Observing arousal at mentally challenged clients in a health care environment: a user requirements study for a monitoring device that support care takers with working with their clients.

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Abstract

The purpose of this research was to find user requirements for a device that supports care takers in directing their attention to mentally challenged clients or themselves when arousal is increasing. In the current situation care takers not always notice when the arousal of clients is increasing. Two steps in the design cycle were made to discover, specify, analyze and validate user requirements. In the first study, a user study was conducted with six participants. Several measurement methods were used to construct a list of requirements, which was translated into an interface design. In the second study 8 participants tested the interface design on feasibility of tasks accomplishment and user satisfaction. The result showed that the design cycle wherein the user was involved, led to an interface that was easy and clear to use.

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Introduction

In The Netherlands 74.658 mentally challenged persons live in a healthcare environment and have intramural care (Vereniging Gehandicaptenzorg Nederland, n.d.). They often show challenging behavior, e.g. being a threat to themselves or to others. Mentally challenged persons have a higher chance of having problems with regulating their anger (TNO, 2011).

These challenging behaviors not only affects themselves but also the people around them, including the care takers who work with them. Mentally challenged persons might find difficulties with communicating what causes stress, hence makes it difficult for care takers to take away the stressors. Instead, mentally disabled persons (from now on referred to as clients) often express their arousal by acting aggressively towards the care takers. 87% of the care takers were faced with aggression and violence. Physical aggression varies from spitting, pushing or pulling (64%) to hitting, kicking and giving a headbutt (63%) (Arbeidsinspectie, 2008).

One of the stressors that influences client's mood is the behaviour of the care takers. Embregts (2002) found that the social behaviour of children who are mild mentally disabled was influenced by the behaviour of the staff who worked at the facility where the children resided. Care takers are not always aware of their own mood and accordingly their behaviour. Because of the continuous interaction between the client and care taker, it is important for the care taker to be aware of his or her own mood.

Currently the care takers monitor the increasing arousal by observing the clients and themselves. Although they are trained for that, cues can be missed because of divided attention caused by multiple tasks. At present there are no devices available that meet this specific target group's needs. For example, Agapie and Pires (2011) designed a monitoring system that supports care takers with working with children with autism. In their study they aimed to design an interface, that visualize live-streaming arousal by monitoring electrodermal activity (EDA). They made some observations of the stakeholders but the stakeholders themselves were not involved in the design decisions that followed from the observations. Though the interface might technically work, it is not clear if the stakeholders are able and be prepared to work with it.

The aim of this study is to find user requirements for a device that supports care takers in directing their attention to mentally challenged clients or themselves when arousal is increasing. This will be achieved by involving the representative users (Lin, Vicente & Doyle, 2002) in the whole process, from exploring the requirements to evaluating the subsequent

design. The present study addresses the following research question: *What user requirements should a monitoring device for care takers working with mentally challenged clients meet, so it supports the care taker in monitoring the arousal level of clients?* The result will be a user friendly interface that presents the state of arousal of clients and care takers. This study will be twofold. Firstly, a user requirements study will be accomplished that discovers the characteristics of the care takers, their needs and the context in which the device will be used. Requirements follow out of the analysis and a concept interface will be designed. In the second part the interface design will be tested on feasibility of tasks accomplishment and user satisfaction. It is expected that this explorative user requirements study will lead to operational requirements and that the resulting interface design will be easy and satisfying to use.

Background

Moodradar

Mood Radar is a project that is initiated by University of Twente and De Twentse Zorgcentra (DTZC). DTZC is an organization in The Netherlands that offers intramural care to mentally challenged clients, approximately 1450 clients live there. Inhabitant's age group ranges from children to adults, IQ from lower than 20 to 70 and emotional the age ranges from zero to six years old. In a commune approximately eight clients live together. DTZC offers support like day care and treatment. A care taker is 24-7 available to watch the clients. The care takers of the DTZC encounter aggressive behaviour from mentally challenged clients, especially the teams that have a more difficult behavioral client group. It is found that in general a lot of care takers who work with mentally challenged clients experience depression and anxiety because of the aggressive behaviour (Mitchell & Hastings, 1998). Signals of stress have also been found at the care takers of DTZC. For this reason as well as for improvement of the well-being of the clients, project Mood Radar has been started. The project studies the use of continuously physiological measurement of arousal of DTZC's in house clients. The electrodermal activity (EDA) measures the activity of the sweat glands, through skin conductance. The spontaneous electral fluctuations of the sweat gland activity indicates of a person's arousal is increasing, though it doesn't indicate its valence (Sequeira, Hot, Silvert & Sylvain Delplanque, 2009). The EDA was exosomatically measured with wireless sensors worn around the wrist. This follow up study contributes by translating the output signals of the EDA data into a concrete information presentation for a monitoring device that signal for upcoming arousal at clients and care takers. It supports the care taker's to direct their attention, the care taker can then establish if an intervention is required.

Definition of requirements

The monitoring device should support the care takers in achieving their goals. This means that requirements must be operationalized, so one can measure if the goal can be achieved. Definition of a requirement is "a statement about and intended product that specifies what it should do or how it should perform" (Sharp, Rogers & Preece, 2007, p.476). In this study the requirements taxonomy is categorized according to user requirements and system requirements. Defining only system requirements might lead to a user interface that is not user friendly, hence the user might not achieve his goal (Maiden, 2008). User requirements are formulated from the user's point of view, these include their needs and goals and what

activities they need to perform to reach their goals. System requirements follow out from the user requirements. System requirements are properties of the system and describe what the system actually does; software developers use these to build the system.

Requirements for the user

Often requirements are formulated with assumptions about the target group and their work environment in mind. But for a product to be successful, it is better to research the specific users to understand their characteristics and what s/he wants to accomplish (Chang, Lim & Stolterman, 2008). In this study it is crucial to know what care takers need of a monitoring device and what possible restrictions of use are. On the one hand a monitoring device needs to grab the attention of the care taker, while on the other hand it must not be interruptive in such a way that it influences job performance, perceived workload and stress (Hopp, Smith, Clegg & Heggestad, 2005).

In the current situation, the care takers have to divide their attention while it often occurs that at the same time tasks and events intervene which each other. In this complex event-driven domain, tasks and events compete for attention. Attention is needed to notice important changes in the environment (Rensink, Regan & Clark, 1997).

At the same time, certain signals from the system to the user can negatively interrupt the user's ongoing tasks and disrupt their prospective memory. Prospective memory is important when the user wants to resume the interrupted task. Task resumption depends to a great extent on environmental cues (Grundgeiger & Sanderson, 2009). Understanding of the context in which the monitoring device will be used is needed. One must consider the conditions such as light, noise and other environmental variables that influence performance (Fairbanks & Caplan, 2004).

The environment is more than the physical surrounding and the tasks that has to be performed in it. It also refers to the user's attitude and behaviour, which impacts acceptation and the interaction with the new technology. The new technology will be accepted and cause user satisfaction in its use when it extends and supports the user in their work (Holtzblatt & Beyer, 2011).

Discovering and measuring requirements

The Institute of Electrical and Electronics Engineers (IEEE) made a guideline for the systematic handling of requirements. It is considered as a requirements process, that involves complex, tightly coupled activities (IEEE Computer Society, 2004). For this study the activities within this guideline are used as a basis for discovering and measuring

requirements. Within these activities, diverse methods are applied. The guideline divides the requirements process in four types of activities: requirements elicitation, analysis, specification and validation.

At the *requirements elicitation activity*, the stakeholders are identified. The stakeholder's goals, domain knowledge and the operational environment are discovered. The viewpoint of the stakeholder is identified and represented. To achieve this, a user study will be done, which consists of a semi-structured interview with the user. Then a taxonomy is made according to the transcript.

The *requirements analysis* follows from the elicitation of requirements. The taxonomy will be analyzed according to the Grounded Theory and descriptive statistics. A persona that represents the user, will be created according to this analysis. This is the basis of creating a list of requirements. Then trade-offs have to be made between conflicting requirements by weighing arguments. Then the list of requirements will be prioritized according to the MoSCoW method.

Then the requirements will be *specified* in detail. Before defining the system requirements, it has to be decided what the form of the device must be. This decision is made based on the condition that the device must support all the requirements that will be implemented. Then, the requirements are distinguished according to user and system requirements, for which a detailed description will be given. With the choice of the device in mind, the system requirements can be described more concretely. For the primary requirements it will be decided on what level it should be automated. It will be distinguished what is automated by the monitoring device and what is operated by the user. This is done to avoid clumsy automation, when there is a poor coordination between the human and the machine (Wiener, 1989). This happens when the automated system creates new tasks which results in more workload, or through an increased complacency, which happens when there is to much trust on the system. Finally, an interface design is developed according to the results.

Last, by means of prototyping, the interface design shall be *validated* on task accomplishment and user satisfaction. The interface is tested on consistency, completeness, clarity and mistaken assumptions. The aim of this activity is to find problems before the monitoring device will be implemented.

The first three activities will be performed in the first study and the fourth activity in the second study. Figure 1a shows the flowchart of the first study design and Figure 1b of the second study design.

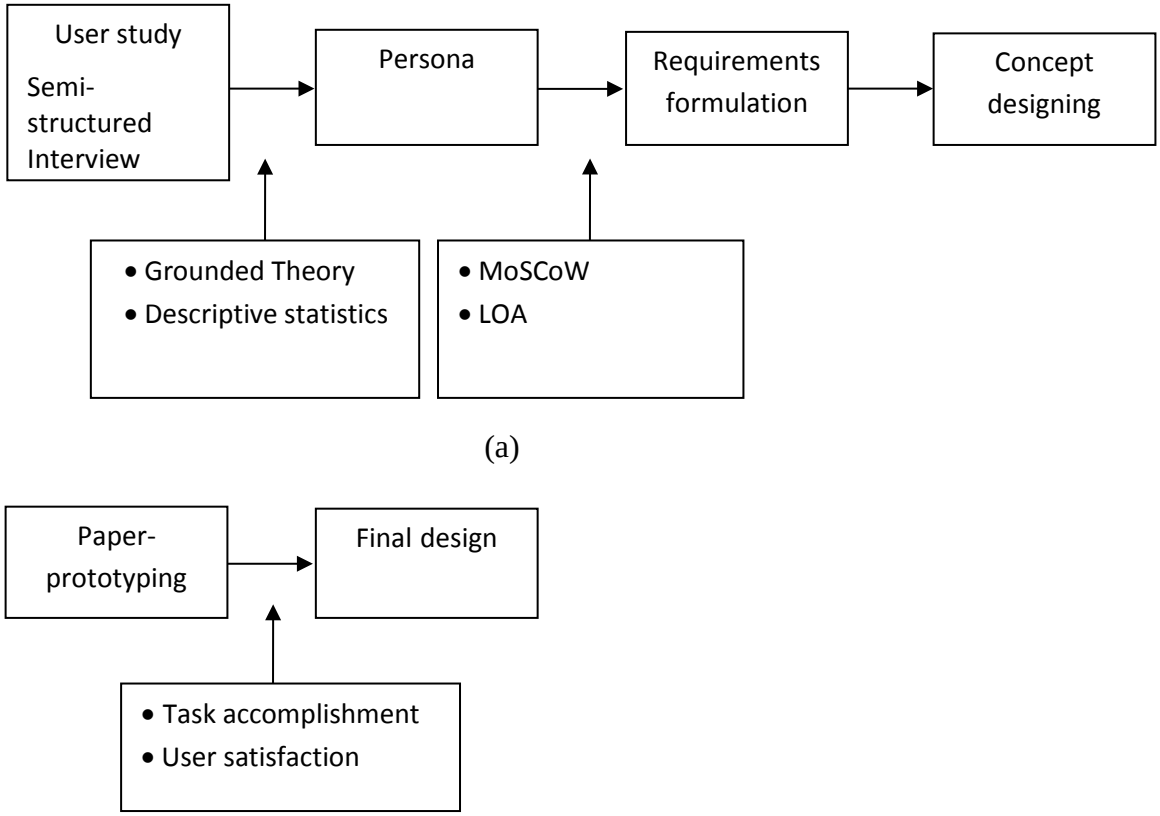

Figure 1. Flowchart of study design 1 (a) and 2 (b).

STUDY 1: From requirements acquisition and Concept Generation

Method

Participants

A nonprobabilistic sample has been taken. The nine care takers who participated before in the Moodradar project were invited to participate in this part of the study. Unfortunately three of them weren't able to participate. The interviews took place took place at DTZC. Five women and one men were available to participate. Age ranged from 26 to 54 years (M = 36.33, SD = 11.54). Experience with working with mentally disabled clients ranged from 4 to 37 years (M = 16.42, SD = 13.22). Working at DTZC ranged from 3 to 27 years (M = 12.75, SD = 9.75). There are a few places where participants work: at the residence of the clients (66.7%), a combination of working at the residence of the clients and daily activities (16.7%) and at school (16.7%). Functions differ from personal care taker (66.7%), group accompanier (16.7%) and a combination of group accompanier and class assistant (16.7%). Prior to the research a pilot interview had been conducted. A care taker
working at the dr. Leon Kannerhuis, a research institute for autism, gave suggestions for topics and formulation of questions after the interview had been conducted. These suggestions were used for the interviews but the answers of this specific interview were not analyzed.

Materials

For the requirements elicitation a semi-structured, one-to-one interview was conducted. This qualitative approach was suitable for exploring user requirements (Karlsson, Dahlstedt, Natt och Dag, Regnell & Persson, 2002). The advantage of an in-depth one-to-one interview is that it can ensures confidentiality; it can be difficult for participants to admit towards their colleagues they encounter difficulties with clients or with work circumstances.

Structured questionnaire. Two items were measured, attitude and experience with consumer technology. Attitude of working with new technology and changing work circumstances, general predisposition towards the use of a monitoring device is decisive for its success (Kukafka, Johnson, Linfante & Allegrante, 2003). For measuring attitude, ten questions were asked, which is sufficient for assessing the attitude construct (Ajzen, n.d.). These items are often measured on a five or seven-point semantic differential scale and assessed on a set of bipolar adjective pairs. Participant chose the number that best described their opinion. Questions existed of two components: feelings/evaluation (e.g.: *Do you think*

that the application that warns you when the arousal of clients is increasing, will contribute to quality of work?) and potential actions (e.g.: A*re you prepared to work with an application that supports you at work?*). Semantic differential scales provide reliable quantitative data for measuring attitude (Passmore, Dobbie, Parchman & Tysinger, 2002).

Having experience with consumer technology has implications for the design. The ease of learning is different for different type of users, novice users prefer other type of feedback than expert users (Wu, 2000). For example experts prefer shortcuts and an efficient interface, while novice users need an easy to use interface with lesser features. Four questions were asked: possession of consumer technology, experience with the use of consumer technology, experience with the use of applications on consumer technology and intention on buying consumer technology in the near future.

Unstructured questionnaire: The unstructured part was explorative and accordingly contained open-ended questions. Questions about demographics were asked first and consisted of six questions. Then 55 open-ended questions were asked, covering nine themes. Themes that might operationalize the components of the research question were postulated. *Physical work environment*: one should know the environment where the monitoring device will be used, to understand its possibilities and restrictions (Johnson, Johnson & Zhang, 2004). *Clients, daily work tasks, interfering work tasks* and *incidents*: take into account the workload and work conditions (Jennings, 2008). 3. *call for help* and *supporting tools*: what tools are currently used when problems occur and how colleagues are organized when there is a need for help. To give an overview of team composition and workflow in the work environment (Anderson, Gosbee, Bessesen & Williams, 2010), 4. *future system*: their mental model about a future supporting tool and their needs and wishes of it. A set of questions was covered in the interview, but the course of interviewing was still flexible in the sense that the interviewee could talk about other important issues and themes with regard to the requirements. The participants were stimulated to expand upon their answers. Probes where used to get more information on a topic or answer, e.g. “Can you tell me more about what you did in that situation?” or key responses “You say that sound would be harmful, can you describe what happens then?”. Prompts were only given when a participant didn’t know what to answer e.g. “What would you like to configurate on such a system?”, a prompt would be “For example muting the alarm”. This often worked as a catalyst for more ideas.

The interview questions of both the structured and structured part can be found in Appendix A.

Procedure

A week before the interviews took place, participants were sensitized and introduced to this study. Sensitizing is "a process where participants are triggered, encouraged and motivated to think, reflect, wonder and explore aspects of their personal context in their own time and environment." (Sleeswijk Visser, Stappers, Van Der Lugt & Sanders, 2005). This was done by emphasizing the importance of participants' contribution. Furthermore, the unstructured interview questions were emailed beforehand, to encourage the participants to prepare themselves for the interview. Participants were asked to keep track of a self-report on a daily basis, in which they could reflect on the questions, how they relate to it and how they experience it (Liang, Rau, Zhou & Huang, 2011).

