could help prevent a critical situation like that one. Additionally, regarding the fact that patients may start to dissociate and are trapped in these so-called "stuck-states", where external is needed to come back to reality, an emergency contact feature might be of reasonable support.
Hence, this option will be added as a requirement, however, it will be marked with low priority since it was found rather rarely in interviews compared to other topics which are more at heart of experts.

7.3.1.6 Concept: Skills-chains

Besides building skills and using them for intervention, skills-chains come into play as well. In simple words, a skills-chain is a list of skills which is processed (each one after the other) to lower a person's tension level (Bohus and Wolf-Arehult, 2013). It is known that during times of high tension simply using one skill may not help reducing distress. Therefore, another one and another one have to be applied until the person feels comfortable with the situation again. A simple schematic of how a skills-chain works and looks like is displayed in Figure 7.13 (Bohus and Wolf-Arehult, 2013).

As with skills themselves, skills-chains are of individual character, as well, and can not be formalized for the entire user group. Several interview partners talked about skills-chains (Ms. I, Mr. L, Ms. M, Ms. N, Ms. P), where more than one skill needs to be applied by a person to reduce their tension. Two interview partners explicitly mentioned its establishment as a desirable feature for the app (Ms. M, Ms. P), whereas several characteristics need to be taken into account. According to an expert, skills-chains - when being built - need to target different access channels. That means, a skills-chain should contain skills from different accessory channels (Ms. P). In addition, patients could have multiple skills-chains depending on the underlying feeling. This is especially prone with issues since persons with BPD may not be able to identify the relevant emotion which makes selecting a corresponding skills-chain difficult.
However, skills-chains then interplay with a person's tension (Ms. P): That means, a user rates their tension, then starts with a skill from the skills-chain to be applied for like 10-15 mins, then again rates their tension to follow-up with the next skill from the same skills-chain. The skills-chain and constant interplay would then be terminated on the user's request. They are the ones to decide if a tension level reached by applying the skills-chain are indeed tolerable. Otherwise, the process of doing skills to lower tension goes on.

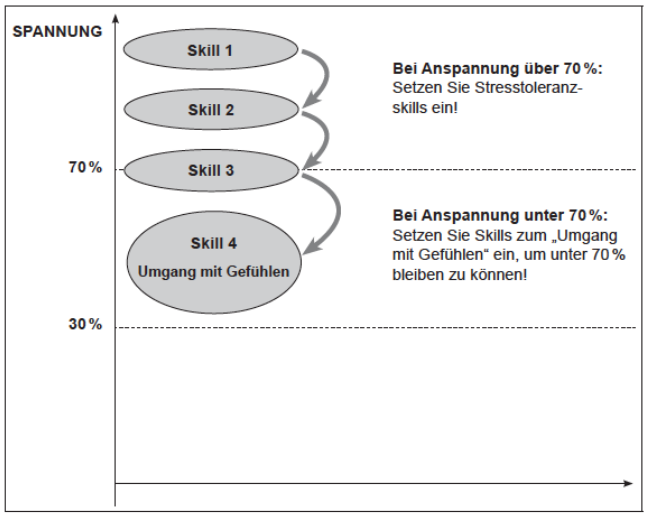

Figure 7.13: The structure of a skills-chain and its interplay with the level of tension. Figure is taken from Bohus and Wolf-Arehult (2013).

Skills-chains are used in the context of using distress tolerance skills to avoid a crisis or a self-injurious act (Ms. M). Hence, they are considered relevant for the project in that moments of high tension will prompt several skills instead of just one. Explicitly building designated skills-chains in the app will, however, add another layer of complexity. According to literature, one needs to define the sequence, i.e., which skill comes after the other, and then adhere to it (Bohus and Wolf-Arehult, 2013). Therein, it also states that the number of skills used within the chain should not exceed three to four skills. This aspect conflicts with one expert's statement to use as many skills as needed until a level of comfort in tension is reached (Ms. P).
Nonetheless, seeing that only two experts actually raised the topic of establishing individual skills-chains by the application user, knowing on the other hand the app itself should be simple and not too confusing or complex, another step to *enter* designated skills-chains is not marked as a high priority requirement, thus, not considered for the app. Skills-chains are, however, *used* during moments of high tension, but will be automatically built by the app based on a user's previously entered working skills. It seems difficult to balance the issues between comprehensiveness (in terms of including core and relevant features), making the app worthwhile, and then on the other hand also easy to use and understandable. Designing too many features to reflect the therapeutic workflow as much as possible (in good faith) is not a desirable goal.

7.3.1.7 Concept: Tension protocol

Results of previous rounds had already established that regularly prompting users to rate their tension throughout a day was perceived as something positive, compare Section 7.2.2.2.
The question what kind of content should be included in addition to tension scales could not be exactly answered after interview rounds II. Nonetheless, feedback tended to be ok with the prototypical content of tension prompts which included a tension scale as well as emotions to be rated. Basically, experts who viewed the emotion component within the tension prompts with concern focused at large on a Borderliner's diminished ability to identify emotions. As a fallback-option a simple text area was thought of, where patient could enter whatever thought ran through their head when they replied to the notification. To answer the unresolved question, this topic was left for further investigation during interview rounds III. Figure 7.14 displays certain viewpoints of experts from interview rounds III only:

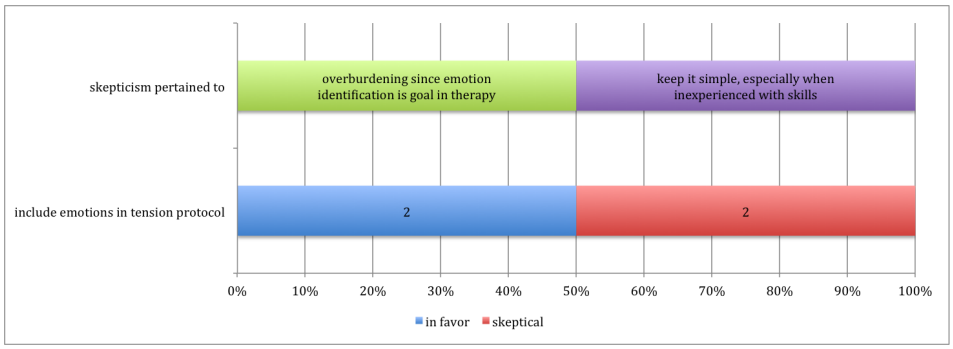

Figure 7.14: Perception on including emotions besides the tension scale within the tension protocol. Only perceptions of experts from interview rounds III are displayed.

Of the four remaining experts interviewed, two were in favor of keeping items regarding one's emotion (Ms. O, Mr. R). Particularly, because as a therapist or a researcher in that matter there seems no better way to track mood development than by regularly receiving updates with the support of user notifications.
The third person was skeptical about collecting emotions because of the known issue that it might overburden a Borderliner for emotion identification is a designated goal in therapy per se (Ms. P). Furtheron, she argued that for a Borderline person tension is a measure of emotion already. One remaining expert said that especially with patients who are not that experienced with skills it should be kept rather simple (Ms. Q). For instance, simply have them focus on rating their tension and maybe let them give a short description of its reason, if a higher tension level is reached (which would pin-point to using the fallback-option). Basically, her point was to keep it simple and besides the tension curve rely on the therapeutic relationship to uncover details.
The findings of Ms. O and Mr. R coupled with one expert's interest in the question of whether regular prompts to identify or rate one's emotion might yield a learning effect is regarded enough evidence as to let users reflect on feeling states besides their tension (without forcing them do so). Additionally, the author reasons, that both Ms. P's and Ms. Q's concerns were basically about overburdening with the challenge to rate emotions. This is considered to potentially being resolved since emotion levels were introduced that ought to empower patients who are not yet able to identify - much less, rate - emotions. Furtheron, leaving emotions inside would be necessary to follow-up with possibly answering the question of the emotion learning curve some time in the future (also it doesn't render irrelevant included progress diagrams which show mood development as an overlay with self-injurious parameters).

7.3.1.8 Concept: Emotion scales

Experts' perceptions on using emotion scales is illustrated in Figure 7.15. Only those interviews are displayed, where the topic of emotion scales was explicitly mentioned, which is why numbers do not add up to the total number of people interviewed.

Additional information about thoughts on "collecting" emotional states which cannot be expressed in numbers is textually described:
Two interview partners in interview rounds III felt that the emotion scales would be overburdening for patients (Ms. P, Ms. Q). One explicit suggestion was to rather use picture of facial expressions (with the emotional identification underneath), where patients would try to figure out what kind of emotion they were experiencing (Ms. Q). For the third interview partner the emotional scales were perceived ok. However, she mentioned emotional research literature stating that it would be useful to introduce the language of well-being and to kind of introduce one positive emotion for each negative emotion listed (Ms. O). A fourth interview partner did not ex-

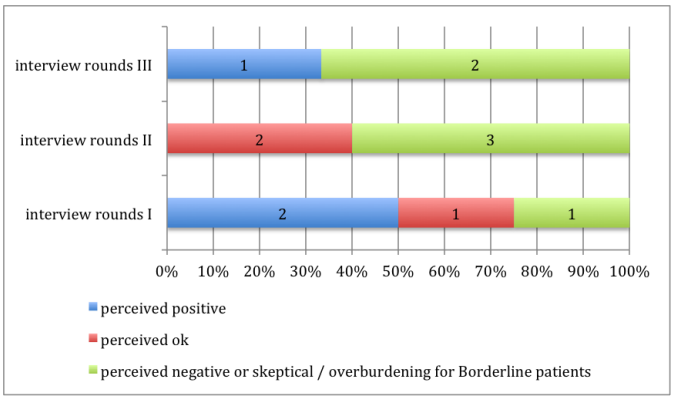

Figure 7.15: Perception on using emotion scales in the application after all experts had been interviewed.

plicitly comment on the emotion scale but was definitely in favor of having data about patients' mood development (Mr. R).
Previous analysis stages yielded two experts that were in favor and thought really positively about the possibility to identify and rate emotions (Ms. C; Mr. G) with the objective to look if patients would actually learn to reflect on their feelings. Three other experts thought it was ok to have emotional scales, in general (Mr. D, Mr. L, Ms. N). Four other experts were classified as either negative or somewhat skeptical about emotional scales (Mr. F, Ms. I, Ms. K, Ms. M). Three people could imagine using emotion protocols from within the app (Mr. J, Ms. M, Ms. P). Two experts during the pilot phase did not explicitly mention emotional scales, but said that emotions in general are important to assess before / after self-injury and that emotional (mood) development is beneficial to keep track of (Ms. A, Ms. B).
However, bearing an either positive or negative attitude towards emotional scales, the overall aspect that emotions need to be learned first (since Borderliners have difficulties even identifying and distinguishing between emotions) was found in most interviews. This important criterion coupled with the indifference and ambiguity of interview partners leaves one with a compromise. Depending on the stage of one's capability to identify emotions the application is proposed to include two concepts for emotions. Patients who have yet to learn to distinguish their feelings are given several graphical facial expressions, they have to choose from. At a later stage, the application can be switched to an advanced mode, where emotional scales do come into effect. A next step could then be to perform a trial and to find out if both or either one approach is working for Borderliners.

7.3.1.9 Concept: Types of emotions

What kind of emotions should be used for the app is difficult to pin-point. Frequently mentioned emotions by interview partners were anger (Ms. C, Mr. D, Mr. G, Ms. N), emptiness (Mr. D, Mr. G, Ms. N), desperation / misery or helplessness (Mr. G, Ms. N). One interview partner supported to have some sort of free-form text fields, where a user could add emotions (Mr. D). That means, self-learning and individualization regarding emotions in the app were deemed important. Although it was stated that some positive emotions do not make sense in asking Borderliners about, for instance, joy (Ms. N), two experts talked about including positive emotion states as well (Ms. C, Ms. O). "You want to be introducing the language of well-being" (Ms. O) is considered invaluable with the aim to help users / patients realize that there is something positive as well. Examples for positive states were "contentment", "at peace" or simply "satisfied" (Ms. O). Referring to the emotional list that is covered in the DBT-A diary cards one positive state ("happy") is included as well (along with "anger", "fear", "anxious", "sad", "shame" and "misery") (Klonsky et al., 2011). For a graphical presentation of experts' perceptions see Fig-

ure 7.16.
The author can imagine the positive function of using "states of well-being" and proposes a combination of frequently mentioned emotions by interview partners and several emotions from the above mentioned DBT-A diary card: "anger", "contentment", "emptiness" (or "loneliness"), "satisfied / happy", "anxiousness", "misery".

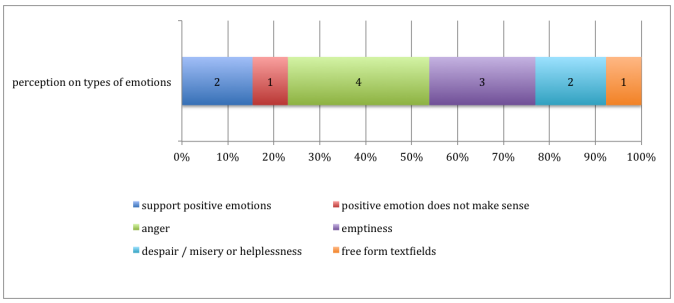

Figure 7.16: Perception on which types of emotions might make sense and how frequently they were mentioned among experts.

7.3.1.10 Concept: Entertainment factor

Entertainment seems to be closely linked to motivation. Hence, this topic is once more revisited. One of the first interview partners to mention the need of such an app to be entertaining by designing it as some sort of a game (Mr. D) was joined by the last expert to be interviewed who explicitly mentioned a game-like entertaining system (Mr. R). A quick sketch drawn by him during the interview is shown in Figure 7.17 (Mr. R).

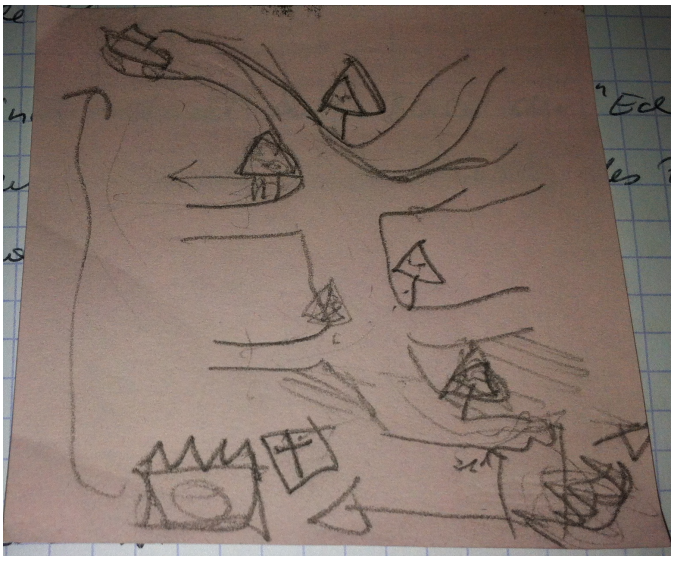

Figure 7.17: Upon imagining a game-like character for the app as introduced and sketched by one interview partner (Mr. R).

He explained it as a story, where one is driving in one's car on a road that has several turns and cross-roads. Every now and then, like at every turn there are warning signs (like traffic signs) that could be filled with specific individual warning notes regarding behavioral patterns or states of well-being. While hypothetically driving along the road, one could then, for instance, click at the warning signs to read about the dangers of specific turns or be prompted with skills depending on the actual necessity and content of the signs per se. In addition, the environment could somehow reflect mood states one is at or one would want to be at which include gamification aspects.

He mentioned for instance beautiful gardens or meadows with flowers (much like Consolvo's UbiFit Garden), Buddha statues, or other darker places, for instance, cemeteries. If one were to go astray one might end up in an accident or with the car broken down or at the car dump. If a ride would have ended at this place, one could then "go back to start" and start off freshly with a clean slate.

7.3.2 Functional requirements

During analyzing and writing up the interview results it became clear that there is a big number of requirements which can simply not all be included for the app itself. Henceforth, they are now assigned a priority (except those that are removed) that is solely used to identify high priority requirements for the app. It is to note, that these priorities do not mark any of these aspects less irrelevant in therapy. The author decided to use priorities with a range from 1 to 3, whereas 1 means highest priority and 3 means lowest priority. Priorities are abbreviated by the term "Prio" in this section.
In addition, a status label is assigned to each requirement to reflect its evolution with respect to interview rounds II. The status labels are given in square brackets and have the following meaning:

A **(added)** These requirements were not existent before and have been added to the catalogue after figuring its need upon completing analysis of interview rounds III.

M **(modified)** The requirement has been refined or modified.

R **(remains unchanged)** The description of the requirement may have slightly been improved in expression, but remained the same regarding its actual content.

X **(removed)** This requirement existed before but has been removed, reasoning is included in each label.

Functional requirements as they have been modified or newly established after analyzing the most recent conversations from interview rounds III are outlined below. Each requirement is listed, however, some of them did not yield any changes compared to the list of requirements established in rounds II. To reduce redundancy, besides being assigned the corresponding status, it is explicitly noted that no modifications have been made without further describing the requirement once more. For details and comparison regarding previously established requirements readers are referred to Section 7.2.3.

Req 1 ***Add an entertainment factor.*** [Status: X (removed; note: content shifted to Req 15 and Req 15a)]

Req 2 ***Prepare for analyzing correlation*** [Status: X (removed; note: was removed after interview rounds II)]

Req 2a ***Curves for self-monitoring. [Prio: 2]*** [Status: M (modified)]
The importance for Borderliners to rate and know about their tension during therapy made it clear that tension curves should be displayed to users as well. Besides displaying mood curves (and respective self-injurious parameters) on a per emotion basis, tension curves are required to support self-monitoring processes. Tension curves are important for both therapist and patient themselves to look at.

Req 3 ***Expand on emotional scales.*** [Status: X (removed; note: content shifted to Req 9a]

Req 4 ***Therapy method. [Prio: 1]*** [Status: R (remains unchanged)]

Req 5 ***Emotion and cognition. [Prio: 1]*** [Status: R (remains unchanged]
This requirement remains unchanged, whereas its link to Req labeled Req 6 (which was established during interview rounds II) is maintained intact.

Req 6 ***Situational interpretation as triggers. [Prio: 1]*** [Status: R (remains unchanged)]
This requirement remains unchanged, whereas its link to Req labeled Req 5 (which was established during interview rounds II) is maintained intact.

Req 7 ***Frame in context of BPD. [Prio: 1]*** [Status: R (remains unchanged)]

Req 8 ***Avoid high-score effect.*** [Status: X (removed; note: content shifted to Req 15a]

Req 9 ***Emotional black and white. [Prio: 2]*** [Status: M (modified)]
The app shall operate on either of two modes, whereas the user can switch between one and the other. The first one targets patients at an early stage of therapy, who have not yet learned to identify and express their emotions. Emotions are to be represented as pictures revealing several facial expressions, whereas the corresponding emotion goes underneath. Users need to identify whatever emotion they think they are experiencing. The advanced mode - for patients who are at a later stage of therapy - shows several emotional color-coded scales, where users need to identify and rate their feeling at a designated scale. The structure of the scale is the same as before and runs from item *0: not at all* to item *5: extremely strong*.

Since requirement labeled *Req 9 'Emotional black and white.'* deals with the structure of how emotional expressions are presented in the app, a new requirement was found to be needed. It deals with the actual type of emotions which should be used and which has caused discrepancies in opinion during the entire research process.

Req 9a ***Types of emotions. [Prio: 2]*** [Status: A (added)]
The prototype should present the following emotions (or likewise equivalents) "angry", "contempt", "anxious", "satisfied", "empty", "misery".

Req 10 ***Time and company. [Prio: 1]*** [Status: R (remains unchanged)]

The upcoming requirement, previously labeled as *'Req 11 Providing patient's data to therapist'* will be enhanced by a requirement to retrieve data from the therapist. Altogether, two new requirements will be added, whereas a newly established Req 11 will represent the top-level group which consists of corresponding requirements from the functional area of data transfer between Android app and EMR / PHR.

Req 11 ***Enable data transfer. [Prio: 1]*** [Status: A (added)]

Req 11a ***Providing patient's data to therapist. [Prio: 1]*** [Status: R (remains unchanged)]
Data collected via the cell phone ought to be immediately uploaded to the corresponding EHR / PMR at the therapist's in the background. This is done to:

1. let the therapist have an overview of a patient's "behavioral trajectories", and
2. prevent the app from eating up limited phone resources.

Thus, this requirement covers both functional and non-functional aspects. If no network connection is available or the webservice is not reachable, a fallback-option would be to archive the data at the user's phone and mark them for later upload.

Req 11b ***Retrieve patient's data from therapist. [Prio: 1]*** [Status: A (added)]
Data, which is stored in the EMR / PHR should also be readily available for retrieval by the user's cell phone. This ensures that both phone and EMR / PHR are up-to-date and synchronized and that the application is updated in terms of information newly entered or modified by the therapist. Specific examples when this requirement comes into use are:

1. when the patient *responds to a tension prompt* and depending on the level reported a skill from the corresponding modules is to be triggered, and
2. as soon as a *patient records an urge*, which yields (di)stress tolerance skills to be retrieved and displayed to them.

Req 11c ***Include a publish / subscribe mechanism. [Prio: 2]*** [Status: A (added)]
In order to preserve battery power, constantly polling for new data to be entered at the therapist's said ought to be avoided. Hence, the application shall support a publish / subscribe, publish / consume mechanism in the context of a messaging service, where the application registers its interest to a specific topic queue, then gets notified of new information arrival and can subsequently download them for storage in the phone or display to the user. For a better understanding, this requirement - which is more of a non-functional character - is mentioned in here, where one can see its link to the group of transferring data from and to the mobile application.

Req 12 ***Skills. [Prio: 1]*** [Status: R (remains unchanged)]

Req 12a ***Modules. [Prio: 1]*** [Status: R (remains unchanged)]

Req 12b ***Intervening point. [Prio: 1]*** [Status: R (remains unchanged)]

Req 12c ***Intervention. [Prio: 1]*** [Status: M (modified)]
The requirement remains the same as far as the interaction between tension levels and skills modules triggered are concerned. What adds up to it, is that these skills modules shall either be retrieved from the EMR / PHR or from the app's internal archive, if the webservice cannot be accessed due to network problems, for instance.

Req 12d ***Skills protocol. [Prio: 1]*** [Status: R (remains unchanged)]

Req 12e ***Stress tolerance. [Prio: 1]*** [Status: R (remains unchanged)]

Req 12f ***Skills training. [Prio: 1]*** [Status: R (remains unchanged)]

Establishing and using pro- and contra lists often came up during interviews, see the textual description at the beginning of this chapter. Although pro- and contra lists are solely one specific kind of skills, thus, are already covered in Requirements labeled *12a to 12f*, their emphasis in recent interview rounds seemed to grow in importance. It is regarded an outstanding and working skill that manages to revisit one's goals when they are displayed in detail, which is why these are explicitly added as requirements.

Req 12g ***Prepare a pro / contra list. [Prio: 1]*** [Status: A (added)]
During times when tension is not too high, the user shall be able to establish a pro / contra list containing short- and long-term aspects regarding self-injury. Items to be entered are:

1. *short-term* advantages and disadvantages of *self-injury*,
2. *long-term* advantages and disadvantages of *self injury*,
3. *short-term* advantages and disadvantages of *using skills instead*, and

4. *long-term* advantages and disadvantages of *using skills instead*.

What a person thinks about their self-injury changes over time. Hence, a user should be able to constantly refine and adapt this list based on changed needs, thoughts, or circumstances.

Req 12 h ***Make pro / contra list explicit. [Prio: 1]*** [Status: A (added)]
This entire list ought to be used as a skill for intervention during times of high tension and urges to injure, whereas it is important that each item written down by the patient is shown, not only the keyword "pro / contra list".

Interviews revealed further that skills-chains are indeed a requirement for an app. Hence, requirements labeled *Req 12h 'Teach the app your working skills-chains'* and *Req 12i 'Link skills-chains to tension levels'* are added to this list. Due to issues in complexity they are not marked as a top priority requirement at this point (because emergency sets, respectively, distress tolerance skills are already a core component for the app).

Req 12i ***Teach the app your working skills-chains. [Prio: 3]*** [Status: A (added)]
The app should enable a user to establish designated skills-chains, whereas the order of sequence needs to be defined as well. In theory, there can be several skills-chains available depending on an underlying feeling. Skills-chains can change over time which is to be accounted for within the app.

