

## Developing a Personalised Virtual Coach ‘Denk je zèlf!’ for Emotional Eaters through the Design of Emotion-Enriched Personas

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**Abstract** — Obesity is a fast-growing societal threat, causing chronic conditions, physical and psychological health problems, as well as sickness absence and heavy healthcare costs. Despite numerous attempts to promote physical activity and healthy diet, existing interventions do not focus on the common emotional causes of obesity. There is a need for self-management support of this vulnerable target group: emotional eaters. This paper presents the results of the design case study focusing on a holistic design and evaluation of a personalised virtual mHealth coach that provides self-management training ‘Denk je zèlf!’ (Dutch for ‘Develop a wise mind and counsel yourself’). The target group are young adults with an emotional eating disorder and who are obese. The contextual inquiry study was conducted to gain insights into the needs and experiences of the target users, including interviews and questionnaires with emotional eaters, patients undergoing obesity treatment, and healthcare practitioners. Personas and the use-case scenario were derived from these results and translated into the new ‘Denk je zèlf!’ virtual coach, based on Dialectical Behaviour Therapy and experience sampling measures to capture user experience and emotional state. The main contributions of this paper are: (a) combining holistic eHealth design, behavior chain analysis, and dialectic behaviour therapy in one personalised virtual mHealth coaching application for emotional eaters; (b) applying emotion-enriched Personas to guide the design; (c) the results of the initial user evaluation. Preliminary results suggest that the ‘Denk je zèlf!’ virtual coach is useful for helping the target group. Future research will be aimed at further iterative (re-)design and evaluation, as well as development of the dialectical dialogues for the virtual coach and content for the education and instruction modules.

**Keywords**-obesity; emotional eating; Dialectical Behaviour Therapy; Persona; personalised care; virtual coach; persuasive design; young adults.

### I. INTRODUCTION

The fast growth of obesity is a major threat to society. Treatment of obesity and obesity-related conditions imposes a heavy societal burden due to high healthcare costs, reduction of life spans and increased risk of developing other chronic conditions such as diabetes, heart disease, osteoarthritis, and certain cancers [1]-[4]. Obese patients often suffer from psychological comorbidities, such as depression and low self-esteem [5]. *Obesity* is defined as an abnormal or excessive fat accumulation that may impair health and is classified as such by a Body Mass Index (BMI) of 30 kg/m<sup>2</sup> or higher [6].

Nearly 50% of the Dutch population suffer from being overweight and 12% from obesity [5].

Obesity is associated with poor eating habits and lack of physical activity, unhealthy family lifestyle and low socio-economic status. Increasing physical activity and reducing food intake (dieting) are considered cornerstones in the prevention and treatment of obesity. However, though many of the existing interventions are successful and help patients lose weight in the short run, long-term randomised studies demonstrate that “diets are not the answer” [7]. Existing interventions and online weight loss programs, such as Weight Watchers [8], My Diet Coach [9] and Lose it! [10] focus primarily on the ‘Big Two’ aspects, namely: eat less, exercise more. They do not provide the necessary support in the long run, as people are unable to maintain their bodyweight over a longer period.

#### A. Emotional eaters and obesity

Recent studies have shown that a considerable group (40%) of the obese population overeat due to negative emotions [11]. Emotional eating is an atypical stress reaction. A normal reaction to stress and negative emotions would be loss of the appetite. Emotional eaters show this atypical behaviour because they confuse negative emotions with hunger. They have a narrow view of what happens in their bodies (poor interoceptive awareness) and they are experiencing difficulties identifying and describing emotions and feelings (alexithymia). Emotional eaters are facing problems with emotion regulation - the ability to keep one’s emotional system in a healthy condition [12]. Diets and behaviour therapies do not help people with high degrees of emotional eating as they do not tackle the underlying emotional regulation difficulties, that lead to emotional eating [13][14].

Most emotional eaters have a long history of dieting, followed by the inevitable overeating and starting dieting again. They gain weight because of poor emotion regulation, not just due to poor eating habits or an insufficient level of physical activity [15]. Many times, they have tried to lose weight and when the emotional eating behaviour kicked in again, they end up being heavier than when they started their previous dieting episode. This is an example of the so-called ‘yo-yo effect’ in health behaviour [16][17]. It is highly conceivable that this is the cause of an accumulation of disappointments and a growing lack of confidence that one will ever succeed.

### B. Emotional eaters and eHealth

Evidence suggests that eHealth and Cognitive Behaviour Therapy can be just as effective as face-to-face treatments. Evidence-based therapeutic procedures can be delivered online [18]. In addition, emotional eaters need personalised anonymous support that is always available. Not only do emotional eaters need moral support, but a personalised self-management support could also clear away obstacles that keep emotional eaters away from face-to-face contact with a therapist.

Obese emotional eaters form a particularly vulnerable group of people. To avoid further setbacks, they need support they can rely on, that is both trustworthy and promising, but realistic, and that matches with their needs. Such support needs to be accessible and comfortable so that one feels safe and secure. There is a need for supportive training programs for this specific target group of emotional eaters. This paper presents a design case study aimed at the development of a personalised virtual mHealth coach application for self-management support of young adult emotional eaters who are obese.