Before the interview started, the procedure was explained to the participants and a consent form was signed by them when the procedure was understood. The self-report could be used by the participants as a reference. The unstructured questions were asked first, the structured questions last. A placemat with an adapted version of the triangle of experience (Kabat-Zinn, 1990) was given as a prop for expressing participants experience (Figure 2).

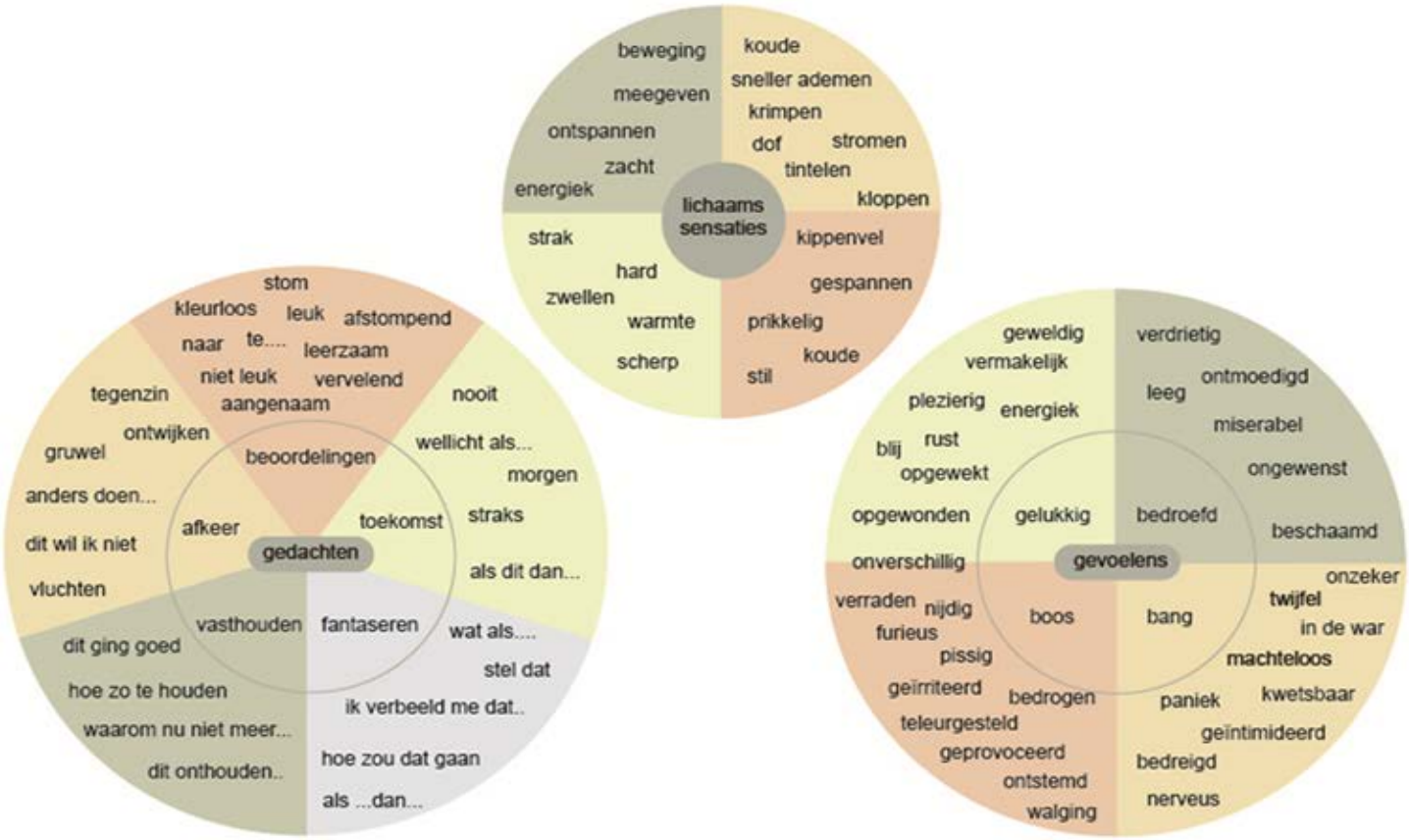

Figure 2. Triangle of experience in Dutch. The first circle consists of thoughts, the second consists of physical sensations and the third circle consists of feelings. Every colored segment

of the circle contains the same type of experience. When questions about experience was asked, the interviewer referred to the placemat as a possible assistance for answering the questions.

Data Analysis

Inter-rater agreement. First the degree of agreement of the coders on the label system was measured. This was done by labeling an interview by two independent coders; the assessors both applied independently the current developed label system on the interview (Appendix B). If both assessors came to the same result, the label system was considered reliable. This is calculated by the ratio of agreements to disagreements. Then Cohen's Kappa (1960) was measured, it is a statistic that takes into account that observers sometimes (dis)agree by chance. A kappa value under .41 indicates an agreement equivalent to chance, between .41 and .60 can be considered as a moderate agreement, between .61 and .80 as satisfactory or solid agreements and above .80 as nearly perfect (Everitt, as cited in Burla et al, 2008).

Structured questionnaire. Analysis for the close ended questions existed of descriptive statistics. Of the attitude the mean and standard deviation was measured. Of the experience with consumer technology a summary was given.

Transcription of the interviews. The interviews were transcribed on the computer and analyzed with Atlas.ti software. The focus of this study was exploring general themes and patterns. Henceforth for the level of detail in transcribing it was chosen not to transcribe all utterations like *ehm* nor incomplete sentences, unless it would change the intention or meaning of the comment (McLellan, Macqueen & Neidig, 2003). Nonlinguistic observations were transcribed when participants made gestures on how to work with an object or device. The taxonomy can be found at Appendix C. A description of the taxonomy and an improvement of it can be found in Appendix D.

Unstructured questionnaire. The Grounded Theory methodology was applied for evaluating the data. It is a qualitative method for systematically analyzing data according to some well-defined procedures. The Grounded Theory follows three stages of analyzing: open coding, axial coding and selective coding (Corbin & Strauss, 1990). Though Grounded Theory finds its origin in social research, it is also useful for designing user experience and generate design ideas (Swallow, Blythe & Wright (2005).

First stage was to conceptualize the transcripts on the first level of abstraction, by the heuristic technique of open coding to reduce the data into meaningful categories, enabling to organize the text. The type of codes were clustered by differentiating core labels from sub

labels and checked by comparing fragments that were labeled by these codes. Codes that have the same meaning were merged into one code. Several rounds were used to code the interviews as advised by Boeije (2005). After the first round two interviews were analyzed, and the first collection of labels formed the first version of the label system. At the second round, again two interviews were analyzed and iteratively a final version of a label system was developed, where (key) themes where defined. For the four interviews a selection has been made: three women and one man, whereby two of the women where older (>45 year). With the new label system, the last two interviews where coded. It was found that the codes covered the two interviews which means that after four interviews the point of saturation was reached. The text fragments fitted well under the themes. New dimensions were added, but it didn't change the label system.

Next stage was axial coding according to a coding paradigm to understand how themes relate. It involves the phenomenon (the central idea, what is being managed, arising from conditions), conditions (events, incidents, time which lead to the phenomenon. Also what facilitates or constrain strategies like economic and cultural conditions), the context (under which the conditions takes place, like location of events), strategies applied (actions and interactions among actors to handle the phenomena) and consequences (of these actions). Axial coding is a good guidance, because it shows how themes relate to one another: changing conditions and how actors respond to it and what the consequences of these actions are; pragmatic for understanding the work environment of care takers, how they act on it and where to find opportunities to improve it.

Last stage of the coding procedure is selective coding, where the themes are connected in a narrative form and refinement of the themes. A list of requirements followed from this analysis.

Persona. A persona describes key characteristics of the user and is written from the user's point of view. A persona is a tool to create interfaces and products (Cooper, 1999). The analysis of the selective coding was used as input for creating the persona. Hence the characteristics of the persona were grounded in the empirical data. The claims made in the interview justify each relationship between the themes (Faily & Flechais, 2011).

Prioritization. The list of requirements needed to be prioritized. Without implementing the most important requirements, the application will fail. The less important requirements can be implemented at a later stage. One requirement prioritization method is the MoSCoW method, developed by Dai Clegg in 1994. The MoSCoW method is a prioritizing method suitable for a small number of requirements (Ma, 2009). Requirements were categorized

hierarchically on a nominal scale. Because the categories were ordinal scaled, all requirements in one priority group have the same priority (Hatton, 2007). The four priority categories stands for “Must have”, “Should have”, “Could have”, and “Won’t have”. All requirements under the “Must have” category are non-negotiable and have to be implemented. The "should have” category represents requirements that are highly desirable, but without them the system is still usable. “Could have” requirements are nice to have but not necessary, it contributes to user’s satisfaction; the choice for implementing these requirements in this study depends on how complex the system will be with those requirements. “Won’t have” requirements are out of scope and will definitely not be implemented (Coley consulting, n.d).

The decision of categorizing the requirements was based on the weight of arguments. Often participants indicated how important something is and why. An example is if an emergency alarm should make a sound: *"There should be a sound when a colleague alarms. In such a situation you want colleagues to be with you immediately, within seconds. The type of sounds makes you think like: I have to go now!"*. Sometimes the trade-off was made by the researcher. For example one participant mentioned that s/he wanted different signals for every client in the group. This wish would give problems with designing for learnability: the user should learn all eight signals as well as all other signals that will be implemented. This would lead to a more complex application.

Requirements specification

User and system requirements. The user requirements were translated into system requirements. System requirements are more explicitly defined in what the monitoring device exactly does and are used for the implementation of the application.

Level of automation. The aim of this study is to find requirements that signal for upcoming arousal. This suggests that the monitoring device is to some level automated. For every primary requirement it is determined on which stage of information processing it finds itself. Then it was determined on what level it should be automated according to the model of Parasuraman, Sheridan and Wickens (2000). The first stage is information acquisition, where stimuli is perceived and processed via the sensory system. In a low LOA, these stimuli is presented as objective raw data and in high LOA this data is filtered, where the system shows the user the most important information to attend on. At the information analysis stage, these stimuli are processed with cognitive functions like the working memory, needed for situational assessment. At a low LOA, the operator is allowed to give input into decision making. With a high LOA all data is combined to a single value. At the stage of decision and

action selection, a decision has to be made between several alternatives. Finally at the fourth stage, an action is executed consistent with previous stage. At a low LOA, the operator is performing the actions while at a high LOA the system makes the decision, without consulting the operator.

Results

Attitude

Internal consistency was measured to determine if the attitude scale was reliable. Analysis of the ten questions showed a Cronbach's alpha of .917, which indicated a high level of internal consistency; according to George and Mallery this is an excellent output (2003, p.231) To determine the attitude of working with new technology and changing work circumstances descriptive statistics were calculated. The mean of the attitude towards it was M = 4.5 on a scale of 1 to 5, where 1 stands for a low attitude and 5 for high attitude (SD = .71).

Experience with consumer technology

Four questions were asked about the use and experience with consumer technology. All six participants had a mobile phone and a computer, which are used on a daily basis. Five possess or have experience with a tablet. One person didn't had experience with applications, though had some experience with a tablet and an e-reader. Two participant just bought new consumer technology, two were going to purchase it soon and two were not planning to buy in near future. Experience varied between novice users and expert users, with a tendency towards the former.

Requirements analysis

A total of twenty themes emerged from the data during the open coding phase (Appendix B). The inter-rater agreement on the twenty themes ranged from .11 to 1.00, with an average of .64 and an overall Cohen's Kappa of $\hat{k}$ = .61. The kappa value of .61 can be considered as satisfactory.

Axial coding. The core phenomenon evolved from the data and is identified as arousal, for both the care takers and clients. All other major themes related to arousal. It appeared 18% in the data, a total of 511 codes were applied to the interviews of which 92 related to arousal.

Even when conditions vary, the explanation holds. It changes how high or how low arousal will be. Figure 3 shows the model of dealing with arousal, constructed from axial coding.

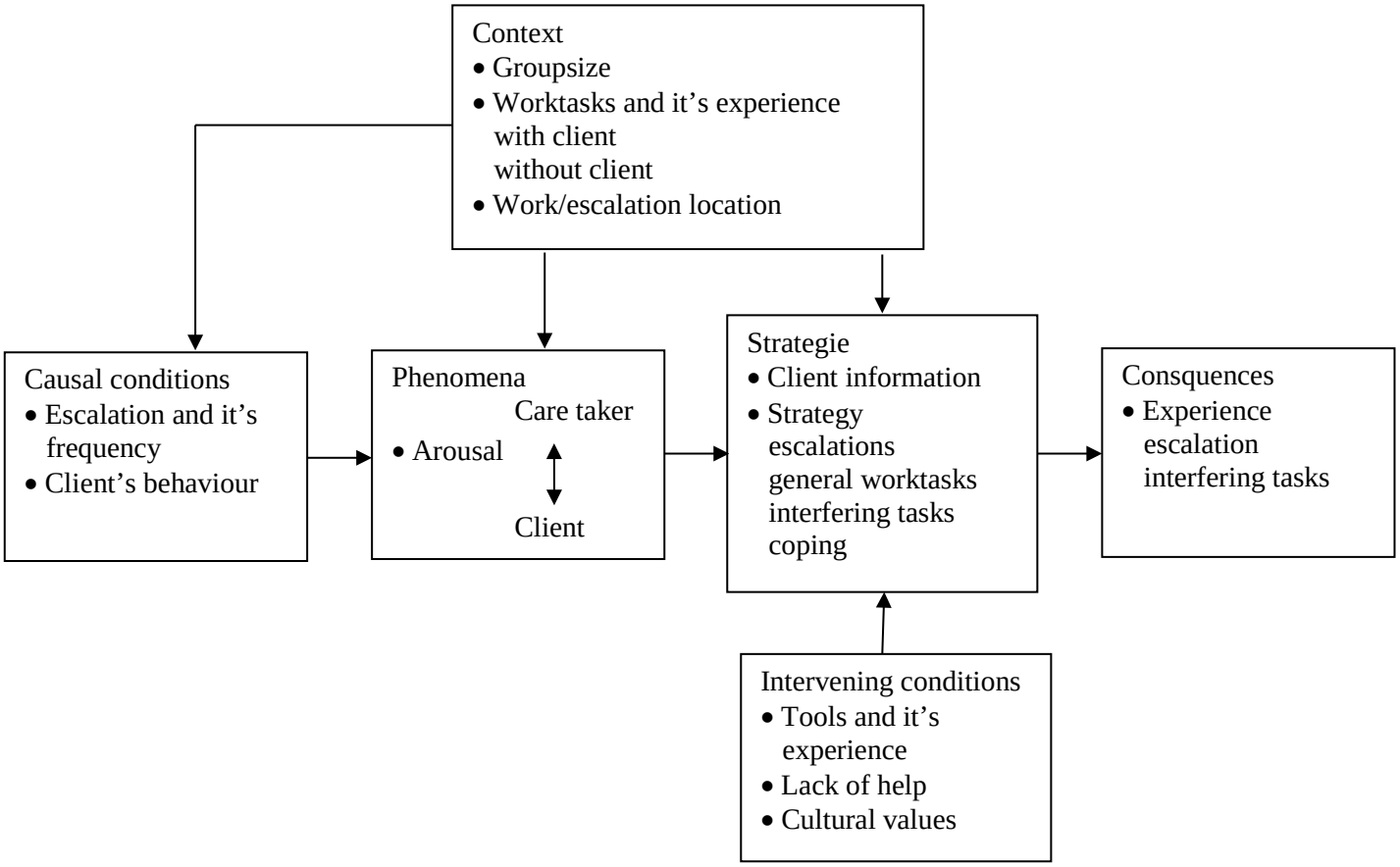

Figure 3. Model of dealing with arousal. The codes are categorized according to the phenomena, causal conditions, context, strategy, intervening conditions and consequences.

Selective coding. For the participants their own well-being, but mainly the well-being of their clients is of paramount importance. Even before the start of this study, they thought of ways to create an environment without stress and tension. Both client and care takers' arousal can be considered as the phenomenon, because they continuously influence each other. The main causal condition of the phenomenon were the escalations that takes place and clients behaviour, which ranged from threatening behaviour to making humming sounds the whole day, which affects both the care takers and the other clients arousal state.