Req 12j ***Link skills-chains to tension levels. [Prio: 3]*** [Status: A (added)]
Skills-chains need to be linked to their respective tension level. That means, as soon as a tension level is reached which does not reflect high distress any longer, skills from the emotion module could / should be used, for instance.

Req 12k ***Make skills-chain and tension prompts alternating. [Prio: 1]*** [Status: A (added)]
Skills and tension reports should take turns. For instance, as soon as a tension is reported, a skill should be prompted, which is then followed by another tension prompt (to confirm tensional change and the newly established tension level), which is subsequently followed by the next skill from the skills-chain and so on.

Req 13 ***Mind individual content. [Prio: 1]*** [Status: M (modified)]
Users should be enabled to enter and modify their individual skills to their current situation. The therapist identifies the number of tension prompts to be delivered to an individual (default is a value of six). A general storyline (and its corresponding sub-goals) as given per default can be individualized by the therapist. Also, achievements coming from the therapist (as well as any data that is provided by the therapist to one specific person) need to be on an individual basis. That means, that a link between EMR / PHR and the identification of the patient and their cell phone app need to be ensured at all times. Content which is entered by the therapist in one's EMR / PHR must be delivered to the one patient, respectively, their app only.

Req 14 ***Provide alternatives.*** [Status: X (removed; note: duplicate)]

Req 15 ***Reward, motivation and gamification. [Prio: 1]*** [Status: M (modified)]
A general storyline is provided for the EMR / PHR, thus, the app. The therapist modifies the storyline, identifies or modifies sub-goals as well as the skills modules (skills-module and number of tokens to be collected for that) for an individual patient.

The previous requirement labeled *Req 8 'Avoid high-score effect'* which had been shifted to Req 15a was modified in content and is now merged with an additional aspect to enable token

collection. The latter part stems from feedback regarding motivational aspects and achievements for the software application.

Req 15a ***Collect tokens while avoiding high-score effect. [Prio: 2]*** [Status: M (modified)]
The application shall enable token collection each time a skill is trained or applied. No tokens can be collected upon documenting urges or acts as such. This is to ensure that there is no trigger to reinforce dysfunctional behavior.

Req 15b ***Add social community support. [Prio: 3]*** [Status: A (added)]
In addition to the individual storyline (basic storyline and modified enhanced therapist storyline) a patient's progress for each obstacle could be shared via an online community, like PatientLikeMe's Borderline Personality community. Community members in turn could then comment on these progress or success messages. This accounts for the social component to be added (which was mentioned by an interviewee). The social support from a peer may turn into a cheerleading and motivating effect for the patient.

Req 15c ***Reward patient with video link. [Prio: 1]*** [Status: A (added)]
A therapist should be able to enter a Youtube video link as an achievement or a reward for a recently achieved sub-goal or therapeutic success for display to the patient. The mobile application itself should be able to download / integrate these achievements (as soon as new ones are available, compare Section 7.4.8.1 in the upcoming chapter). Regarding the small screen size this would be done best as a separate achievement screen that lists all achievements and enables video playback functionality on the basis of single achievement items.

Req 16 ***Event-based versus system-based sampling. [Prio: 1]*** [Status: R (remains unchanged)]

Req 16a ***Specifics of documenting self-injurious acts. [Prio: 1]*** [Status: M (modified)]
According to what has been discussed in the previous section, the app shall collect the following information:

1. *method one engaged in*,
2. *tool which was used*,
3. *if the user had suicidal thoughts*,
4. *what time the act was gone through*, and
5. *the time the act was recorded*.

Req 17a ***Structure of how a patient reports their tension. [Prio: 1]*** Status: R (remains unchanged)

Req 17b ***Content of tension prompts. [Prio: 1]*** Status: M (modified)
Tension prompts shall have the following content:

1. *color-coded tension scales* with an entire range of 0% to 100%, where levels are represented as steps of 10%,
2. *visual facial expressions* with underneath emotion information when ability to identify emotions is at an early stage, or
3. *color-coded emotion scales* that are to be rated based on six-point-items ranging from 0: not at all towards 6: extremely strong when ability to identify emotions is at a more sophisticated level.

Req 18 ***Provide picture to therapist after injurious episode.*** [Status: X (removed; note: removed at the end of interview rounds II]

To prevent or at least help reduce critical situations where a patient is stuck in a crisis or at a level of high tension, a requirement to support an emergency contact feature will be added. This yields the app to also persistently archive name and phone number of emergency contacts in the internal storage of the mobile device.

Req 19 ***Reach out. [Prio: 3]*** [Status: A (added)]
The app shall recommend calling one of the emergency contacts as soon as a tension level of 100% is reached. Additionally, a user may initiate an emergency phone call action manually from within the app by themselves.

Req 19a ***Enter emergency contacts. [Prio: 3]*** [Status: A (added)]
The app shall persistently archive name and phone number of emergency contacts in the internal storage of the mobile device.

7.3.2.1 Mapping of functional requirements

The following Table 7.8 attempts to outline the mapping process of the above refined requirements to prototypical features. Shown are features from an older version of the prototype and its enhancements / modifications with respect to the newly established functional requirements (above):

- ***Column 'Req'*** The numbers refer to the corresponding requirement as shown in the previous section and illustrate the link to prototype features.
- ***Column 'Dropped'*** outlines features from the previous prototype which were rendered somewhat irrelevant or inappropriate (once mapped to drafted requirements).
- ***Column 'Added'*** delineates the modification regarding the corresponding requirement and old prototype functionality that feeds into refinement of the final prototype.

Req	**Prototype feature**	
	Dropped	*Added*
1	*compare Req 15*	*compare Req 15(, 1, 8) and 15a*
2	The prototype enables a user to see mood curves overlaid with parameters regarding self-injury per se.	*remains unchanged*
2a	The prototype included the display of mood curves and their overlay with self-injurious parameters on a per emotion basis.	The mood curves were not modified, the information they are fed with still rely on dummy data at this point. A tension curve, containing "real" data as reported from the app's tension prompts, is displayed in the play! web application only, compare the description of the proof-of-concept webservice prototype in Section 7.4.7.3.
3	*compare Req 9a*	*compare Req 9a*
4	*The structure of the entire application already reflected its focus on DBT.*	*remains unchanged*
5, 6	Situation, emotion, cognition and bodily sensation were included as features.	*remains unchanged*

7	*Self-injury was regarded in the context of BPD, thus, ambivalence and emotions targeting the specific disease were thought to be included in the prototype.*	*remains unchanged. Emotional abilities of Borderline patients are now reflected in the prototype to a certain extent, compare Req 9.*
8	*compare Req 15a, 8*	*compare Req 15, 1, 8 (and its sub-category 15a, 1, 8)*
9	Prototype provided emotions only as color-coded rating scales. This feature was due for modification.	The prototype empowers users to adjust the representation of emotions based on their actual ability to identify emotions. Switching between two modes is enabled: - "Emotion level: basic", and - "Emotion level: advanced". Mode *"Emotion level: basic"* (beginner's mode for patients who have yet to learn emotions) shows images of facial expressions[7]. Mode *"Emotion level: advanced"* (advanced mode for patients who are at a later stage regarding emotion education) are presented with color coded emotion rating scales. The emotion level chosen affects how emotions in system-initiated prompts (tension prompts) and event-based documentation (entering an urge) are represented.
9a	The prototype covered types of emotions based on the DBT-A diary card by Klonsky et al. (2011). These were modified because interview analysis suggested to use other feelings and states of mind.	Facial expressions and emotion rating scales in the prototype cover the following kinds: - "angry", - "contempt"/ "peaceful", - "satisfied", - "anxious", - "misery", - "lonely" / "empty".
10	The application let a user define whether they are alone or in company. Time of reporting was considered to be collected in the background. Entering time of occurrence was found as a requirement in the previous chapter, already, but was not incorporated due to lack of time.	The prototype now supports entering time of occurrence manually. It enables users to document an urge / act after it had happened since it is not regarded feasible during the event.

11	No actual functionality was included in the previous prototype version.	An interface to enable data transfer and make retrieval of new information on the basis of a publish / subscribe principle possible has been added to the prototype. For details compare requirements Req 11a, 11b, 11c.
11a	This feature was described in theory only, up to now.	The current prototype partly enables automatic data upload in the background upon collection. Within the proof-of-concept implementation of the PHR which is running at localhost of the author's machine the smartphone solution automatically uploads: - newly entered skills, - tensions prompts and - event-based documentation of acts. This feature is only available when the mobile application is deployed to the emulator since the prototypical PHR is installed at localhost.
11b	The prototype did not retrieve any information from a webservice until now.	The current prototype includes an interface to retrieve data from the corresponding proof-of-concept PHR implementation (for display to the Android emulator). As of now, retrieval of (di)stress tolerance skill is supported as soon as a user indicates an urge to self-injure.
11c	The prototype did not include any feature regarding a publish / subscribe mechanism.	The final prototype makes use of a messaging service that allows the Android emulator to register its interest to a certain topic queue and gets notified if new content was entered to the PHR webservice by the therapist. As of now, this pattern does only pertain to the establishment of video achievements, where a youtube videoid is the only item that is transferred to the emulator for later video playback from within the application.
12	*compare sub-categories of requirement 12 (i.e., 12 a, b, c, etc.)*	
12a	Five skills modules are represented by graphical icons within the app, each of them contains a set of default skills.	*remains unchanged*

12b, 14	Interventions were said to be delivered to the user at the point of an urge and upon responding to tension prompts. It is to say, that the old prototype did not actually reflect this functionality.	If the application is deployed to the Android emulator, skills are retrieved from the proof-of-concept PHR - running at localhost - and displayed to the user during their urge documentation. All skill from the (di)stress module are retrieved and aim to build a skills-chain for the user, whereas they decide for themselves which ones they actually apply, if skills are helpful, how long skills are applied and if further skills should be displayed before a decision to injure or not injure is made.
12c	The prototype is said to intervene with skills adapted to their corresponding tension level. This feature was a theoretical construct of the prototype and was not implemented.	Due to limited time, this feature is not reflected in the final prototype, but definitely marked as very important for future development of the application.
12d	A few skills classified into their respective skills modules are readily available as default in the app.	*remains unchanged*
12e	The old prototype had the (di)stress module readily available for display. Having patients identify and classify respective skills as emergency skills was elaborated on, but had not been included in the previous prototype version.	The final prototype makes editing skill as well as entering skills possible. That means, that patients are able to identify certain skills as their working (di)stress tolerance skills. However, the back-end functionality to store newly entered skills in the cell phone app or display the changes is lacking. But, newly entered skill are transferred to the proof-of-concept PHR for storage, if the app is deployed to the Android emulator.
12f	The possibility to do and record training of specific skills in the app had been included.	*remains unchanged*
12g	*This requirement had not been introduced until now, hence, there is no comparable feature in the prototype.*	The final prototype does not contain any feature to cover this requirement due to reasons of time.
12h	*This requirement had not been introduced until now, hence, there is no comparable feature in the prototype.*	The final prototype does not contain any feature to cover this requirement due reasons of time.
12i	This requirement has only been established after completion of interview rounds III. Functionality to cover it was, hence, not included in the prototype.	Since this requirement is not marked a top-priority and remaining time was limited, there is not feature that supports this requirement in the final prototype.
12j	This requirement has only been established after completion of interview rounds III. Functionality to cover it was, hence, not included in the prototype.	Since this requirement is not marked a top-priority and remaining time was limited, there is not feature that supports this requirement in the final prototype.

12k	This requirement has only been established after completion of interview rounds III. Functionality to cover it was, hence, not included in the prototype.	Making tension prompts and display of skill as interventions for the user alternating is an important requirement and was anticipated for the final prototype, but could not be developed during the little time remaining. It is marked for future development of the app.
13	The individualization of the application had not been included in the old prototype. It was reasoned that such a feature could only be included once the core functionality would have been established.	Users are enabled to enter new skills and modify or delete no longer useful ones according to their needs. Currently, these changes are not displayed or reflected in the prototype. But if a new skill is entered, these data are transferred to the proof-of-concept PHR. Additionally, content can be retrieved from the PHR and displayed or stored to the internal memory of the device, respectively, emulator. That means, that the possibility to individualize and tailor the application to one's needs is already enabled to a certain extent. Future development will need to take care of completing the implementation and maybe build more sophisticated solutions.
14	*compare Req 12, 14*	*compare Req 12, 14*
15, 1, 8	nothing removed	Patient's progress could be shared by providing a single button like it is done when sharing information via Facebook or Twitter. However, this feature involves a time consuming task to design and implement and can therefore not be incorporated into the app itself. It is marked for future enhancement of the app. Please refer to 15a, b, c for further aspects.
15a	In order to avoid high-score effects, it was proposed to allow rewards, ribbons or badges collection only when practicing skills. No actual feature that supports this functionality was implemented.	Although the author intended to cover this requirement in the final prototype, it could not be included any more. Due to its close link with the storyline and its sub-goals it is required for the application in the future, to maintain the idea of motivating a user by having them work through an abstract storyline or journey.
15b	This requirement has only been established after completion of interview rounds III. Functionality to cover it was, hence, not included in the prototype.	Adding social community support is considered as a feature in theory as of now. Hence, there is not feature that meets this requirement. Future development should work on enabling social peer support for the application.

15c	This requirement has only been established after completion of interview rounds III. Functionality to cover it was, hence, not included in the prototype.	The final prototype, once deployed to the Android emulator, retrieves newly established content regarding youtube video identifiers on a publish / subscriber basis. This is part of the orchestration of the Android application, the proof-of-concept EMR / PHR and a messaging service called RabbitMQ. Future development ought to focus on allowing to establish and retrieve any kind of content, without any restrictions.
16	Tension prompts "beeping at" the user at random times during the day were incorporated in the old prototype version. For details, compare *Req 17 (resp. 17a, b, c)*.	No changes regarding the tension prompt as in notification feature itself were made. Changes are mostly attributed to their respective content. For details, compare *Req 17 (resp. 17a, b, c)*.
16a	The old prototype version had items *'intensity'* and *'number of wounds'* removed. Tabs to enter emotions after an act and a text regarded as positive reinforcement were still shown.	The final prototype includes the following items: - *time of occurrence*, and - *suicidality*. In addition, tabs 'emotions' and 'positive reinforcement' have been removed since it seemed unlikely to fill out so many details during or after an act had occurred. Also, it is known by therapists and patients that self-injury is helpful which is why rating emotions afterwards was rendered less important by the author.
17	*compare Req 17a, b, c*	Prototype includes color-coded tension prompts with color-coded emotion scales or facial expression in place of the scales.
17a	The prototype supported SeekBars with a range from 0% to 100%, whereas users define their tension in steps of 10%. The SeekBar is color-coded.	*remains unchanged*
17b	The prototype used color-coded rating scales for emotions. A backup-plan was to use text areas so users could fill them on their own terms. The requirement, hence, also this prototype feature remained unclear and still open for discussion.	The actual content now contains tension rating scales and color-coded emotion rating scales, respectively, facial expressions representing emotions.

17c	The prototype incorporated a default number for tension prompts.	The prototype still supports the default number of tension prompts. However, minor modifications would enable the application to accept an individually set number of tension prompts (by either patient or therapist).
18	A feature like that was rendered irrelevant for the prototype and has thus never been included.	*remains unchanged*
19	No equivalent feature in previous prototype version.	This requirement was established with a low priority since it was not found in interview material very often. The final prototype does not include a feature to cover this requirement but may make sense for future development.
19a	No equivalent feature in previous prototype version.	This establishment was established with a low priority since it was not found in interview material very often. Hence, the final prototype does not include a features to cover this requirement but may make sense for future development.

Table 7.8: Each requirement (identified by its number) is mapped to a certain aspect or feature of the prototype as such. The mapping process accounts for a previous prototype feature that has been rendered irrelevant *(column 'Dropped')* as well as its final refinement based on the specific requirement *(column 'Added')* within this thesis.

[7] Images were borrowed from http://englishcommunicationcourse.wikispaces.com/file/view/Emotions_2.JPG/181513783/Emotions_2.JPG.

7.3.3 Discussion Rounds III

Conforming to the structure of each thesis chapter amiable readers would probably expect the final prototype to be displayed at this point. Its presentation, however, is put off until the upcoming chapter since one owes to discuss usability and non-functional requirements which affect prototypical design and implementation.

Overall, this chapter is understood as a summary of the results from all four interview stages. Among the most prominent findings is the requirement to target Borderline patients at different levels of emotion identification ability: The ones who have yet still to learn to identify and express whatever they are feeling and those whose ability to do so has already evolved.

Several details were given up regarding the documentation of self-injurious acts over recent analysis rounds. Although it may seem that the information to be entered still is "a little over the top" and has been critically acclaimed several times, the results provide enough evidence that these might also be therapeutically helpful. More than once interview partners have stated that a final answer may only be given by patients themselves which is why an actual trial was encouraged from several sides. Based on this reasoning items like "method of self-injury" or "tool used to perform it" were not removed until further notice by study results. Several add-on requirements - which are of lower priority because little remaining time does not allow for inclusion in this thesis' final prototype - include social community support as well as a tendency towards inclusion of a more light-weight and game-like mechanism for the app for future reference. The aspect of automatically uploading any data collected for a therapist to see "behavioral trajectories" in quasi real-time, however potentially interesting and necessary / feasible due to the very nature of the mobile device, raises both legal as well as psychological issues. Using these real-time data to individually tailor achievements or rewards to a patient's personal success may thus be questioned at the moment, making it necessary to investigate further in that topic.

One expert entered the scene at a late stage of the project, after the official interview phase had already been completed. The author argues this as the reason why his feedback and expertise could not be included as thoroughly and comprehensive as would have been anticipated by the author herself. The interest and motivation that drove this person to approach the author does however account for the potential impact / benefit and actuality of such an application in therapeutic work.

7.4 Details of design and implementation

This chapter has a strong focus on design considerations and coding details of the prototype and its orchestration with a surrounding framework. Its (the prototype's) basis is constituted by previously elicited functional requirements as well as remaining requirements and Use Cases which are depicted in this chapter. Besides these aspects, overall design considerations like proposed data exchange formats and an entity relationship diagram are illustrated. The technological framework outlines libraries that are already in use / may be of future benefit upon further development (and actual) realization of the app. Furtheron, considerations regarding the establishment of a RESTful network communication and a description of the proposed architecture per se are given. Specific design patterns used and proposed for the framework follow. Subsequently, a few coding snippets accompany discussed design topics and allow to glance at features that are already in use with the Android prototype. The chapter concludes with delineating limitations which are inherent in the application and are not feasible to be overcome within this thesis anymore given limited time and project scope, i.e., the prototype built up to this point.

7.4.1 Usability requirements

During analyzing interviews after rounds II the prototype was taken to an expert on user-centered design for review and feedback (based on the video material prepared in Chapter 7.2, whereas screenshots were captured and presented in Section 7.2.4). The following points were reasoned legitimate and, thus, led to refinement of the software. Since they are stemming from a usability perspective, they are labeled *'U Req <x>'*.

U Req 1 **User Feedback.** After triggering the upload function a feedback message upon success or failure of the data transfer should be shown to the user.

U Req 2 **Additional items in progress diagrams.** Introducing a note or additional information about why a person had been exposed to an excessive amount of tension could be interesting for the progress diagrams, especially with respect to its motivational function of self-monitoring.

U Req 3 **Provide severity levels.** Define levels for self-injurious act severity conforming to the structure of emotional rating scales (for instance, not severe up to very severe).

U Req 4 **Possibly make external skill adaptive.** The external skill prompting a user just before they decide whether or not to postpone giving in to their urge is phrased as a positive statement. However, if previous decisions have led to the fact that acting upon a self-injurious urge had been postponed "1 out of 10 times" only, the message "That is just great" might be taken as very provocative for a patient. It will be further investigated in upcoming interviews how such a case and expression better be framed.

U Req 5 **Avoid slang.** Until interview rounds II, slang had been used to label data entries within the app. In order to avoid rejection among elder people, removal of slang phrases was proposed.

U Req 6 **Enlarge text areas.** The areas to enter text upon documenting an urge to self-injure are too small. It was recommended to either make them resizable by the user or let a big textarea pop-up upon clicking on this very field.

U Req 7 **Make purpose of scales transparent.** The scales-picture on the bottom of the main screen (intended to act as some kind of reward or positive reinforcement) is difficult to understand without further explanation. A cue like a short message should be displayed along with the picture to understand its functioning and meaning.

U Req 8 **Differentiate buttons and their behavior more clearly.** To make the design and UI more appealing and more intuitive the buttons should more clearly indicate their purpose. In addition, one could put down a longer text and label the button itself with a graphical cue that is to-the-point of the underlying feature.

U Req 9 **Limit number of tension prompts.** A number of 5-6 tension prompts throughout a day might be bothersome for patients. It was proposed to gradually reduce this number correlating with lessened severity of the disease as such.

7.4.1.1 Mapping of usability requirements

The issues with and requirements for the prototype have already been delineated in this chapter. The following table, compare Table 7.9, gives a short overview on which usability requirements had been used to refine the prototype further. If requirements are not considered, reasons are given for doing so.

Req	Prototype integration		Reasoning
	Yes	*No*	
U Req 1	✗		The button to manually upload one's collected data will be removed since an upload will occur as soon as new data entries are available. A user will be informed beforehand that each data entry will yield automatic upload in the back.
U Req 2		✗	This has also been mentioned by one interview partner (Mr. L). If possible, additional items will be included. It is likely, however, that the screen of a cell phone is just too small for that, which is why this is rather regarded a requirement for a web application, like an EMR / PHR that is linked to the cell phone app.
U Req 3	✗		Severity levels provided range from not severe to very severe on a five-point item basis.
U Req 4	✗		This is a valid and important requirement. However, during the time being it is still unclear how rephrasing (and still maintaining the function of positive reinforcement) can take place. This requirement will be taken to experts in interview rounds III for discussion and, if possible, be somehow included in the app. Chances are, however, that a psychological aspect like that cannot be shifted and managed by an app since it requires a reasoning psychotherapist to inject positive phrases all the time.
U Req 5	✗		Slang phrases might not be understood by certain people or have a negative impact on acceptance. Hence, slang phrases were transformed into "regular" expressions.
U Req 6	✗		Upon touching one of the text boxes (within the urge screen) a dialog will pop up, which lets the user enter multiple lines of text. Additionally, it offers the Android built-in feature of auto completion. The text area will automatically enlarge upon writing.
U Req 7		✗	It is a valid requirement; however, the motivational scales-picture was replaced due to issues in how to calculate the balance as such. The idea is to offer some sort of a story line, that is self-explanatory. In case a picture is used, the requirement will come back into play.
U Req 8		✗	It is a valid requirement and should definitely be considered to make an app like this more user-friendly. But since this is a prototype only (and also to stay within the time limit), major effort was set on functional properties.

U Req 9	✗	Limiting the number of tension prompts has been one of the concerns all along. On the other hand, according to experts, patients are required to write down their tension and related properties *every* hour - at least at the beginning of therapy. Therefore, a high number of tension prompts or even hourly prompting the user is not totally irrelevant or out of question. Nonetheless, the plan for the app will be to adapt the number of tension prompts to the individual user's needs. It is not included in the final prototype, but may be included in future development of the app, presumably requiring little additional work effort.

Table 7.9: Usability requirements - labeled with *'U Req <x>'* are listed with a focus on whether they are used for refinement and inclusion in the final prototype. Especially, if they are not considered for integration, reasons are given.

7.4.2 Non-functional requirements

A number of non-functional requirements was drawn from interviewee's contributions. However, the majority stems from brainstorming as well as principles and best practices regarding Android application design, compare Android (2012). The order, in which the requirements are listed, does not constitute any priority.

NF Req 1 ***Preserve battery life.*** The app should be designed and implemented as to waste as little battery life as possible.

NF Req 2 ***Stay with rules-of-thumb of app design.*** The app should not force the user into new app patterns. That is, gestures, buttons and actions that are designed in a certain way in each Android application should not be placed to different positions or be hidden behind unusual "ways" of interaction. This includes that icons that are specifically designed for certain Android versions and which are linked to specific actions, e.g., save, delete, add, etc., should be reused from the available SDK. The design should not invent new icons, unless it provides new functionality of which there is no existing equivalent.

NF Req 3 ***Always give sufficient feedback to the user.*** The user should always know what is happening upon invoking certain actions within the app. For instance, actions that might make a user's life difficult or might be unintended should be acknowledged by the user first. This is attributed to removing items, working with notifications, or transferring data over the network, for example. Android's design patterns cover this very aspect, compare the respective workflow in Figure 7.18 (Android, 2012).