The paper is structured as follows. In Section II, related work on online eHealth interventions for emotional eaters and obesity is discussed. Next, in Section III the approach and methods are presented for developing Personas and applying them to guide the design process. In Section IV, the results are presented including a use case scenario and the first prototype of the ‘Denk je zèlf!’ virtual coach. Finally, a discussion and conclusions are presented in Section V.

## II. RELATED WORK

### A. Dialectical Behaviour Therapy

Dialectical Behaviour Therapy (DBT) is a new way of treating emotional eating behaviour. DBT was originally designed to help people who are suffering from Borderline Personality Disorder [19]. The therapy focuses on the process of ‘reduction of ineffective action tendencies linked with dysregulated emotions’ [20]. Recent research into the deployment of Dialectical Behaviour Therapy shows positive results in weight loss management and weight maintenance in obese emotional eaters [13]. DBT might be successful in patients where insufficient progress was achieved using Cognitive Behavioural Therapy (CBT) [12][21][22]. Currently, CBT is considered the state-of-the-art in treating eating disorders, aimed at treating eating disorders such as *Boulimia Nervosa* (BN), *Anorexia Nervosa* (AN) and *Eating Disorders Not Otherwise Specified* (EDNOS). The core of these eating disorders is the patient’s over-evaluation of his control of weight, shape and/or eating. The efficacy of DBT for the treatment of *Binge Eating Disorder* (BED) and emotional eating behaviour has been demonstrated in the results of various studies and trials [23][24][25][26].

### B. The dialectical focus

One of the most powerful ‘mechanisms of change’ or mediators in DBT is its dialectical focus. Since an

invalidating environment plays an important role in the lives of emotional eaters, it is important that they are treated with a well-balanced mix of being validated in their perception of negative emotions and being confronted with a practical focus on changing problem behaviour. “Based in the biosocial theory, DBT has a unique approach to targeting behavioural dysfunction that is not typically seen among other cognitive-behavioural treatments; one key difference is the emphasis placed on emotions and emotion dysregulation.” [20].

### C. DBT and eHealth

There is a broad variety of eHealth self-management treatments available but the majority focus on weight loss and behaviour change. The discussion on the effectiveness of such interventions is progressing only slowly [27]-[33]. Little knowledge in the field of eHealth treatment using Dialectical Behaviour Therapy or even emotion regulation has been acquired so far, let alone about emotion regulation focused on emotional eating behaviour.

The results of one quasi-experimental study on the effectiveness of the mobile “DBT Coach”, that focused only on one particular skill in DBT (Opposite Action), showed that emotion intensity decreased within each coaching session in participants suffering from *Borderline Personality Disorder* [34][35]. The target group uses the DBT Coach when it is needed most for them – after engaging in dysfunctional behaviour. One paper discusses the lack of user-friendliness of a DBT self-management mHealth application [36].

A small number of DBT-based self-management mHealth apps can be found in the Google Play Store and in the Apple App Store. However, they typically lack scientific grounding, user involvement in the design process, psychological aspects, and personalization.

### D. Virtual coach and behaviour change

Substantial research has been dedicated to the employment of virtual coaches [37][38]. A virtual coach, as an interactive and self-learning persuasive system, can assist in attitude and/or long term behaviour change by providing immediate and personalised support [37][39]. Various definitions of virtual coaching exist in research studies, focusing either on mediated communication via internet or phone, or on the telemonitoring of health but not on the personalised feedback side of coaching [37][40]. In this research, we adopt the definition of eCoaching by Lentferink et al. [38, p.16]: “...eCoaching is defined as the remote and automatic provision of just-in-time tailored feedback for healthy lifestyle management, by enabling users to set personal goals and encouraging to track personal progress towards their goals, adapting the feedback to the usage patterns and context, and encouraging long-term use.” Current eCoaching developments and studies often lack user and stakeholder involvement and are not grounded by the behavior change theories, which leads to low usability and therefore low adherence [38].

### III. APPROACH AND METHODS

The objective of this research is to develop a personalised self-management intervention based on Dialectical Behaviour Therapy for young adult emotional eaters who are obese. We regard young adults as people in the age range of 18-44 years. Midlife transition, starting at the age of 40 to 45, might bring along other circumstances. Development is guided by the CeHRes roadmap (Center for eHealth & Wellbeing Research, University Twente) – a holistic eHealth framework for developing eHealth interventions based on a participatory design process and persuasive design approach to maximize the impact of the behavior change support intervention [41]. It is essential to emphasise the effect of the ‘look and feel’ of the intervention interface design on the adherence of the user. The interface design should be attractive and engaging to the user, otherwise he or she is unlikely to use it. User-centered design and an inter-disciplinary approach are therefore incorporated in the CeHRes roadmap framework [42]. In addition, it is important to determine which design features are used in successful eHealth interventions. Other essential aspects are suitable input modalities (such as speech, text, gestures, mouse, touch, haptic, and tangible) [40] and interactivity, information architecture, the degree to which information is updated, aesthetics, usability, credibility, and entertainment factor [43][44].