Care takers tried to work pre-emptively; when they noticed an increase in clients' arousal, especially at the beginning of client's tension that is important. Then it was still possible to change client's mood, by applying the behavioral intervention plan (Gedrags Interventie Plan, GIP). It described how to handle a specific client for a specific stage of

arousal. Care takers were supposed to know the GIP by heart, though the participants understood that new people working at DTZC don't always knew it. When increase in tension is not noticed, it could end up in an escalation. When that happened and it was not possible anymore to communicate with the client, they applied the Facet grip and brought the client to the time out room. Often this couldn't be done alone and a they called colleagues for help with a beeper or walkie-talkie. Helping a colleague is of the highest priority, everything s/he is doing is dropped and their own clients are brought to their own rooms first. Then they rushed to their colleague to help. Beforehand it is told where they approximately would be. Often it happened that a colleague has been called pre-emptively in an urgent situation to help to soothe. Sometimes they stepped into the situation too late, sometimes too early which resulted in a situation that still escalated, which normally wouldn't have happened. A self-strategy care takers apply to decrease their own arousal is to evaluate the situation with their colleagues and ventilate their emotions. Feedback is given how to do it different next time. Care takers not only work with the clients, they have administrative tasks too. Client evaluation and fill out forms is done on daily basis at the end of the day at the office, or when there is an opportunity, somewhere in between activities so salient details about e.g. escalations were not forgotten. When a care taker went to the office, the client had to be left alone.

These strategies were influenced by contextual markers. It was difficult to watch clients while doing instrumental activities in the house or doing an activity with another client because the houses don't have a clear overview. Often care takers were tied up in the many tasks that were not done efficiently so there was less time to be with a client. Administrative tasks couldn't be done efficiently and cover a lot of time. Altogether it could cause care takers stress which they weren't always aware off, because they are continuously occupied. Their tension in return influences the clients' mood and behaviour.

In addition to context, intervening conditions also influenced the strategies. Current tools were not sufficient enough to do something about these causal conditions. Observation of clients was not always sufficient enough to see an increase in arousal, even though the care takers were trained well. Also it was difficult to keep an eye on colleagues, when they were not nearby. When something happened, current tools were not always sufficient enough to ask colleagues for help. Beepers didn't gave enough information, it didn't show the location of the escalation and the rushing colleague couldn't anticipate because s/he didn't know the clients arousal state. A walkie-talkie is ergonomically difficult to use in a situation where one needs to react quickly. In case it wasn't possible to use those tools, they screamed for help,

which resulted in not getting help on time. Cultural values seemed important in how self-strategies were applied. In some teams care takers stimulated each other to share their experience and gave suggestions, while in other teams did not dare to open up to their colleagues, because of negative response.

As a consequence of an open culture, care takers felt better and learned from the situation after applying self-strategy. This doesn't mean that they felt quit all right. After an escalation where again the same client acted aggressively towards the care taker, there was a feeling of doubt about themselves and powerlessness and sadness because they didn't understand why the client went out of control. As a consequence of the high workload which also contains inefficient administrative tasks, care takers felt often frustrated.

Changing the context is out of the scope of this study but needs to be understood for developing the requirements. However, the conditions that facilitate the increase of tension of both the care takers and the clients, could be changed. These facilitating conditions were mentioned by the care takers and emerged after coding the interviews. From the selective coding it can be concluded that at the whole shift and everywhere on the DTZC, the monitoring system must be available to 1. easily warn colleagues when there is an emergency, with information on who is asking for help and where s/he is, so help can be there on time, 2. notify when tension of the care taker self is increasing, so s/he can take a time out instead of continue with the current activity, 3. notify when client's status is changing, so one can work pre-emptively and 4. work more efficiently on administrative tasks.

Persona

Wendy, 45 years old, works for 18 years now at DTZC. She really enjoys working with mentally disabled clients, to help them making their lives more pleasant. She is a personal companion for eight clients. But sometimes she feels powerless. For example, a week ago when she was walking with Andreas to the farm he suddenly became mad, pulled her hair and kicked her. She used her training to get loose of him and took her distance, then she pressed the button on the beeper to call her colleague Peter for help. As a protocol, she already told him what her walking route would be, so he would approximately know where she would be. Where did Andreas' anger came from so suddenly? Was it actually that sudden or was his arousal increasing while she didn't notice it? If she would have known that he already was in stage 3, she would

have gone back to the house and change his daily program; she could have anticipated on the possible escalating situation. Also, if Peter would have known that Andreas arousal was increasing and where she was exactly, he could have come earlier to check on the situation. Thinking about that situation gave her the chills again. Luckily, she could ventilate her feelings with her colleagues afterwards and evaluate what went wrong. It would have been nice if she could have seen her own behaviour. Peter told her that she was already a bit tensed that day and was talking louder than she normally does. In general it is known to her and her colleagues that Andreas is a very sensitive person, maybe he felt that she was tensed. It would help a lot if she could manage her emotions when she is with the clients but the thing is that she needs to be aware of it, which is not always the case. She knows for sure that her own mood and certainly her tension influence the client's mood… She suddenly remembers that she has to make a dentist meeting for Ahmet, another client within the team. Dentist practice is closed now, so she has to call tomorrow. Ah, her agenda, she left it at her office! On the table she finds a pen and writes the reminder on her hand, before she forgets it. Back to Lucy, with whom she was playing with the ball, throwing it at each other. Suddenly she hears her colleague Maria calling for help. Immediately Wendy jumps up, says to Lucy she has to play alone for a few minutes and runs to Ahmet's apartment, where they probably are. When she opens the door, she sees Maria taking steps backward and covering her head. Full of adrenaline, Wendy spurts to Ahmet and with Maria they use the Facet grip and bring Ahmet to the time-out room. If only she would have known what happened here, seen that the situation between Ahmet and Maria would escalate. She could have helped sooner so this wouldn't have been confined. It would be wonderful not to have this kind of situations anymore, so it would give more peace to her, her colleagues and the clients. She would even learn new ways of working, if it would contribute to the quality of her relationship with the clients. Wendy read an example of it in a journal, where care takers of an healthcare center for autistic clients used some kind of device to see when the clients become aroused. It could even be used here, if such an device wouldn't be too difficult to use of course; she remembers the time when she had to learn to use her mobile phone and the computer, it was a bit exciting but she is glad she can operate it now. Looking at Maria, she could tell that she is sad: red spots in the neck, eyebrows down; Maria never gets used to escalations. Wendy offers a cup of coffee so Maria could calm down. With a shaking voice Maria talks about how she feels and doubt on what went wrong. What should she have done differently? After a few minutes they go back to their activities. Ahmet is calmed down too and is allowed to

watch television with Lucy. Wendy confirms to Maria that she will watch Ahmet for a short while, so Maria can go to the office and fill in her evaluation forms.

Requirements specification

MoSCoW. 17 requirements were constructed from the persona. These requirements were devided in three categories: *monitoring, administration* and *evaluation*. Next the requirements were labeled according to the MoSCoW method. The monitoring category consists of 6 “Must have”, 2 “Should have”, 1 “Could have” and 1 “Wont have” requirements. The administration category consists of 4 “Should have” and 1 “Could have” requirements. The evaluation category consists of 2 “Should have” requirements (Table 1).

Device. According to the “Must have” and “Should have” requirements and arguments of the care takers, it is decided that it should be a small wearable device because it is always available and the care taker can keep it for him/herself: "*If it would be something that I have with me, that notify me when someone’s tension is increasing*" (pp#1); “[The device] *must not send to much stimuli to the client*” (pp#4); "*When I have to arrange a lot I don't have much time for the client. But when I have something in my pocket [...] I can stay with the client*" (pp#3). Within the frame of existing devices, a smartphone could meet all wishes. A smartphone is a multi-functional device that can support all requirements, so that no other devices are needed: *“I already have a beeper, a walkie talkie, keys and then I have to carry a phone with me too. I would think that I could better wear a belt with those leather bags at it; that would be too much. But if it would be integrated in something..”* (pp #5). The gestures that are used to interact with the smartphone as described in Table 1, are explained in Appendix F.

Level of automation. For the requirements that have a signaling characterization, the level of automation was defined. These requirements were 1. *signal arousal client to care taker and team,* 2. *Make an emergency call to a colleague,* 3. *Receive an emergency call from a colleague* and 4. *Signal the arousal of the care taker self and show how it relate to client’s tension*. Table 3 shows the automation level of every requirement.

Concept design

With the input of the requirements specification, a concept design was generated. Figure 4 shows the wireframes of most pages of the application. A navigational scheme shows how the pages are connected.

Table 1. Requirements taxonomy

The user requirements were distilled from the persona and were prioritized according to the MoSCoW method. Every user requirement shows a quote related to these issues, translated from Dutch. A solution for the user requirement is given in the following column. The system requirements describes what the device concretely behaves. The requirements were grouped to its function: monitoring, administration and evaluation.

#	Priority	User requirement	Concrete solution	System requirement
		Monitoring		
1.1	M	Want to know when arousal of client increases and in which stage it is. *"Yes. I think that would be useful [to know in which phase clients tension is]. It can happen, that someone's tension can increase at once, than you have to react differently than when someone is at the initial stage of tension"* (pp #4).	It starts warning when arousal reaches stage 1 and further. On the screen it shows the phase. It keeps alarming until the user mutes it. It doesn't alarm on decrease of arousal. Not warning when client is playing sports, otherwise it would continuously set off.	It vibrates when arousal reaches stage 1. Without any action a graph on the screen that shows the arousal as a red blinking dot. Graph line is coloured: between phase 0-1 it is green, 1-2 = yellow, 2-3 = orange, 4-5 = red. After muting the system has a 10 minutes cooldown, in which the system is not warning for that client again until reset. Learn the system that the alarm doesn't set of when "day activity = sport". Alarms the whole team. After 10 minutes the screen sets back to the primary page, the client page Gestures: Vibrating stops when a mute button is pressed. See history of arousal by flicking the graph to the right and see the trend by flicking to the left, as

				mainstream applications have. Zoom in by pinching and out by pinching out on the graph.
1.2	M	Whole team should be warned when one of their clients tension increases. *"That you can warn your colleagues with the device. Let's say something happens in the classroom, that I can indicate that they should keep an eye on me, because my client is tensed."* (pp #6)	It starts warning when arousal reaches stage 1 and further. On the screen it shows the phase. It keeps alarming until the user mutes it. It doesn't alarm on decrease of arousal. Not warning when client is playing sports, otherwise it would continuously set off.	It vibrates when arousal reaches stage 1. Without any action a graph on the screen that shows the arousal as a red blinking dot. Graph line is coloured: between phase 0-1 it is green, 1-2 = yellow, 2-3 = orange, 4-5 = red. After muting the system has a 10 minutes cooldown, in which the system is not warning for that client again until reset. Learn the system that the alarm doesn't set of when "day activity = sport". Alarms the whole team. After 10 minutes the screen sets back to the primary page, the client page Gestures: Vibrating stops when a mute button is pressed. See history of arousal by flicking the graph to the right and see the trend by flicking to the left, as mainstream applications have. Zoom in by pinching and out by pinching out on the graph.
2	M	Activate an emergency call to a colleague. *"When it really is going to escalate, that we can press on an emergency*	By pulling a string from the device or pressing the emergency button on the screen.	Activating by pulling a small string from the jack of the smartphone. Optional to tap it on the screen Feedback on the screen that alarm is switched on. It vibrated as feedback that it was activated.

		system, so several colleagues can come" (pp #3)		Gestures: Reset by putting the string back in the jack or tap the stop alarm button.
3	M	Getting an emergency call from a colleague. *"In an emergency situation yes. When it has an SOS button, alarm bells should go off, that you think: I have to go now."* (pp #1)	A loud sound sets of, so one knows that s/he have to rush to their colleague.	Device makes a loud sound Vibrates too Without actions, shows a map of where the alarm is set off. Gestures: Vibration and sound stops when tap mute button. Set volume by pressing the sound buttons on the side of the device.
4	M	Want to know when arousal of care taker self increases and how it relates to clients tension. *"Now we only talk about the client [...]. But with Moodradar it was supposed to find out what influence your own increase of tension has on accompanying of clients. [...] I'm convinced that that is the case. [...]. But how, what and when..."* (pp #2)	It starts warning when arousal reaches phase 1 and further. On the screen it shows the phase . It keeps alarming until user mutes it. It doesn't alarm on decrease of arousal. It can be compared with clients arousal in one glance. Visual comparison more clear than a text that says that being aroused.	It vibrates when arousal reaches phase 1. Arousal in same graph as clients, but as a grey line. Only visible on own device. Gestures: Vibrating stops when a mute button is tapped.
5	M	Location tracker shows where the	When a colleague uses the alarm	Without actions on the screen of receivers.

		emergency is. *"It would be perfect if you can read on the beeper the location, where you are on the terrain." (pp #3)*	function, colleagues in the team sees the location where the alarm is activated with the name of the activator.	Mini map with recognizable buildings and names, with a blinking red dot. Name of the activator visible. Mapping and localization with RFID Technology through active RFID trilateration, because GPS doesn't work well indoors. It is used for moving objects. Gestures: Pinch-in or -out to zoom in or out on the map. Map stays visible until it is tapped away. Confirmation asked, respond by tapping on yes or no button.
6	S	Reading the GIP. *"Suppose that an alarm goes off when client is in phase 2. That by linking I can get to the interventions that I can do; of course that differs per client."* (pp #5)	Show the GIP of a selected client when one asks for it.	GIP option is accessed on clients page. Within that function choose the phase to read about it. In case the client is in a certain phase, it jumps to the information corresponding to that phase. GIP button lights up when client is aroused. Gestures: Tap on GIP button and flick through the information.
7	S	Video or audio observation of the client. *"Audio or video support, things I do not hear like when something happens with* [name client]*, that I*	Check on clients and what they are doing when not in the same environment, even if arousal is not increasing.	Camera's only in rooms where they already are, where consent is given by the guardians of the clients. Video images can be seen at clients profile. Gestures:

		get a sign that something is going on." (pp #1)		Tap on video option to show video and/or hear sound. Sound can be muted by tapping on mute button.
8	C	GIP of the care taker. "*Maybe it would be useful via de computer information like: we measured this, try this or try that. I think advice is always good, you can always learn.* (pp #4)	Information on what to do when the care taker gets aroused.	Information button with tips like some relaxation techniques. Gestures: Tap on button and flick through the information.
9	W	System in the environment, e.g. objects in space. *"That when I see a light flickering, that I check what is going on? Yes, I am prepared to do that. Size up the situation."* (pp #1) *Administration*	n.a.	n.a.
10	S	Fill in forms digitally. *"I would prefer something like a phone, that afterwards I could enter my report immediately.* [...] *We have an eight hour shift, that you have to think about what happened then, but instead you can do it immediately; it*	Fill in all forms digitally. Advantage that it can be linked to the client and his /her EDA data. Optional: some care takers might want to fill it in on paper or on their computer, like in current situation. Also find all documentation	Empty and filled in forms are accessed via the administration page or on clients page. Saving the form with the save button or cancel it. At the graph of the client an icon that a FOBO has filled in for that time. Not necessary to finish the form immediately. When going to another page, all information is kept in the device's memory. At the administration page an

		would also save much time, that would be really nice. I would wear such device everywhere, so I can reread things and can make notes." (pp #5)	digitally: *" I would rather see everything digital.* [...] *Everything is in one place, you don't have to look in the computer for reports or e-mails and take folders* [...] *and have to print out the FOBO. Is more easier for me as PB, if I have to verify everything that I have a clear overall picture, that I do not have to get two, three folders."* (pp #3)	icon shows that a form has to be finished yet. Daily program of the client is available on the client page. Gestures: Tap administration button. FOBO can be accessed too by tap + hold on the graph at the moment escalation happened. At the form, name, time, phase and activity are prefilled. Optional to drag and drop a FOBO marker. Activity under the graph can be changed by tap + hold: a list with activities appears. Tap to choose that activity or type it. This is automatically changed on client's daily program, with time of editing and by whom. Type text by tapping on the text field.
11	S	Read and respond to e-mail. *"When I carry a device, that I already can check my e-mail or fill in a part of the reports. When everything is digital, I can take care of it while doing other activities. Maybe that would save some time."* (pp #3)	Can settle work related e-mail while being with the clients.	Accessible on administration page Private, not accessible by the team. Gestures: Tap the e-mail button.
12.1	S	Agenda: personal	Everyone has their own personal agenda where they can make	Is private and only accessible with own device. Option to have a to do list with a checklists.

		"Currently not so pleasant [experience of private notebook], *I cannot place it just everywhere. So then I put it on top of my mailbox, which means that I cannot grab it any moment I need it. I like to see what I have to do, there are always tasks that have to be done. If I don't have it with me, it happens that forget to do tasks."* (pp #1)	notes and plan meetings.	Gestures: Tap the personal agenda button. Checking the to do list by tapping on checkbox.
12.2	S	Agenda: team *"It happens occasionally* [missing an appointment noted in the agenda or daily program], *when I'm very busy. But often I am the one who helps to remember others"* (pp #4)	Agenda that is used by the whole team	Accessible and edited by whole team. Option to have a to do list with a checklists. When editing, that person's name and time of editing is noted. Gestures: Tap the team agenda button. Checking the to do list by tapping on checkbox.
13	C	Make notes at client's graph. *Evaluation*	Notes about unusual happenings or how a situation has been solved. Might help discovering patterns about why a client is getting upset. Also to help each other. Printed on monthly output with the digital colourcards.	Accessible by the whole team at client's graph. Icon on the graph shows that for that point a note is made. Gesture: Tap + hold on the graph, like the FOBO. Popup where one chooses to make a note. Optional to drag and drop a marker. Open or edit a note by clicking on its icon on the graph.

