



Maastricht University

KNOWLEDGE IN ACTION

## Faculteit Wetenschappen School voor Informatietechnologie

master in de informatica

### **Masterthesis**

***A mobile companion for stress management for students in higher education***

**Alexander Vandoren**

Scriptie ingediend tot het behalen van de graad van master in de informatica

### **PROMOTOR :**

dr. Gustavo ROVELO RUIZ

De transnationale Universiteit Limburg is een uniek samenwerkingsverband van twee universiteiten in twee landen: de Universiteit Hasselt en Maastricht University.



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# Foreword

I would like to thank dr. prof. Karin Coninx and dr. Gustavo Roveló Ruiz for allowing me to work on this topic and guiding me. I also want to express my gratitude to dr. Gustavo Roveló and Cindel Bonneux for reading my thesis and giving me feedback on my progress.

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# Abstract

Students are confronted with a lot of stressors: next to dealing with new instabilities regarding career and relationships, they also deal with deadlines and social conflicts at university. Stress is correlated with mental disorders such as anxiety, depression, and having suicidal thoughts and behavior. Even though there are several stress management applications developed in both academics and commercial mobile application stores, they lack proper user testing, lack helpful interactive content, or suffer from low adherence. In this project, we design and develop a mobile application that supports students in managing their stress. We use a user-centered approach to understand the needs and preferences of the students and to include features that effectively help them, improving their user experience. We make use of qualitative and quantitative methods. We have semi-structured interviews with teaching staff, and (student) psychologists as they are regularly exposed to (stressed) students. A survey and a focus group were conducted to get input from the students themselves and to gain insight into their situation and current coping methods. The results help us conclude to realize a general stress management app that is targeted to students and contains relevant topics. We combine theory in psychology regarding stress management with Human-Computer Interaction techniques (such as gamification and anthropomorphism) to solve the current shortcomings of existing studies and solutions.



# Summary in Dutch

## Probleemstelling

Volwassenen tussen de 19 en 29 jaar krijgen te maken met een aantal uitdagingen. Veel mensen uit die groep worden geconfronteerd met nieuwe beslissingen met betrekking tot hun educatie en carrière [150]. Daarnaast dragen factoren zoals veranderingen in de kijk op de wereld, in peergroups en in romantische relaties bij tot instabiliteit in het leven. Samen met andere dimensies in die periode, verhoogt de beperkte stabiliteit de kans op stress, angst en depressie [151]. Een groot deel van die populatie zijn studenten in het hoger onderwijs, waarin ze veel leerstof te verwerken krijgen, sociale druk ervaren en conflicten tegenkomen in groepsopdrachten. 20% van de studenten in KU Leuven vertonen symptomen van stress of zijn gevolgen (depressie, substantiemisbruik...) [5]. Een verhoging van stress werd bovendien bij nieuwe studenten geobserveerd die niet verminderde doorheen hun studieloopbaan [22]. Ondanks dat stress studenten kan helpen om leerstof te verwerken of aan projecten te werken, kan het ook ervoor zorgen dat ze taken niet efficiënt of zelfs helemaal niet uitvoeren [60,81,91] en slechtere studieresultaten [87,128].

Hoewel stress een rol heeft in het beschermen van het menselijk brein en lichaam, kan het negatieve effecten hebben op de mentale en fysieke gezondheid. Zo kan het leiden tot het vertonen van mentale stoornissen zoals depressie- of angststoornis [91,103,132], of het hebben van suïcidale gedachten of suïcidaal gedrag vertonen [9,33,120]. Bovendien verhoogt stress de bloeddruk en de hartslag van de persoon, wat leidt tot een verhoogde kans op hart- en vaatziekten, de grootste doodsoorzaak ter wereld van 2002 tot 2016 [175,176].

In de meeste Belgische universiteiten zijn consultaties met een studentenpsycholoog gratis [177–179]. Toch is de drempel om hulp te zoeken nog steeds wat hoog [161]: minder dan 20% van de studenten die symptomen vertonen zoeken hulp of zetten de stap voor een behandeling [85]. Bovendien zijn adolescenten met een lage emotieregulatie zelfs minder geneigd om voor hulp te vragen, ondanks hun verhoogde kans op depressie of suïcidale gedachten en gedrag [35]. Andere factoren die kunnen meespelen zijn sociale en culturele stigma's, financiële redenen, ervan uitgaan dat de symptomen vanzelf overgaan en niet weten waar hulp voorzien wordt [1,56,69]. Primaire therapie kan daarentegen helpen met stress management en de ontwikkeling van copingvaardigheden [149,172].

Ondanks dat er commerciële toepassingen beschikbaar zijn die helpen met stressmanagement, zijn die zelden effectief of geschikt voor langdurig. Bovendien is het aantal studies over digitale applicaties voor mentale gezondheid laag. In de studies die er over zelfmanagement applicaties voor mentale gezondheid, wordt er een concept of implementatie van een prototype beschreven waarbij er validatie ontbreekt. Een ander type applicatie in dezelfde sector zijn webinterventies. Ondanks dat hun positiviteit



effectiviteit op de behandeling van mentale stoornissen wel aangetoond is, is de kans groot dat gebruikers vroegtijdig afhaken.

## Achtergrondinformatie over stressmanagement

Cognitief gedragstherapie (CGT) wordt door psychologen gebruikt om een patiënt met een mentale stoornis met behulp van probleemgericht coping te behandelen [61]. Deze soort therapie gaat er vanuit dat, ondanks dat ze met elkaar verbonden zijn, je gedachten, gevoelens, je gedrag en fysiologische reacties aparte delen zijn en dat je wel je gedachten en gedrag kunt bijsturen of aanpassen, wat ervoor kan zorgen dat je stressfactoren in de omgeving mindert of dat je minder stress ervaart door die factor [59]. Bij het ontwerpen van de applicatie kunnen we ons baseren op de theorie van CGT in combinatie met Barlow's model genaamd Unified Protocol, een evidence-based protocol dat voorstelt dat een therapie bestaat uit onder andere correct en duidelijk van de beperking van de patiënt en het aanpassen van gedragsmatige gewoonten [180].