#### A. eHealth Intervention Architecture

The intervention consists of a series of education and instruction modules on emotional eating behaviour and emotion regulation. A personalised virtual coach will guide the user through four modules. First an ‘intake procedure’ will take place: the user will be invited to make a commitment never to lose him or herself in emotional eating behaviour again, followed by educational modules on mindfulness, emotion regulation, and stress tolerance (Fig. 1).

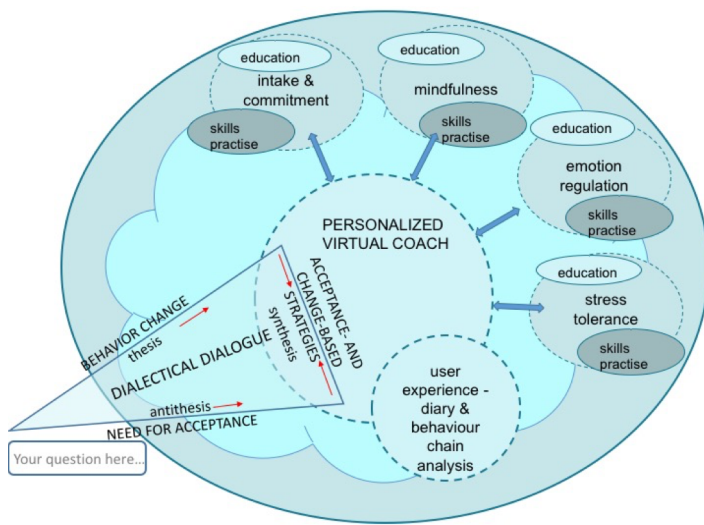


Figure 1. Schematic drawing of ‘Denk je zélf!’ mHealth intervention

The training offers exercises based on practical experience in daily life. Modules are replaceable – they can be replaced by modules with content that might be focused on users with low socio-economic status. Users are invited to fill in their behaviour chain analysis (Fig. 2) and emotion diary on a daily basis. The behaviour chain analysis is to be performed at the moment a participant has given into cravings and poor eating behaviour or is just about to do so. The behavioural chain analysis is utilised to analyse problem behaviour and determine prompting events and vulnerability factors. People can also fill in new personal goals and consider ways to prevent prompting events and to think of solutions to reduce susceptibility in the future. Reminders to log in to the application and fill in the behaviour chain and the diary are sent out at the fixed times previously agreed with the user. Both components are considered indispensable in the face-to-face training being daily ‘homework’ for the participants.

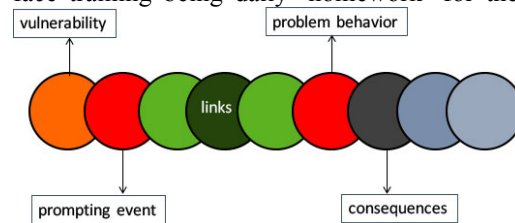


Figure 2. Behaviour chain analysis model by Linehan [19].

#### B. Contextual inquiry

This study focused on the contextual inquiry and early design phases. First, the contextual inquiry phase was carried out. To become familiar with what kind of support emotional eaters really need, it is important to understand the target group [45]. Even though interventions can be evaluated as positive in terms of effectiveness, if the target group is not captivated by its design and functionalities, they are not going to use it.

The use of user profiles and Personas as a tool to inform design is still rare in social sciences. We used the LeRouge classification model [45] and Van Velsen’s additions to it [46] as a guideline to develop two Personas to guide the design of a virtual mHealth coaching intervention. Personas contain information on their *technology skills* and smartphone use, *demographic facts*, and *healthcare specifics* such as current practices in managing one’s own healthcare, support network, and information seeking attitude. In addition to the standard Persona classification model [41], Persona Lisanne is enriched by emotions and feelings in second iteration of contextual inquiry.

To gather input for user profiles and Personas, questionnaires (N=321) were circulated via social media and the network of contacts. The target group was “young adults, 18-44 years of age” who are self-declared emotional eaters. Examples of questionnaire questions: “For what purposes do you use your smartphone? (social media, news gathering, mail, gaming)”, “At what specific moment in time would you like to/are you in need of contact with a help system?”, “What kind of support do you expect from a smartphone

application?” We approached healthcare practitioners for expert interviews (N=13). In the next sections, we present the results of this design case study, including Personas, the use case scenario, and a description of the architecture and design of the ‘Denk je zèlf!’ virtual coach.

The use-case scenario is developed based on Personas (Fig. 3) and the specific lifestyle characteristics of the emotional eaters from the literature and interviews.