NF Req 4 ***Don't block the app during network operations.*** Enduring operations, e.g., network operations, should rely on asynchronous communication, thus, operate in the background in a non-blocking mode. (Additionally, the user should always be informed about what's going on in the background, especially if network operations are initialized that might incur additional fees.)

NF Req 5 ***Mind small screen sizes.*** Small screen sizes make it necessary to limit the number of items which are displayed on one screen at a time. Additionally, entering large chunks of text is difficult. Hence, features like autocompletion should support the user if working with text areas.

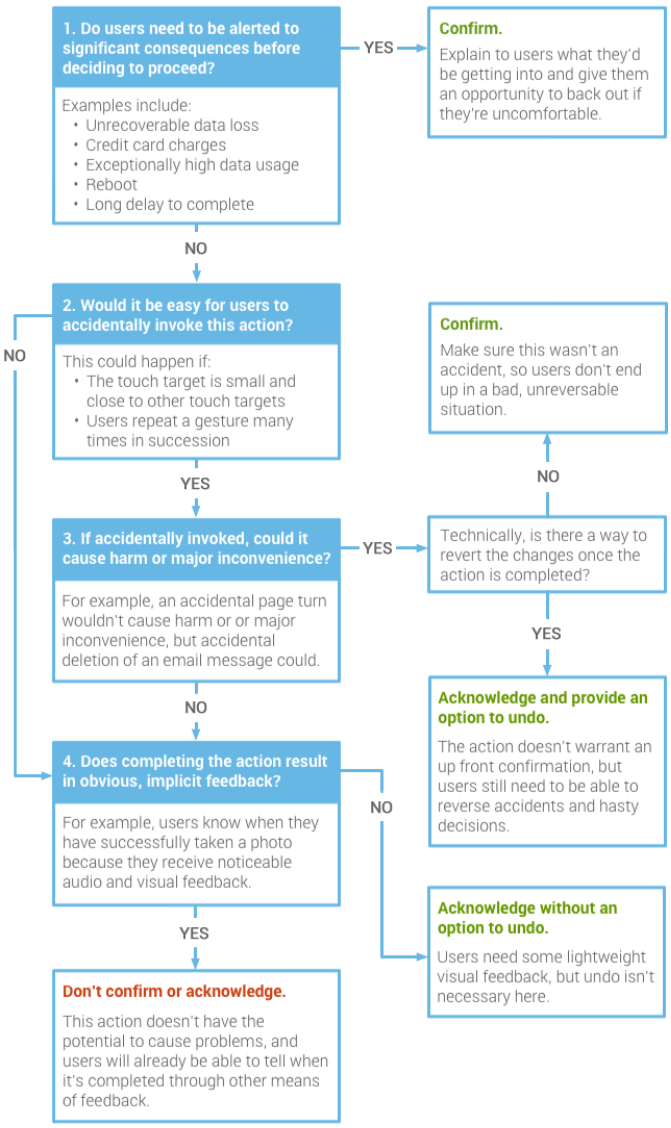

Figure 7.18: Flowchart regarding confirmation and acknowledgment within Android apps, taken from the Design Patterns at Android (2012).

NF Req 6 ***Provide context-sensitive help.*** The application should be easily usable and understandable at first sight. Tutorials and help screens should, however, be provided to a user. Best Practices state, that displaying a bulk of information is not useful. Rather, support should be given in a context-sensitive way. Therefore, the app should adhere to the positive example set by youtube (mobile), which only informs the user about possible actions related to the current screen when it is visited the first time.

NF Req 7 ***Support gestures the user knows about.*** Navigation should always be based on the navigation controls that are supported by the current Android version and which are known to the user. Thus, it becomes an important usability and acceptance factor that largely depends on the look-and-feel of an app. For instance, if swipe gestures are known and make the navigation more intuitive, one should not rely on using buttons to move to the next page (and to confirm all data on a screen has been reviewed, for instance).

NF Req 8 ***Let the user always know where they are.*** Within the app, the user should always know where they are, which is one of the main design principles in Android. Ways to support that are for instance, intuitive navigation like master / detail views, gesture control, or

labeling where in the hierarchy one is at - older Android phone versions, for instance, do still have a built-in hard "back"-button, while newer ones in turn always need to display a virtual soft "back"-button in the bottom bar of the app.

7.4.2.1 Mapping of non-functional requirements

The way the non-functional requirements from Section 7.4.2 are mapped to / attributed by the prototype can be looked at in Table 7.10.

Req	Prototype feature
NF Req 1	Constantly polling the webservice for new information is avoided to preserve battery life. Instead, a publish / subscribe - principle is used, which notifies the application that new data is available, which, then, in turn, can be retrieved.
NF Req 2	Platform-specific icons for the target Android version are used. If no corresponding icons are to be found, new ones are used for the prototype.
NF Req 3	Feedback given to the user is largely based on Figure 7.18. For instance, the user is notified after they have reported their tension. They are also notified, if an action is likely to have a bigger impact on the user, like removal of items.
NF Req 4	Network operations are not performed on the app's main UI thread. Rather, an asynchronous task is invoked to transfer data over the network.
NF Req 5	The number of items displayed at a time on one screen is reduced to the smallest amount as possible. Text areas enable entering multi-lined text, they enlarge their size upon entering text. In addition, the autocompletion-feature is enabled for all text areas.
NF Req 6	A minimal amount of help is displayed to the user (in form of a dialog) when he sees a screen for the first time.
NF Req 7	Navigation through the app is largely based on swipe gestures.
NF Req 8	The tab-layout of the app's core features gives hints as to where on is at within the app. In addition, the direct father's node within the hierarchy is displayed as textual information at the top bar of the app. The Android phone which is used as a testing device has a built-in hard "back"-button, which is why back-navigation by soft-keys in the app is considered unnecessary.

Table 7.10: Non-functional requirements - labeled with *'NF Req <x>'* are listed with a focus on how they are covered in the final prototype.

7.4.3 Workflow scenarios

The concept of the design has several workflows to offer. Drawing and including all workflows available would blow up the extent of this thesis, which is why two sample workflows by means of UML Activity Diagrams are shown in Figure 7.19 and Figure 7.20.
Figure 7.19 centers around the concept of prompting the patient to report their tension level and its reasoning. At its core, the app calculates a tension range and provides contextual skills targeted at the reported tension value (aiming for its reduction).

Interviewed experts stated that tension curves are made up of several tensional dimensions or ranges, each yielding specific sets or modules of skills (Mr. L, Ms. M, Ms. N). This case is undermined in Borderline-specific books by Bohus (and Wolf-Arehult) (Bohus, 2002; Bohus and Wolf-Arehult, 2013). They divide up a tension curve into three areas, whereas the dividing line slightly differs (cf. ibid.). A tension range from 0% to 30% corresponds to skills module "awareness", 30% to 70% (or 40% to 70%) corresponds to module emotion and 70% to 100% (or 80% to 100%) requires distress tolerance skills. Since a tension value of 70% has been marked as the point of no return (times of high tension) during the empirical research, thus, yielding stress tolerance skills, partitioning and reacting to tensional dimensions follows the approach described in Bohus and Wolf-Arehult (2013).

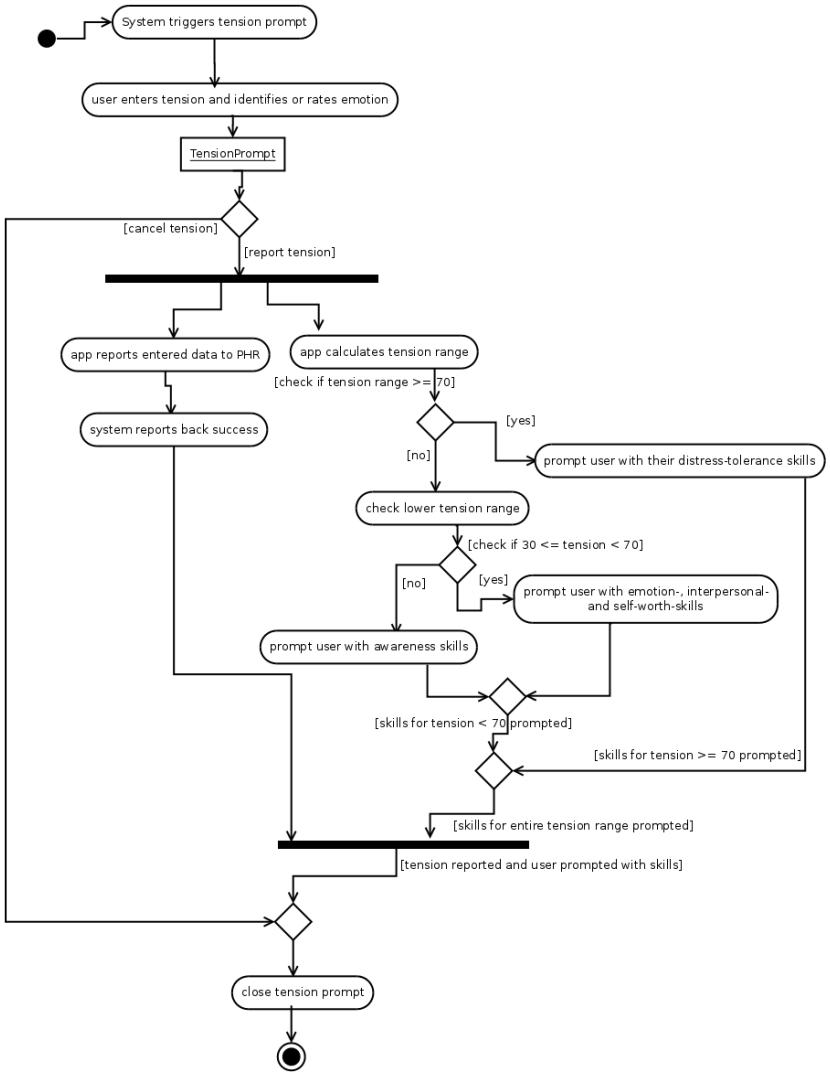

Figure 7.19: The workflow of the app when the system triggers a tension report is outlined as an UML Activity Diagram. Software Dia was used to create the model.

Figure 7.20 focuses on the typical workflow of an event-based documentation - done by the patient themselves - of a self-injurious urge. At its core, the patient has to decide whether (or not) they can postpone acting upon their urge. This reflects the ambivalent state Borderline-patients are in themselves, and has been suggested (Mr. G). This decisional scenario has been positively reviewed by other interview partners (Ms. M, Ms. N). Literature actually supports this aspect since all diary cards, which were reviewed, included an item of whether (or not) an act of NSSI took place, compare Bohus (2002), Klonsky et al. (2011), Bohus and Wolf-Arehult (2013) as well as additional material from interviewed experts (e.g., Mr. J).

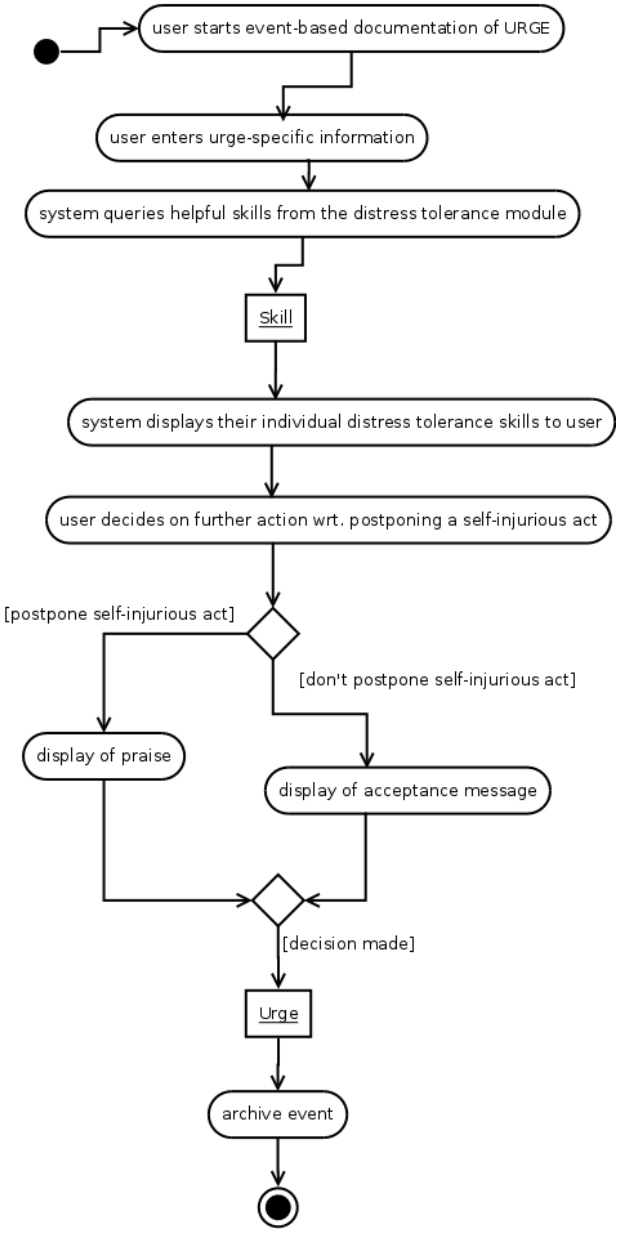

Figure 7.20: The workflow of the app when the user documents an event of type self-injurious urge. Software Dia was used to create the model.

7.4.4 Use Cases

The Use Case Diagram for the proposed system can be seen in Figure 7.21. It is sub-divided into its four logical components:

- tension prompt management,
- skills management,
- behavioral management, and
- EMR / PHR.

The latter largely includes Use Cases which are logically linked to (or actually happening) on the webservice side. Four actors have been designated to trigger / initiate Use Cases:

- the user (who is equivalent to the patient),
- the therapist,
- the system«app» (as in the application), and
- the system«webservice» (as in the service running at the side of the EMR / PHR).

For a better understanding, a few Use Cases, see *UC02 "Document urge"* in Table 7.13, *UC07 "Trigger tension prompt"* in Table 7.18, *UC20 "Report tension"* in Table 7.34, are described in detail. That means that actions performed within these Use Case are given stepwise, while the remaining Use Cases are outlined in plain and simple descriptions of what is happening. That is, all actions performed in there are given as textual summaries. The only information outlined in less detailed Use Cases pertain to Use Case number and name, actors triggering the Use Case, a summary, consequences of the Use Case as such as well as links to other Use Cases. Use Cases that rely on specific preconditions have them listed, others lack this property in the descriptions below. The terms user and patient are used alternately; they do, however, refer to one and the same role.

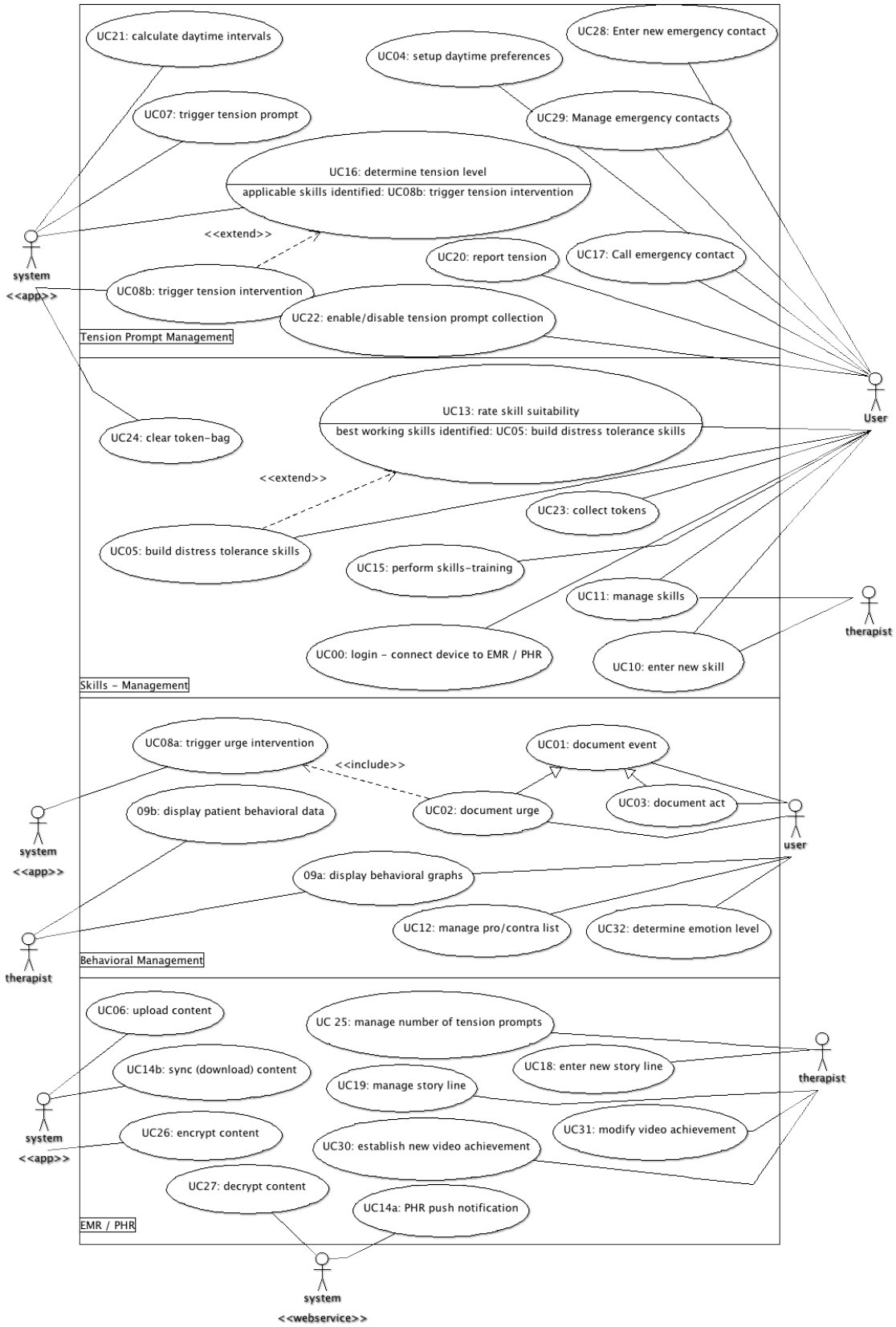

Figure 7.21: Use Case Diagram of the proposed system after analyzing all interviews conducted. The entire diagram is divided into its four logical components to ease understanding: tension prompt management, skills management, behavioral management and EMR / PHR (for actions happening and logically being linked to the webservice side). In total, there are four actors, some of them are shown multiple times to make the picture less cluttered. ArgoUML was used to create this diagram.

Use Case	UC00 *Login - Connect Device to PHR*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The app is installed.
Actors	user, system«app»
Summary	The user invokes an action to pair their device's application with the respective PHR of their therapist. Thus, authorization and authentication need to be ensured at all times. This process is supposed to happen only once during the setup phase of the application, as soon as the application has been started the first time. Mechanisms to pair the PHR with the app could be relying on Google's OAuth2[8] authorization mechanism, where an access token is issued by the webservice that needs to be checked against with the app's stored authentication credentials. (Note: A detailed specification is lacking since this feature could not be thoroughly considered for this project due to lack of time and because OAuth2 is a somewhat complex and big topic on its own.)
Consequences	The app is successfully paired with the EMR/PHR of the therapist. Each communication is handled in an encrypted and securely authenticated way.

Table 7.11: UC00 is initiated by both user and the system itself and deals with the pairing process and secure authentication of the device's app with the respective EMR/PHR of the therapist.

Use Case	UC01 *Document event*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	user
Summary	The patient documents that a specific event has happened (ideally at the time and place where it occurs). According to its type either UC02 or UC03 come into play.
Consequences	An event of either type urge or act is archived within the system (in the RESTful Webservice as in EMR/PHR and/or the internal storage of the user's device).
Linked Use Cases	UC02, UC03

Table 7.12: UC01 is intialized by the patient (end-user). It describes the documentation of an event.

[8] https://developers.google.com/accounts/docs/OAuth2

Use Case	UC02 *Document urge*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The user has set their respective emotion level (UC32). The system has determined whether to display facial expressions or color-coded rating scales based on determined emotion level.
Actors	user
Actions	Patient documents information regarding an urge to self-injure including intensity, situation, cognition, whether alcohol or substance abuse are involved, whether they are alone or in company. Additionally, the patient identifies a list of presented emotions by means of color-coded rating scales or depicted facial expressions. Time of reporting is collected in the background, although time of occurrence can be entered manually. 1.) Patient hits the button "Urge" from the main menu of the application. 2.) Tab "Urge" - Patient sets the color-coded slider to their respective urge intensity. 3.) Tab "Urge" - Patient enters a textual description of the situation (upon clicking on the associated textfield, a bigger and adjustable MultiLine textarea opens). 4.) Tab "Urge" - Patient enters a textual description of their thoughts (upon clicking on the associated textfield, a bigger and adjustable MultiLine textarea opens). 5.) Tab "Urge" - Patient enters a textual description of their bodily sensations (upon clicking on the associated textfield, a bigger and adjustable MultiLine textarea opens). 6.) Tab "Urge" / Patient may manually enter the time when the urge occurred. 7.) Tab "Urge" - Patient marks the relevant checkboxes "Are you drinking alcohol?", "Are you taking drugs?", "Are you alone?". 8.) Patient performs a swipe gesture or clicks on Tab "Emotion". 9.) Tab "Emotion 1" - Patient sets the color-(and-value-)coded slider to their respective anger intensity. 10.) Tab "Emotion 1" - Patient sets the color-(and-value-)coded slider to their respective peacefulness intensity. 11.) Tab "Emotion 1" - Patient sets the color-(and-value-)coded slider to their respective anxiousness intensity. 12.) Patient performs a right-to-left-swipe gesture or clicks on Tab "Emotion 2". 13.) Tab "Emotion 2" - Patient sets the color-(and-value-)coded slider to their respective loneliness intensity. 14.) Tab "Emotion 2" - Patient sets the color-(and-value-)coded slider to their respective being satisfied intensity. 15.) Tab "Emotion 2" / Patient sets the color-(and-value-)coded slider to their respective misery intensity. 16.) Patient performs a right-to-left-swipe gesture or clicks on Tab "Skill". 17.) Tab "Skill" - This step interlinks with *UC08a "Trigger urge interventions"*.

	18.) Patient performs a swipe gesture or clicks on Tab "Decision." 19.) Tab "Decision" - Patient clicks either button "YES, I can" or "NO, I can't".
Consequences	A decision has been made whether patient followed-up with a self-injurious act or whether he was able to postpone "acting out". An urge object containing all user-given information (timestamp is automatically stored along with the data) is archived (in the RESTful Webservice as in EMR / PHR and / or the internal storage of the user's device).
Alternative scenario	9.a)-15.a) Tab "Emotion" - Patient selects one or several facial expressions that represent their current emotional state.

Table 7.13: UC02 is initialized by the patient. It describes the documentation of a self-injurious urge.

Use Case	UC03 *Document act*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	user
Summary	The patient may document a self-injurious act at the time when it occurs. Thus, time is archived in the background without the user having to enter it manually. In addition, since this is not regarded a realistic scenario, the user can manually enter the time of occurrence as well. That way it is ensured that the application can calculate and record the time span that passes in-between the occurrence of an urge and the occurrence of an act. Beside the timestamps, which is automatically recorded, the following details about the behavior itself are entered by the user: *) the method one engaged in, *) the tool used to injure oneself, *) if the patient had suicidal thoughts at that very moment, and *) the time when an injury had been inflicted upon oneself.
Consequences	An event of category act is archived within the system (in the RESTful webservice as in EMR / PHR and / or the internal storage of the user's device) for later display to therapist and / or patient.

Table 7.14: UC03 is initialized by the patient. It describes the documentation of a self-injurious act following an urge.

Use Case	UC04 *Setup daytime preferences*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	user
Summary	The patients updates their settings as to when they "allow" the system to trigger tension prompts at random times during a day. Wakeup-time as well as sleeping-time can be set.
Consequences	No prompts reach the user during their night (blackout) times.

Table 7.15: UC04 is initialized by the patient. It describes the setup of a "day"-interval whereas the patient is ok with receiving notifications via their cell phone.

Use Case	UC05 *Build distress tolerance skills*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A set of skills needs to be readily available at the phone.
Actors	user
Summary	The patient builds their individual emergency suitcase by identifying, defining, selecting three to five different intervening strategies that are most likely to be working to replace maladaptive behavior.
Consequences	The emergency suitcase contains between three to five different interventions that have proven to be successfully working as alternative cues during times of high tension.