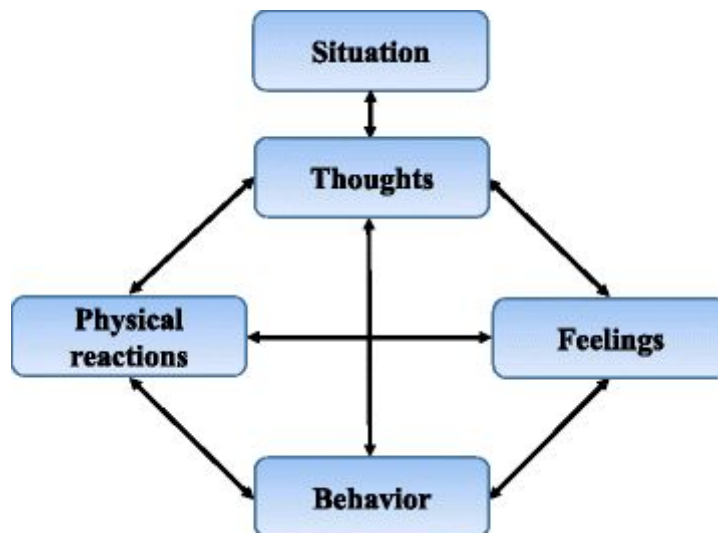


Figure 1: visuele voorstelling van de theorie achter cognitieve gedragstherapie [23]

De aanwezigheid en kwaliteit van sociale steun kan een grote rol spelen in het mentaal welbevinden van een persoon [100,127]. Deze thesis geeft ons de mogelijkheid om te onderzoeken of een mobiele stressmanagementapplicatie kan helpen in het onderhoud of voorzien van sociale steun.

Een aantal studies hebben aangetoond dat therapiehonden een snel effect hebben op stress van studenten tijdens examenperiodes. Bij het design van de applicatie, laten we ons inspireren door de voordelen van dieren op het mentaal welbevinden van mensen [21,43].

## Gebruikersanalyse

In deze thesis onderzoeken we hoe een mobiele applicatie universiteitsstudenten kan helpen in het managen van stress. Een gebruikersgerichte aanpak wordt gehanteerd om de grote oorzaken van stress in die groep te detecteren en te bepalen welke onderwerpen en welke type interacties we kunnen aanbieden om hen met stressmanagement te helpen. Daarvoor gebruiken we zowel kwantitatieve als kwalitatieve methoden. We houden een aantal interviews met studentenpsychologen en leden van het onderwijsteam van de UHasselt (meer bepaald in de richtingen rechten en informatica). Om wat meer informatie te winnen in verband met de stressproblematiek en hoe goed of slecht ze omgaan met stress maken we gebruik van een enquête en een focusgroep.

Een aantal van de resultaten zijn heel interessant om een richting te kiezen voor de ontwikkeling van het prototype. In de resultaten van de enquête zien we dat studenten bij examengerelateerde activiteiten het vaakst stress ervaren. We hebben ook aanwijzingen dat andere mensen een factor kunnen spelen: groepswerken, verwachtingen van anderen of afspreken met leden van het onderwijsteam kunnen heel wat stress veroorzaken. Andere grote bronnen van stress zijn hun eigen gedachten en onzekerheden, de aanwezigheid van veel werk en hoge kwaliteit behalen aan wat ze werken (bv. ze willen goede projecten afleveren).

Bovendien leverden de interviews met de studentenpsychologen en de studiebegeleider ons veel nuttige informatie op. Zowel inzichten in hun methoden, als hun visie op de huidige problematiek en potentiële oplossingen hebben ons uiteindelijk geleid tot een concept van een applicatie die niet alleen laagdrempelig is, maar ook studenten het gevoel geven dat ze snel iets kunnen doen aan hun stress.

## Gerelateerd werk in mens-computerinteractie

Het aantal studies rond technische oplossingen voor het helpen met stressmanagement zijn beperkt in aantal [89]. Een aantal onderzoeken hebben toch kunnen aantonen dat het gebruik van technologie een positieve invloed kunnen hebben op het managen van stress.

Een voorbeeld van een dergelijke applicatie is een digitale stressmanagementkalender voor studenten dat gebruikmaakt van sociale ondersteuning, problem-focused coping, “mind-set shifting” en gamification [19]. De kalender wordt aangevuld met deadlines door docenten en zou raadplegende studenten helpen met stressmanagement en er bewust mee te zijn [19]. In de paper zijn enkel theoretische motivaties voor de designkeuzes vermeld die zouden aanwijzen tot het verlagen van stress [19].

Woebot gebruikt Facebook Messenger om jongvolwassenen die aangeven angst of depressie te helpen met een chatbot dat gebruikmaakt van cognitieve gedragstherapie (CGT) [63]. De onderzoekers van de chatbot ondervonden dat de symptomen van depressie en angsten van de testgebruikers degelijk verlaagd werden [63].

In een studie van Hoffmann et Al. ondervonden de onderzoekers dat applicaties die de gebruiker helpen met stressmanagement amper beroep doen op gamification [82]. ondanks haar positieve effecten op de motivatie bij onder andere het volgen van zelfmanagementprocedures en zelfzorg [82], waarbij het laatste de zelfwaargenomen gevoelens van stress kan verlagen en de weerbaarheid kan verhogen [7,44].

Momenteel is er ook niet veel onderzoek gedaan op de impact van chatbots en agents op mentale gezondheid [31]. In een studie van Pickard et al. [131] wordt vermeld dat die elementen juist een lagere drempel kunnen bieden tot het vragen van hulp voor mentale moeilijkheden, aangezien ze “veilig” aanvoelen zouden en zouden een alternatief kunnen bieden aan therapeutische face-to-face-gesprekken. Testgebruikers in dezelfde studie hadden liever digitale “avatarinterviewers” om over gevoelige onderwerpen te praten dan menselijke interviewers. Het includeren van antropomorfe elementen biedt bovendien voordelen zoals het makkelijk invullen van sociaal verlangen, het bieden van een gevoel van voorspelbaarheid of het verhogen van motivatie voor het behalen van een bepaald doel [37,58].

Een aantal studies maken gebruik van dieren om gebruikers te helpen met mentale of fysieke tekortkomingen. Sociaal ondersteunende robotdieren, zoals Paro en AIBO, demonstreerden dat ze stressreacties kunnen verlagen en het humeur bij ouderen kunnen verbeteren [117,163]. De robots worden vooral gebruikt in tehuizen bij ouderen met dementie waarbij de ze ook de rol van facilitator tussen de bewoners en zorgverleners opnemen [117,163]. Een andere studie ontwikkelde een prototype met een virtuele hond die gebruikers kunnen verzorgen door bewegingen te doen met de pelvis [47].

## Design en ontwikkeling van een prototype

Een prototype werd uitgewerkt waarin zowel de theorie van stressmanagementtechnieken in verwerkt zijn als human-computerinteractionstechnieken bevat om de effectiviteit en gebruiksvriendelijkheid te verhogen. De inhoud en functionaliteiten zijn bovendien ook gebaseerd op onze bevindingen van de onderzoeken die we hebben uitgevoerd.

De applicatie bevat antropomorfe elementen (zie Figuur 2) die de gebruiker begeleiden met zowel het gebruik van de applicatie als stressmanagement. Niet alleen heeft de aanwezigheid en toepassing van antropomorfisme in applicaties aangetoond tot een betere gebruikerservaring en motivatie in eHealth-toepassingen, maar we kunnen de digitale personages in het prototype zo implementeren dat ze elementen van sociale steun en psycho-educatie kunnen overbrengen.