Personas	
Lisanne, 25 years, high educated	Anita, 46 years, limited education
	
“I wish that I was more confident about myself ....”	“When I am stressed out I start snatching the cookie tin”
Background	
Lives alone, single / High school graduate / Suffers from obesity / Co-morbidity unknown / I. 1.62 mtr., w. 91 kgs.	Lives with husband and two sons / low SES / Suffers from obesity / Co-morbidity unknown / I. 1.65 mtr., w. 85 kgs.
Attributes	
Feels insecure about her body / Is not able to sense the difference between hunger, appetite or emotion / Fears experiencing what she really feels.	Is worried about putting on more weight / Suffers from stress and finds comfort in food / Has a ‘sweet tooth’ / Hates to be patronized by authorities.
User needs	
Education on eating behaviour / Self-confidence / Help to set realistic goals / Support from peers.	Stop gaining more weight / Education about healthy food / Getting support from her family / Stop harassing thoughts.

Figure 3. Key Personas Lisanne and Anita

### C. Design & prototyping

During the design phase, a first clickable prototype of the graphical user interface was designed, based on two Personas, namely Lisanne and Anita (Fig. 3), and the Gestalt design principles [47], Nielsen’s usability heuristics [48], and Gomez’s heuristics on mobile devices [49]. The wireframes were created in Adobe Illustrator and reshaped to screens in Adobe Photoshop. Interactivity was added using InVision. The prototype consists of loading screen (visible when the application is loading), a login screen and a link to Frequently Asked Questions. The user is shown an informative text about how to use this application. Navigation is divided into four buttons: ‘coach’, ‘modules’, ‘diary’ and ‘profile’. The user can start a conversation with the coach through dialogues in a Whatsapp (messaging application for smartphone) layout style. The button ‘modules’ leads to subsets of learning

modules on mindfulness, emotion regulation, and stress tolerance. In ‘diary’, the user can record feelings experienced. In ‘profile’, he or she can adjust settings and personal information such as uploading a personal picture. The user can also store encouraging items such as favorite pictures and quotes. Via the ‘central’ button the user can navigate back and forth to all the modules and functions available in this prototype.

To develop an architecture of the personalised virtual coach, including the two vital parts - the behaviour chain-analysis and the emotion diary, the Persona and use-case scenario were translated into user stories (example: ‘As a user (Lisanne) I would like to get an overview of my diary so that I can see my history’). Next, user stories were translated into a functional prototype of the architecture of the virtual coach.

### D. Heuristic expert evaluation

Iterative user evaluation in the early design stage is essential to obtain early feedback from the potential users and so improve the prototype. An expert evaluation of the first version of the clickable prototype of the user interface was conducted by a usability expert (a lecturer in User Centered Design at Hanze University of Applied Sciences) This expert was asked to perform eight different tasks. The heuristics [48][49] were scored using a 5-point Likert-scale (1=does not fulfil requirements; 5=fulfils requirements). Examples of the applied heuristics include: “Is there an option to navigate back (button)?”; “Is there a facility for horizontal scrolling?”; “Do drop-down menus have a logical order?”; “Is there sufficient contrast between text and background?”

The expert was guided through a task scenario. Tasks were: *Log in to the app; Read the introduction about the app; Read the Frequently Asked Questions; Communicate with the Virtual Coach about your eating behaviour; Setup/configure your profile; Set the alarm to receive daily notifications;*

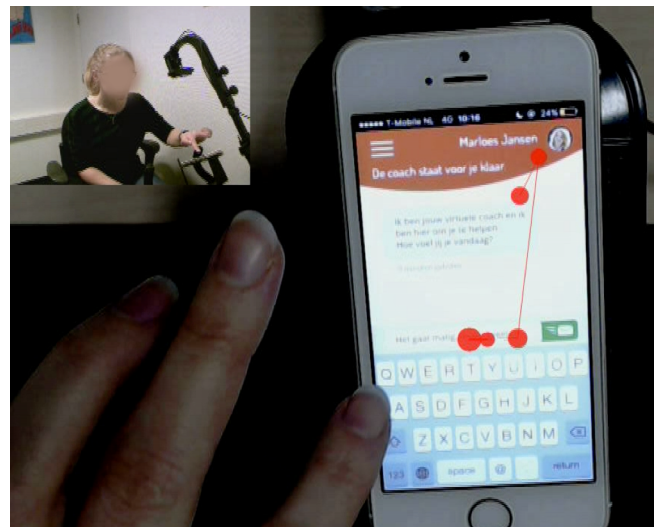


Figure 4. Screen capture from the usability test: eye tracking gaze plot video

*Check on available modules and Fill in your diary.* The results were used to modify and to adjust the prototype.

#### E. Usability evaluation with eye-gaze tracking

Next, a usability evaluation of the second improved version of the clickable prototype was conducted among the target group (N=10).

*Participants, procedure & materials:* Task scenarios were created. Tasks were presented as short stories to give more context. In total, ten participants [50] volunteered to perform a test with eight tasks. Among the ten participants, five were university students studying behavioural sciences, three were self-declared emotional eaters and two were user interface designers. Participants were recruited via the Facebook social network used by the students. The usability test took around 30 minutes. Participants first received a pre-briefing on the goals of the usability test and the nature of volunteer participation. Next, users executed the task scenarios followed by a post-test interview.