14	S	Digital colourcards, to discover patterns about clients tension. *"Colourcards can be made more efficient, if you can click on it on the computer. Currently we write and we colour* [manually], *it is double work. But the coloursystem is nice, the overall picture. For every month you can see where client's tension was, for which days or which part of the day.*" (pp #4)	Information about the phase of arousal, activity, time of the day and notes are send to the computer, which generates the graphs.	Data from the device generates a graph on the computer and saves it in a database.
15	S	Video or audio observation of the care takers. *"That's nice, video recordings are used here sometimes. In some situations where there is tension and video recordings are made, to see how one acts.* [...] *Often when you see yourself in a certain situation I think: did I do this? You can do something with that."* (pp #4)	Possibility to record oneself with the device and controlled by themselves. Not obliged: *"I know from a lot of people from the neighbouring group that they feel watched and don't want to participate in it."* (pp #3)	Smartphones already have a build in camera. The video is saved on a cloud and send to the computer instead of on the device (disk space will be full soon) and be reviewed via de smartphone or computer. - Video on the screen, with a button to save the video or delete. *Gestures:* Controls same as other video players. Tap on save or delete.

Table 3. Level of automation of user requirements (UR).
The requirements classified according to the processing of information.

Information acquisition	Information analysis	Decision and action selection	Action implementation
UR1: Signal arousal client to care taker and team			
High-Level Automation Support of Info Acquisition	Full Automation Support of Info Analysis	Automated Decision Support	Manual Action and Control
EDA data was received from the sensors and sent to the mobile device. The raw EDA was measured in micro siemens, but this was not shown to the care taker. Interpretation of it (phase) was shown in context of its history System observes the client, but the care taker had still an important function in observing the client and gathering information Graph could always be consulted. It could already been relevant when it was rising to phase 1 Prioritizing clients was done by the care taker. Vibration attracted attention.	System was alarming when stage of arousal reached phase 1 Graph showed the trend and context of arousal Graph gave an interpretation of the phase, by coloring it which was linked to the severity Valence of arousal was not given, care taker must interpreted it	System didn't gave directions on what to do, it depended on the care taker Optional to consult the GIP for help, but the care taker had to ask for it. It attracted attention by blinking softly It was up to the care taker which situation prevailed, e.g. when two clients were aroused, the system didn't mention who to help first	Care taker had the choice to intervene in the situation or walk away
UR2: Emergency call to a colleague			
n.a.	n.a.	Human Decision Making	Manual Action and Control
No information acquisition	No information analysis.	The system didn't gave advice on when to call for help, even if the	Care takers had to activate the alarm, it didn't activate by itself,

		client was in phase 5	even if the client was in phase 5

UR3: Receive emergency call from a colleague

High-Level Automation Support of Info Acquisition	High-Level Automation Support of Info Analysis	Human Decision Making	Manual Action and Control
All devices of the whole team received the signal from the activator's device The signal was translated in a map on the screen with the location of where it was activated and by whom. Device vibrated and made a sound	The location was shown by a blinking red dot	Care taker was forced to see the map and the blinking dot, but there were no options given on what to do	Care taker decided on helping his/her colleague

UR4: Signal arousal of care taker self and show how it relate to client's tension.

High-Level Automation Support of Info Acquisition	Full Automation Support of Info Analysis	Human Decision Making	Manual Action and Control
EDA data was received from the sensors and sent to the mobile device. The raw EDA was measured in micro siemens, but this was not shown to the care taker. Interpretation of it (phase) is shown in context of its history Care taker had still an important function in observing him/her self Graph could always be consulted. Vibration attracts attention.	Showed the context with the trend and how it related to client's tension	Possibility to read the GIP, but the function didn't attract attention.	Care taker decided on what to do with his/her tension

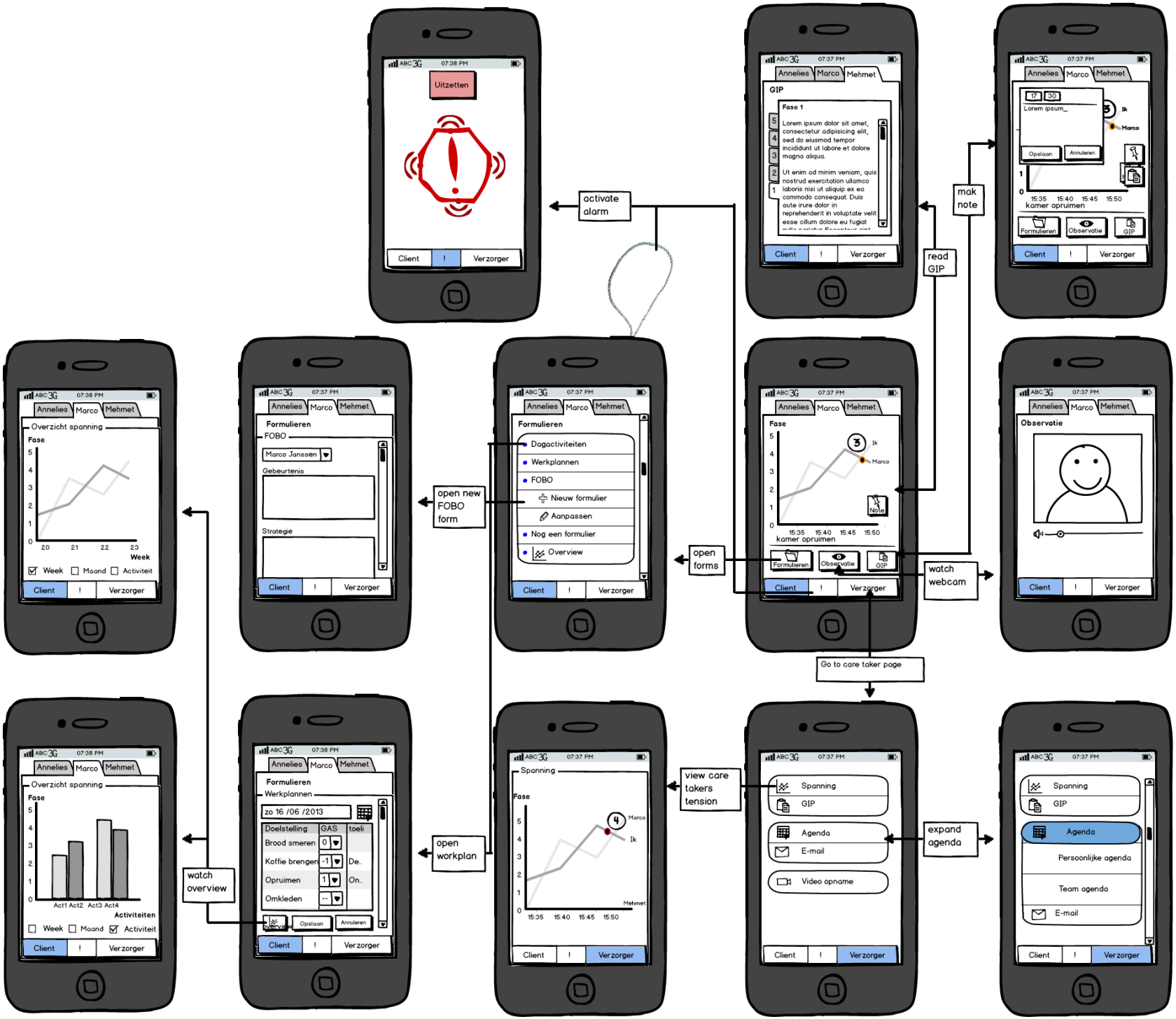

Figure 4. Wireframes of the concept design after the second step of the design cycle.

Discussion

All participants were very motivated for the study, they all subscribed for the Moodradar project and also for this interview they seemed motivated. Often it was mentioned by them that they really want a system that support their work with clients. They contributed by giving a lot of suggestions for the system.

More than a monitoring device

It was initially assumed that the monitoring device only gives information on the arousal level of clients and care takers. Through the course of the interview it was discovered that not only escalations with the clients lead to stress. Other factors such as workload of a full work scheme seemed to influence care takers mood and therefore the interaction with the client. These factors were categorized as administrative requirements and evaluation requirements. According to the user, implementing these requirements would contribute to a better work environment.

Attitude

From the attitude questionnaire it seemed that the care takers were prepared to adapt to a new way of working if it improves their working conditions. Even the care takers who are not experienced, were willing to learn to work with a new device.

Experience with consumer technology

Experience with working with consumer technology varied between novice users and expert users, with a tendency towards the former. It is therefore decided to accommodate both the novice and expert user. The hierarchical structure of the application has a maximum of three layers deep, to keep it clear and simple. The “Must have” features (Table 1) are easy accessible for the novice user. These features can be found at the highest, first layer. The primary screen shows the arousal of both the client and the care taker in one graph. It provides information on the status in time, without extra need of actions. Also the warning button as well as the string in the jack of the phone are always visible. It is possible to operate the interface by only one interaction type, which is *tapping*. Novice users have the opportunity to get used to it and gain confidence with working with this layer, before they move to a deeper layer (Shneiderman, 2003). Expert users may use secondary features, which are one to two layers deeper. Other gestures like *flicking* and *hold + tap* can be used to operate the interface.

Appendix F shows the hierarchical architecture of the application. It also shows which functions are activated by the user, which by the system and which functions that are activated by both the user and the system.

Device

The power of a digital system is that it can connect and update information immediately. Moreover, a smartphones combines mobile communication and powerful computing in a relatively small size. Smartphones are widely adopted by the general public and the application of it in health care is popular (Mosa, Yoo & Sheets, 2012). Even so, the conditions in which a handheld like a smartphone can be used within the health care environment should be carefully thought of. Communication tools can distract and interrupt the ongoing task (Risk bulletin, 2012). For this reason a smartphone should only be used for work related activities. This can be done by setting restrictions on it. The quantity of signals should be limited to the "Must have" requirements, to avoid the decrease of the feel of urgency for the signal.

Grounded theory

There is controversy on analyzing qualitative data with Grounded Theory. It "forces" the data into the code paradigm which narrows the ways in which the concepts can be constructed. Though this may be true, it is in the nature of qualitative research that it up to some point must be interpreted (Peshkin, 2000). The Grounded Theory is an effective method to design for users (Khambete & Athavankar, 2010). Furthermore, the validity of the result was tested in the second study.

STUDY 2: Preliminary

This part of the study was twofold. Firstly it was measured if participants were able to perform the user-cases with the paper prototype. Secondly it was measured how satisfied the participants were with working with the prototype.

Paper prototyping is a method used to find problems in an early state and redesign the flaws at the interface, thus designing better products (Snyder, 2003, p.172). These flaws could be a discrepancy between user's expectations of the system and how this system really works in respect to concept and terminology, navigation, content, layout and functionality.

User satisfaction affects a person's attitude towards a system and therefore its success (Chin, Diehl & Norman, 1988). User satisfaction is determined if the user feels in control of the system which occur if user's expectations are proven right (Nielsen, 2011).

Method

Participants

Six females and two males participated in this study. Six of them participated before in the requirements study. Age ranges from 27 to 55 years (M = 37.13, SD = 11.38). Experience with mentally disabled clients ranges from 4 to 37 years (M = 14.13, SD = 11.85). Working at DTZC ranges from 4 to 33 years (M = 13.13, SD = 11.07). There are a few places where participants work: at the residence of clients (87.5 %) and at school (12.5 %). Functions differ from personal care taker (62.5 %), group accompanier (25 %) and a combination of group accompanier and class assistant (12.5 %).

Materials

Paper prototype. The wireframes (Figure 4) were used for paper prototyping. Every screen was cut out and stacked in the sequence of the tasks that had to be performed. A smartphone (Samsung Galaxy S) was used as a demonstration of the gestures that could be applied.

User-cases. Eight user-cases (Appendix G) were given according to the "Must have" and "should have" requirements formulated in the first study (Table 2).

QUIS. The Generic User Interface Questionnaire (QUIS) version 5.0 was used to measure the satisfaction of working with the interface (Chin et al., 1988). The questionnaire consists of 27 semantic differentials on a 10 point scale from 0 to 9 according to five themes: overall reactions to the system, the screen, terminology and system information, learning and system capabilities. The in Dutch translated questionnaire can be found in Appendix H. Five

questions have been dropped, because it was not appropriate for this study. These where questions about system speed and messages that were not meant to be designed, like help messages. The QUIS was used to assess the user's satisfaction level after working with the paper prototype. The questionnaire has a high degree of reliability and stability, even when questions where dropped out of the questionnaire, and has been advised by doing requirements studies (Chua & Feigh, 2011).

Procedure

Every participant was met individually. Before the interview started participants were given a consent form. On a smartphone it was demonstrated which gestures one could make and that the tasks on the paper prototype could be performed in the same way. It was needed to explain that a small string has to be pulled out of the jack of the phone to alarm colleagues, because this type of interaction has never been applied before. These are realistic user-cases to test if the tasks could actually be accomplished by the participants. The participants had to interact with the paper prototype to perform on these tasks. It was asked that while performing the tasks, to think out loud as the participants went through the process. When participants didn't know what to do, it was said just to try. While performing on the tasks, the facilitator sat opposite the participant and played the role of the computer by placing new user interface elements on the prototype. Afterwards notes were made about the performance. After doing the tasks, it was asked to fill in the QUIS and demographic details.

Data Analysis

Paper prototype. For every participant it was scored on a detection matrix when a mistake was made while performing on a task. A percentage was given on the result.

QUIS. Satisfaction was analyzed by measuring the average and standard deviation of each question in the QUIS. The comments participants made about the design were collected and counted.

Results

Paper prototype

Of all participants, 75% possesses a smartphone, 62.5% of them uses a smartphone on daily basis and 12.5% on weekly basis. The participants who don't own a smartphone are not using it either, one of them incidentally worked with a tablet and recognized how to interact with a touch screen.

From the monitoring requirements, 100 % of the tasks could be completed (Table 6). One "Should have" requirement (*Read clients GIP*) could initially not be completed because the button could not be found. All participants tapped the form button when they were asked to open the GIP. One "Could have" requirement (*Make a note on the graph of a specific client*) could initially not be completed. Seven participants didn't tap the note button when asked to make a note on the graph of a client, while one did. All eight participants didn't tap + hold or drag the button to make a note at a specific time.

Table 6. Detection matrix
Detection matrix of mistakes that were made on first try were scored with a 1.

#	Task	pp1	pp2	pp3	pp4	pp5	pp6	pp7	pp8
1	Watch webcam of specific client	0	0	0	0	0	0	0	0
2	Activate alarm so colleagues can help you	0	0	0	0	0	0	0	0
3	Check your own tension	0	0	0	0	0	0	0	0
4	Fill out a specific client's FOBO form	0	0	0	0	0	0	0	0
5	Check a specific client's tension and activity and turn off the alarm	0	0	0	0	0	0	0	0
6	Find your colleague on the map	0	0	0	0	0	0	0	0
7	Read the GIP of a specific client	1	1	1	1	1	1	1	1
8	Make a note on a graph of a specific client on a certain time	1	1	1	1	1	1	1	1

Satisfaction

The internal consistency of the items were measured on reliability. Analysis of the twenty-two questions showed a Cronbach's alpha of .847, which indicates a high level of internal consistency and can be considered as good. The scores on the questions varied from 5 to 9, with M = 7.6 and SD = .88, where 0 indicates a low satisfaction and 9 a high satisfaction. The item that measured reliability of the interface design (Appendix F, question 19) scored low (M = 7.33, SD = 1.21). Three participants mentioned that they were not sure if the application

would be reliable, because it would depend on if it is technical workable. All comments participants made on the prototype can be found in Table 7.

Table 7. Additional comments participants made

#	Positive comment	Total
1	Well-organized	4
2	Easy to use	3
3	Looks attractive	2
4	Integration of diverse functions is efficient	2
5	Useful	2
6	Fast alarming and possibility to respond to it	1
7	Possibility to read the GIP, because one cannot remember it of all the clients	1
8	Can see tension building of the client and of oneself	1
9	Possibility to finish the forms at a later time	1
10	Possibility to fill in forms	1
11	Useful to see location of colleagues when they alarm	1
12	Design is well considered	1
13	Possibility to watch a client from a distance	1
14	String for alarming is useful, because when a client grabs you, one cannot press the button	1

	Negative comments	Total
1	There should be a single reporting system, for example the work plans form should also be on the application. Also the “middelen en maatregelen” form should be integrated into the FOBO form, instead of being two different forms (current situation)	3
2	The icons without labels should be explained ones	2
3	A smartphone is vulnerable, it breaks easily	2
4	When a colleague calls for help, it would be useful to see which client it concerns	1
5	Exclamation mark should be red, because when it is getting out of control, you don’t have time to think where the button is	1

Discussion

Paper protoyping

The participants tapped the form button when they were asked to open the GIP. Some even doubted first, before they tapped the button. This probably happened because the design of the GIP button wasn’t consistent with the design of the buttons for forms and webcam. It didn’t contain a label while the latter two had. A design solution was to make it more consistent by labeling this button and place it next to the other two buttons.