Table 7.16: UC05 as initialized by the patient is about the management of an emergency suitcase.

Use Case	UC06 *Upload content*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The cell phone should have an active network connection.
Actors	user
Summary	Data are automatically uploaded to the EMR / PHR in the background as soon as the patient enters new information.
Consequences	The data collected by the end-user is uploaded to a web application (database / back-end) the device is coupled with. Thus, the therapist is able to see whatever information had been collected by their patient starting from the last date where an upload occurred.

Table 7.17: UC06 is initialized by the patient, whereas he manually uploads the collected information.

Use Case	UC07 *Trigger tension prompt*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The app needs to be set up with a daily bothering interval (UC04). The timestamp for the planned next tension prompt to be triggered is stored in the app's preferences (UC21).
Actors	system«app»
Actions	1.) The system internally wakes up the device with an AlarmService every 15 minutes (+/-; note: the service relies on inexact repeating). 2.) The system compares the actual time with the previously calculated timestamp of the next tension prompt to be triggered. 3.) The actual time is before the next triggering timestamp. 4.) The system does nothing and waits for the next AlarmService-wake-up-cycle.
Consequences	A notification is displayed to the patient's cell phone alerting them to rate their tension and emotional well-being at random during their day.
Alternative scenario	3.a) The actual time is later than the next triggering timestamp. 4.a) The system invokes the NotificationManager to display a tension prompt to the user.
Consequences - alternative scenario	No tension prompt is displayed to the user. In fact, the user does not even see / realize that anything was going on in the background.

Table 7.18: UC07 is initialized by the system which calculates time slots throughout the day, wherein tension prompts are triggered and brought to the user.

Use Case	UC08a *Trigger urge intervention*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A user enters information based on the event of an urge to self-injure.
Actors	system«app»
Summary	Interventions are triggered by the system on either one of two ways: a) as soon as the device recognizes the documentation of an urge, b) upon the user's input in reply to a system-triggered tension prompt. Thus, the mobile devices intervenes in a context-sensitive way. Here, distress tolerance skills are retrieved from the EMR / PHR and displayed in a respective tab of the urge documentation. That way, webservice and Android application deliver an intervention stemming from the user's emergency suitcase or at least one that was rated successful or has worked before for the individual.
Consequences	An intervention is displayed to the cell phone, respectively, to the patient in order to evoke a reflection process and possibly make them think about going an alternative route.

Table 7.19: UC08a is initialized by the system. An intervention is triggered as soon as the end-user has documented that an urge to self-injure is happening.

Use Case	UC08b *Trigger tension intervention*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A user gives input in reply to a system-triggered tension prompt.
Actors	system«app»
Summary	Interventions are triggered by the system on either one of two ways: a) as soon as the device recognizes the documentation of an urge, b) upon the user's input in reply to a system-triggered tension prompt. Thus, the mobile devices intervenes in a context-sensitive way. Here, the system determines the tension interval a user is currently in and subsequently displays interventions that are associated to the respective tension interval. That way, there are certain "workflows" to be considered in parallel. If the reported tension is below 30, the system will filter archived skills from the module awareness. If the reported tension is between 30 and 60, the system will deliver skills from modules awareness, emotion regulation, and interpersonal skills. As soon as a tension level of 70 or higher is reported, the system will only trigger skills from the set of distress tolerance skills.
Consequences	An intervention is displayed to the cell phone, respectively, to the patient in order to evoke a reflection process and possibly make him think about going an alternative route.

Table 7.20: UC08b is initialized by the system. An intervention is triggered as soon as the end-user has replied to a tension prompt, thus, reported their respective level of tension.

Use Case	UC09a *Display behavioral graphs*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). Data regarding mood, tension and behavior need to be available.
Actors	patient, therapist
Summary	The actor selects an emotion of interest on the phone which will be shown as a chart displaying the corresponding mood curve on top of the self-injurious acts curve. The therapist selects the tension curve or another emotion of interest from within the webservice. The timeline will be shown according to the data collected.
Consequences	The device displays an overlay of self-injurious behavior on top of a mood curve, whereas the corresponding emotion selected is displayed. The webservice either shows the tension curve or emotion curves based on the emotion selected.

Table 7.21: UC09a can be initialized by two actors - the patient and the therapist. Upon collection of mood and self-injurious behavioral data an overlay of behavior on top of a single mood curve is generated. Tension curves are displayed in the webservice.

Use Case	UC09b *Display patient behavioral data*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). Data regarding mood, tension and behavior need to be available. The therapist is logged on to the relevant patient's EMR / PHR.
Actors	therapist
Summary	The actor chooses the relevant tab from within the webservice that is of interest. The data that has previously been collected by the patient and archived in the database attached to the webservice are displayed.
Consequences	The webservice displays the behavioral data based on its availability and the selection of the therapist.

Table 7.22: UC09b can be initialized by the therapist from within the webservice. Upon selecting a tab of interest, available data regarding a patient are displayed.

Use Case	UC10 *Enter new skill*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A pre-defined set of skills, along with their skills category, is readily available within the app. The user has clicked on the 'skills'-button.
Actors	patient, therapist
Summary	The user selects a specific skills category, then hits the 'menu' button and clicks on the 'add new skill' option. The app shows a new screen asking the user to enter a short name or title for the skill, yet again choose (in case the user decides to move the skill to another category) the corresponding skills module from the list and give a description of what the skill is about, what activities are involved in the skill. Hitting the button "Save" will archive this skill, have it show up in the selected category and have it accessible as an intervention. The therapist can enter and define new skills from within the webservice to be collected by the respective patient's Android application.
Consequences	A new skill, belonging to a certain skills module, is defined and archived (in the RESTful Webservice as in EMR/PHR and/or the internal storage of the user's device).

Table 7.23: UC10 is triggered by either patient (from within the Android application) or therapist (from within the EMR / PHR). They can enter a new skill (along with its parameters like name or title and description) and assort it to a specific skills module.

Use Case	UC11 *Manage skills*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A set of skills, along with their skills category, is readily available within the app. The user selects a specific skill and hits the 'menu' button.
Actors	patient, therapist
Summary	The user clicks on either 'delete' or 'edit'. If 'edit' is chosen, a new screen is displayed showing all the information that is already existent about the skill. The user can then modify any parameter, hitting "Save" will archive the modified version of the skill. In case, the user hits 'delete' the skill will be permanently deleted from the user's working skills list. In both cases, the user receives adequate feedback about the action performed. The therapist can edit or remove a skill from within the webservice.
Consequences	An already existing skill has been modified and archived (in the RESTful Webservice as in EMR/PHR and/or the internal storage of the user's device) or deleted.

Table 7.24: UC11 is initiated by either patient (from within the Android application) or therapist (from within the EMR / PHR), who then modifies or removes a skill.

Use Case	UC12 *Manage pro / contra list.*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The app is installed, the patient is not within a moment of high tension.
Actors	user
Summary	The user clicks on a designated button to establish or modify a pro / contra list about their self-injurious behavior and enters short-term advantages / disadvantages, as well as long-term advantages / disadvantages of keeping NSSI as a coping mechanism.
Consequences	A pro / contra list is established and ready to be used as a skill for intervention. In case, the user made modifications, these changes are reflected in the pro / contra list that is archived.

Table 7.25: UC12 is initiated by the user, who enters or modifies short- and long-term advantages and disadvantages as to maintaining self-injury as a coping mechanism.

Use Case	UC13 *Rate skills suitability*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A set of skills needs to be existent on the phone.
Actors	user
Summary	The patient rates a skill as individually suitable or helpful in order to reduce tension.
Consequences	Patient identified working skills tailored to their individual situation.
Extension point	best working skills identified -> UC05: build distress tolerance skills

Table 7.26: UC13 is initiated by the patient. A number of skills which is listed within the section of skills-training can be rated regarding their suitability for the individual patient.

Use Case	UC14a *PHR Push Notification*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The app is installed, device is connected with the PHR (app is not necessarily online). Therapist entered new information.
Actors	therapist, system«webservice»
Summary	The RESTful PHR WS issues a push notification for the device that has been connected to the PHR, as soon as the therapist entered new information or changed an existing data entry.
Consequences	The device, respectively, the app is informed that new content is available and need to be synced to the cell phone.

Table 7.27: UC14a is initiated by the system at the RESTful webservice side. New information originating from the webservice is placed in the PHR Push Notification queue.

Use Case	UC14b *Sync (download) content*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The app is installed, device is connected to the PHR and online. New data from the webservice is available (UC14a).
Actors	user, system«app»
Summary	The app, the system queries the RESTful PHR WS for retrieval of the new or modified data and stores them in the cell phone's internal memory storage.
Consequences	Synchronization was successful and both PHR as well as app contain the same up-to-date information.

Table 7.28: UC14b is initiated by the system and the user at the mobile device side. The application synchronizes / downloads newly available / modified information.

Use Case	UC15 *Perform skills-training*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A list of skills is available.
Actors	user
Summary	A patient performs skills-training by practicing some of the skills that are available and documents the training.
Consequences	Documentation of what, when, by whom a specific skill was trained is updated. Depending on whether the user designated the skill as a emergency skill, it is further archived within the distress tolerance module.

Table 7.29: UC15 is initiated by the patient in order to practice his / her skills.

Use Case	UC16 *Determine tension level*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A user has successfully reported their tension.
Actors	system«app»
Summary	The system determines the tension interval, which contains the user-reported tension level. Based on the specifics of the tension range, the system looks up a table that links tension ranges to skills modules, thus, identifies which sort of skills are to be triggered. This use case includes an extension point.
Consequences	The tension range that holds the reported user tension is determined. The system then consults a look-up table to identify skills modules to be triggered for the specific tension range.
Extension point	Applicable skills identified -> trigger tension intervention UC08b

Table 7.30: UC16 determines the tension interval that contains the user-reported tension and identifies the skills module to be used for intervention.

Use Case	UC17 *Call emergency contact*
Precondition	Emergency details need to be stored in the phone's preferences (UC28).
Actors	user
Summary	During times of highest tension, i.e., at a tension level of 100, the patient is opted with the possibility to call a designated emergency contact.
Consequences	A phone call is instantiated from inside the app.

Table 7.31: UC17 can be initialized by the patient only. A call to the therapist or another emergency contact will be invoked upon clicking a designated button.

Use Case	UC18 *Enter new storyline*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The therapist is logged on to the designated EMR / PHR of the patient.
Actors	therapist
Summary	The therapist enters a new storyline, respectively, a sub-goal of the storyline and defines number and type of skills the patient needs to have, in order to reach the sub-goal. When the therapist confirms their action, the storyline-object is placed in the Push PHR notification queue that, in turn, informs the connected device about the existence of new data / updated information.
Consequences	A new storyline sub-goal is defined and sent to the PHR notification queue for collection by the app.

Table 7.32: UC18 is initiated by the therapist at the RESTful webservice side. A new storyline sub-goal is defined and placed-in-queue for the respective patient.

Use Case	UC19 *Manage storyline*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The therapist is logged on to the designated EMR / PHR of the patient. A story line sub-goal is existent.
Actors	therapist
Summary	The therapist selects an existing story line sub-goal and updates the information according to their or their patient's needs. Upon confirmation, the updated storyline-object is placed in the PHR Push notification queue (for later collection by the phone's application).
Consequences	The contents of a storyline are modified and sent to the PHR Push notification queue for collection by the app.

Table 7.33: UC19 is initiated by the therapist at the RESTful webservice side. A storyline sub-goal is modified and placed-in-queue for the respective patient.

Use Case	UC20 *Report tension*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). A tension prompt is shown at the user's mobile device (UC07).
Actors	user
Actions	1.) The user opens the tension prompt from the notification area. 2.) The user rates their tension by adjusting the displayed slider to their respective tension level. 3.) The system compares the actual time with the previously calculated timestamp of the next tension prompt to be triggered. 4.) The user reasons about their tension level by also identifying and / or rating their corresponding emotional state. 5.) The user hits the button "Report". 6.) The system gives feedback about the action that is performed in the background.
Consequences	The tension prompt is cleared from the devices' notification area. The information given in this tension prompt is archived (sent to the RESTful Webservice as in EMR/PHR and/or stored in the internal storage of the device).
Alternative scenario	1.a) The user clears all notifications from their phone's notification area. 1.b) The user does not react to the tension prompt in their notification area. 5.a) The user does not hit the button "Report" but cancels the tension prompt.
Consequences - alternative scenario	The tension prompt is cleared form the devices' notification area. Nothing regarding tension is archived (with respect to 1.a), 5.a)). New notifications are triggered, however, the system keeps displaying the tension prompt with the timestamp that came first. The tension prompt remains visible in the devices' notification area until they are cleared or answered by the user (with respect to 1.b)).

Table 7.34: UC20 is triggered by the user (upon receiving a new notification), who reports their tension on a regular basis throughout the day.

Use Case	UC21 *Calculate daytime intervals*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). The application is set up with a wake-up time and a bedtime.
Actors	system«app»
Summary	The system calculates the timespan between wake-up time and bedtime and determines time slots - given a predefined number of tension prompts, during which tension prompts are to be triggered by the system. Usually, the system does only calculate the next upcoming timestamp (and stores it in the app's preferences settings) after a tension prompt is issued, thus, brought to the user's attention.
Consequences	The planned timestamp for a new tension prompt to be issued has been generated and is stored in the app's preferences settings.

Table 7.35: UC21 is initiated by the system. The system determines the times slots, when tension prompts can be triggered throughout the day.

Use Case	UC22 *Enable / disable tension prompt collection*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	user
Summary	The user can either enable or disable the feature to receive tension prompts throughout the day. This can be done any time in the general settings of the application.
Consequences	If tension prompt collection is disabled, the notification about new tension prompts is suppressed during the time being. If tension prompt collection is enabled, the user receives new tension prompts in the phone's notification area based on their daytime settings and predefined number of tension prompts to be collected.

Table 7.36: UC22 is initiated by the user, who can enable or disable the issuance of tension prompts.

Use Case	UC23 *Collect tokens*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	user
Summary	The user collects virtual tokens each time they perform skills-training, whereas tokens are collected at a skills level. Tokens are then put into their respective virtual tokens-bag, which reflects the corresponding skills module. In addition, tokens are collected, if skills are used during tension reports and during documented urges to injure. There is no punishment if the user decides to go through with self-injury.
Consequences	The number of tokens that is held in a virtual tokens-bag - reflecting the respective skills module - increases.

Table 7.37: UC23 is initiated by the user, who actively collects tokens upon fulfilling specific tasks.

Use Case	UC24 *Clear token-bag*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	system«app»
Summary	As soon as the therapist has delivered a new sub-goal with respect to the storyline, the system clears the content of each virtual token-bag.
Consequences	The content of each virtual token-bag is cleared.

Table 7.38: UC24 is initiated by the system, which clears the virtual tokens-bags to prepare for newly assigned token-collection.

Use Case	UC25 *Manage number of tension prompts*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	therapist, system«webservice»
Summary	The therapist enters a new number of tension prompts to be collected throughout the patient's day via their EMR / PHR. These data are then queued for push notification and delivered to the phone, where the system updates the archived number of tension prompts with the newly delivered value.
Consequences	The default number of tension prompts is cleared, instead it is updated with the number the therapist entered in their EMR / PHR and which was, in turn, delivered to the phone.

Table 7.39: UC25 is initiated by the therapist, who updates the number of tension prompts for the user. The system applies these changes in the application.

Use Case	UC26 *Encrypt content*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). New data entry.
Actors	system«app»
Summary	As soon as a new data entry is available, it is securely encrypted and then stored in the phone's internal memory and / or archived in the corresponding EMR / PHR.
Consequences	The encrypted data is stored in the phone's memory and / or in the backend of the webservice.

Table 7.40: UC26 is initiated by the system. Newly entered information is encrypted.

Use Case	UC27 *Decrypt content*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00). An encrypted object has been successfully transferred to the EMR / PHR webservice.
Actors	system«webservice»
Summary	The webservice needs to decrypt the object for later display to the therapist.
Consequences	The encrypted and transferred object is decrypted and can be looked at by the therapist in clear text.

Table 7.41: UC27 is initiated by the system (webservice). Newly synchronized information is decrypted.

Use Case	UC28 *Enter new emergency contact*
Precondition	-
Actors	users
Summary	The user enters new emergency contacts.
Consequences	Emergency contacts are archived inside the app and accessible during a crisis.

Table 7.42: UC28 can be initialized by the patient only. Emergency contacts are managed and archived from within the app.

Use Case	UC29 *Manage emergency contacts*
Precondition	At least one emergency contact exists in the app (UC28).
Actors	patient
Summary	The user selects an emergency contact and changes its details according to their needs. Thus, it is also possible to delete this specific contact altogether.
Consequences	An emergency contact has been updated or deleted.

Table 7.43: UC29 can be initialized by the patient only. Emergency contacts are managed and archived from within the app.

Use Case	UC30 *Establish new video achievement*
Precondition	Therapist is logged on to the respective patient's EMR / PHR.
Actors	therapist, system«webservice»
Summary	Based on a patient's recent progress towards achieving their goal, the therapist establishes a new video achievement. To that extent, they enter the video identifier of a youtube video into the respective "create achievement"-form within the webservice. The video identifier can be copied from the url of the youtube video. The system then stores the video achievement in the database that is attached to the webservice, places the thus generated video achievement in a corresponding PHR push notification queue, where the Android application has registered its interest to.
Consequences	A new video achievement has been generated and archived and is placed in a message queue for collection by the Android application.

Table 7.44: UC30 can be initialized by the therapist only. A new video achievement has been established from within the webservice.

Use Case	UC31 *Modify video achievement*
Precondition	A video achievement is existent in the respective patient's EMR / PHR (UC30).
Actors	therapist, system«webservice»
Summary	The therapist selects the relevant achievement and modifies its parameter (i.e., the video identifier at the moment) in the "edit achievement"-form within the webservice. The system then updates the video achievement in its database and places the modified object in its corresponding PHR push notification queue, where the Android application has registered its interest to.
Consequences	A video achievement was successfully modified, updated in the database and is placed in a message queue for collection and respective update by the Android application.

Table 7.45: UC31 can be initialized by the therapist only. Established video achievements are modified from within the webservice.

Use Case	UC32 *Determine emotion level*
Precondition	The user's phone application is connected with the designated EMR / PHR (UC00).
Actors	user
Summary	The user sets the emotion level - either basic or advanced - depending on their respective ability to identify and rate emotions.
Consequences	The application archives this setting within its preferences and displays emotions as either color-coded rating scales or facial expressions.

Table 7.46: UC32 is initiated by the user, who can set their respective emotion level.

7.4.5 The final prototype

After analyzing all interviews, derived functional requirements from Section 7.3.2, usability from Section 7.4.1 and non-functional requirements from Section 7.4.2 as well as established workflow scenarios and drawn Use Cases led to a new and improved version of the prototype. Several core features and functionality was implemented by the author until the milestone set as "code-freeze" had arrived. The result of this recent coding stage is the final prototype, of which a few screens are illustrated in Figure 7.22 below. Keep in mind that screens which have already been presented and did not undergo further modification, for instance, one's daytime preferences, are not shown any more to keep redundancy to a minimum.

For easier reference, each screen is labeled with an upper-case letter. Their respective description and functionality is as follows, whereas main features are triggered via gray buttons. Further settings and functionality is hidden under the menu options:

A This is the main screen as in the global access point of the application. Underneath the four buttons which trigger corresponding functionality, a default storyline with a sub-goal to collect awareness tokens is shown. The options menu has been opened up to see where additional settings and features are hidden[9].

B Clicking on menu button *"emotion level"* presents users with a screen where they can choose their ability to identify emotions:

- ***Mode basic*** represents feeling states as facial expressions, whereas
- the ***advanced mode*** requires users to identify and rate respective emotions according to their intensity with color-coded rating scales.

C Upon clicking menu button *"music"* users can enter a youtube search query in the provided text area. The first video result returned from youtube would then be stored in the app's SharedPreferences and could potentially be used as a skill whenever one would feel low or needs distraction.

D Clicking button *"urge"* triggers one of the app's main functions to document an urge. The entire urge section is designed as a tabbed layout.

E Clicking on one of the text areas opens up a new dialog that automatically adjusts its size depending on the amount of text that is entered.

F Tab "emotion" displays facial expressions in stead of emotion rating scales if emotion level basic had been chosen by the user[10].

G Tab "skill" retrieves skills from the distress module as interventions and displays them to the user. This feature is linked to the proof-of-concept webservice prototype, hence, works currently only on the author's local computer. Upon clicking the button "display next skill" another skill will be shown upon availability. To make the appearance of new text more evident and appealing a newly retrieved skill description uses a fade in animation upon display.

[9] The settings option makes use of the respective Android icon, the achievements picture was taken from http://www.mtsv-maedchenfussball.cms4people.de/pokal_347_460.jpg, the music icon was taken from http://www.stupidedia.org/images/thumb/c/c6/Musiknote.png/130px-Musiknote.png. Pictures taken from other sources than the Android SDK itself were transformed into corresponding Android icons by using Studio (2013).

[10] The facial expressions are sketches taken from http://englishcommunicationcourse.wikispaces.com/file/view/Emotions_2.JPG/181513783/Emotions_2.JPG.

H Tab "reinforce" still displays some static text, but delivers the option to decide between two diametral alternatives, namely to injure or to not injure.

I If the user decided to go through with self-injury a short message is displayed.

J If the user decided to NOT go through with self-injury a little cheerleader is displayed due to this recent success.

K Upon clicking button "act" from the main entry point of the application, a user is enabled to enter method, instrument, time of occurrence of an act and whether they were suicidal.

L If the therapist has created a new video achievement for their patient, a corresponding link to the video is transferred via the network from the webservice to the Android application. The user can then watch their personalized achievement as in a youtube video from within the app[11]. An alternative would be to playback the video that was obtained from entering one's own youtube search query, compare bullet C in this list.

Figure 7.22: Several screens of the final prototype.

[11] The current screen displays the youtube video with the identifier 'U2yiphu8Ff8' (*artist: Anna Nalick, song: Breathe (2AM)*).

The skills manager part of the application is shown in Figure 7.23:

M Upon clicking the button with the orange ribbon labeled "Skills", the application displays a grid with five different images corresponding to the five skills modules.

N Selecting one category displays a list of skills that are already stored in the application. Note: this is a static list only, whereas new skills can be entered by the user.

O Shows the activity, where a user can enter their new skill. Upon clicking apply this skill will be archived to the proof-of-concept webservice representing the patient's PHR / EMR. This feature is, however, only enabled while working with the emulator at the local computer of the author since the webservice currently runs at localhost only.

P Users can look what specific skills are about. This screen provides an entry point to delete, edit or practice this specific skill.

Q When the button "practice" from screen P was clicked, a user can enter information about their skills training according to a skills protocol that was given to the author in the course of one interview (Ms. M).

Figure 7.23: Skills manager part of the final prototype.

The notification, i.e., the tension and mood prompt, part of the application still is a core feature of the application, see Figure 7.24. If the application is run in the emulator, thus, on the local computer of the author, tension prompts are archived over the network to the proof-of-concept webservice. That in turn enables a person, e.g., a therapist, to view whatever tension was reported by the patient and have a look at their respective tension curve:

R Regular notification throughout a user's day are shown in the top level bar of the cell phone.

S This screen shows a detailed view of how the notification, the so-called tension prompt, is displayed in the notification section of the cell phone.

T The tension prompt in case the user had chosen emotion level basic in the application.

U This tension prompt is shown when the user selected the advanced emotion level in the application.

Figure 7.24: Notification part of the final prototype.

7.4.6 General design considerations

To "speed up" the application in terms of data transfer and reduce the load of overly complex data structures to be communicated, JavaScript Object Notation (JSON) is the primary choice for network communication, compare upcoming Section 7.4.7.3, in terms of this project. Reasoning for this decision is based on late research, which is illustrated just below. A second general consideration points to the design of an Entity Relationship Model to get an understanding of the complex interplay of different data objects which is hidden under the surface.

7.4.6.1 Data exchange formats

Data exchange when developing mobile applications is commonly performed by either using eXtensible Markup Language (XML) or JSON[12] (Motorola, 2012), each one of them having their very own advantages and disadvantages. XML represents a more complex data structure, often associated to be difficult for humans to read, while JSON provides a simpler representation and a more lightweight mechanism of exchanging information (Maeda, 2012).