During the usability tests (Fig. 4), participants were monitored by eye tracking, using a 'Tobii Mobile Device Stand' (MDS) [51], followed by an interview in accordance with the Retrospective Think Aloud Method [52]. A calibrated eye tracker (one that follows the eye pupils of a test user) registered what the user is looking at while performing each task using the second clickable prototype. The evaluator is able to see what parts of the interface the user is looking at, even if the test user scrolls, or zooms in while interacting with the user interface [51]. The results are plotted on so-called gaze plots and the evaluator is able to watch a slow-motion replay.

With participants' permission real-time gaze replay video is recorded of the eye-tracking sessions.

*Measures:* we measured the task performance by recording some quantitative measures, such as registering how much time is needed to complete each task, the number of times a participant made 'wrong' choices/clicks, how many tasks were completed, and the number of taps or swipes that were needed to perform each task. The ways in which the designer performed the tasks was taken as a reference point. Tasks were measured on a scale 1-3 (1 = user failed to perform the task; 2=user performed the task but with errors; 3=user performed the task without any errors). Qualitative measures were extracted from the post-test interviews. The Retrospective Think Aloud (RTA) method [52] is used to collect additional information about the motivation of the choices users make while performing the tasks. After each user test session, post-interviews are conducted with each participant in order to give the user the opportunity to further explain why he or she made specific choices, as well as to obtain feedback on the user experience as additional input to improvement of the prototype. The RTA method - in combination with the eye-tracking allows a user to focus completely on the task. Research has shown that in retrospective think-aloud protocols, more problems were detected by means of verbalization, because the participants had more time to verbalize the problems [53]. Analysis of the gaze plots is not yet finalized and is work-in-progress.

## IV. RESULTS

### A. Questionnaires and interviews

In total, 321 responses were collected from the questionnaires and 13 interviews with healthcare practitioners (dieticians, physical therapists and psychologists) were conducted. The interviews were all transcribed and coded. We used a free coding style (no pre-set codes) so as not to lose the richness of the data. In addition, six obesity therapy patients were interviewed to obtain insight into the daily needs and experiences of the emotional eaters.

Data extraction from the questionnaires was processed for the purpose of creating user profiles and Personas according to the method proposed by LeRouge [45]: (a) personal and demographic information; (b) technical capabilities and limitations; and (c) needs and desires concerning support and care. Data derived from the interviews with experts and patients gave information about eating styles and the problems that emotional eaters encounter.

### B. Personas and use-case scenarios

Two Personas were derived from the questionnaire data: Lisanne (25 years) and Anita (46 years). Figure 3 shows their personal profiles. Lisanne is a highly educated young woman. She is an obese emotional eater. Her eating behaviour is caused by a negative self-image. Eating gives her a feeling of comfort as long as the eating lasts. Afterwards, she feels guilty and depressed. Anita is 46 years old and a mother of two. She worries about the family's financial situation and overeats in stressful situations. Anita left school at an early age. She is from a low socio-economic background.

What we learned by creating the Personas is that we achieved a better understanding about the specific needs of the target group. We obtained a better comprehension of the moments and situations that cause emotional eating behaviour and the kind of intervention that might be helpful to them. During the design process, you can ask questions such as: "What would Lisanne think of this? Would she like it? Would she consider this as useful?"

To illustrate how Lisanne will benefit from the virtual coaching application, we created a use-case scenario (Fig. 5) in which she is about to give in to emotional eating craving. Use-case scenarios [54][55] are derived from Personas, interviews, and questionnaire results by describing the user goals, motivations, actions, and reactions while using the virtual mHealth coaching application.

In the "Day of Lisanne's life" scenario (Fig. 5) – the most common characteristics are mentioned, such as suffering from negative emotions and low self-esteem. Persona Lisanne is enriched with emotional characteristics and personal feelings. All her emotions are linked to realistic and possible causes, such as difficult situations at work or at home. Personas are distinguished from each other in terms of technical skills, demographic backgrounds and healthcare status specifics. As a result, they are realistic personifications of their very specific sub-target groups. The existing Personas Lisanne and Anita both are emotional eaters but the emotions and feelings that urge them to overeat, diverge widely.