The participants could not make note on the graph, while at the start of the experiment it was explained that all gestures could possibly be used while interacting with the interface.

An explanation is that the featurer's behaviour wasn't consistent with the behaviour of the other feature's, where one only needed to tap once. Therefore it was decided to make it's behaviour consistent with the other functions. All adaptations to the design were in agreement to the care takers.

Satisfaction

On a 10 point scale where 0 indicates a low satisfaction and 9 a high satisfaction, a mean of 7.6 can be considered as satisfactory. The negative comments were used to adapt the design (Figure 4). The main screens of the client and the care taker were designed in more detail (Appendix I).

General discussion

In this study requirements for a monitoring device for care taker who work with mentally challenged clients were explored. These requirement were translated into an information presentation and tested on feasibility and satisfaction through paper prototyping. The results were then processed into a final design. As far as it the researcher of this study concerns, the involvement of this specific user group in the process has not done before.

Limitations

Sample size. Even though saturation was already reached after four interviews, a small sample size has always the risk of not representing the whole population. More information could have been distracted from the data if the sample size was larger, for example a correlational analysis how working with new technology relates to gender and age. With an expected difference and a power of 80%, a sample of 15 to 18 interviews would have been needed to do a correlational analysis (Stevens, 2007, p.413). Then again, a qualitative study sample size is about representativeness and less about large numbers. It is about complexity of the research subject and the heterogeneity of the population on relevant characteristics (Baarda, De Goede & Teunissen, 2009). The sample in this study was heterogenous on diverse variables such as age and experience with working with mentally challenged clients. Furthermore, a theoretical saturation can already be reached with six interviews (Khambete &

Athavankar, 2010). Measuring descriptive statistics gave already a good indication of the care takers needs and understanding of the work context.

Future research

The results of the preliminary study are positive. In future research the effectiveness of a high fidelity, working prototype can be tested. With a usability test speed of task accomplishment, accuracy and perceived workload can be measured and warning signals implemented.

In the current situation clients and care takers are measured with a bracelet. This is not always perceived as physically as well as emotionally comfortable and is sensitive for breaking when a client is showing challenging behavior. Pervasive healthcare is developing steadily and is needed for long term monitoring. Kappeler-Setz, Schumm, Kusserow, Arnrich & Tröster (2010) researched the validity of integration of a sensor system in the shoe or sock and found that the sensor system was capable of measuring EDA. This is a promising feature that can be applied for these users.

Conclusion

In this requirements study for a monitoring device that predicts the increase of arousal of clients and care takers, two steps of the design cycle were made. For each part, a study was performed. The guideline of the IEEE (2004) was useful for the systematic handling of requirements in the two studies. Diverse methods were applied with clear results.

The first explorative study, operational user requirements were discovered that were translated into an interface design. Involving the users by interviewing them served as a basis for formulating these requirements. The user study gave a good overview of the user's characteristics and the context in which they work. The monitoring requirements were considered most important and must certainly be implemented. The administrative and evaluative requirements serve as efficient working and can be implemented at a later stadium.

From the second study it was found out that the care takers were satisfied by the final result. The primary tasks could be operated immediately without explanation, even by the care takers who were not very experienced with the use of consumer technology. The data that represented the stage of arousal, could immediately be interpreted from the interface design.

This study contributes to the well-being of both the care takers and clients. The care taker can, with the use of the tool, establish in an earlier stage which intervention to apply. The clients who have difficulties with making themselves understood, are given a voice. The monitoring device has the potential to be used in other domains where challenging behavior might occur.

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Appendix A: Semi-structured interview

Interviewer:……
Geïnterviewde:…….
Datum interview:…….

1. Introductie (5 min)

a) Interview openen:
- Begroeten, voorstellen, koetjes-en-kalfjes.

b) Inleiding tot het interview:
- Introductie mezelf en mijn doel;
- Uitleggen dat deze studie een onderdeel is van het project Buienradar, met specifiek waar dit deel toe dient;
- Uitleggen waarom deze geïnterviewde uitgenodigd;
- Uitleggen dat de vragen gaan over de werkomgeving en hoe geïnterviewde hierin staat.
  Dat beleving en emoties voorop staan en er geen foute antwoorden zijn;
- Wanneer er een vraag wordt gesteld over beleving, dat ter ondersteuning kan worden gekeken naar de driehoek van lichaamssensaties – gedachten – gevoelens -> uitleggen;
- Vragen hoe het voorbereiden v/h interview ging;
- Uitleggen dat er negen thema's zijn en met daaronder subvragen;
- Rollen: interviewer stelt de vragen, maar de geïnterviewde mag op elk moment onderbreken en terugkomen op voorgaande vragen;
- Wat er met resultaten gedaan wordt;
- Uitleggen waarom het interview wordt opgenomen en dat deze anoniem is;
- Duur interview;
- Vraag expliciet of geïnterviewde het verhaal heeft begrepen en of er nog vragen zijn.
- Afsluiten met vragen informed consent te tekenen.

c) Demografische gegevens opnemen (informatie van DTZC)
- Leeftijd: .....jaar
- Geslacht: Man/Vrouw
- Jaren ervaring met werken met verstandelijk gehandicapten:.....jaar.
- Jaren werkzaam bij De Twentse Zorg Centrum: .....jaar.
- Werkplaats:..... wonen/dagbesteding/school/ combinatie voorgaande....
- functie omschrijving: ..... persoonlijk begeleider/ groeps begeleider/ klassenassistent

2. Vragen m.b.t. werkomgeving (30 min)

Voor het ontwerpen van een hulpapplicatie of het aanpassen van de werkomgeving, is het nodig te begrijpen hoe uw huidige werkomgeving eruit ziet en hoe u deze ervaart. Hoe de applicatie of de werkomgeving u informeert over de spanningsopbouw bij cliënten of uzelf wordt vervolgens hierop aangepast. Neem voor elke vraag rustig de tijd om de situatie in te beelden alvorens u antwoordt.

1	**Takenpakket**
1.1	Welke taken voert u dagelijks uit m.b.t. cliënten? Dit kan in de woningen van de cliënten zijn, maar ook daarbuiten. Het gaat hierbij om algemene taken die u uitvoert voor alle cliënten.
1.2	Wat moet u aan het eind van de dag rapporteren? Wat doet u om dit te bereiken?
1.3	Wat beleeft u wanneer u deze taken uitvoert?
2	**Interfereren/overlappen van werktaken**
2.1	Zijn er werktaken die met elkaar in tijd overlappen? Dat wanneer u een taak uitvoert, tegelijkertijd een andere taak de aandacht vraagt?
2.2	Hoe vaak komt het dagelijks/wekelijks voor dat er taken met elkaar overlappen?
2.3	Hoe gaat u met een dergelijk situatie om?
2.4	Wat beleeft u in deze situaties?
2.5	Wat zou een ideale oplossing hiervoor zijn? U bent vrij ideeën te spuien.
3	**Incidenten**
3.1	Heeft zich weleens een spannende of bedreigende situatie voorgedaan in relatie tot cliënten? Kunt u voorbeelden noemen?
3.2	Hoe vaak komt dit dagelijks/wekelijks voor?
3.3	Kunt u van een voorbeeld omschrijven hoe bedreigend het was? *bijv. op een schaal van 1 t/m 10, waarbij 1 zeer ontspannen is en 10 zeer bedreigend.*
3.4	Kunt u van dit voorbeeld aangeven waar het incident zich fysiek in de ruimte plaats vond? Waar vinden incidenten zich doorgaans/meestal plaats?
3.5	Welke beleving had u in deze situatie?
3.6	Hoe heeft u deze situatie opgelost?
3.7	Stelt u zich een situatie voor waarin zich een incident afspeelt. Waar zou u

	controle op willen hebben?
4	**Hulp inschakelen** De volgende vragen gaan over hulp van en aan collega's tijdens de werkzaamheden.
4.1	Zijn er situaties waarin u hulp of ondersteuning nodig heeft? Geeft u een voorbeeld van zo'n situatie?
4.2	Lukt het u dan ook om hulp in te schakelen? Waarom wel/niet? *Fysiek: bijv. geen middelen om collega's op te roepen* *Mentaal: bijv. u wilt het alleen oplossen* *Psychosociaal: bijv. schaamte tegenover collega's*
4.3	Wat is het moment dat u deze hulp inschakelt?
4.4	Hoe schakelt u hulp in? Kunt u het proces in gedachte voor u halen?
4.5	Bent u weleens ingeschakeld om een collega te ondersteunen? Hoe komt deze informatie tot u?
4.6	Wat beleeft u wanneer u uw collega helpt?
5.1	**Omgeving** De volgende vragen gaan over uw fysieke werkomgeving, zowel het huis van de cliënten als ook andere plekken waar u met cliënten werkt.
5.2	Hoe beleeft u de fysieke omgeving waarin u werkt met de cliënten?
5.3	Hoe ervaart u de omgeving qua geluid? *prettig, ondersteunend, hinderlijk?*
5.4	Hoe ervaart u het licht in de ruimte? *prettig, ondersteunend, hinderlijk?*
6	**Cliënten**
6.1	Waar worden cliënten gespannen of agressief van?
6.2	Worden cliënten gespannen/agressief door bepaald licht?
6.3	Worden cliënten gespannen/agressief door bepaalde geluiden?
6.4	Wat beleeft u wanneer cliënten gespannen/agressief worden?
6.5	Neemt u voorzorgsmaatregelen bij risicovolle cliënten?

7	**Ondersteuning** De volgende vragen gaan over of u gebruik maakt van externe hulpmiddelen.
7.1	Gebruikt u bronnen voor werkondersteuning? *dit kunnen apparaten zijn zoals een walkie-talkie, pen en papier, enz.*
7.2	Zo ja, Hoe vaak schakelt u deze in of gebruikt u deze?
7.3	Hoe beleeft u deze vorm van ondersteuning?
7.4	Gebruikt u op het werk weleens apparaten of andere middelen die u ergens voor waarschuwen of helpen herinneren aan een taak? *horloge, wekker, gsm, pager?*
7.5	Wat vindt u er prettig aan? Onprettig?
7.6	Mist u weleens een alarm? Zo ja, kunt u ook aangeven waar dat door komt?
8	**Wensen en verwachtingen** Zoals eerder uitgelegd, is het de bedoeling van deze studie om een applicatie* of omgeving** te ontwerpen dat u zal ondersteunen in uw werkzaamheden. Uw ideeën en wensen hierin zijn zeer waardevol voor het ontwerp. *Met applicatie wordt een digitale toepassing bedoeld. Een voorbeeld daarvan is een programma op een computer of telefoon. **Met omgeving wordt bedoeld uw fysieke omgeving, het huis van de cliënten en andere plekken waar u met cliënten werkt.
8.1	Heeft u ideeën wat u zou kunnen helpen ter ondersteuning van uw werkzaamheden? Wat heeft u nodig?
8.2	Wat zou u verwachten van een dergelijk applicatie of omgevingselement?
8.3	Wat zou u wensen van een dergelijk applicatie of omgevingselement?
8.4	Op welke manier denkt u dat het zal bijdragen aan de kwaliteit van zorg? *Meer controle, machteloos, meer/ minder aandacht voor cliënten*
9.	**De applicatie** De volgende vragen gaan over de situatie dat u daadwerkelijke gebruik maakt van een applicatie of omgevingselementen, om u te ondersteunen in uw werkzaamheden. Deze houdt de spanningsopbouw van uw cliënten en uzelf in de gaten. Beeldt u zich in dat u gebruik maakt van een dergelijk applicatie of

	omgevingselementen.
9.1	Hoe ziet het apparaat of de omgeving eruit? Hoe benadert u deze of hoe neemt u deze waar?
9.2	Wat voor gevoel geeft het apparaat of omgevingselement u?
9.3	Stel dat het een apparaat betreft, waar zou u deze laten wanneer u er op het moment geen gebruik van maakt?
9.4	Zou u bereid zijn een extra handeling te verrichten om de informatie over spanningsopbouw tot u te krijgen? *bijv. een apparaat uit de zak halen of kijken of een waarschuwingslicht brandt in de kamer*
9.5	Zou u de applicatie of omgevingselement willen kunnen aanpassen/configureren? Wat zou u aanpassen? *Persoonlijke voorkeuren als hoe hard het geluid of de trilling van het apparaat, of hoe fel het licht, hoeveelheid informatie dat wordt getoond en welke? Per cliënt andere informatie?*
	Spanningsopbouw bij de cliënt
9.6	Stelt u nu voor dat een cliënt een snel toenemende spanning ondergaat. Hoe waarschuwt het apparaat of de omgeving u?
9.7	Aan welke informatie heeft u dan behoefte? Hoe uitgebreid? *Bijv. tips hoe met de situatie om te gaan, verloop van de spanningsopbouw, of is alleen een waarschuwing voldoende?*
9.8	In hoeverre kunt u invloed uitoefenen op de informatie die de applicatie of omgeving u geeft?
9.9	Hoe zou u de informatie gepresenteerd willen zien, horen en/of voelen?
9.10	Waar wilt u bij een dergelijk applicatie of omgevingselement controle op? *Bijv. het kunnen uitschakelen v/h alarm.*
9.11	Aan welke informatie heeft u nog meer behoefte bij zo een applicatie of omgevingselement?
	Spanningsopbouw bij de begeleider
9.12	Stel dat er een snel toenemende spanningsopbouw bij uzelf plaatsvindt. Hoe waarschuwt het apparaat of de omgeving u?
9.13	Aan welke informatie heeft u dan behoefte? Hoe uitgebreid? *tips hoe met de situatie om te gaan, zoals ontspanningsoefeningen, hoe hoog uw*

	spanning is. Of is alleen een waarschuwing voldoende?
9.14	In hoeverre kunt u invloed uitoefenen op de informatie die de applicatie of omgeving u geeft?
9.15	Hoe zou u de informatie gepresenteerd willen zien, horen en/of voelen?
9.16	Aan welke informatie heeft u nog meer behoefte bij zo een applicatie of omgevingselement?

3. Vragen m.b.t. ervaring met applicaties en consumententechnologie (1 min)
De volgende vragen hebben betrekking op uw ervaring en gebruik van consumententechnologie.

1.	Bent u in het bezit van consumententechnologie, zoals een gsm, smartphone, tablet, computer? Hoe vaak gebruikt u deze?
2.	Heeft u ervaring met het werken met consumententechnologie, zoals een gsm, smartphone, tablet, computer?
3.	Als u ervaring heeft met een smartphone of tablet: maakt u gebruik van applicaties? Welke en hoe vaak?
4.	Bent u van plan om binnenkort consumententechnologie aan te schaffen? Welke?

4. Vragen m.b.t. attitude (5 min)
Hieronder staan zes stellingen. Bij elke stelling heeft u een keuze uit vijf antwoordmogelijkheden. Kruis het antwoord aan dat uw mening het beste weergeeft, er zijn geen foute antwoorden.
Hier volgt een voorbeeld vraag: “Wat vindt u van boeken lezen?”

	heel erg	beetje	beiden niet	beetje	heel erg	
spannend	☐	☐	☐	☐	☐	saai

Wanneer u boeken lezen enigszins saai vindt, dan kruist u het vierde vakje aan. Vindt u het enigszins spannend, dan kruist u het tweede vakje aan.