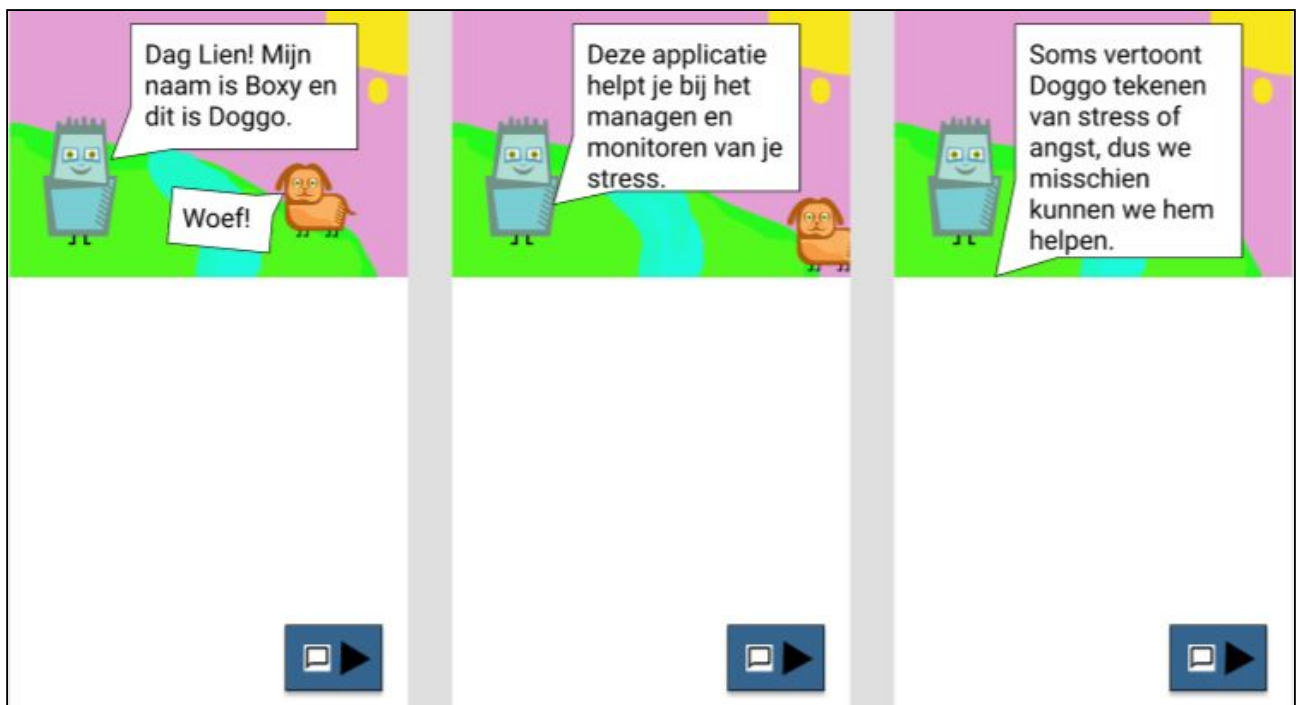


Figure 2: antropomorfe agenten in de applicatie begeleiden de gebruiker doorheen de applicatie en ondersteunen hem in stressmanagement

Om de huidige (stress)situatie in te schatten van de gebruiker, wordt aan hem gevraagd om de Depression, Anxiety and Stress Scale (DASS) vragenlijst in te vullen (Figuur 3). Aan de hand van de resultaten kan de digitale begeleider in de applicatie een aantal voorstellen maken die de gebruiker zou kunnen doen. Bijvoorbeeld, indien er een indicatie is van een heel hoog level van stress, stelt de applicatie voor om een afspraak te maken met een van de studentenpsychologen.

Figure 3: aan de hand van een gestandaardiseerde vragenlijst kunnen gepaste suggesties gemaakt worden voor de situatie van de gebruiker

Met behulp van een emotiedagboek willen we de gebruiker patronen laten vinden of de oorsprong van zijn emoties beter laten begrijpen. De gebruiker kan een dag eens core geven, aangeven welke emoties hij voelt en welke ervaringen hij ermee koppelt. Deze gegevens worden niet uitsluitend gebruikt om een dagboek aan te bieden met als doel tot reflectie. De applicatie kan aan de hand van kernwoorden checken welke strategieën of welke oefeningen kunnen worden aangeraden. Indien de gebruiker aangeeft dat hij bijvoorbeeld veel stress ervaart door de hoeveelheid werk voor zijn studies, kan de applicatie voorstellen om een afspraak te maken met de studiebegeleider of een oefening te maken die gaat over veel studiewerk (Figuur 4).



Figure 4: suggesties worden gebaseerd op onder andere de persoonlijke ervaringen die de gebruiker deelt

Een speelse oefening met elementen van CGT zit ook in het prototype (Figuur 5). De oefening helpt de gebruiker om een doel te bereiken door zijn gedrag of denkpatroon te wijzigen. De gebruiker kan kiezen om vooraf gedefinieerde oefeningen te maken (gebaseerd op stressvolle onderwerpen die we ontdekten tijdens de analyses) of te starten vanuit een leeg sjabloon om persoonlijke of specifieke situaties.



Figure 5: Met een oefening gebaseerd op CGT kan de gebruiker stapsgewijs tot een oplossing komen voor een gewenst resultaat en leren over slechte denkpatronen



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# Chapter 1: Introduction

Emerging adulthood takes place between the ages of 19 and 29 years old [151]. This stage of life is associated with many challenges; people are confronted with possible life decisions regarding education and career [5,151]. Other factors during this period such as changes in worldview, romantic status, and peer groups contribute to instability, which is very stressful for humans [151]. Each of those dimensions in this stage has potential mental health implications such as psychological stress, anxiety, or depression [5,151]. The majority of those emerging adults are studying in higher education where they are confronted with processing lots of learning materials and dealing with social pressure and conflicts in group projects. If we take those stressors and the challenges during emerging adulthood together, we can assume that students are very prone to having a (too) high amount of stress. Indeed, in a study for the World Health Organization, it is reported that one in five first-year students of KU Leuven shows symptoms of stress or its psychological effects (depression, substance abuse...) [5]. The stress level of students rises upon entry to university and often does not lower throughout their time on campus [22].

## 1.1 What is psychological stress?

Because of people's differences in genes, development, and experience, stress is not perceived the same way by everyone [110]. Cohen, Kessler, and Gordon generally defined psychological stress as an occurrence that shows up when an individual perceives that environmental demands tax or exceed his or her adaptive capacity [36]. In more recent literature, it is stated that this experience can also be caused by internal processes [136,138]. The brain perceives an experience (a stressor in this case) as stressful causing psychological, behavioral, and biochemical change [13,36]. Experiencing psychological stress is in general normal because of its function as the body's defense mechanism: it is a signal to fight or escape a certain situation to let the individual survive [51,138]. We can distinguish two types of stress: positive stress (eustress) or "negative" stress (distress). While eustress may be a motivator to do a task like working for a school project, eustress may prevent a person from letting him efficiently work on the task or even start working due to the negative feelings the brain wants to avoid [81,91,97].