Day of Lisanne's life – a Use Case Scenario	User Profile
<p>The alarmclock goes off; Lisanne presses the snooze button. She had a <u>bad night</u>. Probably because she spent a lot of time on her tablet and watching television last night, but she <u>couldn't sleep</u> anyway....</p> <p>Lisanne gets out of bed eventually. She is standing in front of her drawer. What to wear? She slips into an oversized black sweater and a pair of jeans. She is <u>way too fat</u> to wear a fashionable dress.</p> <p>"Oh bummer... <u>no time for breakfast</u>..." The bus is leaving within 5 minutes. The <u>bus stops exactly in front of the building</u> Lisanne is working. She meets colleague Esther at the coffee corner. Esther convinces Lisanne to <u>come with her to the supermarket</u> on the other side of the street. Esther didn't have any breakfast herself and she fancies a bite. Lisanne <u>wants a freshly baked sandwich</u>. That way she could <u>make up for her missed breakfast</u>. It is very busy in the store. She should focus on her presentation, scheduled for less than 10 minutes from now. Esther yells at her, waving, her hands full with <u>donuts and soft drinks</u>. Lisanne: "Oh well, I will get a healthy sandwich later in the day...."</p> <p>Ok, one last <u>sip of coke</u> and off she goes. The meeting is about to start now. Lisanne is <u>nervous</u> – she <u>hates</u> presenting in front of a group. She thinks that everyone in the room is convinced that <u>she is dumb</u> and that <u>she looks fat</u>. Her <u>clothes look ugly</u> on her.</p> <p>It is noisy in the hall. The door opens. A colleague is standing in the door opening. She is carrying a birthday cake and starts handing out cake to everyone in the room. Lisanne <u>is upset</u>. She <u>hates to do presentations</u> and now she is interrupted too.... The colleagues don't seem to care so Lisanne decided to <u>keep her mouth shut</u>. Coffee time! Esther brings Lisanne a mug and nestles herself on Lisanne's desk. She fancies going out tonight to their favorite bar. Tonight is <u>Fry-night: all-you-can-eat</u> chips &amp; snacks for a fixed price. Lisanne <u>doesn't feel like going</u>, she'd <u>better have something more healthy to eat</u>. But Esther persuades her, saying it will be fun. "Mm, I really should stop nagging.... why am I making all this fuss about nothing? Why care? <u>Tomorrow is another day. Tomorrow we will start eating healthily!</u>"</p> <p>Esther turns around on her way out and throws a <u>bag of chocolate peanuts</u> on Lisanne's desk. Here, <u>something to nibble</u> while you are working. Now Lisanne is <u>totally miserable</u>... doesn't Esther realise what she is doing? The <u>bag with chocolate peanuts is empty</u> and the amount of work still high. She has got only two hours left and she <u>starts panicking</u>. She was <u>not able to get a lot of work done</u>. She is about to <u>cry</u>. Esther appears in the door opening. Time to go! Lisanne <u>brings up some poor excuses</u> - she really <u>doesn't feel like going out</u>. But Esther doesn't want to hear it and drags her along. The Fry-night has started of and both the girls are served a <u>large plate with fries and chicken satay</u>. Esther babbles along, as she usually does. In the meanwhile everybody in the bar is a bit tipsy. Lisanne <u>feels lonely</u>. Esther is standing at the counter, talking to some guys. She invites Lisanne to come over and join them. Lisanne grabs her handbag. She is going home. She waves and gestures to Esther that she feels nauseous and that she is leaving. On the one hand she <u>feels relieved</u> that she has left but on the other hand she is <u>disappointed in herself</u>. Why can't she <u>just enjoy an evening out</u> and have fun just like everybody else? Why is she <u>so damn shy</u>?</p>	<p><b>Aspects of a sedentary lifestyle: computer, television; poor sleeping habits (sleep hygiene: going to bed too late); people with obesity often suffer from sleeping problems.</b></p> <p><b>Obese people often suffer from low self-esteem and low body image.</b></p> <p><b>Poor eating habits– no breakfast; no decent meals, just snacks, sugary soft drinks; little knowledge about what is healthy food.</b></p> <p><b>What the hell effect: totally giving up on set goals (diet, exercise) after one single slip and feeling justified in giving in to poor habits (binging) because the intention is already 'ruined'.</b></p> <p><b>Negative self image: people who are overweight suffer from a lack of self-confidence and have an inferiority complex.</b></p> <p><b>(unrealistic) Assumptions about what others might think of you; not assertive, not able to stand up for oneself.</b></p> <p><b>Mindless eating (mostly snacks and sweets); eating as a coping-strategy to cope with stress – emotion regulating eating behaviour.</b></p> <p><b>Social introversion – quiet and reserved in large groups and around unfamiliar people.</b></p> <p><b>Low self-esteem and a bad body image.</b></p> <p><b>Having difficulties acknowledging and expressing feelings and emotions.</b></p> <p><b>Emotional eaters have trouble recognizing feelings of hunger and thirst, pleasure or discomfort. Most of the negative feelings are translated into appetite.</b></p>
<p><i>situation upcoming food craving:</i></p> <p>Lisanne comes home and plumps down on to her couch, next to the pile of laundry that still needed to be done. She is <u>hungry</u>. She <u>feels lonely</u>. <u>Nobody likes her...</u></p> <p>Her <u>stomach is rumbling</u> and she takes a quick glance at the kitchen cupboard. Lisanne is about to giving in to her food craving. Butter biscuits and potato chips. She <u>feels tempted to rip open</u> the bag of potato chips and plunge into it, <u>grabbing chips by the handful</u> at the same time. Binge eating lies in ambush for attack and she senses a <u>craving need for some kind of support</u>, for someone who could provide her with <u>advice to pull her through this situation</u>. After finishing the bag of chips, she eats some leftover portions of ice cream she ordered at the take-away yesterday, and some mouldy cookies she found in the bread box.</p>	
<p><i>situation upcoming food craving – consulting the 'Denk je zèlf!' virtual coach:</i></p> <p>Lisanne comes home and plumps down on to her couch, next to the pile of laundry that still needed to be done. She is <u>hungry</u>. She feels lonely. <u>Nobody likes her...</u></p> <p>She reaches for her phone and activates the 'Denk je zèlf!' app. The virtual coach welcomes her with: "Hi Lisanne, how can I help you?" Lisanne starts typing:</p> <p><i>-When I come home at night I start craving for snacks and chocolate... I just can't resist them...</i></p> <p><i>-Hi Lisanne, I really feel sorry for you. Let me try to help you. The greater part of emotional eating occurs at night, due to feelings of loneliness or experiencing stress, but it can also happen because of irregular eating behaviour. Shall we give it a try to investigate this?</i></p> <p>The virtual coach refers Lisanne to the <i>behaviour chain analysis</i>. Lisanne finds comfort in the reassuring words of the virtual coach and starts with the behaviour chain exercise.</p> <p>After finishing the chain exercise Lisanne feels somewhat relieved. The coach urges her to reward herself. She treats herself with a hot bath. The perfumed bath water makes her feel calm and sleepy...</p>	