Hier volgende de vragen:

	heel erg	beetje	beiden niet	beetje	heel erg	
1. Zou u informatie over de spanningsopbouw bij cliënten gebruiken, wanneer dit wordt gegeven door een applicatie op een apparaat of door een element in de omgeving?						
gebruiken	☐	☐	☐	☐	☐	niet gebruiken
2. Bent u bereid om met een applicatie of omgevingselement te werken, ter ondersteuning van uw werk?						
niet bereid	☐	☐	☐	☐	☐	bereid
3. In hoeverre werkt u graag met nieuwe technologie, zoals smartphone, tablets, computers, e-reader?						
plezierig	☐	☐	☐	☐	☐	onplezierig
4. Bent u bereid om een nieuw instrument te leren als dit meer werk-ondersteuning biedt?						
bereid	☐	☐	☐	☐	☐	niet bereid
5. Denkt u dat het gebruik van een applicatie of omgevingselement, dat u waarschuwt voor spanningsopbouw bij cliënten, zal bijdragen aan kwaliteit van werken?						
minder kwaliteit	☐	☐	☐	☐	☐	meer kwaliteit
6. Op welke manier denkt u dat een waarschuwing van de applicatie of omgeving uw interactie met de cliënt zal beïnvloeden?						
verbeteren	☐	☐	☐	☐	☐	verslechteren
7. Zou u een gevoel van controle hebben wanneer u een apparaat gebruikt dat de spanning van cliënten weergeeft?						

machteloos	☐	☐	☐	☐	☐	controle
8. Bent u bereid een extra handeling te verrichten, zodat u toegang heeft tot informatie over spanningsopbouw bij cliënten of uzelf?						
niet bereid	☐	☐	☐	☐	☐	bereid
9. Zou u een gevoel van controle hebben wanneer u een apparaat gebruikt dat de spanning van uzelf weergeeft?						
machteloos	☐	☐	☐	☐	☐	controle
10. Denkt u dat het gebruik van een applicatie of omgevingselement, dat u waarschuwt voor spanningsopbouw bij uzelf, zal bijdragen aan kwaliteit van werken?						
minder kwaliteit	☐	☐	☐	☐	☐	meer kwaliteit

Afsluiting (~1-5 min)

- Vragen wat geïnterviewde van het gesprek vond en of deze vrij heeft kunnen spreken;
- Vragen of er onderwerpen zijn die niet aan bod kwamen maar nog graag over zou willen vertellen;
- Bedanken voor de waardevolle informatie en tijd.

Appendix B: Code book

This table contains the labels and descriptions used for coding the interviews. Some labels contain other labels as well, e.g. a label about escalation always implies that it connects with client arousal. Instead of tagging it with both labels, it is only given one label. This code book has been used by a second assessor to measure inter-rater reliability.

Codes of the interview

Code #	Code name	Description code	Implies other code
1.1	Arousal_Care taker	Situations where arousal level of the care taker is low or high	
1.2	Arousal_Client	Situations where arousal level of client is low or high	
2.1	Client_information	Characterization about clients, e.g. age, skills.	
3.1	Escalation & Interfering tasks_Frequency	How often escalations and/or interfering tasks take place.	Always implies ‘Arousal_Client'
3.2	Escalation & Interfering tasks_Location	Where escalations and incidents physically take place	Always implies ‘Arousal_Client’
4.1	Experience_Escalation	How escalations are being experienced by the care	Always implies ‘Arousal_Client’

		taker	
4.2	Experience_Interfering tasks	How tasks that interfere with one another, affects the experience of the care taker	
4.3	Experience_Tools	How current and future tools are being/would be experienced by care taker	
4.4	Experience_Work Location	How working environment is experienced by care taker	Always implies "Work location’
4.5	Experience_Worktasks	How worktasks are being experienced by care taker	
5.1	Groupsize accompaniment	Number of care takers working in a team and number of clients in a group	
6.1	Strategy_Escalations	Strategy to cope with or preventing an escalating situation.	Always implies ‘Arousal_Client’
6.2	Strategy_General worktasks	Strategy used when performing general worktasks	
6.3	Strategy_Interfering tasks	Strategy used to cope with interfering tasks	
7.1	Tools_Current	Current tools used for supporting work tasks	
7.2	Tools_Future	Wishes, ideas, needs and necessities for tools, used for supporting work tasks.	
8.1	Work location	Where worktasks physically takes place	
9.1	Worktask_Interfering	Worktasks that interfere with one another.	
9.2	Worktask_with client	Worktasks where clients are involved.	
9.3	Worktask_without client	Worktasks where clients are not involved.	

Appendix C: Taxonomy

The participant column contains two colums. The first column scores if the label applies to that participants, where 1 is yes, 0 is no and an empty cell that it is not mentioned in the interview. The second column gives the valence towards the label, where '+' is positive, '-' is negative, '+/-' is both positive and negative, '0' is neutral and an empty cell that it is not mentioned.

Core theme	Theme	Label	Participants					
			PP1	PP2	PP3	PP4	PP5	PP6
Arousal	Client	Because other clients	1		1	1	1	1
		External					1	1
		Loud sounds				1		
		Unpredictability			1			
		Not being understood				1		
		Vagueness				1		
		Care taker	1	1	1	1	1	
	Care taker	Change client couple						1
		Evaluate with colleagues			1			1
		Ventilate it with colleagues		1				1
Escalation &	Frequency interfering	Daily	1	1	1	1		1

Interfering tasks	tasks	Weekly					1		
	Frequency upcoming situation	Daily					1		
		Weekly			1	1			
	Frequency escalation	Weekly	1	1			1		
		Monthly				1			
	Location	Inside	1	1	1	1	1	1	
		Outside	1			1	1	1	
	Intensity	1-4	0	0	0			0	
		5-7	0	0	1			1	
		8-10	1	1	1			0	
	Control	Be prepared	1					1	
		Backup colleague		1			1	1	
		Emotions			1		1		
		Attitude towards client		1					
		When to call for backup	1						
Strategy	Upcoming escalations	Ask colleagues to keep watch	1	1			1		
		Bring client back inside					1	1	
		Change daily program					1	1	
		Separate clients who agitate each other				1			
	At escalation	Step out of situation	1			1			
		Keep distance					1	1	

		Call colleague for help	1		1	1		1		1		1
		Move client to time-out room			1							1
		Apply Facet grip				1		1				
	General work tasks	Telling colleague when outside	1		1					1		
		Administration planning	1		1	1		1		1		1
	Interfering tasks	Work it out themselves				1		1				1
		Ask help colleague				1						1
	Coping after escalation	Takes time-out			1			1		1		
		Evaluating with colleague				1		1				
Tools	Current	Beeper	0		1	1		0		1	+	0
		Walkie-talkie	1	-	1	-	1		1	-	1	+/-	0	-
		Shouting	1			1		1	-			1		
		Cellphone				1						1	+
		Babyphone								1			
		Camera			0	0		0		1		0	
		Care assistant	0									1	+
		Client observation	1		1	1		1		1		1	
		GIP			1	+	1						
		Paper reports	1			1		1	+/-	1		1	
		Time timer				1							
		Group agenda	1			1							
		Colour cards				1	+						
		Personal paper agenda	1		1	1		1	+				
		Computer reports			1	1				1		1	
		Personal paper notebook	1	-									
		Post-it’s						1		1			

		Watch										1	
		Writing on hand									1		
		Video recordings evaluation							1	+	0		0
	Future	Continuity for client					1						
		Efficient					1						
		Willing to do more actions	1		1		1		1		1		1
	Wishes	Signal increase arousal at client		+		+		+		+		+	+
		Signal increase arousal care taker				+		+				+	+
		Phase of arousal client				+		+		+		+	+
		Phase arousal care taker		-								+	-
		See arousal client and care taker simultaneously				+						+	
		Signal increase arousal client of colleague								+			+
		Stop warning signal increase arousal of client		+				+		-			+
		Stop warning signal increase arousal self		+				+					+
		Colour codes											+
		Location tracker						+				+	
		Configurate system											
		Digital colour cards								+			
		Report efficiently on a computer								+			
		Evaluation (like FOBO) digital on a small apparatus						+				+	
		Monitoring system available all the time		+									
		Video observation client		+						+			
		Audio observation client		+									
		Multifunctional tool		+								+	
		Wearable		+		+		+				+	+
		In environment								+		-	-
		Clients unaware of measuring device				+							

		Small device						+		+			
		Extra person		+									
		Video observation self				+		+		+			
		Advice what to do when client's arousal increases		-				-/+		+		-	
		Advice what to do when care takers' arousal increases		-		-		-		+/-		-	
		Hufterproof						+		+		+	
		Clear overview in the house		+									
Feedback	Increase arousal client	Visual		+		+		+		+		+	
		Audio		-		+		-		-		-	
		Tactile		+				+		+		+	
	Increase arousal care taker	Visual				+		+				+	
		Audio						+		-		-	
		Tactile		+		+		+		+		+	
	Emergency alarm colleague	Visual						+				+	
		Audio		+		+		+				+	
		Tactile						+					
	Emergency alarm self triggered	Audio											-
		Tactile										+	
	Client must be unaware signals					0		+		+		+	
	Feedback client dependent							+					
Worktask	Interfering	Clients ask attention at same time.			1		1		1				1	
		Working with client and outsider asks attention.			1						1			
	With client	Activities of Daily Living (ADL): personal care clients	1		1	+	1		1	+	1		0	
		Activities			1	+	1		1		1		1	+
	Without client	Instrumental activities of daily living	1		1	-			1	+	1		0	

		(IADL)							
		Reporting activities, details and goals, daily program of client, POP		1	1	1	1	1	+
		Evaluation with colleagues		1	1				
Client information	Age group	Adults	1	0	0			0	
		Children	0	1	1			1	
Groupsize accompaniment	1 on 1					1	1	1	
	1 on many		1	1	1	1		1	
Work location	Inside	In homes (living room, bedrooms, kitchen, bathroom, hall, office)	1	1	1	1	1	0	
		School (class, kitchen)	0	0	0	0	0	1	
		Public places (gym, swimming pool)					1	0	
	Outside	Garden, terrain, farm	1	1	1	1	1		
Experience	Escalation	Startled						1	
		Powerless	1			1		1	
		Tensed						1	
		Adrenaline			1		1	1	
		No emotions					1		
		Annoyed					1		
		Sad				1			
		Frustration			1				
		Vulnerable	1						
		Chills	1						
		Mad	1				1		
		Depends on own mood		1					
		Doubt		1					
	Interfering tasks	Stress	1						
	Tools future	Less tensed		1					

		Stronger relation with client										1
		Peace of mind	1					1		1		
		Makes working easier			1							
		Clear overview	1					1				
		More safe				1				1		
		More attention for clients						1				
		Trustful								1		
		Satisfying						1		1		
	Work environment	Space		-	-		+		+/-		+	+
		Light		+	+		+		+		-	+
		Sound		+/-	-				-		-	-
	Work tasks	Very busy	1							1		
		Stressed			1					1		
		Useful			1			1				
		Challenge										1
		Prepared to anticipate				1						
		Pleasant						1				1

Appendix D: Description & solution

Core team	Theme	Description	Improvement
Arousal	Causes of increase of clients arousal	Because of other clients: teasing each other, annoyed by their behaviour e.g. sound, gestures, fuss.	When care taker is warned about arousal increase of client, s/he can estimate why it happens and separate client from the

		By external people: when they change routine of client. Also to many people who decides about clients: team, parents, temporary workers: approximately 10-11 people.	inconvenient source. Because of the immediate feedback from the system, a link can be made with what is on a client's mind. It is necessary that all care takers in a team see the arousal level of all of their (maximum) eight clients in the house, because sometimes they change client - care taker couples.
		Loud sounds of everything, e.g. other clients, leaf blowers contribute to increase in arousal level.	
		Unpredictable behaviour of other people or unpredictable changes in daily program.	
		A client is not being understood, which mostly happens with new colleagues who don't know the client well. They don't always understand what the client wants or needs.	The GIP explains behaviour of a specific client and is a guidance for operating. It would be easier for both client and the new colleague if this information is available all the time so the care taker understands behaviour and know how to communicate with the client. Make it possible to read it when not busy, to learn the GIP.
		Being vague to the client, so s/he doesn't understand what care taker wants from him/her.	
		Of the care taker: clients are sensitive for care takers tension, it correlates with one another.	Warn the care taker know when s/he is tensed, so s/he can adjust own behaviour, e.g. by relaxation techniques.
	What to do when a care taker is conscious about the increase of his/her own arousal:	Change care taker - client couple: care takers tension can increase because of the interaction with a specific client.	Give a signal that care takers tension is increasing. For some care takers it is useful when the situation is recorded, so there is something concrete to evaluate.
		Evaluate with colleagues about what would have been a better solution given that situation.	
		Ventilate it with colleagues and talk about their emotions.	
Escalation & Interfering tasks	Frequency interfering tasks	Daily: ranges from every day to two to three times a week. Duration can differ: some situations take five minutes, others longer.	When two clients compete for attention from the care taker, most of the time priority is given to the client who makes most noise or needs most help. Make it possible to check whose arousal is increasing the most.
		Weekly: not on daily basis.	

	Frequency upcoming situation	Daily: happens often with the more risky client group.	With enough information care takers can decide to do interventions to decrease client's arousal or to let him/her outburst in a controlled way. This information can be based on salient details that are noted by colleagues at clients status, and is accessible by the whole team.
		Weekly: those situations can be handled and changed, sometimes by care taker self and sometimes with the help of a colleague.	
	Frequency escalation	Weekly: it can differ in intensity. Also depends on the client and client groups: with some groups escalations happen more often than with others.	Escalations don't happen on daily basis, so one doesn't expect an outburst. Besides signaling when clients' arousal is increasing, make it possible to see an overview of tension increasing and decreasing. Patterns about when, how and why it happens can be discovered.
		Monthly: once every half a year when it is really going out of control.	
	Location	Inside: in the bedroom, apartment, bathroom, kitchen, living room, hallway. At school in class. At the gym, swimming pool.	The system must be accessible everywhere, since clients can be everywhere as do escalations. Even in one place, like their own house, there are different areas where an escalation can take place.
		Outside: at the terrain around the houses, garden, parking place.	
	Intensity	From a scale on 1 to 10, where 1 is calm and 10 is threatening, it ranges between 5 to 10.	Avoid an escalation by being on time or otherwise being prepared on the threatening mood of a client. The surprise makes it stressful.
	Where care taker wants to have control over:	Be prepared: be aware that arousal is increasing, so that the care taker is less tensed. Makes it possible to work prevantative.	Signal when clients' arousal increases.
		Emotions: uncontrolled anger of care taker self, because it affect clients.	Give a signal when care taker's tension is increasing, so one can anticipate on own stress level and be in control when interacting with the client. They only need to be aware of one's own tension, phase doesn't matter.
		Attitude: how one enters an escalation influences how the client feels, e.g. it is better to be in control instead of acting angry.	

		Backup of a colleague so s/he can keep watch; knowing somebody covers your back makes one feel less tense.	Signal of clients' tension should be send to all colleagues in a team. When they are not warned yet by the emergency alarm, they can carefully check up on their colleague, without interrupting the situation. Asking a colleagues to come and watch, interrupts the flow with the client.
		When to call for backup: on the one hand it might work contrarily when a colleague comes to soon; asking help to soon can make the situation worse because it makes the client feel threatened. On the other hand it can escalate when a colleague comes to late to help.	
Strategy	Upcoming escalation, when client shows threatening behaviour	Ask colleagues to keep watch and to pay attention: to watch the situation before interfering. Sometimes done with code words, so the client doesn't presume anything. They watch from a distance or through a peep-hole in the door.	Signal all colleagues in a team that one of the clients increase in arousal, so they can keep an eye on them instead of bursting into the room while client is still at e.g. phase 3. Makes asking to watch each other obsolete.
		Bring client back inside: the homes are a safe place for both client and care taker to do the intervention.	For temporary workers it is not always clear what to do. Help them to choose the right intervention by letting them read the GIP for concerning phase immediately when they need it.
		Change daily program according to the GIP.	
		Separate clients who agitate each other.	
	At an escalation, when client is physically aggressive towards the care taker	Step out of the situation, to get oneself together before doing the intervention.	In the ideal situation it will not come this far, since the care taker is already warned at an earlier stage. But when both the care taker and colleagues are busy with another client, s/he knows because of the system that client's tension is at a higher level, so s/he can keep distance on time.
		Keep distance: so client cannot attack the care taker physically by bringing oneself in safety.	
		Move the client to the time-out room, where they are allowed to be aggressive so tension can decrease.	
		Call colleague for help with warning systems like the beeper, walkie-talkie, shouting or cellphone.	Call for emergency when the situation is unsafe and cannot be solved alone. This must be easily

		Apply Facet grip and communicate to temporary workers what they have to do.	and quickly done, with the certainty it went off at colleagues.
	General work tasks	When going outside with a client, care takers tell their colleagues when they go and where they go, so they can estimate where the emergency is when they call for help.	Now they have to estimate where colleague is. Where is s/he on the route? In which room of the house? Every second counts in a threatening situation. So when emergency alarm goes off, colleagues must see immediately where the alarm went off.
		Administration is done at the end of the day in their office or sometimes when clients are doing activities by themselves and they see a chance to go out.	It would be easier when administration can be done in the same room as where clients are, while at the same time they can't read what is been written about them. Secondly, salient details are not being forgotten. Third, when they don't have time to go to the office that day, work has to be postponed for another day.
	Interfering work tasks	Work it out by themselves: by doing an activity with both clients, e.g. play with both children. Daily program shifts a bit then. Or when working with a client, let him do an activity independently while going to the other who asks for attention. When external people need attention, like on the phone or at the door, the client has priority.	If the monitoring system offers more functions except monitoring and warning, it shouldn't be distracting.
		Ask help from a colleague: to take care of one client while taking care of the other client.	In these cases there is time enough to ask a colleague. To many signals will devaluate to urge to respond to a signal.
	Coping after escalation	Takes a time-out to get some rest while a colleague takes over his/her clients.	A feedback system on how a care taker acted in a certain situation and the period leading to it.