Hameseder et al. did a comparison of Simple Object Access Protocol (SOAP) webservice (WS) and Representational State Transfer (REST)-based WS using XML, JSON and Fast Infoset as data exchange formats (Hameseder, Fowler, and Peterson, 2011). While using SOAP WS is

[12] http://www.json.org

not regarded efficient for smartphone use due to its overhead, REST-based services delineate differences depending on the underlying data format as well. They found that JSON performs better in terms of transferred data volume compared to XML (37 bytes versus 78 bytes during a simple message type request on an init operation). XML, on the other hand, is in favor related to serialization time (0.64 ms versus 1.51 ms as average time for a simple message type in an init operation). Deserialization time is, then, however, much faster with JSON than XML (2.02 ms versus 2.89 ms on average for a simple message type in an init operation). The authors recommended using JSON as data exchange format in REST web services while developing iPhone applications (Hameseder, Fowler, and Peterson, 2011). One could assume that the same recommendation directly transfers to any smartphone OS, like Android, as well.

7.4.6.2 ERD

The corresponding ERD for the designed app is illustrated in Figure 7.25.

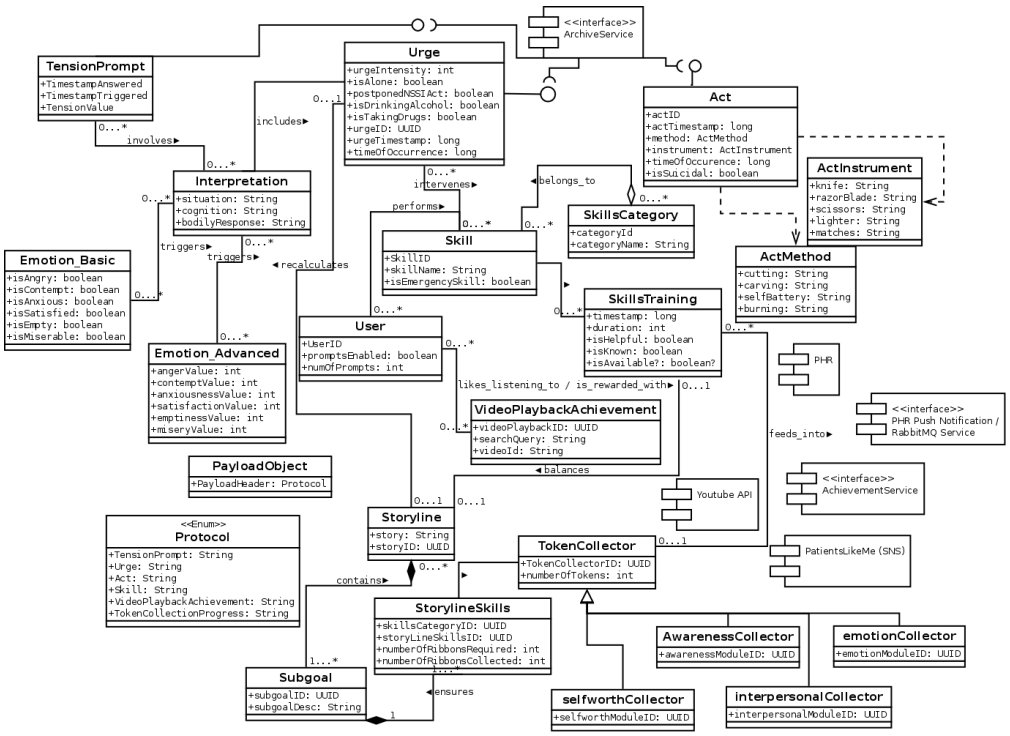

Figure 7.25: Entity Relationship Diagram resulting from the design step after analyzing interviews throughout the empirical research, whereas classes as well as interfaces and external packages are depicted. The ERD had been designed using the DIA software (version 0.97.2).

7.4.7 Technological framework

The project is based on Google's open source Android software development kit (SDK) (Android, 2012). For starting off with developing an Android app, several Android Developer Tools (ADT) - for instance, Android SDK Manager, emulator - respectively, an ADT Bundle need to be downloaded. These can then be easily installed within an existing Integrated Development Environment (IDE), such as Eclipse, and configured according to one's needs.

During the development process the app can be run on either the emulator or an actual hardware device that is to be connected or mounted via the ADT Tools (Android, 2012). Every Android project is structured in a certain way to be run by Android devices. The most important components shall be mentioned in here, in a nutshell, and are as follows:

- *AndroidManifest.xml*
  The manifest is the corner stone of each app and is based on the XML datastructure. Every component that is written and used within the source code needs to be declared in here. In addition, it defines whatever version of Android SDK is regarded a minimum and regarded a target version for the app. Also, in here, one registers permissions the app is in need of to properly perform all of its tasks, as well as several Services, Receivers, Activities and such.

- *src /*
  The source folder contains all the project's source files. At creation, at least one Activity is included which is initialized upon launching the app.

- *res /*
  All the resources used by the app are kept in the res folder. Besides layouts, i.e., XML-files defining the structure of each screen, respectively, Activity, it contains values to store string-resources or drawables, which are bitmaps, menu icons etc. used by the app.

Before an application can then be deployed to an Android phone it needs to be signed (Android, 2012). Eclipse largely supports this process. Upon creation of a private key and a thus self-signed certificate the application can be signed from within Eclipse. The result is an .apk-file which can then be copied to the phone and is ready for install. These actions were performed to deploy the prototype to the author's Android cell phone to support interviews.[13]
Once a fully functional application will be ready for deployment in the future, it is, however, recommended to either provide the .apk-file at a website or publish it on Google Play for easy download and distribution to interested users.

7.4.7.1 Libraries used

In order to include a variety of APIs that have only been introduced recently to the Android API library, the Android Support Library is used. Since the app was designed to support v4 as minimum SDK (while having a target SDK of 17, i.e., Android 4.2), the minimum support version for Android API v4 was chosen and downloaded via the Android SDK Manager[14]. That way, access to features and functionalities that are only available starting from Android 3.0 to more recent versions are enabled for older versions (starting with v4) as well (Android, 2012). It does however add a layer of complexity since working with the library requires a bit of adaptation in terms of coding compared to Android patterns that had already been learned but were targeting older versions without compatibility features.

To avoid having to build charts and progress diagrams for the Android app from scratch, the achartengine library[15] was used. That way, a variety of different charts is at hand that can be readily embedded within the app and provide an interactive look-and-feel.

During the empirical research design, requirements for a specific Android widget became apparent which are, as such, not provided among the existing UI widgets. Hence, a library project

[13] For matters of comprehensiveness, the author states that after the code-freeze date minor modifications relating to labeling and naming of parameters in the Android application led to unexpected major disturbances. It was assumed that the app's target version was the reason that compiling the source code after cleaning and afterwards rebuilding the project did not seem to work anymore. After updating the Android target version to the latest SDK available in the corresponding *AndroidManifest.xml*, the compilation process again ran through successfully. However, from that time on, exporting a self-signed .apk-file from within Eclipse has been crashing every time for unknown reasons. Nonetheless, the application can still be directly deployed to a real phone, however, requires the installation to be done via the IDE in development mode.

[14] http://developer.android.com/tools/extras/support-library.html

[15] http://www.achartengine.org

by karabaralex[16] was used to include SeekBars that supported a UI design reflecting a slider that has specified certain nodes or intervals to be shown along some kind of a rating scale. However, properties were needed to be set up. Also, the source code was modified (for instance, a color coded canvas showing a horizontal linear gradient ranging from green to red was added underneath the slider, parameters like stroke, design of selected nodes etc. were changed) by the author of the thesis in order to fit the requirements for the project in question (and to make a selection more apparent for the user).

In order to show and play videos from within the app available frameworks, like Google's API Java Client and Android's MediaController / VideoView, were looked at and "evaluated". Among them, Androids built-in MediaController and VideoView classes did not provide the anticipated level of quality and interaction and were disregarded. A Youtube Data API was available, but according to a post on stackoverflow[17], the Youtube Data API within Google's API Java Client did not support Android until its recent release of version v3.

The Youtube Android Player API seamlessly integrates with an Android app and provides high quality in video playback. Hence, the Youtube Android Player v3 API[18] is used for incorporating display (including navigation) of videos for the app. A prerequisite to be able to run and use the Youtube API for Android is to have the mobile Youtube app available at version v4.2.16 or later (Developers, 2013). The Youtube Data API has been activated for the project (and is incorporated) as well[19]. Sample code for querying and retrieving information from Youtube's video database by Jeremy Walker[20] has been used and modified by the author to fit this project's purpose. Libraries used to make the YouTube video playback functionality work include: Google API Client Java, Google API Client Android, Google API Services YouTube and YouTube Android Player API.

The proof-of-concept webservice built with the play! framework, compare Section 7.4.7.3 uses the charting library Highcharts.com (Highsoft Solutions, 2013) to display interactive tension curves of patients.

To enable using a light-weight publish / subscribe - mechanism for communication, RabbitMQ (VMware, 2013) is used by both, the Android application and the RESTful play! webservice application. The code parts required to establish a connection to RabbitMQ in the author's framework largely rely (with slight adaptations) on interface implementation as described in a tutorial by Dixon (2013).

7.4.7.2 Architecture

An illustration of the proposed architecture can be found in Figure 7.26. It consists of several parts - the Android clients themselves, RESTful webservices (that are deployed onto a webserver) including a Personal Health Record (PHR) and an Achievement Service (AS), whereas both provide corresponding interfaces. The backend is made up of a MySQL-Database (DB), where the webservices will archive their data to. Additionally, the Android clients communicate with a Social Network (SN) like the online Borderline Personality Disorder community of Pa-

[16] https://github.com/karabaralex/android-comboseekbar

[17] http://stackoverflow.com/questions/14163513/using-youtube-data-api-in-android

[18] https://developers.google.com/youtube/android/player/

[19] The Youtube Data API v3 is a service that needs to be configured from within the Google API console, compare https://code.google.com/apis/console/?pli=1. Therein, all services one's project uses can be either enabled or disabled, whereas a quota limit per day is set for free services. In order to access these services one additionally needs to obtain an API key (activated via one's Google gmail account) that authenticates one's application and registers it with the chosen Google APIs. (Developers, 2013)

[20] https://code.google.com/p/youtube-api-samples/source/browse/samples/java/youtube-cmdline-search-sample/src/main/java/com/google/api/services/samples/youtube/cmdline/youtube_cmdline_search_sample/Search.java

tientsLikeMe by means of an interface they provide. Uploading collected data on the Android clients toward an associated Personal Health Record, and in turn, the Achievement Service relies on HTTP / REST protocols via the Internet, whereas accepted MIME-types are preferably JSON or XML as optional exchange mechanisms.

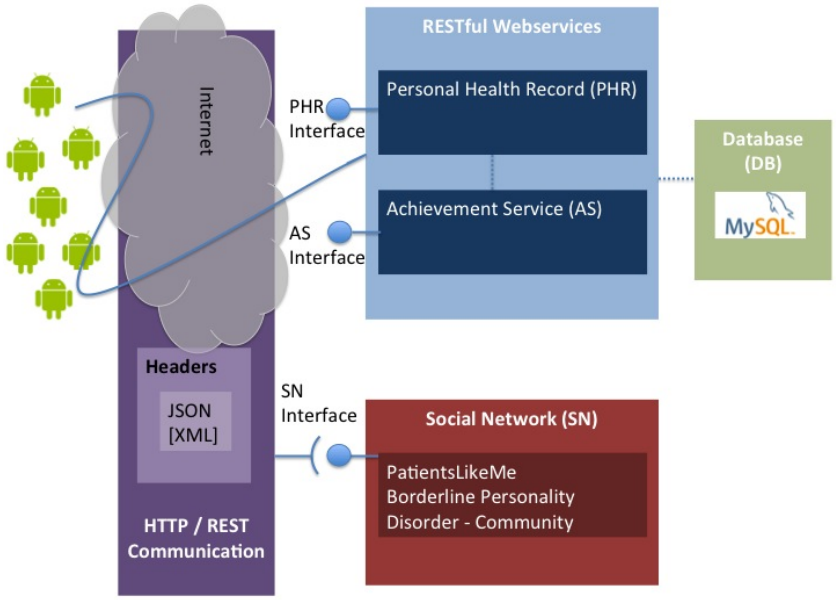

Figure 7.26: The proposed architecture shows how the designed mobile application (depicted by Android clients) fits into the bigger picture. The architecture relies on several components beside the clients, namely, RESTful webservices including the Personal Health Record (PHR) and an Achievement Service (AS) together with designated interfaces, a MySQL-Database acting as the backend and a Social Network (SN) platform like PatientLikeMe's Borderline Personality Disorder community that could be accessed over their API. Network communication between the Android clients and the webserver will be handled via HTTP / REST protocols and JSON (optionally, also XML) exchange messages.

The author states once more that this represents an architecture proposal only and does not reflect the framework's actual implementation. What was actually developed is stated at several places in this thesis, but for the sake of clarity and comprehensiveness it is listed here one more time as follows. Note that network communication does currently work only when the Android application is deployed to the Android emulator, thus, relies on being run at the author's local computer. Interested readers are referred to Appendix C for code snippets:

Android The prototype for the Android application is partly developed. Therein, the notification service (as in mood and tension prompts throughout a day), the individual building of skills / skill management and skills training, the documentation of urges and acts as analyzed from and designed upon interview results, the incorporation of basic and advanced emotion identification levels, the playback of youtube videos from within the app are developed. A section where potentially collected data can be graphed but display an overlay of mood progress and self-injury rely on dummy data. Entered data are not archived to the device, a backend relying on network communication is only partly realized to act as a proof-of-concept. That is, new skills, tension prompts and video achievements (video identifiers) can be transferred over the network from the emulator via HTTP / REST and JSON.

Social The social community support via PatientLikeMe's Borderline Personality Disorder community is a theoretical construct, only.

PHR There is no actual Personal Health Record developed nor attached to the mobile prototype. But, a proof-of-concept RESTful webservice, which represents a Personal Health Record, is developed. It resides at localhost and illustrates that skills, basic achievements and tension prompts can be transferred over the network (from and to Android applications) via HTTP / REST protocol using JSON MIME types. Data in the RESTful webservice do, however, not get archived to a MySQL database, but rather the default in-memory database: *jdbc:h2:mem:play*.

Achievement The achievement service is mostly a design feature in theory, only. Nonetheless, the implementation of the RESTful play! webservice supports to establish video achievements by entering a unique video identifier which links to a corresponding youtube video. Since videos can contain any type of content and could hypothetically easily be created by therapists, they are regarded to be individually tailored to a respective patient. These video identifiers are published to a queue, where an Android client has registered its interest to, by the RESTful play! webservice. The thereupon used publish / subscribe - principle relies on RabbitMQ and is implemented in both the Android client and the RESTful play! webservice.

Database The database used in here is the default in-memory database: *jdbc:h2:mem:play* of the play! framework. However, the modular framework of the concept allows for an easy switch towards including a MySQL database (or any other database for that matter) for future steps since it is only a configuration option in play!.

7.4.7.3 Network communication with RESTful webservice

At its core, a webservice that implements REST focuses on using and addressing resources. RESTful webservices are stateless, use HTTP methods, can transfer XML and / or JSON MIME-types and represent their directories in form of Uniform Resource Identifiers (URIs). Addressing resources over HTTP methods follows the Create Read Update Delete (CRUD) principle. That is, operation POST is equivalent to creating a resource, operation GET is equivalent to querying a resource, operation PUT conforms to updating an existing resource and operation DELETE removes a resource. (Rodriguez, 2013)

A quick-and-dirty webservice using the play! framework[21] has been established, building on the REST architectural pattern. Given the small time limit remaining it cannot be implemented in a sophisticated, neither comprehensive but rather a very basic and simple way. That is, it represents a proof-of-concept prototype of communication between the RESTful webservice - running at http://localhost respectively http://10.0.2.2[22] - and the Android emulator.
For a quick reference of the prototypical proof-of-concept implementation compare figures as follows:

- Figure 7.27 lists all skills available that were either archived by a user via their Android application or generated by a therapist. Each skill from the "distress" or "stress tolerance" module will then be queried by the Android application to act as an interventional skill upon high tension or an urge to self-injure.
- Figure 7.28 displays the data stemming from a user's reported tension prompts that are regularly displayed to their cell phone. These objects are stored in the play! webservice and displayed to interested therapists in form of a tension curve. To that extent, the

[21] http://www.playframework.org
[22] The Android emulator confuses localhost with itself, which is why localhost needs to be addressed as 10.0.2.2 when initiating a connection from the emulator.

charting library Highcharts.com is used to enable interactive display (Highsoft Solutions, 2013). Compare also Listing 7.1 for an excerpt of the implementation within the play! framework.

- Figure 7.29 tries to show the interaction between the play! framework and the Android client. The play! webservice uses RabbitMQ to publish a youtube video identifier - as in a video achievement - to a topic queue the Android client is listening to. The mobile application in turn consumes the achievement, stores it in its SharedPreferences and displays the youtube video in the recently-gained-achievements-screen of the application.

```
@(tensions: List[Tension])

@import helper._
@import helper.twitterBootstrap._

@main("Graph Tension", nav = "tension") {

<h1>Tension curve</h1>


<script type="text/javascript">

$(document).ready(function() {


  var tensiondata = new Array()
  var tensiontimestamp = new Array()

  var i = 0;
  @for(tension <- tensions) {
    tensiondata[i]=@tension.tensionValue;
    tensiontimestamp[i]=new Date(@tension.timestamp)
    i=i+1;
  }

    var chart1 = new Highcharts.Chart({
       chart: {
          ...
       xAxis: {
         type: 'datetime',
         dateTimeLabelFormats: {
               day: '%e. %b',
               hour: '%H:%M'
          },
          categories: tensiontimestamp
       },
       yAxis: ...
       series: [{
          name: 'Patient A',
          data: tensiondata

       }]
    });


 });
  </script>
  ...
}
```

Listing 7.1: Excerpt from *graphtension.scala.html* which used to display collected tension prompt data.

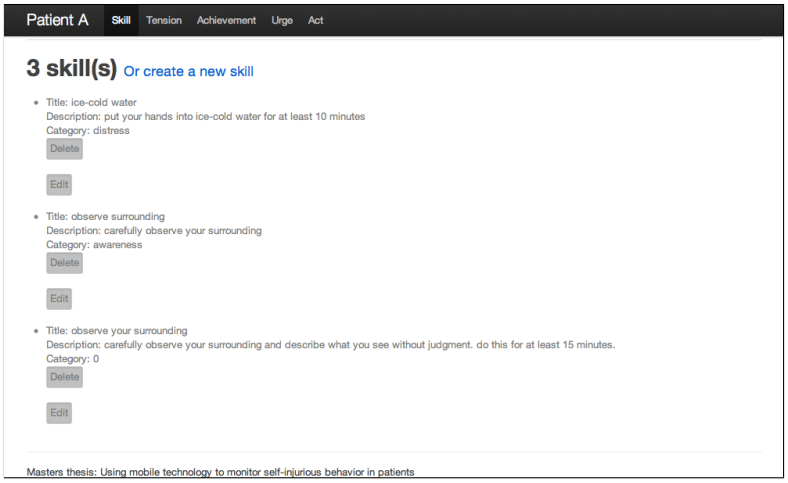

Figure 7.27: A list of skills as archived from the Android application and as established from within the play! proof-of-concept webservice application.

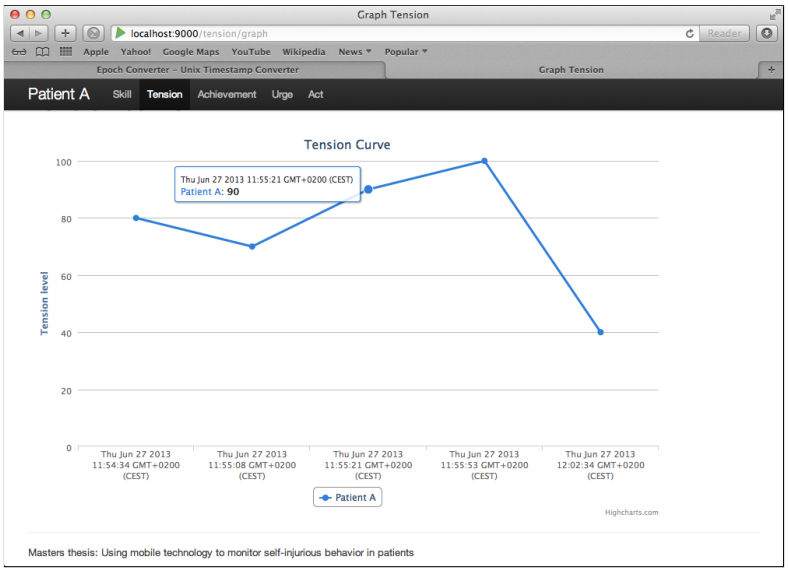

Figure 7.28: The tension curve which is implemented using Highcharts.com. The relevant data displayed stems from reported tension prompts from within the Android application.

Based on above figure, one can see that resources like skills, achievements and tension objects are successfully created (and transferred from the Android emulator) and can also be retrieved from the webservices for access or display to the Android emulator, thus, device. An implementation of the remaining resources would follow the exact same pattern and is, hence, not coded further in the proof-of-concept prototype webservice.

Upon starting the play! application using the command

```
play -DapplyEvolutions.default=true run
```

the default *jdbc:h2:mem:play* (internal memory) database gets connected to the application. Subsequently, the webservice which communicates with the Android emulator is represented by the URI http://10.0.2.2:9000/<resource>/<operation>. Once a valid and authenticated connection between Android app and play! webservice is established, the app requires following resources to enable proper communication: user, urge, act, skill, tension, training, tokencollector, storyline, videoplayback, etc. conforming to the ERD in Section 7.4.6.2.

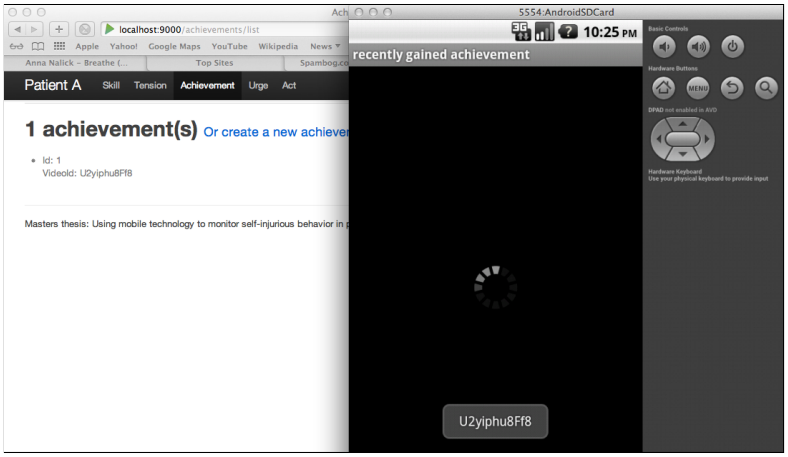

Figure 7.29: A recently generated achievement is displayed in the play! webservice application on the left. The value of the videoId parameter gets published to a message queue by using RabbitMQ. It is then consumed by the Android application on the right hand side. The application in turn displays the value retrieved and queries the youtube server for video playback from within the app.

7.4.8 Design patterns and code snippets

Technological design considerations and patterns used include - amongst others - a publish-subscribe model for delivering messages and push notifications to repeatedly prompt the user for data input.

7.4.8.1 Publish / Subscribe - Principle

In order to facilitate electronic communication between therapist (via the web application) and client (via the Android client) a publish / subscribe - principle will be used. Thus, draining the battery way too quickly and wasting many resources by repeatedly querying the web application, so-called pull requests, for new data or information can be avoided (or at least diminished). One way to design a publish / subscribe mode for eased Android network communication is to use RabbitMQ as a broker. RabbitMQ[23] - which is some kind of lightweight Java Messaging Service (JMS) mechanism - is said to be working with Android and could, thus, easily incorporated with the entire framework. RabbitMQ is based on the Advanced Message Queuing Protocol (AMQP)[24]. In addition, RabbitMQ could easily be incorporated into the play!framework, which is the framework of choice to building a web application more easily within this thesis[25]. A publisher is known as the producer or originator of a message that needs to be broadcast to one (or many) registered receivers. For a schematic design of such a topic queue compare Figure 7.30 (Figure is taken from VMware (2013)). The message will be forwarded to a queue that is bound to a certain topic, waiting there to be consumed. The receivers, in turn, need to register their interest into whatever will be in store for them eventually by subscribing to a topic. As soon

[23] http://www.rabbitmq.com

[24] AMQP - a so-called wire-level protocol - is an open standard to delivering business messages, read more at http://amqp.org.