Figure 5. Persona Lisanne translated into use-case scenario aspects

Lisanne gives in to cravings, driven by disgust, while Anita binges when she is under a lot of stress. The next step in this research is to develop a use-case scenario for all the Personas next to Lisanne, each of them enriched with their own specific emotional characteristics.

### C. Prototype of a "Denk je zèlf! personalised virtual Coach

The first prototype of the architecture of the virtual coach and a clickable prototype of the user interface were developed during the pre-design phase. The Personas Lisanne and Anita served as a starting point for a concept design (Fig. 5) of the

user interface and content of ‘Denk je zèlf!’ virtual coach modules: *intake, mindfulness, emotion regulation and stress tolerance*. The Java-based virtual assistant (developed on the Play framework) makes use of the *Alpino* open-source natural language parser. This Dutch linguistic language analyser [56] is self-learning and produces ‘tree diagram’ data in XML format. The output is stored in a graph database (NEO4J).

The virtual coach was developed to meet the needs of the user for immediate support. Every time a user is experiencing negative emotions, he or she can connect to the virtual coach and ask questions and start a dialogue. The virtual coach is the very heart of the e-DBT ‘Denk je zèlf!’ training. It supplies users with so-called dialectical dialogues – providing answers to their need for change and to their need for acceptance. According to Lynch et al. [20], dialectical theory is defined as: “*The thesis (behaviour change) brought forth the antithesis (the need for acceptance), and both acceptance and change-based strategies were integrated into the treatment package (synthesis). Dialectical theory provides the theoretical undercurrent needed to balance and synthesize these strategies. Core acceptance-based strategies derive from client-centered approaches and Zen practice and these involve mindfulness skills, validation, and radical acceptance.*” [20, pp. 463]. The goal of the training is to teach people how to develop their own *wise mind* and to learn to make decisions that have positive consequences for the quality of life. By providing dialectical dialogues, the virtual coach can help the user to practise this process of decision-making by identifying the possible consequences of making decisions. The output of the virtual coach is personalised by data derived from the behavioural chain analysis and the emotion diary. The virtual coach is a self-learning system. Ecological momentary assessment (EMA), often termed experience sampling measures (ESM), is applied within the virtual mHealth coaching application to assess behavioural aspects [57][58], for instance by assessing subjective momentary states several times a day via a user-experience diary integrated into a virtual mHealth coach application.

D. Evaluation of the first prototype: ‘Denk je zèlf!’ virtual coach

The expert user was asked to perform eight task scenarios based on 15 heuristics [44][45]. The overall impression, conveyed by the user expert was good, but he remarked that:

- the functionalities horizontal and vertical scrolling are not yet fully operational;
- no clarity about where to find oneself in the process;
- difficulties in locating the virtual coach;
- some modules do need additional explanation.

The feedback given was processed and the second clickable prototype was built. Ten test users performed the eye tracking test and a Retrospective Think Aloud session.

According to the results of a usability test (see Table 1), the virtual coach application scored highly on the usability, which in this case is defined as the accurate execution of a given task via a user interface. The accuracy of the tasks were assessed on a scale of 1-3. A task is graded 1 if the user fails to perform the task, grade 2 when the performance is done with (some) difficulties and a 3 for a problem-free performance. Two of the tasks scored as unsatisfactory: users found it difficult to navigate to and to find the biography, and to adjust the settings for a notification and to understand its purpose. Users tend to tap on the ‘No logon code? Read this’ link because they had no idea of how to log in to the application. They tried to utilize a non-active link in the text or to navigate back to the login page. Adjusting the personal profile was a difficult task because the corresponding button was labelled ‘settings’ and that made it hard to find. Some users had difficulties with setting up a notification. The routing via the start button and the ‘hamburger menu’ (icon with three parallel horizontal lines) was considered accurate but the alarm icon was not recognised. Test users delivered feedback such as: ‘It is not easy to obtain a login code’, “It is difficult to locate personal settings’ and ‘I don’t like the color orange.’ The designers used clickable prototypes. That means that the interface does not offer unlimited navigation and interactivity. This should have been communicated more accurately to the users.