		Evaluating with colleagues: how to work out this day and ventilate emotions. Also comparing strategies colleagues would have used to avoid an escalation.	
Tools	Current: Warning system	When one needs a colleague to back-up. An alarm has always priority above other tasks and care takers respond immediately to it. Beeper: Small device with a button. When pushed, it makes a loud sound at colleagues device, except for the person who activated it. It gives the ID of the one who pressed it (depending on the group it gives the home address or a client code). Some beepers have a small string that can be pulled out. It also lights up when activated. The beepers with buttons are used for two codes: pressing one time and colleagues from the team come to the rescue; pressing twice and neighbors come too. Positive: quickly activated with one hand (both string and button), gives a safe feeling because one knows backup is coming immediately. Negative: clip breaks easily, which is used to attach it to the trouser. Also it doesn´t give the location where escalation is happening, need to rely on previously given information.	Quick interaction like the beeper works well. Tactile feedback gives the feeling that alarm is definitely activated.

	Walkie-talkie is used when outside, to communicate the location if an escalation takes place. Not used for every client. Positive: can communicate the exact location. Negative: communicating is difficult: need two hands to call for a colleague, while defending oneself from an aggressive client. Sometimes signals interfere. Easily breaks. Also the clip easily breaks, so especially women with small pockets lay them somewhere in the house. Cannot be kept in the pocket, because the button is easily pressed then. Some care takers made their own pocket.	Must be able to activate it without effort, while defending oneself: ergonomics fitted to the situation at hand. Also make it visible for colleagues where the escalation is, because explaining where one is costs the care taker in need time and effort.
	Shouting “help” or a code like “Red” to alert colleagues in house. Negative: it is not always heard and panics clients even more.	Care takers are familiar with colour codes. Colours are both meaningful when hearing it and seeing it. Therefore use it, so mentally directly activated. Avoid the need to shout.
	Personal cellphone: used when walkie-talkie is not at hand to call a colleague. Also used to make notes and to set alarm for a task that has to be done. Positive: always at hand because it is small. Negative: still have to communicate where one is. Also distraction because of personal use.	Make it possible to activate alarm blindly. System should only be used for work, so it doesn’t distract.
	Babyphone: used for one client, two babyphones on two locations, in the bedroom of the client and office of the care taker. Auditively keep watch on client, while doing administration at the office.	Webcam function for clients for whom there is permission to place a camera or microphone. Must be available everywhere to watch, not only when one is in the office. On the other hand it shouldn’t be available for everyone, because of privacy.
	Camera: Some clients have a camera in their apartment. Images can be watched via computer at the office of the care taker.	

Current: Administration	Care assistant: extra person who helps when needed.	Care assistant should have the system too, so s/he can anticipate on the situation.
	Client observation: how tension at a clients is now perceived, by watching and interpreting	Observation with the help of the monitoring system. Interpretation of the signals are still done by the care taker as well as on how to act on it.
	Administration is an important part of working, besides accompany of clients.	
	GIP: Behavioural intervention plan. A guide on what to do if a client is in a particular arousal level.	Considered as a great support tool and it should be known by heart. New colleagues don't always know the GIP, so make it easy accessible for them by integrating it in the system.
	Paper reports: that reads the daily program of clients (can change) and work goals of client. Every work goal has some criteria, if 75% has been achieved, it can be said that that goal has been reached. Daily reports are typed out but most forms are now written by hand. These are digitalized at the end of the month.	Make it more efficient, by not doing the same task twice: type it out immediately. Evaluation criteria for work goals can be marked when done and the system can calculate if it is obtained.
	Computer reports: A FOBO form (fouten ongelukken bijna ongelukken: about accidents with clients) has to be filled in after an escalation. The class assistant has to fill in the LVS (leerling volg system: a system that keeps track of the student). The computer is in care taker' s office.	Not always possible to fill out the form immediately, because clients need supervision which doesn't happen when care taker is in the office. It is more efficient if it can be filled in immediately after an escalation, while still being with clients.
	Colour cards: are drawn by hand, based on how client felt in a certain period. Conclusions are made based on eye-balling patterns. Some groups made their own excel sheet to colour.	More efficient to do it digital. Because the EDA data is digitalized, phases can be linked to colours care takers are familiar with. At the end of the month, an graphical output can be made from the digital data.

Current: General	Personal paper notebook: for making notes of clients and also functions as a to do list. The notebook is not always at hand because it cannot be left in the living room, so it happens that a task is being forgotten.	Possibility to make and read notes whenever one wants that and have all information at the same place that can be accessible from everywhere.
	Paper agenda: personal to-do agenda to not forget the postponed work tasks and daily tasks.	
	Writing on hand: when there is no paper available. Note cannot be forgotten because one is confronted with it all the time.	
	Post-its: for writing a to do task that came up on one's mind.	
	Personal cellphone: always in the pocket and therefore available to make notes when thoughts come up.	
	Group agenda for current affairs: Sometimes appointments are being forgotten.	Have a digital group agenda, accessible for the whole team. Can be read and edited by everyone in the team.
	Some other tools that supports care taker in general tasks. Watch: to check on the time. Important because daily program of clients is strict.	 System can tell when an activity starts.
	Time timer: set so client knows when an activity is finished. Provides clarity to the client.	A tool used for and by the client. Out of scope.
	Video recordings: for evaluative purposes. When there are tensions recordings are made, to evaluate afterwards how one handled the situation.	Not every care taker wants to be recorded: it feels awkward and they wouldn't act like themself. Though for some care takers it would improve the way they work and therefore more quality for the relation with the client. Make it optional.

	Future	Continuity: so there is more time for clients. Now care takers go to their office with door closed to make notes, sending e-mails or doing their administration while client stays in the living room.	More efficient when one can make notes, check e-mails and do their administration while being with the clients.
		Efficiency: immediately do administration when needed, e.g. filling in FOBO after an escalation, instead at end of the day when salient details are forgotten.	
		Willing to do more actions if it means that it support work, e.g. getting an device out of the pocket or check the system in another room.	
	Wishes: Warning system	Signal the increase of arousal at a client: increase can be quick, and therefore it is important to be warned immediately so intervention can be done.	Care takers have a lot of clients and tasks to be aware of and can therefore miss seeing tension at a client. Having a set of extra eyes would support working by being signaled that clients tension is increasing. Especially for temporary colleagues, who don't always recognize signals at a client.
		Phase of clients arousal: type of intervention depends on the phase.	Phase of clients arousal is meaningful, information can be found in the GIP and it depends how to intervene in tense situations so it can be changed. Phase ranges from 1 to 5. At 4 one usually asks colleagues for help but it is still possible to talk to the client. At 5 there is no discussion possible with the client and colleagues are alarmed.

	Signal increase arousal of the care taker: makes one more aware of own tension, which is important because it influences the client. It is difficult to be aware of it, because care takers don't have breaks and go with the flow. Information must be private and not sharable with colleagues.	Only signal the concerning care taker, when his/her arousal increases. It seems that only a signal is enough, because it is about the awareness of the increase of arousal and not about intervention.
	Phase arousal care taker: is not necessary, being warned that they are getting tensed is enough.	
	Signal client's arousal increase of a colleague: sort of social control, colleague perceives it so s/he can be stand-by, without being asked.	Same signal as of own client, because couples can change.
	See arousal of the client and care taker simultaneously: because own tension influences the client's and to be more aware of own tension.	Visually shown, one glance to understand the situation
	Colour codes: colour is recognizable and meaningful, because they already work with colour maps and use it as codes to communicate the situation.	Integrate it in warning signal.
	Location tracker: so care takers see immediately where colleague in need is. No need to communicate it like trying to use a walkie-talkie or shouting.	When a care taker uses the alarm function, colleagues see the location immediately on the screen.
	Stop warning signal when arousal of client increases: increase can also happen because of playing sport, like soccer or cycling. Choice to set off or let it on until arousal decreases. Set it of so the care taker is not getting annoyed by it, unless it vibrates, it can be ignored.	Learn the system that it doesn't set of when "daily activity = sport". Even something that vibrates can be inconvenient for some people when they are doing intervention, so option to mute. But for a certain period of time when client is getting aroused again after 30 minutes, it should set off again.

		Stop warning signal increase arousal of care taker: increase can also happen because of making a long walk or cycling fast.	Mute it for a certain period of time, because when arousal increases again after 30 min, it should set of again.
		Video observation client: In an 1 on 1 situation, it feels more safe if a colleague can watch over you. Also to check on clients, when they are not in the same room as the care taker. Only necessary to check for tension. Privacy of clients has priority.	Privacy has a high priority, for both client and care taker. Only record audio or images on places when both the guardian of the client and the care taker who works at that place give permission for that.
		Audio observation client: Recording to check on clients for same reason as video observations.	
		Advice what to do when client's arousal increases: Everyone supposed to know the GIP. But some say that advice after an escalation happened would be good to read.	Temporary colleagues don't know the GIP well. Optional to link to intervention for that specific client.
		Advice what to do when care taker's arousal increases: not necessary, but possibly for new colleagues. It depends on the culture of the team if people accept that.	Optional function. Bypasses the cultural acceptance by make it private to access.
		Want to have an extra person: a care assistant that can support when there is an escalation.	An extra person is out of scope, but the safe feeling that it can give can be realized.
	Wishes: Administrative	Write evaluation and reports on a device. When one wears a device, the FOBO can be filled in immediately after an escalation. It saves time and salient details are not forgotten, which happen when reports are made at the end of the day. Don't have to go to the office and step out of the situation, can work on it in the same room as where client is doing his/her activity.	Mark a FOBO at the moment when arousal is/was high, at a e.g. a graph that shows the arousal. Pinpoints immediately the time and activity at that moment. A graph shows the whole context of increase and decrease of arousal. Makes it more easy to find a (possible) pattern because time is objectively in the graph. At the end of the month a graph is generated by

		Report everything digitally: every file is on an place and have a clear overview of the information. Now care taker has to print out forms, check e-mails, find paper reports in up to three files. Writing reports digitally have to be done anyway at the end of the month.	the computer, so one sees phase arousal, activity, time of the day and notes made. Notes can be made at the data immediately after an escalation or when clients' arousal increases a bit. About unusual happenings, how they have solved it and current activity of the client. Notes can be read by the whole team. It is not necessary to colour by hand anymore, since the graph with phases is already coloured and time of the day and activities are shown.
		Digital colour cards: more efficient if it hasn't to be done with hand anymore. Gives a more clear monthly overview of clients tension, which days, time of the day, activity. One team already uses a self designed excel sheet for it.	
	Wishes: General	Video observation of care taker: recordings to evaluate own interaction with client. Can evaluation alone and/or with the team, to learn from it. Possible to switch on a small camera by themselves. Though not everyone would want to be observed by a camera.	Optional to do camera observation for self-reflection.
		Multifunctional tool: walkie-talkie and beeper functions in one device. A graph that shows increase, but also the decrease of client's tension. Also images and sound, all in one. Decrease of tension is also useful: can see what gives the client piece of mind, that care taker knows what intervention works.	Warning function is easy to activate and colleagues know exactly the location where it is activated. Complete information when one checks the status of a client: what activity is s/he doing, in which phase is s/he now, trend how it will further increase, see what helps to decrease it and directly experiment with it. a graph is easier to interpret than words. A graph shows the context of tension, so how fast it is increasing and decreasing.

	Wearable system: care takers can be in different rooms and wants to receive signal wherever s/he is, otherwise the system wouldn't be useful. Also wants to watch client status at any moment.	Need to be weared too even when one doesn't have a pocket. This means it must be a small device or has the right support tools like a small belt pouch or a sports armband.
	Hufterproof: because when struggling with a client, a device can drop on the ground.	Object(s) in space should be unreachable for the client. When it is a wearable device: keep it on the body where the client cannot reach for it. An already developed device can be made safe with for example a rubber cover.
	Clear overview in the house: have an overview over the whole situation. So one can track clients wherever they are in the house. It is not because clients get lost, but to track if arousal is increasing and to know what the mood is.	Warning when arousal is increasing is enough. Because of privacy it is not possible to hang microphones and camera's everywhere.
	Clients must be unaware of the hardware of measuring equipment. Some can get tensed of it because they see it around their arm. They should forget that they wear it.	Out of scope for this particular study, but advice would be to attach it on the foot, as mentioned in the literature part.
	System in the environment: for example an item in the room that gives light when clients' arousal increases.	Conflicts with the wish that a signal of increased arousal and client information must be perceived everywhere.
	Configurate system: loudness of alarm, type of sound per client.	Assigning every client another type of feedback would be confusing: care takers would then need to learn to distinguish eight different kind of feedback, besides other types of feedback like an emergency signal. Contrary to the fact that the system should be high on learnability. Loudness of sound should be configurable, because of loud activities that takes place (watching a movie) or for people with impaired hearing.

Feedback of system	Increase arousal at client	Visual: want it with a colour or something that lights up.	Light up, so one can see or read the information clearly. Needs to light up too when it is an object in the environment, that cannot be felt then and it shouldn't make sound. But then one has to be aware that something lights up in another room.
		Audio: can work contrarily: the client and other clients become more aroused of it. Some clients find it interesting. Must be able to adjust the volume, e.g. when sound in a room is loud, like when clients watch a movie.	Argument of an aroused client overweighs the interesting argument.
		Tactile: that a device vibrates.	Can be done when it is a wearable device. Unless it is continuously in ones sight (e.g. in the glasses of the specs), one needs to feel it.
	Increase arousal care taker	Visual: easily compare it with arousal of the client one is working with, because it can increase in parallel.	Visual feedback is useful, for when one forgets the meaning of certain audio and/or tactile feedback.
		Audio: One participant mentioned that a short beep would be good, but later on that a signal must be unnoticed by the client.	No sound because it can make clients tensed.
		Tactile: Different than signal of the client. Significant that only care taker self is warned.	Other type of vibrating than client's.
	Emergency alarm colleague	Visual: to see the location where the alarm is triggered.	A map of DTZC with indicator would make it clear in one glance.
		Audio: To be sure a colleague notices it, audio is also a quick warning. Must be different than signal of tension building. Wants information immediately, without extra actions needed, like swyping a phone screen.	Very important to notice the alarm, configurate loudness when one is outside.
		Tactile: to be sure one notice it.	When one really doesn't hear it, offer more ways to notice it, to be sure.

	Emergency alarm self triggered	Audio: can panic clients even more.	No audio because it makes the situation worse.
		Tactile : Some beepers have a small string, pull it out so one is sure the alarm went of at a colleague.	Tactile feedback gives a safe feeling, when the care taker has something in the hand, s/he is sure one has activated the alarm. Also a vibration to complement the certainty.
	Client must be unaware of signals	Some clients are getting aroused by alarm, because they learn the link and knows what is going to happen; for peace of mind and structure, the less stimuli the better it is. Though, some clients find it interesting, so for them it doesn't matter.	Aroused client outweighs the opinion that it doesn't matter. Therefore chosen that a client must be unaware. Means that it cannot be something that is in room where the client is unless it is at the office.
	Feedback client dependent	A tailor made solution, e.g. it vibrates at one client and not with another client.	Might give problems because to many kind of signals will confuse the meaning of it.
Worktask	Interfering	Clients ask attention at the same time.	System must not interfere too, only for high priority cases.
		Working with a client while an outsider asks for attention (phone, doorbell).	
	With client	Activities of Daily Living (ADL): personal care of clients, like showering or help with dressing themselves.	Care taker is most of the time very busy with several tasks. So when there is high priority, the signal of the system must get ones attention immediately in whatever s/he is doing.
		Activities, like playing, walking, doing sports.	Physical activities raises clients arousal too. To be sure a care taker is not hurrying when a colleagues clients is tensed, the current activity should be known.
	Without client	Instrumental activities of daily living (IADL): arranging appointments, taking care of home environment.	Same as ADL, in both cases care taker is most of the time very busy with several tasks and clients can be close by. So when there is high priority, the signal of the system must get ones attention immediately in whatever s/he is doing.