[25] However, and what has been stated in Chapter 1 already, the built web application will represent more of a proof-of-concept prototype for the scope of the thesis centers on requirement analysis and design of an Android application (without actual fully functional implementation) demanding a lot of time and work effort per se. Additionally, the adherence to the IKIWISI approach made along-side building of a prototype necessary, whereas constant refinement was yielded to support communication and understanding from a psychological perspective. Also, designing and developing software running on smartphones calls for a great deal of preliminary training and learning-on-the-job because patterns and concepts are different compared to development of web applications.

as a message gets published to a topic queue, all registered subscribers are informed and can subsequently, consume the message that was posted.

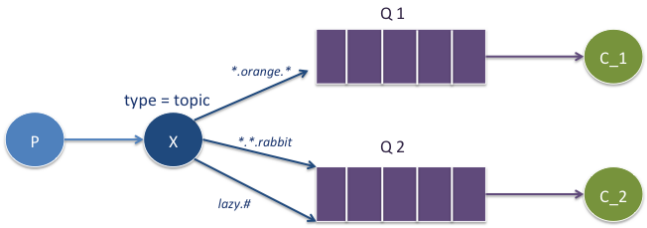

Figure 7.30: A producer P issues a message with a certain topic to its corresponding topic queue, where it is readily accessible by its designated subscribers, respectively, consumers C_1 and C_2. Figure taken and adapted from VMware (2013).

This is regarded a preferred solution for mobile devices for it conserves battery life. A mobile application will only "query" the web server for information if there is something to fetch. Otherwise, it will not waste energy or battery life to query the web application. A proof-of-concept orchestration of the play! framework web application and RabbitMQ to communicate with Android using a simple producer / consumer pattern was established. As described in Section 7.4.7.2, video achievements - as in video identifiers, which are newly generated from within the proof-of-concept webservice by the therapist - are placed in an exchange queue, where the Android application has registered its interest to. The latter is in turn notified upon arrival of new information and stores the corresponding video identifier in the Android application's preferences for later playback of the actual youtube video that is associated with the identifier. To that extent, the corresponding RabbitMQ libraries need to be included in the web application source as well as the Android application. Additionally, after the web services are up and running one needs to start the services of the RabbitMQ server. This is done with the following two commands:

```
start service: sbin/rabbitmq-server -detached
stop service: sbin/rabbitmqctl stop
```

Furthermore, the author states that this proof-of-concept orchestration using RabbitMQ is currently only working when the application is deployed to the Android emulator, thus at the author's local computer.

7.4.8.2 Push notification

Integrating ESM into the smartphone solution is established by tension prompts who "beep at" the user several times during a day. The number of times these notifications are fired can be setup by the therapist or by the patient himself. The period during the day where it is ok be bothered by alerts can be set by the user as well. For that matter, windows during the day are calculated which act as a condition for a notification to be triggered. The notification then in turn shows up regardless whether the app is currently open / in use or not.

So-called Broadcast Receivers are a fundamental component of the Android SDK to take care of delivering notifications to the user (Android, 2012). A Broadcast Receiver registers for a specific Intent (which is simply "a bundle of information") at the Android application. Only if the registered Intent or action is about to take place, the Broadcast Receiver will become "activated". This can be understood as an Android built-in publish / subscribe - pattern. (edureka.in, 2013)

For the Android application two Broadcast Receivers are in use:

- *MyNotificationReceiver*, and

- *MyAlarmRegistration*.

MyNotificationReceiver. The class *MyNotificationReceiver* - compare Listing 7.2 - comes into action every 15 minutes; an Alarm Manager takes over this task to "wake up" the application and prepare a CPU wake lock until the receiver has finished its work. In order to avoid that a user can exactly forecast when a new notification gets triggered and, thus, already prepare their answer to the tension prompt, the Alarm Manager is set to use an inexact-repeating style. That means, that a CPU wake lock is not triggered at the exact top of every quarter which is beneficial regarding a device's battery power. Depending on the given number of tension prompts to be triggered per day, *MyNotificationReceiver* calculates and checks upon available notification time slots based on a user's set daytime preferences. If a new notification is due - current time is within a time window (and a previous notification within this time slot was not issued), MyNotificationReceiver is responsible for setting up a notification based on class *TensionActivity* and several other parameters like how to draw the user's attention to the fact that a new notification has arrived, without disturbing them too much. In this case, a simple VIBRATE pattern was used. Also, if an older notification was not processed (neither cleared nor answered by the user) while a new notification is already issued, it is not piled on, but rather replaces the deprecated notification with the new one. They are distinguishable via their timestamps. This notification object is then handed over to the Notification Manager which in turn actually issues the notification.

```
package midfi.nssi.services;
...
public class MyNotificationReceiver extends BroadcastReceiver {
  ...

  @Override
  public void onReceive(Context context, Intent intent) {

    /* calculate intervals
       check if current time is within actual window
       trigger notification
       set next alert time for notification
    */

    ...

    NotificationManager notifyManager = ( NotificationManager ) context.↩
      getSystemService( Context.NOTIFICATION_SERVICE );
    Intent notifyIntent = new Intent( context, factory.getTensionClass( ↩
      gameLevelIdx ));

    notifyIntent.setFlags(Intent.FLAG_ACTIVITY_NEW_TASK | Intent.↩
      FLAG_ACTIVITY_CLEAR_WHEN_TASK_RESET);
    PendingIntent notifyPI = PendingIntent.getActivity( context, 0, ↩
      notifyIntent, PendingIntent.FLAG_UPDATE_CURRENT );

    NotificationCompat.Builder notifyBuilder = new NotificationCompat.↩
      Builder( context );
    notifyBuilder.setSmallIcon( R.drawable.ic_orange );
    notifyBuilder.setContentTitle( "Tension prompt" );
      notifyBuilder.setContentText( "How do you feel?" );
    notifyBuilder.setWhen(System.currentTimeMillis());

    notifyBuilder.setContentIntent( notifyPI );
        Notification notify = notifyBuilder.build();
        notify.defaults |= Notification.DEFAULT_VIBRATE;
      notify.flags |= Notification.FLAG_ONLY_ALERT_ONCE | Notification.↩
        FLAG_AUTO_CANCEL;
```

```
    //give an identifier for notification
34      notifyManager.notify( 0, notify );

36      ...

38  }
}
```

Listing 7.2: Excerpt from *MyNotificationReceiver*

MyAlarmRegistration. Additionally, proper handling of the Alarm Manager needs to be taken care of in case the phone is shut down sometimes. Hence, an additional Broadcast Receiver needs to fetch previously stored information about an upcoming notification and be again set up with an Alarm Manager that repeatedly wakes up the device from whatever state it is in (except in shut-down-mode) and prompt the user with an alert. Besides implementing the code for the Alarm Manager, the app ought to know at what point in time the Broadcast Receiver, respectively, Alarm Manager should be triggered. This is achieved by "manipulating" the Android Manifest file. The permission *RECEIVE_BOOT_COMPLETED* needs to be explicitly declared, whereas the Intent filter with the *BOOT_COMPLETED* triggers the receiver *MyAlarmRegistration* to be run, compare Listing 7.3.

```
1  <?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
3      package="midfi.nssi"
       android:installLocation="internalOnly"
5      android:versionCode="1"
       android:versionName="1.0" >
7
       <uses-sdk
9          android:minSdkVersion="8"
           android:targetSdkVersion="17" />
11
       <uses-permission android:name="android.permission.VIBRATE" />
13     <uses-permission android:name="android.permission.↩
         RECEIVE_BOOT_COMPLETED" />
       <uses-permission android:name="android.permission.INTERNET" />
15
       <application
17         android:allowBackup="true"
           android:icon="@drawable/ic_launcher"
19         android:label="@string/app_name" >
           ...
21         <receiver android:name="midfi.nssi.services.MyNotificationReceiver"↩
              />
           <receiver android:name="midfi.nssi.services.MyAlarmRegistration" >
23             <intent-filter>
                   <action android:name="android.intent.action.BOOT_COMPLETED"↩
                      />
25             </intent-filter>
           </receiver>
27
       </application>
29
</manifest>
```

Listing 7.3: Parts of the *AndroidManifest.xml* illustrating the registration of the receiver *MyAlarmRegistration*.

7.4.8.3 Factory pattern and Singleton usage

Letting people enter information about their emotional state of mind is based on their respective ability to identify emotions according to the established requirements. The prototypical implementation takes care of this by using the *factory pattern* (Tarr, 2013). That way, a factory becomes the "man in the middle" to decide which actual class will be delivered to the app based on user's preferences. It is a modular concept which ensures that further abstractions of classes or entities can be used without requiring too many code changes at different places. Furthermore, each aspect of the system which needs the "emotional part" does not have to know anything about its actual structure. Instead, it simply delivers its request to the factory which takes over the role of the "know-it-all-person" and returns the right object to be used, compare Listing 7.4. Furtheron, to ensure that no multiple instances of the factory itself are invoked, it is designed according to the Singleton pattern following eager instantiation (Geary, 2003), compare Listing 7.5.

```
public class MyNotificationReceiver extends BroadcastReceiver {

  private SharedPreferences prefs;
  private int gameLevelIdx; //holds the emotion level that was set by the user and stored in SharedPreferences

  // get singleton instance of TensionFactory
  final TensionFactory factory = TensionFactory.getInstance();

  @Override
  public void onReceive(Context context, Intent intent) {
    ...
    // retrieve emotion level from SharedPreferences
    gameLevelIdx = prefs.getInt( Constant.GAME_LEVEL_IDX, -1 );
    // pass emotion level on to TensionFactory to invoke the correct class for building a tension prompt
    Intent notifyIntent = new Intent( context, factory.getTensionClass( gameLevelIdx ));
    ...

  }

}
```

Listing 7.4: Snippet from *MyNotificationReceiver* illustrating the usage of a factory that determines the right Tension activity to be used for the tension prompt.

```
package midfi.nssi.screens;

import midfi.nssi.R;
import android.util.SparseArray;

public class TensionFactory {

  private final static TensionFactory mFactory = new TensionFactory();

  private static SparseArray<Class<?>> tensionClasses; //SparseArray is said to be more efficient than HashMap

  private TensionFactory() {
    tensionClasses = new SparseArray< Class<?> >( );
    tensionClasses.put( R.id.radio0, TensionActivityBasic.class );
    tensionClasses.put( R.id.radio1, TensionActivityAdvanced.class );
  }

  /**
```

```
    * returns a singleton instance of tensionfactory
    * @return
    */
  public static TensionFactory getInstance() {
    return mFactory;
  }

  /**
   * registers new tensionclasses within the tensionfactory
   * @param idx
   * @param c
   */
  public void registerTensionClasses(int idx, Class<?> c ) {

    tensionClasses.put( idx, c );

  }

  /**
   * retrieves the corresponding tension class needed depending on the ↩
     gameLevelIndex
   * that was chosen within the application
   * 0... basic emotions with facial expressions
   * 1... advanced emotions with emotional scales
   * @param gameLevelIndex
   * @return
   * @throws ClassNotFoundException
   */
  public Class<?> getTensionClass(int gameLevelIndex) {

    return tensionClasses.get( gameLevelIndex );

  }
}
```

Listing 7.5: *TensionFactory* demonstrating its usage of Singleton pattern with eager instantiation.

7.4.9 Limitations regarding prototypical development

One limitation which needs to be mentioned since interview results revealed data privacy and security is that login functionality and relevant authentication is not provided in the current implementation of the framework. Neither was it feasible to develop the functionality that is responsible for pairing one's Android application, thus, device with the corresponding EMR / PHR nor introduce secure data transfer by encrypting (and in turn decrypting) information. The fact that these aspects were not implemented does not render them any less important, rather it was a mere decision of limited remaining time. In fact, functionality to ensure data privacy and security is crucial if an application like that is actually developed and put into practice, hence, rendered an obligatory requirement for future references.

8 Discussion

"It is better to recognise that we are in darkness than to pretend that we can see the light."

— Hedley Bull, *The Anarchical Society: A Study of Order in World Politics*

As this thesis has made quite some progress in knowledge and definitely pages, it is about time to discuss what has been learned overall about the project's relevance and its actual use in therapeutic work settings in practice.

The problem description given in the introduction, compare Chapter 1, mentioned the problem of paper diary cards or paper-and-pencil journals that are commonly used in therapy with Borderline and self-injurious patients, but have certain drawbacks. Among these falsifiable information and issues regarding recall bias once having to remember certain situations or conditions after the actual event had happened a long time ago were described. Potential benefits as follows were mentioned when having electronic diary tools at hand:

- possibility to reduce recall bias by allowing information to be entered at the time and place where they occur,
- providing therapist with information as to what their patient is up to in-between therapeutic session, thus, support their work,
- intervene when moments of distress may lead to self-injury in patients.

But to the best knowledge of the author, electronic tools to monitor and context-sensitively intervene or interact with a user, observe behavioral progress over time were stated to be lacking. Hence, the project focused on taking initial steps towards making a transition from paper to electronic diary cards happen. At its core, the project was about interviewing psychologists, psychotherapists, psychiatrists and researchers as experts in the field. Based on the feedback gained from experts, software requirements could successfully be established which try to incorporate the "general vibe" when opinions varied and includes requirements where inter-personal agreements were detected.
Along with the building of requirements, a prototypical implementation for an Android app was initiated. The latter then evolved by including newly found and modified requirements after each interview stage. As far as concept system design is concerned, a proposal for an architecture which is about embedding an Android app in a larger framework including RESTful webservices, EMR / PHR, social networking sites was illustrated. Additionally, Use Cases and workflows were modeled in UML and an entity relationship diagram was established. On top of that, the author reasoned about data exchange format, reasonable and relevant design patterns to be used for an implementation as well as necessary libraries to ensure a corresponding functionality. As one of the final steps, implementation was enhanced after all interviews had been analyzed and interpreted to develop a basic proof-of-concept RESTful webservice, include an interface to transfer collected data in JSON format from an Android phone (better said, the emulator) to the play! webservice and use a messaging library, namely RabbitMQ, to realize a publish / consumer pattern to avoid constant polling of new data. For a cell phone, this would have been too intense in terms of resource consumption.

In addition, the author emphasizes that two papers presenting the work done in here are currently prepared for submission to either scientific conferences or journals.

8.1 Psychological aspects

Since so many different aspects came up during the interview process throughout this project that one could reason about, a few of them are discussed in more detail. Each paragraph is labeled with a "one-phrase-description" of what it is about and includes a quick and condensed reflection on results, outcome and / or future steps relating to the project:

Focusing on self-injurious behavior. Although the herein designed project was built around the concept of NSSI, i.e., self-injurious behavior with the deliberate intent to harm one's bodily tissue by cutting, self-battery, carving, burning and so forth (Nock, 2010), it may as well be adapted to include any behavior that is maladaptive. This becomes especially evident since the target population of people with Borderline Personality Disorder involves a range of high-risk, harmful or parasuicidal behaviors. For instance, drug abuse, going by car at a very high speed, promiscuity frequently occur in BPD (besides NSSI itself as described in the introductory chapters). That is, an applicability of the app is for sure not limited to NSSI, it only serves as an example.

Tension and skill intervention. An important finding was that tension is an equivalent of emotion for patients with Borderline Personality Disorder. Hence, Borderline people are "trained" or encouraged to identify and rate their respective level of tension during therapy. Representing an item to rate tension within the app as a stepless color-coded scale then revealed that tension is rated in steps of 10 on a scale from 0% to 100% in reality, and should thus be modeled in the prototype. In addition, suggestions were made to adapt skill interventions to the respective tension level a patient is at. Also, tension and skill intervention should be an alternating pathway until an acceptable tension for a patient is reached.

Skills modules. Besides Linehan's skills modules, it seems to be common practice to divide them further into categories like situation, thought, emotion, movement or location. Due to the author's lacking background in psychology or psychotherapy as such, she felt unaware of any potential difference between official skills modules and commonly established ones. This means, that the question remains as to how Linehan's skills modules interact or maybe even differentiate themselves from categories like motor / situation / thought / action / movement / location skill. In the author's opinion it might even be possible that therapeutic work relies much more on practical classification of skills (like sensoric, motoric, etc.) than on the structure that is provided by the traditional approach of DBT. Future work will definitely need to investigate in that area.

Location. Collecting the location where a patient is at while being struck with an urge to injure came up during some of the very first interviews. It then seemed that it was not all that relevant after analyzing several interviews more. It thus led further to the decision to not consider location-based-services as an option for the app. However, in retrospect, after having talked to 18 different experts on the topic there might be something to knowing one's location after all. In particular, when skills are selected for intervention, which do not only need to be individual, but also seem to be highly specific regarding situation and location. For instance, it makes a huge difference as to what skills may be applied when one is at work versus one being at home. While it seems a bit unrealistic to model situation- and location-specific interventions with the app, it may be worthwhile considering it or at least further researching on including it for future development.

Level of detail. The introductory chapters presented a quite comprehensive list of self-injurious behavior details that are nice to be known or further researched on. These were used as a primary

basis to inform the design of the app in terms of parameters to be collected. Amongst others, a primary motivation for doing this thesis was to build an electronic journal to reduce things like recall-bias or falsifiable information. As it turned out, and as one interview partner so elegantly put it "the self-injury like the method and tool that were used is not among the things that people forget" (with many more who agreed with her on this topic). The author also does not clearly remember how many times one was confronted with questions like "why do I need to know that? what is the purpose in getting such detailed information?" towards statements like "there is a danger of having people stuck in this behavior because they have to describe it in such detail". However, without testing one may not really know what's going to happen in patients' minds of what outcome it may yield.

Keep it simple. "Keep it simple" is a phrase which came up more than once during the empirical part of this entire project. It is very much understandable and it makes a lot of sense. Keeping things simple is what helps us stay focused and motivated regardless of whatever it is we are talking about. But then again, how can one actually manage to make something simple and have it simultaneously reflect real life conditions as much as possible? Paradoxically, keeping it simple is a hard and complex task by itself. In theory, it should be a straight-forward process, keeping and designing things in a simple way aims to ease things up and if one were to think too hard about how to keep something simple, it would already yield a result that is, in turn, too complex. All in all, satisfying both requirements of keeping things simple, refrain from overloading an app with too many features and yet still provide a somewhat realistic and comprehensive representation of real life to make it useful and beneficial and embeddable for therapeutic processes is a balancing act in itself.

Actual use in therapeutic settings in practice. Talking to all these experts in the course of the thesis revealed that it is of utmost importance to think and come up with a point and time where an app like this is likely to best fit in (to yield the most benefit) into the therapeutic process. That is where psychological behavior change models come into play, compare Section 2.4 for a quick introduction and discussion of their relevance for the IT sector. Thereby, the Transtheoretical model seemed to be the most promising to answer the question of when and how to use an app as a supplement for therapy.

For a quick recap, the TTM offers six stages (precontemplation, contemplation, preparation, action, maintenance and termination), whereas patients bear different stages of motivation within each. (Refer to Prochaska (2008) for a detailed overview on the Transtheoretical Model and its properties.)
The app is not regarded useful or beneficial for patients in the TTM's early stage of precontemplation because they lack the necessary motivation and are termed resistant to therapy. Thinking about the current concept of the app, it is not likely to be capable of behooving the patient into a stage of higher motivation all by itself. The following stages labeled "contemplation" and "preparation" are better suited for a patient to be working with the app. Both phases carry some sort of motivation by the patient to do therapy, to change, to at least become active in the upcoming future. In the author's opinion, contemplation stage may even be preferred since it is linked to ambivalent feelings towards a behavior (that one wants to change) (Prochaska, 2008) and resembles the diagnostic categories of ambivalence of the Borderline target population. Still, it is known that the TTM does not progress linearly and patients can jump back and forth (Prochaska, 2008). That is, a person in the termination phase may indeed be likely to fall back into an early stage like precontemplation depending on life events or circumstances. Therefore, motivational cues are still warranted in case the patient's intrinsic motivation is somehow lowered.

Trials. Performing a trial or if a trial was planned for this project was a common topic among conversations. The author is proud to admit that networking partners were suggested that might

very well be in for a trial, as well as that one institution indeed suggested to initiate a close cooperation including a trial after actual prototype (and framework) development. At the moment, it is in the blue, if this trial is about to really happen, but the author takes it both as a compliment of having found and devoted herself to a topic that is on people's minds and matches with peoples' plans or interest and as a statement that therapists and researchers, one has to say, are indeed interested in working with such a solution or delivering such a solution in the present (or at least the close future).

Time and work effort. Interviewing 18 people requires much dedication both in time and work effort. Not only do interview partners have to be found first, but each single interview, especially at the beginning, at the end and once new questions are to be asked is to be carefully prepared. More than that, it is even more relevant to focus and listen carefully, so as to understand the interview partner and not distract the flow of the conversation. Furthermore, 18 interviews bring with them a very large amount of data, concepts, themes that are grounded in the material per se. The iterative design makes a lot of sense when one does not exactly know which direction a project is headed to, especially when people come from different professions. On the other hand, it also accounts for a bigger work-load since the analysis result of one iteration feeds as an input to the next stage. The alongside implementation and refinement of a prototype which is an important companion to support interviews, puts additional pressure on project investigators due to strict time schedules.

Interviews without borders. The interest in and willingness of experts to support this project by dedicating their time and sharing their expertise is highly appreciated. The author is happy to say that their interest and support did not come to an end at the Austrian border, furthermore spread over to yield participation from experts residing in Germany and even the United States. It is taken as evidence that the overall concept is not that far off from reality and, thus, may become or maybe already is very much relevant for practical clinical work per se.

Missing target group. Talking to one specific group of stakeholders which is affected by the project was deliberately left out, namely the patients themselves. Several reasons can be mentioned for doing so:

- The topic is a very sensitive one.
- The author had little knowledge of the entire area of self-harm, Borderline Personality Disorder or Dialectical Behavior Therapy.
- The general focus of the project was on perception of therapists and their requirements for an application to support therapeutic work.
- Borderline Personality is a complex disorder and much more experience, sensitivity and knowledge in the psychological area would have been a definite requirement of an interviewer to ask questions about triggering content without doing any harm.

However, at least two people mentioned that talking to Borderliners would shed light into certain questions. Therefore, it is not surprising that doing an actual trial with Borderline patients was recommended. That indicates that talking to patients and performing a trial is marked for future development of the project.

8.2 Technical details

A few details regarding design and implementation of the app and its surrounding framework are discussed in this section.

Architecture. Having an EMR / PHR attached to the Android client is a main component of the entire framework architecture. At the end real EMR / PHR functionality could not be provided with the prototype for reasons of limited time and much additional work effort. During the project Indivo X[1], an open-source personal health record platform, was recommended for inclusion in this project since it is said to be easily configurable and offers sophisticated functionality. Therefore, using an existing PHR software package was indeed considered, but its installation process required a long list of steps to be taken, yielding a variety of additional packages and dependencies to be installed. This posed certain challenges with the outcome that the author simply failed to get Indivo X up and running somewhere along the line. Hence, the author decided to choose the play! framework and adapt / develop an application accordingly so that it may represent the EMR / PHR component. Reasons for doing so are grounded in the unsuccessful installation or configuration of Indivo X coupled with the fact that the author had some experience with play! from a previous project. Thus, the play! application developed is regarded a proof-of-concept prototypical implementation which illustrates core functionality but is not built in a sophisticated or comprehensive manner.

Framework implementation. As stated in previous chapters of this thesis, developing a fully-functional Android application, notwithstanding embedding it in an orchestration of an entire framework including RESTful webservice application and messaging protocols was not feasible during this project. The main reason for being so is that the focus of this project was on:

- bridging the gap between two fields that are nothing alike but may benefit so much from collaboration,
- conducting face-to-face interviews with experts, and
- first of all gaining inside knowledge into actual challenges and issues of a complex personality disorder,
- in order to design requirements and establish relevant Use Cases for a mobile electronic diary to support both therapists and patients in their work together and possibly prepare for behavioral change in patients.