## 1.2 Dangers of stress

Despite its role in protecting the human brain and body, stress can be dangerous. There are many ways to handle stressful events, but not every way is beneficial. Individuals sometimes lack experience in managing their big load of stress correctly and may fall back on detrimental coping methods (such as eating unhealthy or abusing substances) [146,153]. People who are unable to control their stress levels are very likely to

experience problems in their personal, academic, or professional life and even in their mental and physical health [132,142,148,175].

### 1.2.1 Stress and mental health

Even though healthy stress (eustress) may be a motivating factor to complete projects and to study materials, long term exposure to stress (chronic stress) or acute stress (very high level of stress at one or multiple moments) can make university life even more difficult [81,91,97,106]. Experiencing a lot of stress has a negative impact on the academic performance of students due to its effects [2,145]. For example, repeated and acute stress results in the impairment of nonemotional memory retrieval [104,135], which can be a handicap during stressful moments like exams or school projects. Furthermore, the increase of assignments and deadlines can lead to cognitive distortions, unrealistic expectations, excessive distress and aversive emotions [46,79,140], making students more likely to avoid or postpone working on their assignments and projects in order to break loose from those negative feelings for a short time [55,79]. A large amount of stress also affects the style of conflict handling, which results in hastier decision making and is possibly correlated to worse than optimum outcomes (in projects for example) [125]. Students may even experience burnout due to the stressors in their academic environment [87,128]. The stress-related syndrome is characterized by depersonalization, exhaustion, and a decreased sense of accomplishment, which has a negatively correlated impact on academic performance [87,128].

Both chronic and acute stress have been observed as an important cause of mental disorders including depressive and anxiety disorders [88,91,104,132]. Depression and anxiety both interfere with everyday life by limiting psychosocial functioning and diminishing quality of life [40,108]. Just like people having a problem with managing their high stress levels, individuals with depressive or anxiety disorder have been observed to have suicidal thoughts and behavior [9,33,120]. Suicidal ideation in the past twelve months has been estimated to be present at ten percent of students globally [119], which is five times the perceived prevalence with the general global population [27]. Suicide is the most common cause of death among people aged 15-49 in Flanders<sup>1</sup> [181]. Another possible effect of stress is sleep deprivation which not only causes (the feeling of) being exhausted but can also provide even more stress [110]. Insufficient sleep is correlated with a decrease in cognitive performance including consequences such as slower response time and a decline in working memory performance [71].

### 1.2.2 Stress and physical health

The presence of stress causes several different reactions in the human body:

- Release of cortisol [152]
- Elevation of both blood pressure and heart rate [110]
- Muscle tension [182]

---

<sup>1</sup> Flanders is the Dutch speaking region of Belgium.

#### 1.2.2.1 Release of cortisol

The human body releases cortisol, the main stress hormone, as a way to cope with stress [152]. High levels of the hormone in a stressed individual cause fat stores, sugar craving, and overeating, putting the body at risk of developing or enhancing obesity [94,152] and accordingly diabetes type 2 [95]. Due to the constant communication between the brain and the gastrointestinal system, stress is very likely to influence organs like the stomach or bowels [154] and may trigger common symptoms like nausea and vomiting, heartburn, indigestion and diarrhea [113].

#### 1.2.2.2 Elevation of both blood pressure and heart rate

The presence of stress causes both the blood pressure and heart rate to elevate [110] to prepare the human body to escape unpleasant situations. Those physiological responses damage the arteries and the heart itself, making stress an important risk factor for cardiovascular diseases (e.g. heart failure) [175], the most prevalent cause of death worldwide [176].

#### 1.2.2.3 Muscle tension

When the body is stressed, muscles tense up which may trigger other reactions in the human body and may result in painful muscle tension for instance in the back and shoulder regions [78,114,182]. Those muscle tensions are furthermore associated with both tension-type headache and migraine headaches [182].

### 1.3 Seeking help for stress symptoms

One of the essential elements for maintaining psychological health is social support [127], which we will discuss in more detail in Chapter 2. Students do not all have access to equally good social support. In general, about 40% of health-care students reported having a limited or lack of social support, which was significantly correlated with worse mental health [24]. For example, the living situation of a student has shown to be correlated with their levels of stress [121]: students living with parents during their students seem to have significantly lower levels of stress than those living in a dormitory or an apartment, either alone or with roommates [121]. However, the positive effects on stress from living with parents depends on the amount of parental support [121], which is negatively correlated with the amount of distress [83].

Even though there is professional help (e.g. individual and group counseling with a psychologist at school, second line therapy, student coaches...) available for students in most Belgian universities for free [183–185], the hurdle of consulting a professional is still too high [161]. Less than 20 percent of the students showing symptoms seek treatment or help according to Hunt et al. [85]. Adolescents with low emotional management competence are even less likely to seek help (whether professional or nonprofessional), despite their increased chance of becoming depressed or suicidal [35]. Other difficulties are social and cultural stigma, not willing to pay or having the money

for professional care, exhaustion, not knowing where to get expert care, and the belief that the symptoms will alleviate over time [1,56,69]. Professional first-line counseling can however help with stress management and improvement of coping skills [149,173].

## 1.4 Research in stress management applications

Past research has proven that eHealth applications have the potential in guiding patients and can be effective if they are optimally designed. However, studies mostly target physical health while the amount of research in mental health applications is limited. Several commercial stress management applications claim to support stress management. Even though they may use concepts that are inspired by existing non-digitized techniques, most of them are not suitable for efficient or long term usage. We can refer to a number of papers that suggest integrating relevant interaction methods (e.g. anthropomorphism) that enhance both the effectiveness of a mobile stress management application and the user experience.

## 1.5 Purpose of this thesis

In this thesis, we investigate how a digital mobile companion can help university students manage their stress levels. It is necessary to understand the problem and the potential solutions as well as the students and their context. That is why we are using a user-centered approach with both qualitative and quantitative methods to analyze the key stressors during a student's academic study and what kind of interactions we can offer to help them manage their stress. A survey is made public for students of Hasselt University with questions about experiencing stress and stress management. Even though the survey is completed by students in different fields of study, we compared the results between the law and computer science students. We also conduct a focus group with PhD./past students of computer science to gain some insights on students' context and current behavior regarding their experience of stress.