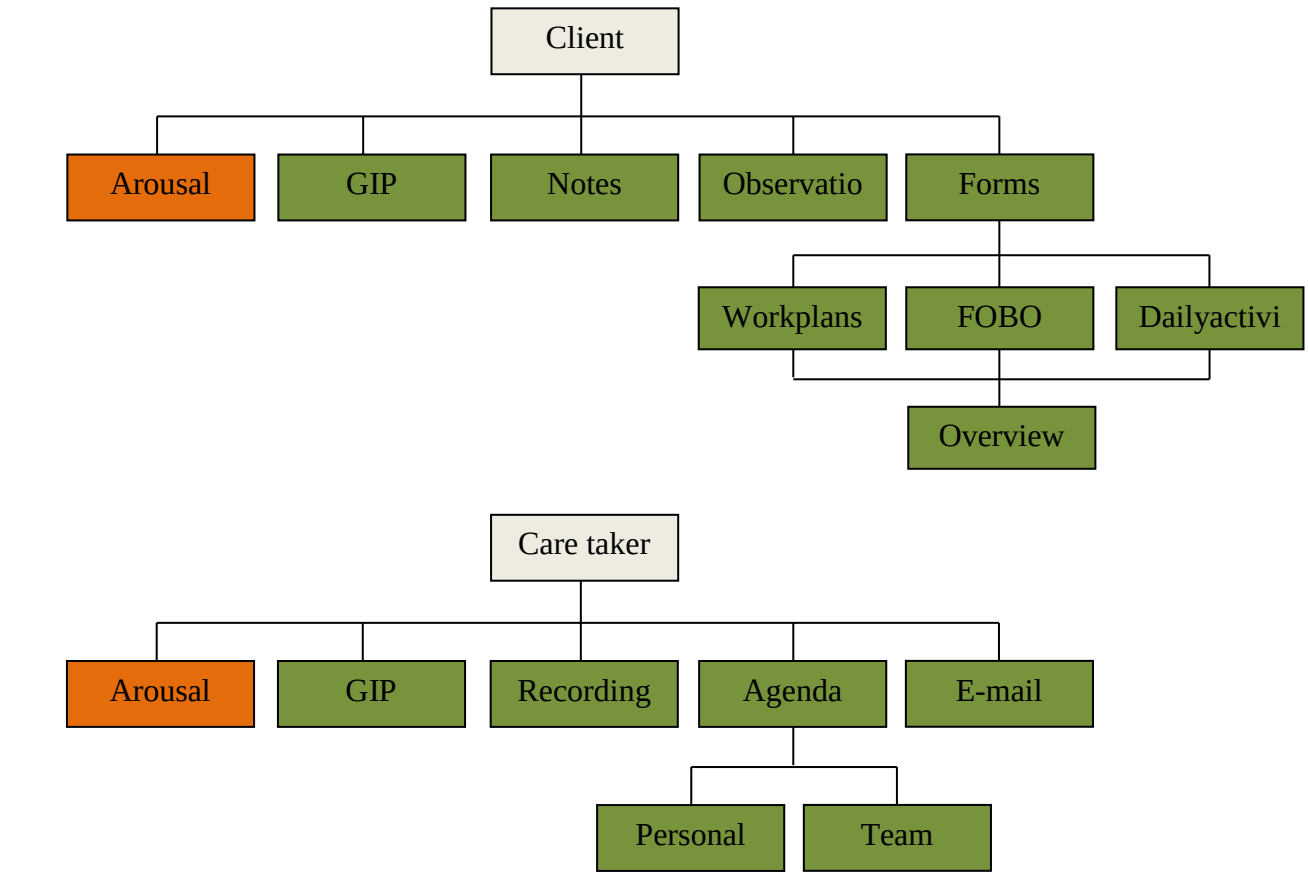
		Reporting activities, details and goals (on the basis of a GAS score), POP (personal support plan: make work goals, make appointments, multidisciplinary meetings about progression of client), daily program of client (are on paper and planned per half an hour. Activities and accompaniment are noted on it. Can be adjusted.)	Done both on paper and digital. That what is done on paper, should also be digitalized at the end of the month. Would be more efficient if it can be done digitally immediately.
		Evaluation with colleagues: 4 to 5 times a day. How to define the day and activities for clients.	Notes made by care taker(s) and information about tension that support the evaluation process immediately at hand, can make it more profitable.
Client information	Age group	Groups are homogeneous made up. Minimum age of the adult group is approximately 31. Age group of children range from 10 to 20 years. Children need structure, but also freedom. Inner restlessness happens often.	Groups are not that different that the system should have different functions for the care takers.
	Other information	Clients living at DTZC are more risky and have more requests for help, and have more difficult behaviour. They need a clear and rigid daily program. Varies a lot though within groups: with some clients it is possible to negotiate about behaviour. Some clients can be explained a lot while some don't understand the care taker. Some can decide what to do with their pocket money while some others have difficulties what to spread on their sandwich.	Monitoring system is especially important then, because not every client can communicate their emotions to the care takers.
Groupsize accompaniment	1-on-1	Some clients need more attention and therefor they get one on one accompaniment. Within a house, they have their own space, their own small apartment.	Help is difficult to ask when a care taker is separated from their colleagues. Important that they can be checked upon or ask help easily wherever they are.

	1 on many	In class groups vary from two to three care takers with four to five pupils. In houses groups vary from two or three care takers up to eight clients, with a maximum of four clients per care taker. Depends of shifts. Client groups are carefully matched, but can change depended on incidents. Though every care taker has his/her own client, it can still change: in reality it intertwines.	Every care taker in a house must have access to information from every client in the house, since they won't always accompany the same clients.
Worklocation		Inside: Homes are to small, noisy and there is not a clear view on clients, especially the ones who are in their own apartment and colleagues who are there for 1-on-1 accompaniment. The snooze room is a small room, with faint light and soft music. Used as a relaxation room for clients. The school has four classes and some pupils have their own room where they can do their tasks.	Make it possible to check on colleagues and clients without being asked and to watch every ten minutes.
		Some activities are outside, like walking to the farm or playing in the garden.	
Experience	Escalation	Startled: when not expecting an outburst of the client.	Signal of increase in arousal should be clear and understandable and be known on time.
		Powerless: not knowing where arousal comes from and why it happened.	By studying the course of the increase of arousal: when it started, what activity was going on, what happened at that moment, or what care takers arousal level was, patterns can be found. Certainty and understanding about what happened can make one feel less powerless, frustrated, doubtful, vulnerable, tensed or annoyed.
		Frustration: tried everything to solve the situation, but it didn't work out.	
		Vulnerable: preconditions for a safe work environment are not always guaranteed.	
		Annoyance: at small incidents that happen with client(s).	
		Doubt: if one does his/her job well.	

		Tensed: because one didn't see client's outburst coming.	
		Adrenaline makes one more alert to act and quickly solve the situation.	The monitoring system warns care taker on time, so they are prepared on the situation. Sadness, chills and angriness can still be part of the experience, but it might decrease because they are mentally prepared.
		No emotion: while there is an escalation going on, only thought is of acting. Emotions are experienced.	
		Depends on own mood: how ones feel that day, time of the day, after or before weekend.	
		Sad: escalations can be frightening.	
		Cold chills in the body.	
		Mad: because cannot lay aside emotions. Trying to hide it from the client.	
	Interfering tasks	Stress, to many things to do.	Tasks keep the same, cannot do anything about it.
	Tools: How future tools makes one feel	Peace of mind, knowing that an extra set of eyes watches client's tension.	Design should have a reliable look and feel and give immediate feedback to the care taker.
		Feeling of having a clear overview.	
		Feel more safe.	
		Less tensed when system warns for increase in arousal at client. Less tension means an increase in quality of care.	Basis for this study, so it is a high priority function.
		Trustful: Must give important information at the right time.	Feedback must be given immediately.
		Stronger relationship with client, preventing emotional outburst of client and be there for him/her.	Therefore clients phase is important to know, so one knows what to do at that moment.
		Makes working easier.	By fill in forms while being at the client.

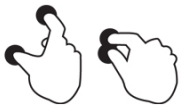
	More attention for clients: some clients find that pleasant, they like to be with the care taker.	Instead of keeping an eye on all clients constantly, the monitoring system can keep watch.
	Satisfying: now a belt of beepers and other devices are being used, which is annoying.	Reduce the amount of devices wearied to maximum one.
Work environment	Space: every house differs in size. That is why some experience it as too small and others as big. It is not depended of client age. In the small houses clients are physically to close at each other. Some say it feels safe. When 1 on 1 accompaniment (some clients have their own apartment in a house), care takers can not check on their colleagues.	No matter how big or small the house is, it still has a lot of rooms. When using objects in the space to warn, it must be in every room of the house, unless it makes a very loud sound. Otherwise the care taker doesn't notice it.
	Light: positive because it is easy to read things, and one can see clearly in the house. Dimmed lights are pleasant and bought by care takers when it is not in the house. Negative about fluorescent lamplight, it might be possible that it increases tension of clients. Some lights are very intense.	When signal of a warning is visual, it can be easily read.
	Sound: some houses are noisy, especially autistic clients can get agitated by sound. Some houses are mute so one misses contact with the colleague who is alone in a client's apartment.	Better not to use audio feedback for the system, clients already have problems with in-house sound.
Work tasks	Very busy: Continuous feeling of the need of being on two places at same time.	Only thing the monitoring system does is giving some extra eyes, so care taker do not constantly have to check up on clients while doing the laundry for example. But it doesn't give any extra hands.
	Stressed, especially the morning shift.	
	Prepared to anticipate, continuously the whole working day.	
	Useful to help clients make them a better life.	System can contribute to more satisfaction, by being easy to learn,
	Challenge, learning more every day, to do the job better.	
	Pleassant to work with these clients.	

Appendix E: Structure of the application



Appendix F: Smartphone gestures

Gestures for interacting with the elements on the smartphone.

Gesture		Action	Description
Tap		Select	Short touch with one finger on the screen, where after the result of the action is shown.
Tap + Hold		Invoke contextual menu	Long touch with one finger on the screen, where after a pop-up menu is shown.
Flick		Scroll	Speed of the scrolling through the content depends on how fast the finger is moved over the screen.
Pinch-in		Zoom out	Spread two fingers on the screen.
Pinch-out		Zoom in	Pinch two fingers on the screen
Drag and drop		Move objects	Touch an item in the screen, hold it and drag it to another spot on the screen. Release the fingers.

Note: Pictures of the gestures where adapted from "Touch Gesture Reference Guide" by Villamor, Willis, Wroblewski, Rhim & Fulton (2010).

Appendix G: User-cases

#	Taak
1	Je bent in de keuken aan het koken en hebt al een tijd niks van client Mehmet gehoord. Je vraagt je af wat hij op zijn kamer aan het doen is. Bekijk zijn webcam op de applicatie.
2	Plotseling wordt Marco erg agressief en je hebt hulp nodig van je collega's. Hoe activeer je deze waarschuwing?
3	Nadat de situatie is gesust, ben je benieuwd in wat voor mate dit voor invloed had op je eigen spanning. Controleer je spanning, hoe hoog is deze?
4	De clienten zijn televisie aan het kijken, dit is een goed moment om Marco's FOBO formulier in te vullen. Open het formulier, vul dit in en sla het op.
5	Opeens gaat Annelies' spanning omhoog. Hoe hoog is haar spanning? Met wat voor activiteit is ze bezig? Zet het alarm uit.
6	Plotseling gaat het alarm af, een collega heeft uw hulp nodig. Hoe heet de collega die uw hulp nodig heeft? Waar op het terrein is hij?
7	Mehmet is een nieuwe client, en je bent even vergeten wat te doen als hij in spanning fase 3 zit. Zoek dit op.
8	Maak een notitie op Marco's grafiek, op tijdstip 15:35.

Appendix H: User evaluation

Naam: ……

Datum: ……

Demografische gegevens

Leeftijd: .....jaar

Geslacht: Man / Vrouw

Jaren ervaring met werken met verstandelijk gehandicapten:.....jaar.

Jaren werkzaam bij De Twentse Zorg Centrum: .....jaar.

Werkplaats: wonen / dagbesteding / school / combinatie voorgaande.....

Functie omschrijving: persoonlijk begeleider / groeps begeleider / klassenassistent

Heeft u weleens een smartphone en/of tablet gebruikt? ja/nee

Hoe vaak gebruikt u deze? nooit / dagelijks / wekelijks

Hieronder staan een aantal stellingen omtrent de applicatie. Bij elke stelling heeft u een keuze uit negen antwoordmogelijkheden. Kruis het antwoord aan dat uw mening het beste weergeeft, er zijn geen foute antwoorden.

GEHELE REACTIE OP DE APPLICATIE	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
1. verschrikkelijk	●	●	●	●	●	●	●	●	●	●	geweldig
2. moeilijk	●	●	●	●	●	●	●	●	●	●	makkelijk
3. frustrerend	●	●	●	●	●	●	●	●	●	●	bevredigend
4. inadequate controle	●	●	●	●	●	●	●	●	●	●	adequate controle
5. saai	●	●	●	●	●	●	●	●	●	●	stimulerend
6. strikt	●	●	●	●	●	●	●	●	●	●	flexibel
SCHERM	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
7. Karakters op het	moelijk ●	●	●	●	●	●	●	●	●	●	makkelijk

scherm lezen												
8. Markeringen vergemakkelijken de taak	helemaal niet	●	●	●	●	●	●	●	●	●	●	helemaal wel
9. Organisatie van informatie op het scherm	verwarrend	●	●	●	●	●	●	●	●	●	●	erg duidelijk
10. Opeenvolging van schermen	verwarrend	●	●	●	●	●	●	●	●	●	●	erg duidelijk
TERMINOLOGIE EN INFORMATIE		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
11. Gebruik van termen door de applicatie heen	inconsistent	●	●	●	●	●	●	●	●	●	●	consistent
12. Woordkeus is gerelateerd aan de taak die je aan het doen bent	nooit	●	●	●	●	●	●	●	●	●	●	altijd
13. Plaatsing van berichten op het scherm	inconsequent	●	●	●	●	●	●	●	●	●	●	consequent
14. Berichten op het scherm die prikkelen om iets te doen	verwarrend	●	●	●	●	●	●	●	●	●	●	erg duidelijk
LEREN		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
15. Leren om met de applicatie om te gaan	moeilijk	●	●	●	●	●	●	●	●	●	●	makkelijk
16. Onderzoeken nieuwe functies	moeilijk	●	●	●	●	●	●	●	●	●	●	makkelijk

	door uit te proberen											
17.	Onthouden van namen en het gebruik van opdrachten	moeilijk	●	●	●	●	●	●	●	●	●	●	makkelijk
18.	Uitvoeren van taken is eenvoudig	nooit	●	●	●	●	●	●	●	●	●	●	altijd
Applicatie mogelijkheden			**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
19.	Applicatie betrouwbaarheid	onbetrouwbaar	●	●	●	●	●	●	●	●	●	●	betrouwbaar
20.	Applicatie neigt tot	lawaaierig	●	●	●	●	●	●	●	●	●	●	rustig
21.	Corrigeren van je fouten	moeilijk	●	●	●	●	●	●	●	●	●	●	makkelijk
22.	Ontworpen voor alle niveus van gebruikers	nooit	●	●	●	●	●	●	●	●	●	●	altijd
			0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	

Aanvullende commentaar op de applicatie

.....

.....

.....

Lijst van positieve dingen

1.
2.
3.

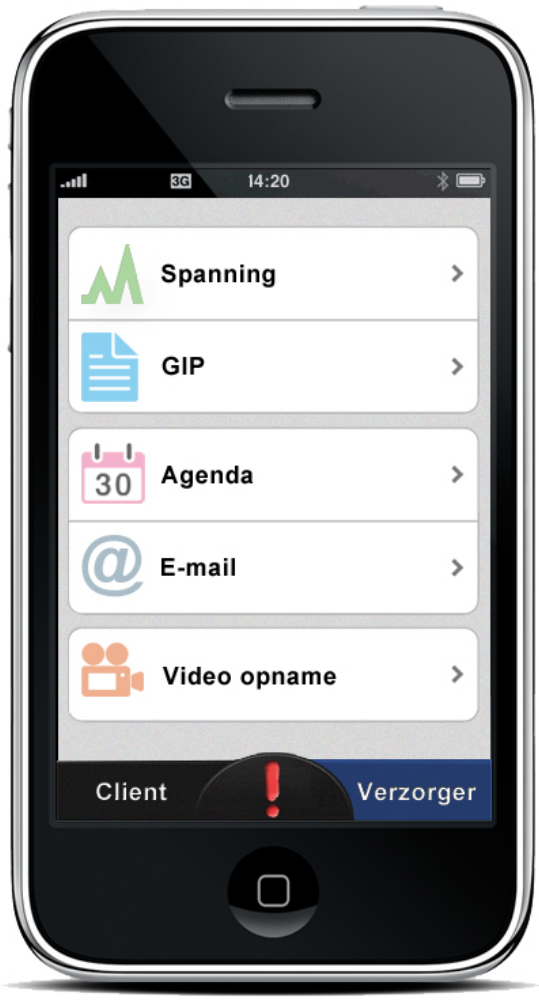
Lijst van negatieve dingen

1.
2.
3.

Appendix I: Graphical design of the interface

The main page of both the client (a) and care taker (b) are designed in more detail.

(a)



(b)