TABLE I. TASKS AND THEIR SCORES

Task no.	Task description	No. of taps /swipes	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	researcher	Total grading
			grading scale 1-3											
1	Getting a login	1 swipe 1 tap	3	3	3	1 <sup>1</sup> (4 taps)	1 <sup>1</sup>	3	3	3	2 <sup>1</sup>	3	3	28
2	Logging in	2 taps	3	3	3	3	3	3	3	3	3	3	3	33
3	read FAQ/ introduction	2 swipes 1 tap	3	3	3	3	3	3	3	3	3	3	3	33
4	send message to the virtual coach	3 taps	3	3	3	3	3	3	2 <sup>2</sup>	3	3	3	3	32
5	adjust personal profile	2 taps	2 <sup>2</sup>	3	2 <sup>2</sup>	1 <sup>2</sup>	2 <sup>2</sup>	3	2 <sup>2</sup>	2 <sup>2</sup>	1 <sup>2</sup>	1 <sup>2</sup>	3	22
6	set up a notification	3 taps 1 swipe	2 <sup>3</sup>	3	2 <sup>3</sup>	2	3	2 <sup>3</sup>	3	2 <sup>3</sup>	1 <sup>3</sup>	3	3	26
7	finish/close module	3 taps	3	3	3	3	3	2	1 <sup>4</sup>	3	3	3	3	30
8	create item in diary	3 taps	3	3	3	3	3	3	1 <sup>4</sup>	3	3	3	3	31
Total time needed (min.)			3:34	2:41	2:21	2:17	3:03	4:38	4:37	3:35	5:36	2:48	01:10	
T <sup>=</sup> test user			1 didn’t understand the concept ‘swipe’ 2 tapped on several buttons to navigate 3 couldn’t find a way to confirm choice 4 didn’t follow instructions					Grading scale 1-3: 1=user failed to perform the task, 2=user performed the task but with errors, 3=user performed the task.						

Four users suggested that the layout color should be adjustable by the user. In the third clickable prototype the label of the button 'settings' is changed to 'profile'. The alarm functionality has a standard icon attached to it, and setting the alarm itself is made more explicit.

## V. CONCLUSION AND DISCUSSION

The main contributions of this paper are: (a) emotion-enriched Personas Lisanne and Anita as a new approach to guide the empathic design, which contributes to a better understanding of the mental model of the target group; (b) use-case scenario describing the daily challenges of an emotional eater, namely Persona Lisanne, which can be used for designing other lifestyle support and eCoaching applications for this vulnerable target group; (c) a clickable prototype of the 'Denk je zèlf!' virtual eCoach user interface; (d) results of the first user evaluation with the usability expert via a heuristic evaluation. The usability of the second clickable visual prototype was tested with users via thinking aloud usability tests using eye tracking. First results demonstrated that users are positive towards the virtual coach prototype. However, the first results are rather limited due to a small number of participants and the incomplete analysis of the eye gaze tracking data.

As a next step, the user interface of the 'Denk je zèlf!' virtual coaching application will be modified, further developed and iteratively evaluated by a larger number of target users. Within this next design and evaluation phase, the preferred appearance of the virtual coach will be investigated, in order to ensure that the virtual character, whether a peer or a health professional, is visually appealing and motivating for the emotional eaters. In addition, the content of the dialectical dialogue feedback messages of a virtual coach will be derived and iteratively validated with users, based on handbooks for therapists and online user forums. The users will be given small assignments such as navigating to the virtual coach and starting a conversation. Participants of the next user evaluation session will be asked to judge the responses of a

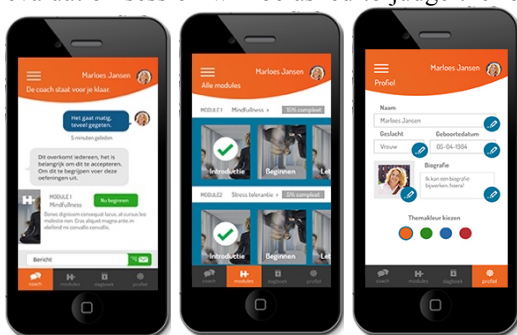


Figure 6. clickable visual prototype of the user interface with screens virtual coach, module mindfulness and profile

virtual coach in terms of their persuasiveness, faithfulness and truthfulness. The output will not only benefit the quality of the user experience and the virtual coach interface, but will also inform future design and summative evaluation.

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Lisanne and Anita are imaginary persons. Photos are retrieved from Shutterstock.

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