As a next step, we design and implement an interactive prototype that allows students to measure and monitor their level of stress including emotion tracking, cognitive-behavioral exercises, and goal-setting. The goal is to come up with a concept for a mobile application that addresses the current shortcomings of both current commercial alternatives and the limited amount of research regarding mental health applications. We include techniques in human-computer interaction such as anthropomorphism, conversational agents, and gamification to make stress management more motivational and accessible for the users. They are guided by an in-app digital guide and a digital pet who both support them in managing their stress. The users also receive notifications and in-app texts based on their location, calendar, estimated stress levels, and past responses of the user. The application has been designed as a stand-alone solution with the possibility to contact student psychologists or student coaches. The student can choose to include the results of the Depression, Anxiety and Stress Scale (DASS) or a summary of the data they have entered in the application.

We would also have liked to ask students to test the resulting prototype, so we can evaluate it on usability and acceptability. Unfortunately, we have decided to not go through with testing due to the COVID-19 situation.





# Chapter 2: Coping, stress management, stress detection and emotions

In this chapter, we discuss current stress management methods that have been proven effective and coping mechanisms the human brain or body utilizes. The information in Chapter 2 provides some background on the choices regarding the analysis preparation and application design choices, which will be discussed in Chapter 3 and 4 respectively.

## 2.1 Coping and other stress management techniques

Coping is defined as “the thoughts and behaviors used to manage the internal and external demands of situations that are appraised as stressful” [66]. There are several ways the human brain controls the way the individual copes, which can be categorized, among other ways, as emotional- and problem-focused coping [38]. Another dimension by which strategies can be classified is cognitive/behavioral (what you think/what you do) [70].

### 2.1.1 Emotion- and problem-focused coping

Problem-focused coping strategies refer to plans to act on the stressors or their sources, while emotion-focused coping refers to attempts to manage the feelings related to the stressors [70]. The former is generally perceived to be the most efficient [96]. However, in some cases (e.g. events or situations that are beyond the control of the individual) emotion-focused coping strategies may be a better choice [96]. On top of that, most stressors elicit both coping strategies [70].

### 2.1.2 Cognitive Behavioral Therapy

Cognitive-behavioral therapy is an evidence-based intervention that aims to improve mental health that is used to treat mental disorders [16,61]. CBT explores the assumption that thoughts, feelings and behaviors are intertwined with each other [59,186], and that the way an individual’s perception of a situation is more connected to their reaction than the situation itself [16,23]. Research has shown that it is effective for both prevention and treatment of mental disorders (e.g. panic disorder, depression or anxiety) [54,59]. The psycho-social intervention aims to change how a person thinks (cognitive) and what they do (behavior) in order to reduce the unwanted behavior (e.g. smoking [166]), mental disorders (e.g. anxiety) or associated distress [28,59]. Due to its nature of reducing the distressing elements, CBT is considered as problem-focused.

#### 2.1.2.1 Cognitive triangle

The cognitive triangle is a model that visualizes how thoughts, feelings and behaviors are linked with each other (see Figure 6). Changes in any of the three domains can improve functioning in the other domains [174]. By identifying irrational, maladaptive or catastrophic thoughts, we can change them into constructive thoughts to modify the

feelings and behavior, thus our perception of the corresponding situation [23], and consequently lowers the experienced distress.

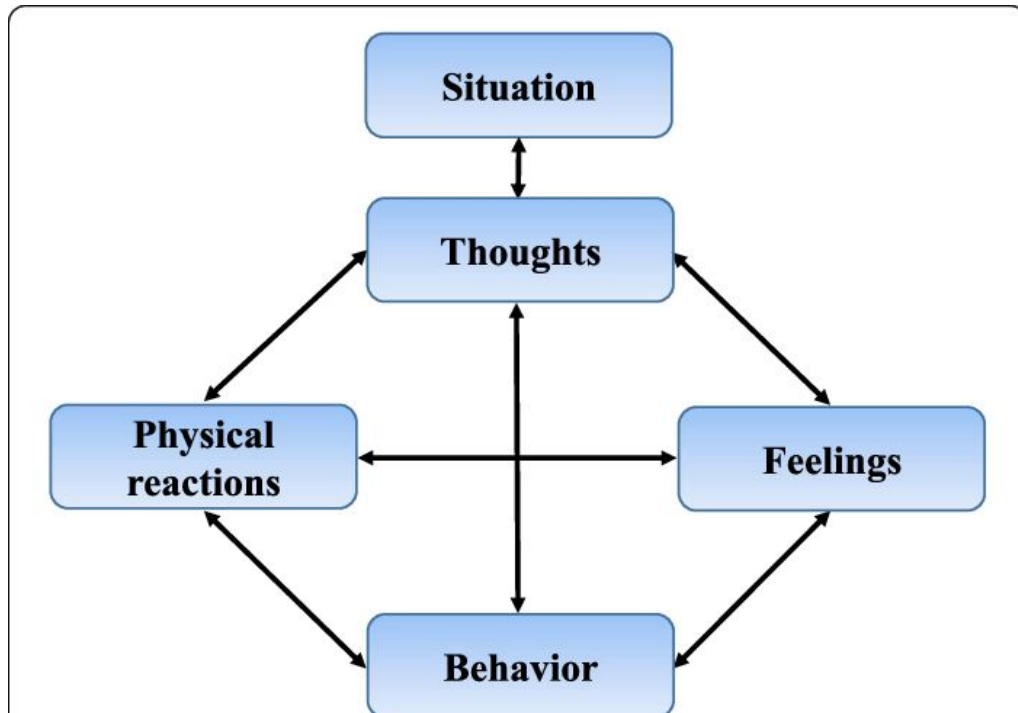


Figure 6: scheme visualizing the CBT’s assumption about the connections between thoughts, feelings and behavior [23]

Unified Protocol (UP) is “a transdiagnostic emotion-focused cognitive-behavioral treatment designed to apply to the full range of anxiety and related disorders” [26]. Although the aim of the thesis does not consist of designing a digital application that fully encompasses the treatment as described by UP, we can refer to its modules to explore evidence-based components we can integrate to design a stress management app. This model by Barlow’s includes four necessary therapy components [180]:

1. Psycho-education
2. Cognitive reappraisal
3. Preventing emotional avoidance
4. Changing behavioral habits

#### 2.1.3.2 Psychoeducation

Therapists and doctors provide both patients as their family basic information about the patients’ diagnoses, symptoms, medications, treatment options, etc. This is called psychoeducation [133]. In combination with CBT (or as a part of), psychoeducation is a frequently applied first step in lowering the intensity of anxiety and in lowering stress-related symptoms [107].

#### 2.1.3.3 Cognitive appraisal

Cognitive reappraisal is an emotion regulation strategy, associated with positive mental health over time [156]. The theory assumes that stress is perceived as the imbalance

between the individual's demands and resources to cope [32]. More specifically, our thoughts are often learned cognitive habits and produce feelings and actions [160,180]. By understanding identifying cognitive errors, individuals can learn the process of critical thinking and treat those thoughts as their own hypotheses instead of facts [180,187]. Examples of distortions related to stress are [187]:

- **Catastrophizing:** people expect the worst to occur, despite the evidence showing the contrary
- **Mind reading:** People guess what other people are thinking based on their own behavior without bothering to check if their hypothesis is correct. For example, "I've offended her, so she is ignoring me" can be incorrectly assumed: she may be distracted or busy.