Hence, it shall be stated here one more time that data privacy and security aspects were indeed considered during designing the application. Also, a complete implementation of data communication with the RESTful webservice was planned. However, a project like this which involves getting to know another area requires thorough preparation as well as dedication in both time and work effort to first conduct, then analyze and figure out the greater meaning of each one of the total number of 18 interviews and therein said topics, does not leave one with much more time to also provide a comprehensive and nicely-designed framework implementation. In fact, from the author's perspective, putting all these segments into action was too eager and complex of a plan for one diploma project but would have deserved to be seen in a bigger scope, or at least, to be processed by more than one person.

8.3 Future steps

What is left is a quick overview on future steps to be taken to take this project further:

- build a stronger focus on including gamification, thus a rewarding system, to motivate using the app and taking steps towards an increased well-being,

[1] http://docs.indivohealth.org/en/2.0/

- investigate further in the topic of real-time data collection and display to the therapist,
- center on the question what therapist think of possibilities to individually tailor achievements to their patients upon seeing their behavioral patterns,
- include an achievement service to administer the individual establishment of rewards,
- include social community support for the app,
- finish off the development of the framework including:
    1. authentication and login mechanisms,
    2. pairing of the app, thus, device and the webservice,
    3. include encryption / decryption mechanism to ensure secure data transfer,
    4. replace the in-memory play! database with a persistent archiving component, like MySQL database or alike,
    5. deploy the webservice to a live URL after development is completed.
- talk to the stakeholder which have been left out of this process so far, namely Borderline patients,
- start a cooperation with an institution or clinic that has relevant experience, and
- prepare and perform a trial to see if there is something to the entire concept of transforming paper journals towards mobile media, thus, empowering patients in their self-reflection and interaction with themselves and strengthening therapeutic relationships with it.

Overall, one can say that it is never easy to find a compromise when talking to several people. Also, including every topic that came up during the conversations is close to being impossible. As a result, the way certain things are included in the prototype or established as requirements may not entirely reflect one's personal opinion. Nonetheless, the author feels that the outcome meets the "general vibe" and reasoning from all those many interviews to an extent that is perceived ok regarding this early stage of such a project and regarding the little things that were actually known upon its kick-off.

Having said all that, the scene is left in favor for William James, who once brought it to the very point, in his work "What is an Emotion?" from way back in 1884 and which accounts for the perfect closing argument of this thesis:

> *It is a real intellectual delight to get a problem solved, and a real intellectual torment to have to leave it unfinished.*

A Additional concepts

This chapter outlines additional results, such as demographics, concepts and themes that have not been covered in the *Results chapters* already (compare Chapter 7.1, Chapter 7.2 and Chapter 7.3). It is structured into demographics of the entire sample of interview partners, as well as the different phases of the research design, interview rounds I, rounds II and rounds III.

A.1 Demographics - entire sample

Demographical information about the distribution of therapeutic approaches, the kind of affiliation (based on a four, respectively, five items assessment) and whether electronic health records are in use are illustrated in this section (wherever the data were available or provided by the interviewee). The entire sample of interview partners (n = 18) was considered upon generating below charts:

- Figure A.1 illustrates the distribution of therapeutic approaches used.
- Figure A.2 reveals the percentage of EHR or other relevant documentation system usage regarding the sample population. One interviewee indicated both answers yes and no and has thus also been included in the chart.
- Figure A.4 delineates the various types of institutions interview partners are affiliated with, whereas multiple answers were possible.
- Figure A.3 gives a rough insight into how many years of expertise interviewed partners have in their given latest capacity from the questionnaire.

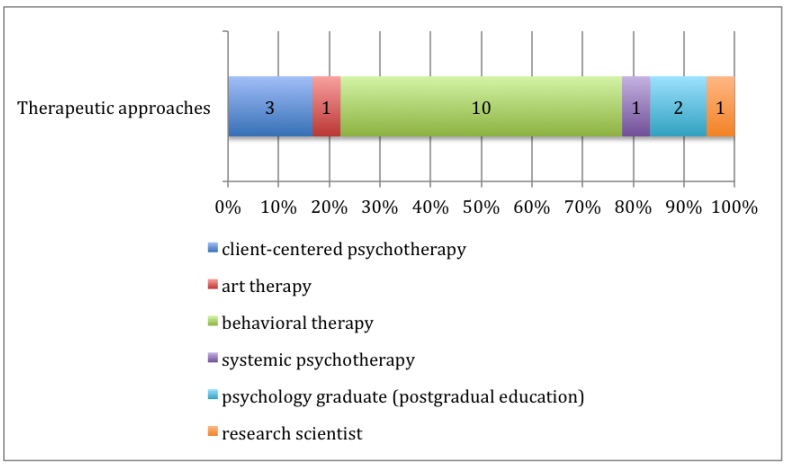

Figure A.1: Distribution of therapeutic approaches used by interview partners, based on the entire sample of n = 18 interviews.

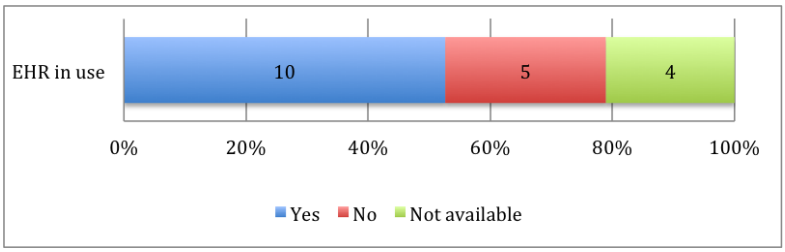

Figure A.2: Overview on whether interview partners use EHRs or some sort of documentation system based on the entire sample of n = 18 interview partners.

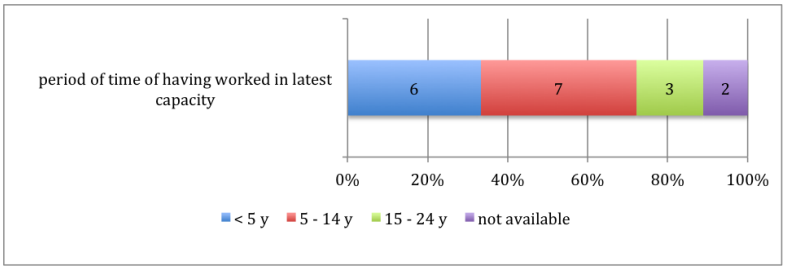

Figure A.3: Overview on the distribution with respect to years of expertise of interviewed people at their most recent capacity given in the questionnaire based on the entire sample of n = 18 interview partners.

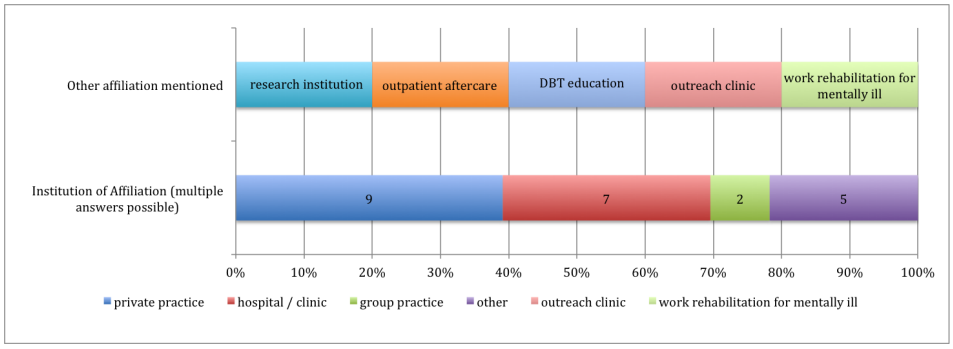

Figure A.4: Distribution of type of institution or practice interview partners are affiliated with based on the entire sample of n = 18 interview partners. The data were collected based on a four-, respectively, five-point item basis. Several professionals indicated to work at more than one institution which has been accounted for in this chart.

A.2 Interview rounds I

This section is about illustrating additional concepts that are deemed important in order to design the app in question. Codes and descriptive instances in here are linked to the person who mentioned via their alias. If no alias is given, it came up during several interviews and is, hence, not explicitly stated. By no means do they reflect a comprehensive overview on *all* concepts that were found in the data as such. Also, only data material from pilot phase and interview rounds I was used to establish these results:

- Table A.1 talks about relevant parameters for the app upon using it as a tool for intervention,
- Table A.2 shows characteristics of NSSI as described by early interview partners, and
- Figure A.5 illustrates the sub-categories which also belong to the concept of NSSI characteristics but are found to comprise a whole range (dimension) of properties. That is the reason why these sub-categories are depicted as sliders, where corresponding end-points mark extrema. Properties all along this line have been found in interview material.
- Figure A.6 presents types of self-harm that are associated with (but not necessarily restricted to) NSSI, Borderline and their high-risk behavior and which are encountered by interview partners in their professional life. These results do not seem to fit into Chapter 7 since they may not yield much benefit to the purpose of the mobile application per se. Nonetheless, compared to the magnitude of different "faces" self-injurious behavior can put on - which is discussed in literature and illustrated in Chapter 2 of this thesis - the author feels that it is interesting to hear about methods which are used in practice. Also, it seems, that the severity and form how an self-injurious act is performed accounts for the comorbidity or disorder which is present.

Intervention (app)	
$Sub-category$	$Properties$
Intervening point in time	urge to self-injure (regardless of its intensity)
Intervening point with respect to tension	high amount of accumulated tension
Identification of individual alternatives	need for exploring what might work and what might not/what works and what doesn't for a person
Provision of individual alternatives	need for them to be tailored to the individual
Identifying a person's ability to comprehend and apply an alternative	in what state of mind, stability, what stage of therapy should a person be in in order for an ability to unfold its functionality?

Table A.1: The concept of intervention within the app, which is described by several sub-categories and their defining properties; pilot + interview rounds I.

NSSI characteristics	
Sub − category	*Properties*
Varying intensity and character or function depending on context of the disorder	-
Situational interpretation	-
Frequency	number of times per day, week
Number of methods applied	-
Necessity of emergent medical intervention	yes, no

Table A.2: The concept of NSSI characteristics, which is described by several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-categories; pilot + interview rounds I.

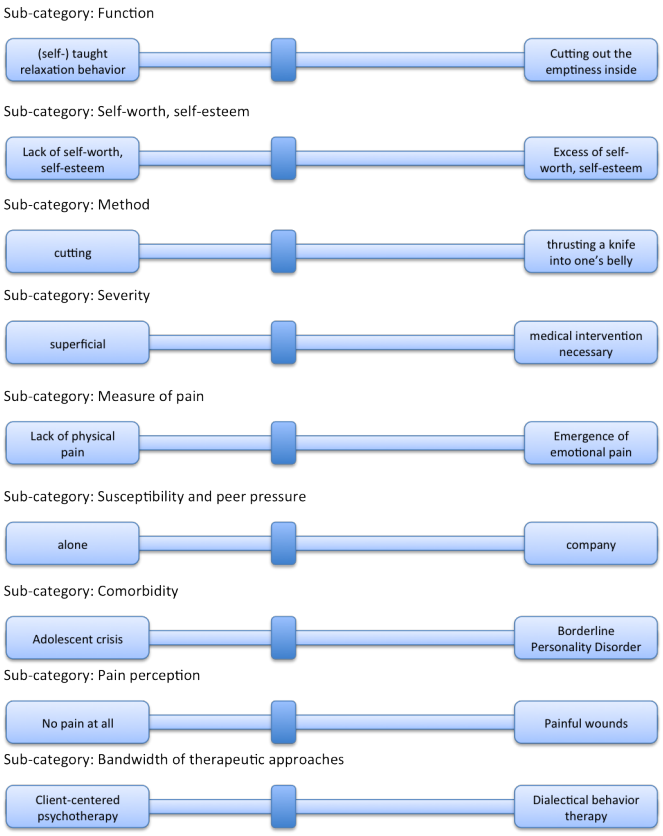

Figure A.5: The sub-categories that belong to the concept of NSSI characteristics. They are depicted as sliders so as to better represent that properties along these lines were found in interview data. Each slider's end-points mark corresponding extrema derived from interview analysis; pilot + interview rounds I.

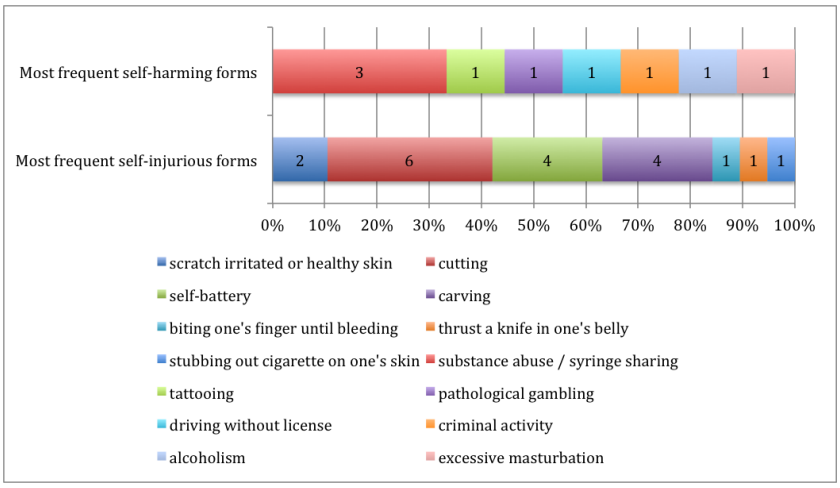

Figure A.6: Most frequent methods of self-injurious and maladaptive behavior as reported by interview partners during pilot phase and rounds I. Note that it is not a representation of NSSI methods per se. The percentage refers to how often the method has been mentioned (thus, also encountered) by different interview partners. Hint: start reading the chart from the bottom, traverse through the legend row by row (columns 1 and 2).

A.3 Interview rounds II

Some of the themes that have emerged after analyzing interviews from pilot phase up to interview rounds II are presented in this section. Codes and descriptive instances in here are linked to the person who mentioned via their alias. If no alias is given, it came up during several interviews and is, hence, not explicitly stated. Compare:

- Table A.3 for a glance at concept *'diary card'*,
- Table A.4 for a brief elaboration on codes and aspects found for the broader category of *'Achievement, Positive Reinforcement and Motivation'*,
- Table A.5 for a quick overview about the concept of *'Content NSSI Urge'*, and
- Table A.6 to learn about *'characteristics of Borderline'* as described by interview partners.
- Figure A.7 illustrates feedback from interview partners about the highly-discussed concept of self-injurious act documentation (labeled *'GROUP_Content NSSI act'*). It is a screenshot of a so-called CodeMap established with the HyperRESEARCH software which supported the author's analysis process. This CodeMap shows codes from interviews and their relationships. Thus, it clearly indicates how different opinions and aspects relate to each other.
- Figure A.8 delineates perceptions of experts on the usage of motivational aspects and their relationships to each other in another CodeMap.

Note that CodeMaps are only a different representation of analysis results compared to the ones that are organized in tables. From the author's perspective, the graphical illustration helps to better communicate the meaning of established themes. Besides showing relationships between codes, the given CodeMaps contain following parts:

Yellow text area *Yellow text areas are established by the author. The goal was to to organize codes into sections, introduce memos by the author or simply define an overall title of what sections are about.*

Parenthesis *Each code is associated with a number given in parenthesis. This is the number of times the actual code came up throughout the data material.*

Content Diary Card		
Sub − category	*Properties*	*Alias*
frequency		
	daily	Ms. M
length of writing diary cards		
	entire period of therapy	Ms. M
content		
	- urge and intensity, suicidality - act - decision towards a new path - skill - emotion - vulnerability factors (PMS, sleep, alcohol, diet)	Ms. M, Mr. L, Ms. I, Mr. J
applicability of diary cards	- DBT, - DBT-A for adolescents (especially mentioned by Ms. I) - behavioral therapy	Ms. I, Ms. A, Mr. F, Ms. E etc.

Table A.3: The concept of diary card content, which is described by several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-categories; interview rounds II.

Content NSSI Urge		
Sub − category	*Properties*	*Alias*
time		
	day time pattern	Ms. A, Ms. C, Mr. D, Mr. H
	person might not be able to document an urge during the time when it occurs	Mr. D
	time passed between an urge and an act	Ms. M
location	location where an urge occurs	Ms. A

company		
	is one alone or in company	Mr. A, Ms. C, Mr. D
decision skill		
	keep track of decisional tree whether to injure or postpone	Mr. G
	positive perception	Ms. N
situation	situation	
situational interpretation		
	- thoughts, - emotion, - bodily changes	Ms. A, Ms. C, Mr. D, Mr. F, Ms. K, Ms. M, Ms. N
vulnerability factor		
	"ABC-Gesund"	Ms. M
intensity		
	intensity of an urge	Ms. M
skills		
	skills are in focus	Ms. I, Ms. J, Ms. K, Mr. L, Ms. M, Ms. N
	patients do not remember skills when needed	Ms. M, Ms. K, Ms. I
	patients are dissociated and need outside help	Ms. N
reinforcement		
	positive reinforcement for not injuring	Ms. B, Mr. D
	positive reinforcement with respect to decisional injuring tree difficult	e.g., Ms. N
	positive reinforcement as external skill	Ms. N
diary card		
	urge documentation as part of diary card content *causal link to concept diary card*	Ms. M

Table A.5: The concept of what to document when an urge occurs, which is described by several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-categories; interview rounds II.

Achievement, Positive Reinforcement and Motivation	
$Sub-category$	$Properties$
perception on rewards	people need a reason to do skills-training or to document, motivation is important, motivation needs to happen prior to using an app, there is reward and there is punishment
perception on the balance scale	not such a bad reward for borderliners aiming at stability; scales functions like a biofeedback-device; positive means of reward;
DO reinforce but without triggering	avoid words like NOT when reinforcing (like "awesome, you didn't cut yourself" since it might be triggering again); praise and reinforce even if people can't take it at first
when is positive reinforcement useful	after one has gone through with self-injury, before one has gone through with self-injury (i.e., when documenting an urge)
suggestions for rewards and motivational aspects	token-system (like collecting points); positive reinforcement with language; positive reinforcement with picture; positive reinforcement with slapstick; positive reinforcement with audio-recording; positive reinforcement with video; showing a little character that shows you what exercises are needed to be done; expressive powerful message like successfully done; strengthening a representational character by filling it up with stuff and, thus, make it more visible; comparison within a social community for reinforcement
additional motivational aspects	introducing psychoeducation with some sort of a game-character; let patient enter his progress towards a set goal; reduce vulnerability (like lack of sleep, poor diet); motivation needs to be individual

Table A.4: The concept of achievement, positive reinforcement and motivation, which is described by several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-categories; interview rounds II.

Borderline characteristics		
Sub − category	*Properties*	*Alias*
educational models		
	neurobiological vulnerability model of BPD	Mr. J
	neurophysiological model and reflection by therapist	Ms. N
ambivalence		
	ambivalent schemata in borderliners	Ms. N
	borderliners are ambivalent in all areas - part of the disease	Mr. G
tension and emotions		
	- tension is fundamental problem for borderliners, tension is equivalent to emotion in borderliners - basal tension in every person is lower than borderline tension - problem rather emotion identification than nssi - emotional affection either positive or negative is always tension - bodily sensation detached from emotions	Mr. G
	- borderline tension curve looks different than ours - shame guilt after nssi act only at a later stage - emotions pretty much not existent in borderliners - black and white emotions in borderliners	Ms. N
	dissociation and nssi as result of high tension	Ms. N, Mr. G
	competing emotions in borderliners	Ms. M
general characteristics		
	- borderline and dissociation - emotional troubles due to invalidating environment	Mr. J
	- ambivalence, dysfunctional tension regulation - dysfunctional emotion identification and regulation	Mr. G, Ms. I
	living in chaos	Ms. I
	parasuicidal actions	Ms. K
	recurrent nssi and recidivism	Ms. N, Mr. H

borderline tough diagnosis to treat - not everybody's favorite	Mr. H, Ms. C, Mr. J
difficulties to accept praise	Ms. N
borderline in context of impulse control disorder	Mr. G
borderline as an early personality disorder	Mr. H

borderline and therapy

- borderline needs therapy - empathetic approach unlikely to yield success - medication is of limited success	Mr. G
- avoidance behavior or rejection as useful therapeutic strategies - talking about focus on self-injurious behavior	Ms. K
- counter-transference by therapist - dysfunctional and functional stress tolerance skills - object relationship towards cell phone app - patient-centered care - sound and smell direct towards previous situations - individual filtering of praise and cross-modal interaction	Ms. N
- emotions and dogmas - objectively looking at dogmas	Ms. M
- non-compliance with respect to documentation in chaotic surroundings - poor medical care from self and education	Ms. I
patients do not remember skills when needed	Ms. E, Ms. K, Ms. M
psychoeducation about BPD as therapeutic means	Ms. A, Mr. D, Ms. M
suicidality as an important factor in therapeutic process	Ms. K, Ms. M, Mr. L
therapeutic approaches with borderline	Ms. A
therapeutic process with borderliners	Mr. J, Ms. K

therapy for borderliners differs from other disorders	Mr. J
borderline and therapy :: borderline-specific therapy problems	
- countertransference and therapy problems - monetary and immaterial problems with borderliners	Mr. J
problems in awareness training	Ms. N
craving for syringes - contagious effects	Mr. H
invalidation of therapist	Mr. G
problematic borderline situations like torrents of hatred via phone, canceling therapy, no-shows, manipulative behavior	Mr. J, Ms. K, Ms. M
reaction after problematic borderline situations difficult, also depends on previous experience	Ms. K

Table A.6: The concept of Borderline characteristics, which offers several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-cateogires. The last sub-category is written as a term like A :: B. It describes a hierarchy, whereas B is yet another sub-concept of A; interview rounds II.

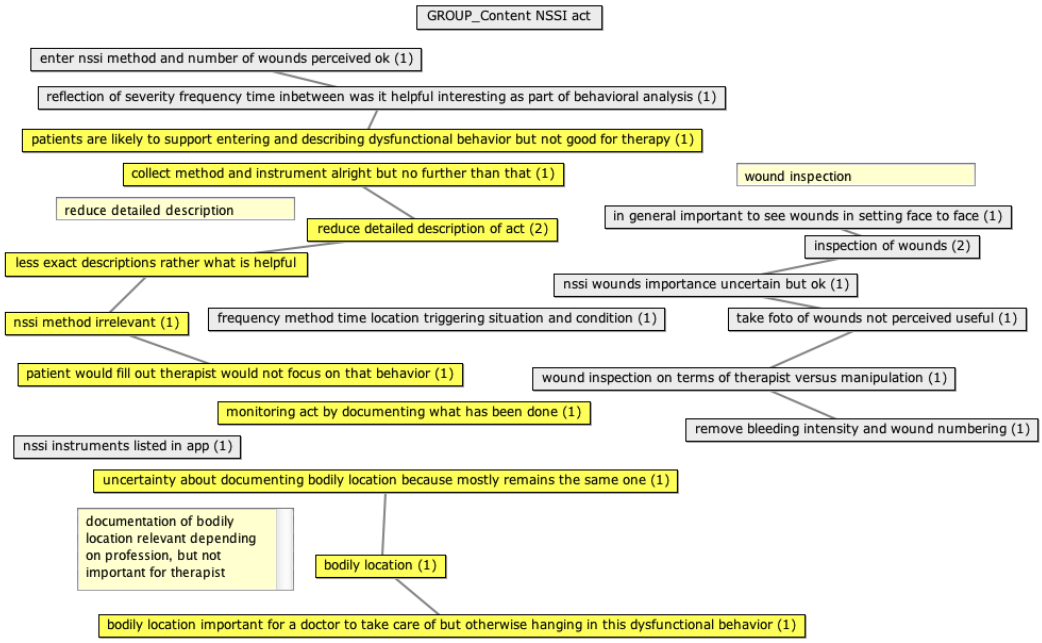

Figure A.7: The Code Map outlines experts' perceptions and reactions towards the prototypical content of documenting an act of NSSI using the HyperRESEARCH software. It is a work-in-progress result after analyzing interviews from pilot phase, rounds I and rounds II.