#### 2.1.3.4 Preventing emotional avoidance

Negative emotions are linked with avoidance, which can lead to hindering the acquisition of skills and the inability to adopt effective strategies for the required task (e.g. fear of failing an exam can cause problematic procrastination) [75,180]. Emotional acceptance helps to regulate an individual's emotions by accepting their emotional response and overriding automatic responses (such as learned habitual thoughts) [45]. This will help to make a decision and take action with emotion as a more limited factor in their decision-making process [180]. Emotional acceptance is an important element in mindfulness [188].

#### 2.1.3.5 Changing behavior in order to reduce stress

We can link behavioral change with problem-focused coping: by acting on the stressor or its sources, we can decrease the perceived amount of stress [70]. Despite the simplicity of "just doing it", emotions play a big role in avoiding or confronting the stressor (see also 2.4) [75].

#### 2.1.2 Therapy animals

Pet-assisted stress reduction programs have become very popular in American universities [165]. Those programs include bringing animals and their handlers and allow students to interact with them in the hope of reducing their indicators of stress [165]. It has been revealed that interacting with dogs reduces signs of depression, stress and loneliness [62], reduces anxiety [43], and motivates social interaction between humans [21]. The numerous benefits are probably an important reason why canine species are involved in the majority of the programs [77].

Stress reduction pet-assisted programs can be a one-time session or consist of multiple sessions distributed over a longer period (e.g. an 8-week intervention) [21]. The short format allows a large group of students to participate, but the effects only last for a short time [165]. Furthermore, it is not practical to let a lot of students participate in a program with multiple sessions due to the limited availability of the animals and handlers, or the number of resources needed to organize those sessions.

### 2.1.3 Social support

Social support can be described as “support accessible to an individual through social ties to other individuals, groups and the larger community” [100]. Positive social support has shown to increase stress resilience, help protect against developing trauma-related psychopathology and play a part in lowering the functional consequences of disorders induced by trauma [127]. It also plays an important part in decreasing functional impairment [155] and increasing the chance of recovering from depression [127,139], while the lack of social support has been associated with onset and relapse of depression [130].

Social support can come in different forms. The most important distinctions are [93]:

- **Emotional support:** includes perceiving empathy and caring from someone [157]. This can be achieved by listening to someone for example. The presence of expressions of comfort, love and trust are big contributors to the presence of emotional support.
- **Informative support:** is support in the form of factual information or (personal) advice [93]. This type of support assists in problem-solving [93].
- **Appraisal support:** involves the communication of information that is relevant to self-evaluation (rather than problem-solving) [93]. This type of support encompasses expressions that affirm the appropriateness of acts or statements by someone else [93]. Sometimes just “hanging out” is sufficient to achieve this type of support [93]. Appraisal support is sometimes referenced as affirmational [93], companionship [167] or belonging [157] support.
- **Instrumental support:** is supporting one in provision or tangible goods e.g. money [93]. We do not incorporate this type of social support in the application’s design.

## 2.2 Questionnaires for screening stress problems

In psychology, a number of standardized tests exist to screen people on possible mental health issues or qualitatively measure their quality-of-life.

### 2.2.1 Depression Anxiety and Stress Scale

The Depression Anxiety and Stress Scale (DASS) is a standardized questionnaire with 14 items for each of its three subscales: depression, anxiety and stress [41]. The questionnaire is known for its high reliability and has been shown to be valid in both clinical and non-clinical samples [29,41,42]. During the thesis, we will use the DASS 21, a shorter version of the DASS with 21 items in total. The reliability of the 21-item questionnaire is almost as high as the original DASS [41]. We will be including the Dutch

short version into the prototype. The content of the questionnaire can be found in Appendix A.

### 2.2.1.1 Measurement of the subscale

In the 21-questionnaire, the three subscales each have seven items [189]. Subjects choose the severity/frequency rate the extent to which they have experienced each state over the past week for each item [189]. Every choice adds a score from zero to three to the scale of each of the negative emotional states [101]. The options to select from are the same for every item [101]:

0. Did not apply to me at all
1. Applied to me to some degree, or some of the time
2. Applied to me to a considerable degree, or a good part of time
3. Applied to me very much, or most of the time

The total score for each subscale needs to be multiplied by two in the DASS 21 [189]. This is not needed when using the original questionnaire.

We summarize the cutoff scores for the results of DASS questionnaires in Table 1.

	<b>Depression</b>	<b>Anxiety</b>	<b>Stress</b>
Normal	0 - 9	0 - 7	0 - 14
Mild	10 - 13	8 - 9	15 - 18
Moderate	14 - 20	10 - 14	19 - 25
Severe	21 - 27	15 - 19	26 - 33
Extremely Severe	28+	20+	34+

Table 1: Cutoff scores for the results of DASS questionnaires [102]

The results should be interpreted dimensionally rather than “categorical” or as a diagnosis [102]. The questionnaire does not replace any assessments by experienced clinicians and serves to “clarify the locus of emotional disturbance” [189].

### 2.2.2 Other relevant questionnaires

We also considered two other questionnaires that may have been relevant to include in the prototype. We will briefly introduce them and discuss what their possible role would have been in this thesis and explain why we did not include them in the prototype.

### 2.2.2.1 Symptom Checklist

The original SCL-90-R is a 90-item instrument to help evaluate a broad range of psychological problems and symptoms of psychopathology [49]. The instrument constructs scores in nine different dimensions including depression, anxiety and interpersonal sensitivity [50].

Usage of the questionnaire requires payment, which was the main reason for not including the SCL-90-R in the prototype. We may have been able to use the resulting information to tailor the content of the application. After analyzing the results of the survey, we also found out that students perceived the concept of stress mostly linked with anxiety and coping strategies that involves avoiding (which is linked to sadness [75] and has a positive correlation with depression [126]), which makes the DASS-questionnaire more suitable to integrate in the prototype for the thesis.

### 2.2.2.2 WHOQOL-100 and WHOQOL-BREF

The WHOQOL-100 is a 100-item questionnaire developed by The World Health Organization (WHO) [170]. This instrument is used to measure the Quality of Life (QoL) of a subject, yielding a multidimensional profile of scores across six domains (such as “Environment” and “Social relationships”) and 28 facets (such as “Work satisfaction” in “Environment” and “Social support” in “Social relationships”) [170]. A short version of the questionnaire is the WHOQOL-BREF, which contains 26 items and only produces scores across four domains [170]. The questionnaire could have been used in the prototype to discover the domains in which the user does not perceive its position in life positively [170]. However, in order to effectively integrate the application, we would also need to include enough content that adheres to the facets. Even though it would be interesting to tailor the application’s content to the perceived quality of life of the user, we decided including the questionnaire will not be part of the scope for the thesis.

## 2.3 Emotions

In the literature, there have been many discussions about the definition of “emotions” [68] and how many basic emotions there actually are [75,111]. Even though there is no universal consensus on how to correctly define “emotion”, we can refer to the definition of by the American Psychological Association (APA): “a complex reaction pattern, involving experiential, behavioral, and physiological elements, by which an individual attempts to deal with a personally significant matter or event” [190].

We can compare the concept of basic emotion with basic colors: the elements of basic emotions can be combined to form complex or compound emotions [57]. However, there is no consensus about the number of basic emotions [75]. For the thesis, we will base on recent theories that state there are four basic emotions: fear, anger, joy, and sadness [74,86,164].

Emotions play a role in our behavior to handle fundamental life tasks [75,116]. Anger and fear can be linked with “fight or flight” actions as a response to stress [75]. Anger is associated with planning to cope with a situation (“approaching” a situation) while fear is associated with uncertainty and avoidance [75]. The other emotions, joy and sadness, may impact the decision to approach or avoid, respectively [75].

### 2.3.1 Writing about emotions and the experiences

Experience sampling is a method that requires writing about experiences. It has been shown to reduce depression and stress reactivity, and physical wellbeing, regardless of the described experiences, are perceived as positive or negative [3,30,67,90,144]. Disclosing reports (whether publicly or privately to a trusted person) about their own experiences and emotions may even increase the positive effects [134]. Writing about the same emotional experiences on multiple days does not seem worse than writing about a different subject every day [90]. Patients that rate repeatedly by writing them down find it easier to acknowledge and translate the findings to daily life practice during feedback sessions with a therapist, and heightens the feelings of empowerment in the treatment process [143].

Writing about experiences with their associated emotions also helps people with self-regulating their emotions, which is finding emotional patterns over time [92,118]. This will allow the writers to monitor and modulate their reactions to stressful events by recognizing the situational nature of the perceived distress and can inform both the writer and possibly their clinicians how to improve their resilience [159]. The process of positive writing also leads to significant increases in emotional intelligence [168], a factor that is negatively correlated with stress and associated with scoping skills [6,124,129].

## 2.4 Summary and next steps

Before we can design an effective application for supporting stress management, it is important to know the background behind it. In this chapter, we have explored several techniques and theories which we can use to integrate into the prototype and will help us decide on including relevant interaction methods or technical opportunities. For example, we can use the content of a digital experience sampling entry and let an algorithm decide on the subject of the entry and propose several actions (e.g. a CBT exercise) and guide students without human intervention.

The effectiveness of social support and animal-guided therapy inspires us to look into anthropomorphism (see Section 3.2). Even though it is technically impossible to generate a real therapy dog for every student, we have the opportunity to use related elements in animal-guided therapy and come up with a design that is either inspired by those elements or contain the elements themselves. We will further elaborate on using the gained insight in Chapter 2 in combination with anthropomorphism in Chapter 5. Last, the DASS questionnaire will help us in gauging the current mental health state of the user and give appropriate actions (e.g. refer to professional help).





# Chapter 3: Related work in HCI

In this chapter, we will discuss relevant existing research regarding computer-assisted stress management. Furthermore, we will go over a number of relevant past research and main design decisions that are relevant for the topic of the thesis.

## 3.1 Personal stress management applications and research

Only a limited amount of research studies about stress management applications exists [89,115]. Furthermore, the resulting prototypes or applications lack formal evaluation, leaving us with limited evidence on the effectiveness and acceptance of the included features and used techniques [34,82]. We will give an overview of research in eHealth applications with a focus on stress management.

### 3.1.1 Digital unguided stress management applications

Berehil et al. developed a digital gamified calendar that is designed to support students in stress management [20]. The prototype was designed based on the theory of problem-focused coping, social support theory and Dweck’s theory on resilience and mindset [20,171]. Gamification elements such as challenges, rewards and narrative elements are furthermore included to let students better engage with the application and boost their motivation [20]. Students are able to create their intermediate deadlines (“challenger goals”) that are shared with other consulting users. Tutors can reward students with virtual badges to students who achieved the challenger goals or suggest good challenger dates. Even though the design is supported by theory, there is no publication regarding a potential evaluation or evaluation results of the prototype.









Date	Frequency	Before	Current	Description
5/08	0			I stop and think about it, which makes me aware!
5/07	1			Im glad im being more aware and attempting to make a change!
5/02	0			Yeah! im glad I've done good today!
4/30	6			Damn im pissed I messed up so bad!

Figure 7: Mobile web-based application that allows the user to track their emotion and help them change their habits [84]

Several papers have explored the possibilities and benefits of using technology to track experiences, emotions, or stress. Hollis et al. looked into a mobile web-based system that allows users to track their emotions [84] (see Figure 7). Participants were asked to log an emotion rating, frequency of the habit, and description for a certain date. The researchers discovered that an emotion tracking application helps users in reducing the persistence of bad habits and in improving goal pursuit. By encouraging reflection of the emotional consequences of engaging in a bad habit, the tracker supports discouraging bad habits that induce distress. In the study, users expressed a preference for seeing successful records, even though remorse can be a much better motivator to reduce a bad habit [14,84]. In the same study, Hollis et al. suggest using system defaults to redirect users to their failures. On top of that, users stated that they would like to sort their entries on emotions.

A number of studies also explored the possibilities regarding emotion tracking applications in the context of stress and mental health in general. Morris et al. designed and developed a prototype that allows users to manually log their emotions [118]. The researchers observed that participants can use their data to reflect on their emotions and appropriately act in stressful situations. Logging emotions in the application can be done by selecting the perceived (subjective) intensity of the selected emotion on a one-dimensional scale (see Figure 8). The prototype furthermore provides methods to lower short term stress by assisting during mindful body scan and asking rhetorical questions designed to encourage cognitive reappraisal. However, they lack interaction and only provide general visual or textual information that is not tailored to the user or their context. Acceptance and effectiveness were measured by user interviews and by comparing emotions scores at the beginning and at the end of the study respectively. Despite significance decreases of self-reported negative emotions before and after the field trial, we cannot assume that the user has learned to (better) cope with stressful situations, as

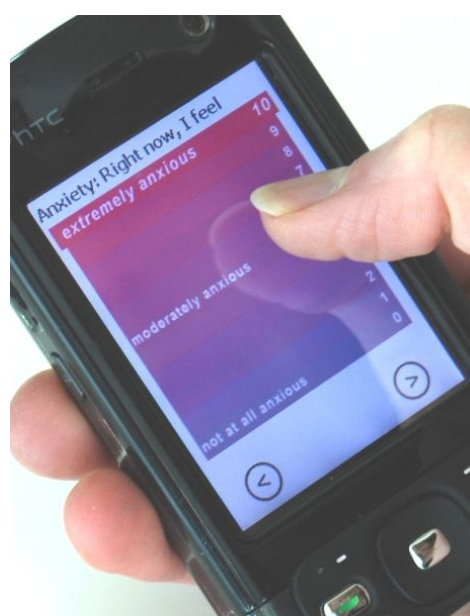


Figure 8: Prototype by Morris et al. for mobile emotion tracking [118]

Cox et al. systematically reviewed commercial self-tracking stress management applications in Google Play Store [39]. The apps adequately support reflection, but not action-taking. The reviewers state the importance of supporting both requirements in order to initiate and maintain stress management. Their statement corresponds to the model of personal informatics systems by Li et al [99] and research theories in behavioral change [137].