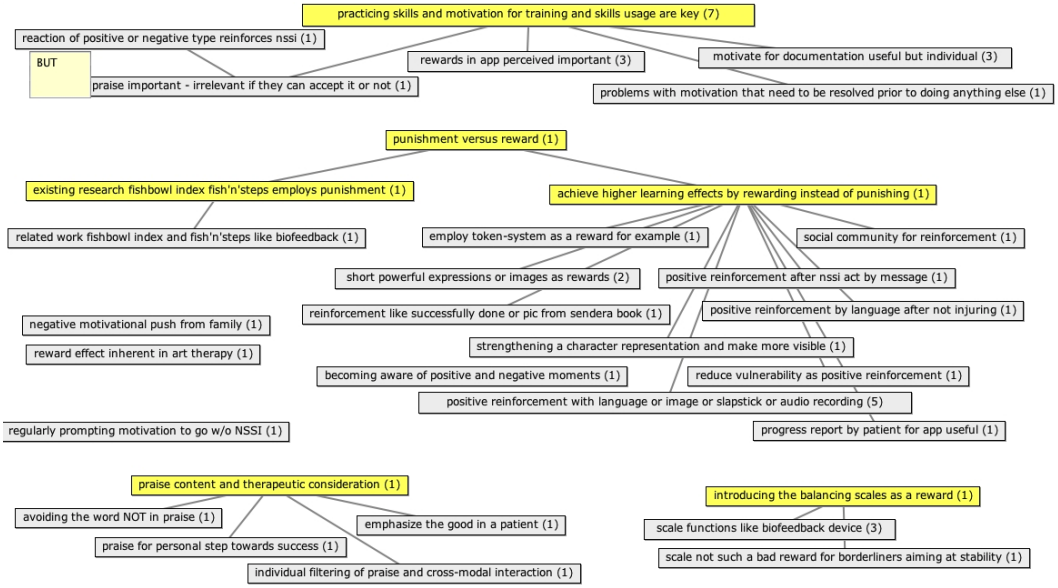

Figure A.8: CodeMap of concepts covering the topic of rewarding systems in an app for Borderline patients. Items have been extracted from interviews and emerged throughout the coding process of the GT method and includes pilot phase, rounds I and rounds II.

A.4 Interview rounds III

During pilot phase and interview rounds I to III, the author was confronted with additional ideas with respect to a useful and potentially beneficial design for the application. It is clear, that several concepts and themes were enhanced after having analyzed the entire set of 18 interviews. But given remaining time and space, only the following concept is outlined here:

- Table A.7 summarizes expert's ideas and thoughts of what an app in the area of Borderline and self-injury could look like. The concept is named 'new ideas for the app'. It contains several sub-categories that are further described by relevant properties, listed in column 'properties'. Each sub-category is an abstract representation and tries to summarize the overall meaning of properties that belong to it. Column 'alias' links properties to the expert who mentioned it.

As usual, alias references are given when explicit links between codes and interviews occurred. These are described in the corresponding column "alias". No alias reference is included if the respective code or property was mentioned by several interview partners.

New ideas for app		
Sub − category	*Properties*	*Alias*
dynamic content		
	app should make use of a self-learning mechanism	Mr. D
entertainment		
	develop a Virtual Reality app to replace actual NSSI	Mr. D
	- use funny little creature leading through exercises and intervention - use munchkin or slapstick or voice of therapist for app to help approaching patient	Ms. Q, Ms. E
	include game-like character with car driving along a road	Mr. R
work as a reminder		
	remind about doctoral visit or therapy session	Ms. I
	remind about updating one's diary	Ms. B
educate the user		
	emotion protocol good to include	Mr. J, Ms. M
	- trick-questioning as psychoeducational means for NSSI - test susceptibility for NSSI	Mr. D
empower the user		
	let patient choose whatever they are rating or entering	Ms. N
	let patient see progress on using non-harmful skills and emotional consequences like effect on life-quality	Ms. I

	- continuous progress report by patient for app useful - rather focus on goal-orientation	Mr. R, Ms. M
	reflect on positive events	Ms. O, Ms. P
anamnestic tool		
	include skidII and schema questionnaire for therapist	Mr. J
	test one's susceptibility for NSSI	Mr. D
intervention mechanism		
	skill intervention at point 100 with phone call	Mr. L
	have people identify favorite music and soothing things like an intake screen	Ms. O
	list strengths and weaknesses about oneself	Ms. C
	include pro conra list at point of decision to act upon urge	Ms. M, Ms. P, Ms. Q

Table A.7: The concept of new-app-ideas, which offers several sub-categories. Column 'properties' illustrates relevant aspects and parameters that belong to specific sub-categories, whereas a sub-category is an abstract description of what properties are overall about; pilot + interview rounds I to III.

A.5 Final concepts

Table A.8 shows entire set of final concepts that have been found after analyzing all interviews from pilot phase, interview rounds I, rounds II and rounds III. Delineating every single code and every single concept or theme in greater detail would exceed the limit of this thesis and also be hard to read and comprehend. That is why the focus of the upcoming table is on displaying bigger concepts (actually concept groups) with an identifier and their name only. The identifier is labeled as *'CG<xx>'* when a concept group is at a top level, sub-groups are represented as *'CG<xx.x>'*, respectively *'CG<xx.x.x>'* depending on the top level concept group they belong to. Altogether, there are 51 concept groups divided up into three levels.

Concept ID	Concept name
CG01	Acceptance of app
CG02	Achievement Reward Reinforcement Motivation
CG03	**Behavior documentation and analysis**
CG03.1	*Behavioral analysis*
CG03.2	*Content NSSI act*
CG03.3	*Content NSSI urge*
CG03.4	*Diary card*
CG04	Behavioral apps
CG05	**Behavioral Therapy**
CG05.1	*Dialectical behavior therapy*
CG05.1.1	Specific therapeutic steps
CG06	**Borderline**
CG06.1	*Borderline and Therapy*
CG06.1.1	Borderline-specific therapy problems
CG07	**Characteristics of NSSI**
CG07.1	*Comorbidities*
CG07.2	*Negative function or consequences of NSSI*
CG07.3	*NSSI and societal norms*
CG07.4	*NSSI methods*
CG07.5	*NSSI triggers*
CG07.6	*NSSI-Alternatives*
CG07.7	*Positive function of NSSI*
CG07.8	*Self-harming behavior*
CG08	Content
CG09	Data security privacy
CG10	Data upload
CG11	**Diploma thesis**
CG11.1	*Interview partners und networking*
CG12	Emotion
CG13	Emotion protocol
CG14	Individualization
CG15	Intervention via cell phone
CG16	New ideas for app
CG17	NSSI-App
CG18	Perception on emotional and tension scales
CG19	Positive function of alternative
CG20	Progress Diagrams
CG21	Psychological terms and contexts
CG22	**Psychotherapy in general**
CG22.1	*Desensitization and exposition*
CG23	Risk factors accompanying NSSI
CG24	Self reports respectively application prompts
CG25	Skills

CG26	Skills-protocol	
CG27	Skills-training	
CG28	Tension protocol	
CG29	Therapeutic interventions	
CG30	Therapeutic means	
CG31	Therapeutic methods of therapists	
CG32	Therapist and researcher details	
CG33	Therapy compliance	
	Sum of group concepts total	*n=51*

Table A.8: This table displays all 51 final concept groups that arose during analyzing interviews from pilot phase, interview rounds I, II and III. They are further divided into three levels representing sub-groups to their respective relative top-level group.

B Set of interview guides

This chapter delineates interview guides which were the basis for interview rounds I, compare Chapter 7.1, rounds II, compare Chapter 7.2 and rounds III, compare Chapter 7.3. Naturally, it does not reflect all questions that were asked due to several reasons. One of them being that some questions targeted an interview partner's specific / unique expertise, so a few questions even changed within one block of interview rounds. However, the purpose of presenting interview guides in this chapter is not to outline each questions that was ever asked but, rather, deliver a bigger understanding of the focus of each interview rounds and illustrate project status and progress in knowledge.

THEMES (IN A NUTSHELL)

- **Introduction**
  - Definition nonsuicidal self-injury (NSSI) in the course of the thesis
  - Professional experience with NSSI
- **Treatment / Therapy**
  - What does NSSI-Therapy look like? What could it look like?
  - Are there different steps?
  - Is the progress of a patient's behavior of interest? (in-between settings, when does sth happen, where/how/what?)
- ***Goals / Motivation***
  - *Goal setting*
  - *What kind of motivational strategies are out there? How do you get the patient to adapt to them? How could one motivate via cell phone?*
- **Prototype – mobile monitoring of behavior**
  - Electronic diary, record behavior and behavioral changes on-the-go
  - Is something like that considered useful?
  - What could be of benefit for the therapeutic process, if the patient were to collect data via their cell phone; wherever they are, whatever they are doing? What functions or features are relevant to know for therapeutic workflows?
- **Causal link assessment – alternative behavior**
  - Causal link between self-monitoring and motivating alternative coping strategies

Note: Questions in italic style depend on the available time slot during the interview.

Figure B.1: Interview guide used for interview rounds I, page 1.

Introduction

Definition nonsuicidal self-injury (NSSI) and typical examples of NSSI [Nock, 2010]

- For how long have you been working with patients, who self-injure?
- How many patients with NSSI do you treat?
- Which methods are frequently reported by your patients?
- Do you see NSSI as an isolated syndrome or is it rather a symptom of another illness / disease in your practice?
- What about NSSI as the primary focus of treatment?

- *For how long are these patients in therapy, on average?*
- *Is it possible to say anything about treatment success? What does actually make the person stop injuring themselves?*

Treatment / Therapy

- How do you treat a person / work with a person presenting NSSI? Are there specific therapeutic approaches targeting (and being used for) NSSI?
- *Research talks about functional therapies as well as cognitive and dialectical behavior therapies regarding NSSI. How do you feel about that? Is it applicable for Borderline patients solely or can it be successful, if NSSI is the primary focus (the actual / primary diagnosis) of therapy?*
- When / what kind of diagnostic criteria do you personally see as a condition to make thorough monitoring of behavior a necessity? Are there any criteria?
- How do you record NSSI momentarily? (are there diaries, homework assignments, etc. in use?) – patient perspective
- What information is relevant to get insights into a person's NSSI?
- How do you record data? Electronic means / paper forms? Do you have EHRs in use? – therapeutic perspective

Goals / Motivation

- *Are there motivational strategies to get rid of NSSI? Which ones?*
- *Where does a therapist start with motivational strategies (alternative behavior)? How can you provoke alternative behavior in a patient?*
- *In what ways could a cell phone application support therapeutic workflows? What is needed to do that?*

Prototype

Problems in retrospective recalls [Stone, Shiffman, 1994][Yoshiuchi, 2008]

Definition ecological momentary assessment (EMA) [Yoshiuchi, 2008]

Keyword: Smartphone App for documentation of events and behavior
Using self-reports (e.g. urge to injure, actual injury, mood) and taking advantage of various sensors (e.g. where am I at right now? Home? Work? Doing sports?) one

Figure B.2: Interview guide used for interview rounds I, page 2.

could collect information wrt lifestyle, self-injurious behavior, whereas the bias of rule-of-thumb estimates could be reduced, because behavior is recorded exactly at the time and place where it happens.

Prototype walk-through…

- What do you expect from a system, which is carried around by the patient all the time?
- Does mood development throughout a day make a difference? *E.g. one could ask the patient (for instance with support of notifications / reminders) ask to report their mood / emotion at various times a day*
- Do you consider such a tool as useful / beneficial to support your daily work? Why? Why not?

Causal link self-monitoring/monitoring behavioral progress – Developing / provoking alternative coping strategies

- What is your opinion about that? Is there a causal link between progress monitoring of behavior (EMA) (respectively, also self-monitoring) and motivation towards alternative coping strategies?

References

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Figure B.3: Interview guide used for interview rounds I, page 3.

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Diplomarbeit:
"Using mobile technology for monitoring behavior of self-injurious patients: requirements and concept system design"

Interview guide

1. *Prototype walkthrough… and collecting thoughts on it*
2. What do you like about it? What don't you like about it?
3. Do you feel like there is something missing? If so, what?

4. Certain things are known to trigger NSSI. What should one focus on in terms of developing an app in order to avoid these triggers (for instance, body outline to mark the location of a wound, taking a foto of a wound, selecting a method applied / instruments used, number of wounds)

5. Which therapeutic approach are you relying on and what methods of self-injurious behavior (SIB) are you facing in your work?

6. What would support your therapeutic workflows (regarding an app)?

7. What kind of information do you collect / do you need as a therapist to get a better understanding (about self-injurious behavior of a patient)?

8. Does the behavioral approach differ on working with a Borderline patient who self-injures versus working with a patient who self-injures but is not a Borderline patient?

9. Can you tell me something about your therapeutic process (NSSI + Borderline)?

10. Skills-Training

    a. What does help?
    b. How can it be beneficially included in an app?

11. Therapy problems (NSSI + Borderline)?

12. Therapy compliance:

    a. What is therapy compliance in the therapeutic setting?
    b. Can, and if so, how, an app support increasing therapy compliance?

13. Keyword:
    a. Event-based documentation:
       What aspect is therapeutically interesting?
    b. System-based documentation:
       What aspect is therapeutically interesting?

14. Do you think an app like the one proposed in here is useful / beneficial?

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Figure B.4: Interview guide used for interview rounds II.

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Masters Thesis:
"Using mobile technology for monitoring behavior of self-injurious patients: requirements and concept system design"

Prototype walkthrough (and collecting thoughts on it)

1. What do you like about it? What don't you like about it?
2. What would you change about it so that it meets your needs and expectations as a researcher / therapist?
3. Certain things are known to trigger NSSI. How do you feel about including the following within an app: body outline to mark the location of a wound, taking a picture of a wound, selecting a method applied / instruments used, number of wounds)
4. Besides level of tension – what information would you want to collect by system-based sampling?

Your research / therapeutic work

5. Are you relying on some kind of therapeutic approach in your research / what kind of therapeutic approach are you relying on and what methods of SIB are you facing in your work?
6. In your experience, do you often see SIB in people who have Borderline Personality Disorder? Does it matter for your research (if someone has BPD)? Or do you just focus on SIB itself?
7. Do you distinguish if SIB is suicidal or not?
8. How do you gather all the information for your research? (mobile software, paper questionnaires, face-to-face interviews)
9. What kind of information do you collect / do you need as a researcher / therapist (about SIB)?
10. Borderline and Emotions?
11. Does the level of detail differ in relation to what is of interest to a psychologist / psychotherapist in practice?

Motivational factors and incentives

12. Do you provide your study participants with some sort of incentives? / Do you use rewards in skills-group-sessions or DBT as such?
13. What kind of reward / reinforcement / gamification aspect do you think would be useful or would work for self-injurious patients (in an app)?
14. Language as positive reinforcement: what needs to be considered wrt NSSI and Borderline?

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Figure B.5: Interview guide used for interview rounds III, whereas two versions (one targeting a researcher, the others therapists in practice / clinicians) were combined.

C Additional code snippets

This chapter contains additional code snippets regarding network communication and transfer of JSON object between the Android app from within the emulator and the RESTful play! web-service implementation:

- Listing C.1 shows that the Android application uses an asynchronous task to post JSON objects to the RESTful play! webservice.
- Listing C.2 is invoked from above asynchronous task, establishes a connection to the webservice, builds the entities in questions and performs the relevant network operation to transfer JSON objects to / from the webservice.
- Listing C.3 shows how a newly established skill is transformed into a JSON object and executes the asynchronous network archiving task.
- Listing C.4 describes the interface to establish a RabbitMQ connection, declare an exchange queue and corresponding channel. This interface is used by Android to interact with RabbitMQ; the implementation was taken from Dixon (2013) and slightly adapted to the specific project's needs.
- Listing C.5 illustrates how Android is notified about the arrival of a new message, the way it is consumed and how this message is then stored in the application's so-called SharedPreferences. This excerpt is largely based on the coding solution of Dixon (2013).

```
1  ...
   import android.os.AsyncTask;
3
   public class PostDataTask extends AsyncTask<String, Void, Void> {
5
     private NSSINetworkConnection conn;
7    private HttpPost httpPost;

9    @Override
     protected Void doInBackground(String... args) {
11
       conn = new NSSINetworkConnection( args[0] ); /*args[0] contains the URI
13                            args[1] contains the JSONObject as a String*/
       conn.doPost( args[1] );
15     return null;
     }
17
   }
```

Listing C.1: Excerpt from *PostDataTask.java* - an asynchronous task initiated from within the Android application to post JSON objects to the RESTful play! webservice.

```
public class NSSINetworkConnection {

  HttpClient httpClient;
  HttpPost httpPost;
  HttpGet httpGet;

  public NSSINetworkConnection(String uri) {
    httpClient = new DefaultHttpClient();

    httpPost = new HttpPost( uri );
    httpGet  = new HttpGet( uri );


  }

  public HttpResponse doPost(String jsonString) {

    HttpResponse response = null;
    StringEntity stringEntity;
    try {

      httpPost.setHeader( "Content-type", "application/json" );
      stringEntity = new StringEntity( jsonString );
      stringEntity.setContentType( new BasicHeader( HTTP.CONTENT_TYPE, "↩
        application/json" ) );
      httpPost.setEntity( stringEntity );
      response = httpClient.execute( httpPost );

    } catch (UnsupportedEncodingException...
    return response;
  }

  public String doGet() {

    ...

    try {
      httpGet.setHeader( "Content-type", "application/json" );
      response = httpClient.execute( httpGet );

      if ( response.getStatusLine().getStatusCode() == 200 ) {
        ...
      }
    } catch (ClientProtocolException
    ...
  }
}
```

Listing C.2: Excerpt from *NSSINetworkConnection.java* - which establishes the network connection builds HttpPost and HttpGet entities and performs the data transfer.

```
public class SkillDefinitionActivity extends Activity {

  ...
    Button bSkillDefApply = (Button) findViewById ( R.id.bSkillDefApply );
    bSkillDefApply.setOnClickListener(new View.OnClickListener() {

      @Override
      public void onClick(View v) {
        // TODO Auto-generated method stub

        long timestamp = System.currentTimeMillis();
        JsonObject newSkill = new JsonObject();
        newSkill.addProperty( Constant.SKILL_TITLE, eSkillDefTitle.getText↩
          ().toString() );
        newSkill.addProperty( Constant.SKILL_DESCRIPTION, eSkillDefDesc.↩
          getText().toString() );
        newSkill.addProperty( Constant.SKILL_CATEGORY, skillCategories.↩
          getItemIdAtPosition( skillCategories.getSelectedItemPosition() ) ↩
          );
        //doPost
        if ( Constant.EMULATOR ) {

            /* build the params for the upcoming POST action to the RESTful↩
               webservice
             params contains
            1.) URI to access the relevant resource in form of a String
            2.) JsonObject that needs to be posted over the network as a ↩
              String
            */
            String params[] = new String[]{ Constant.SKILL_URI, newSkill.↩
              toString() };

            // invoke PostDataTask which runs asynchronously
            new PostDataTask().execute( params );

        }

        ...
      }
    });


  }


}
```

Listing C.3: Excerpt from *SkillDefinitionActivity.java* - it shows how the JSON object to be transferred is built and invokes the asynchronous task above.

```
...

import com.rabbitmq.client.Channel;
import com.rabbitmq.client.Connection;
import com.rabbitmq.client.ConnectionFactory;

/**
 * taken from Simon Dixon's blog about android and rabbitmq, compare
 *  http://simonwdixon.wordpress.com/2011/06/03/getting-started-with-rabbitmq-on-android-part-1/
 * with slight adaptations according to project's needs *
 */
public abstract class IConnectToRabbitMQ {

    public String mServer;    //host
    public String mExchange;  //exchange-queue

    public int mPort;   //port number
    public String mVHost; //virtual host

    protected Channel mModel = null;  //channel
    protected Connection  mConnection;

    protected boolean Running;

    protected  String MyExchangeType;

    /**
     * added port number and virtual host
     * @param server The server address
     * @param port The port number
     * @param vHost The virtual host
     * @param exchange The named exchange
     * @param exchangeType The exchange type name
     */
    public IConnectToRabbitMQ(String server, int port, String vHost, String exchange, String exchangeType) {

        mServer = server;
        mPort = port;
        mVHost = vHost;
        mExchange = exchange;
        MyExchangeType = exchangeType;
    }

    ...

    /**
     * Connect to the broker and create the exchange
     * @return success
     */
    public boolean connectToRabbitMQ() {

        if(mModel!= null && mModel.isOpen() )//already declared
            return true;
        try {

            ConnectionFactory connectionFactory = new ConnectionFactory();
            connectionFactory.setHost(mServer);
            //set port necessary to connect to rabbitmq
            connectionFactory.setPort(mPort);
            //set vhost necessary to connect to rabbitmq
            connectionFactory.setVirtualHost(mVHost);
```

```
            //establish connection using connectionFactory
            mConnection = connectionFactory.newConnection();
            mModel = mConnection.createChannel();
            mModel.exchangeDeclare(mExchange, MyExchangeType);//dropped last parameter to avoid redeclare exchange-exception

            return true;

        ...
}
```

Listing C.4: Excerpt from interface *IConnectToRabbitMQ.java* - it shows how Android connects to RabbitMQ and declares its interest to a certain exchange and message queue. The interface implementation was taken from Dixon (2013) and slightly adapted to the project's needs.

```
public class MainActivity extends Activity implements ViewSwitcher.ViewFactory {

  SharedPreferences prefs;
  private Connection rabbitConn;
  private Channel channel;
  private QueueingConsumer consumer;
  private MessageConsumer mConsumer;

  ...

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);

  ...

        if (Constant.EMULATOR && Constant.RABBITMQ) {

         /*this section uses code from simon dixon's blog about how android interacts with rabbitmq and
    consumes messages with slight adaptations
    url: http://simonwdixon.wordpress.com/2011/06/03/getting-started-with-rabbitmq-on-android-part-1/*/
            mConsumer = new MessageConsumer("10.0.2.2", 5672, "/",
                    "logs2",
                    "fanout");//need to declare port and virtual host as well

            //Connect to broker
            mConsumer.connectToRabbitMQ();

            mConsumer.setOnReceiveMessageHandler(new MessageConsumer.OnReceiveMessageHandler() {

        @Override
        public void onReceiveMessage(byte[] message) {//param message contains the videoId for the achievement

            String text = new String("");
            try {
              text = new String(message, "UTF8");

            } catch (UnsupportedEncodingException e) {
              // TODO Auto-generated catch block
              e.printStackTrace();
            }
```

```
44            //updates achievement videoId in sharedpreferences for retrieval ↩
                in achievementactivity
              prefs = context.getSharedPreferences( Constant.SHARED_PREFS, ↩
                Activity.MODE_PRIVATE );
46            SharedPreferences.Editor editor = prefs.edit();
              editor.putString( Constant.YOUTUBE_VID_ACHIEVEMENT, text);
48            editor.commit();
            }
50
              });
52
            }
54
           ...
56
  /*source: simon dixon's blog*/
58  @Override
  protected void onResume() {
60    super.onResume();
      if (Constant.EMULATOR && Constant.RABBITMQ) {
62      mConsumer.connectToRabbitMQ();
      }
64  }

66  /*source: simon dixon's blog*/
  @Override
68  protected void onPause() {
      super.onPause();
70    if (Constant.EMULATOR && Constant.RABBITMQ) {
        mConsumer.dispose();
72    }
  }
74
}
```

Listing C.5: Excerpt from *MainActivity.java* - upon being notified that a new message was posted in the relevant queue Android consume it. This excerpt is largely based on the coding solution of Dixon (2013).

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List of Abbreviations

NSSI nonsuicidal self-injury

EMA Ecological momentary assessment

RE Requirements Engineering

UML Unified Modeling Language

SRS Software Requirements Specification

GT Grounded theory

DSH deliberate self-harm

CDC Centers for Disease Control and Prevention

NCIPC National Center for Injury Prevention and Control

IT information technology

SDK software development kit

JAD Joint Application Development

DFD data flow diagrams

SADT Structured Analysis and Design Technique

QA quality assurance

ERM entity relationship models

ERD entity relationship diagrams

OMG Object Management Group

DRM Day Reconstruction Method

ESM Experience Sampling Method

UbiComp Ubiquituous computing

CBT cognitive behavior therapy

DBT dialectical behavior therapy

F Req functional requirements

NF Req nonfunctional requirements

EHR electronic health records

EMR electronic medical records

PHR personal health records

BANs Body Area Networks

IKIWISI "I'll know it when I see it"

TTM Transtheoretical Model

HBM Health Belief Model

SCT Social Cognitive Theory

VAS Visual Analogue Scale

AMQP Advanced Message Queuing Protocol

JMS Java Messaging Service

SNS social networking sites

IDE Integrated Development Environment

ADT Android Developer Tools

XML eXtensible Markup Language

JSON JavaScript Object Notation

WS webservice

VR Virtual Reality

OA Opposite Action

REST Representational State Transfer

CRUD Create Read Update Delete

URIs Uniform Resource Identifiers

SOAP Simple Object Access Protocol

SIB self-injurious behavior

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