Even though having applications that support reflection and action-taking may be a significant improvement, we need to consider the personal informatics systems model and its barriers described by Li et Al [99]. Their iterative stage-model consists of five stages: preparation, collection, integration, reflection, and action (see Figure 9). We summarize the explanation and possible barriers to the stages below:

1. **Preparation:** concerns itself with people's motivation to collect personal information: what, why and how should they record their personal information?
2. **Collection:** is the time when users actually record their information.  
Possible barriers:
  - Finding the time and motivation to log data
  - Guessing the data that needs to be logged
  - Remembering to record
3. **Integration:** is the stage between collection and reflection. During this stage, the collected information is combined, prepared, or transformed before actually looking back to the processed information (reflecting).  
Possible barriers:
  - Scattered visualizations (e.g. on different sites)
  - Organizing data
  - Data are stored in separate places
4. **Reflection:** is when the user reflects on their information. Possible techniques to reflect are to explore information visualizations or looking at a list of personal information.  
Possible barriers:
  - Lack of time to go through everything
  - Limitations and uselessness in information visualization
  - Difficulty interpretation
  - Emotionally difficult to look at (past) personal and sensitive data
5. **Action:** is the stage when the user chooses to do something after understanding the (new) information they gathered. For example, a user logging his food intake may be skipping his next snack if he understands that he has already reached his calorie limit for the day.

By keeping these stages and barriers in mind, we are able to design a stress management app for personal use that is usable, useful, and comprehensible.

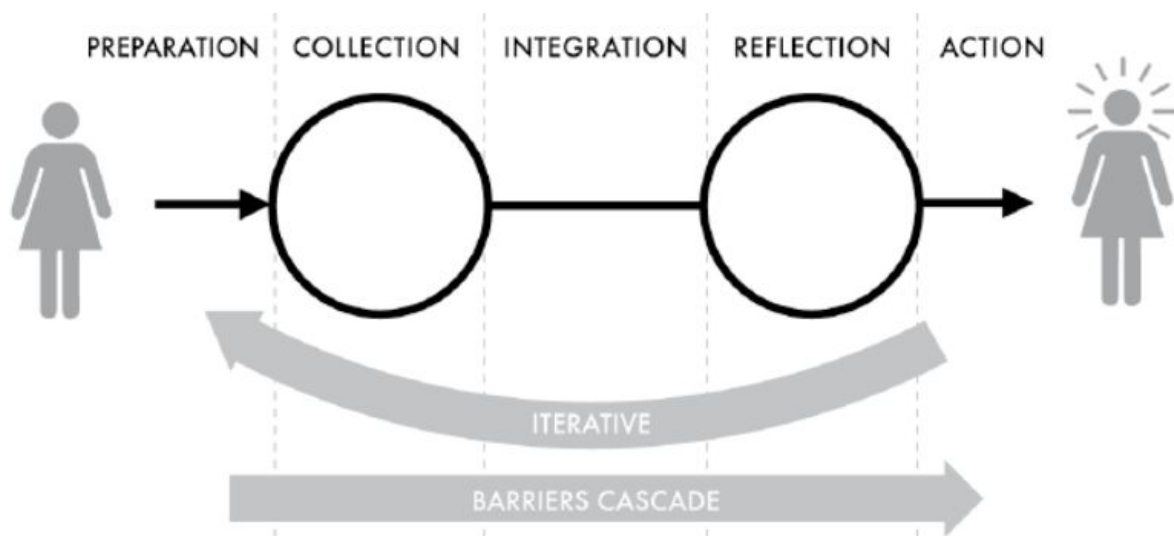


Figure 9: An iterative model for personal information systems [99]. The circles are user-driven stages during which they provide data (collection) and interpret the information based on their data (reflection)

### 3.1.2 Web-based applications for stress interventions

Web-based applications for stress intervention have comparable outcomes with traditional therapy [4,12]. However, the mentioned digital media suffer from low adherence and low adoption [17,52,53]. Several elements have been shown to raise adherence. Next to digital inclusions (e.g. machine-based tailoring of content, notifications, or device interaction), providing the option to contact or be guided by a therapist significantly raises users' attachment to the application [53]. The use of computer-based applications allows blended therapy: the combination of in-person therapy sessions and an application allows for increased access to content, lower time commitment for clinicians, and reduced costs [64].

Bakker et al. have compiled a list of sixteen recommendations for the design and development of future mental health apps [8], which we can refer to motivate our design choices of the prototype in the thesis.

## 3.2 Anthropomorphism

In the context of Human-Computer Interaction (HCI), anthropomorphism refers to the technological efforts of providing computers with human characteristics and capabilities [73]. In this subchapter, we will go through the benefits and (potential) uses of designing applications with human-like features.

The inclusion of anthropomorphic elements positively contributes to the user experience of the application. The elements help users to accept the application faster, and can make using the application more enjoyable, and more usable [37]. On top of that, correctly integrating anthropomorphism gives users the feeling of predictability, ease of use and engagement, which all contribute to the user experience of the application [48,58,122].

Not much research about the use of digital agents in mental health applications has been done [31,63,131]. However, integrating anthropomorphism in an application for mental health has several potential benefits. Pickert et al. observed that a digital agent provides a feeling of safety and is more preferable than a human therapist for sensitive information [131]. The inclusion of virtual agents in applications can impact motivational outcomes such as self-efficacy and attitude change [15]. Both factors have a positive impact on improving coping skills [72]. Anthropomorphism in HCI is able to fulfill the human desire of social contact and affiliation [58] and battle the feelings of loneliness [18]. Furthermore, we can design agents to contain the following social elements that may aid students in supporting managing their stress:

1. Social support (also see Section 2.1.3)
  - a. Appraisal
  - b. Emotional [48]
  - c. Informational
2. Enabling personal disclosure (also see Section 2.4.3)
3. Trust [18] (e.g. with the optimal use of human language in the interface [141])
4. Increased relatedness and familiarity [141]
5. Empathy [63]

Fitzpatrick et al. has used some of the possibilities of anthropomorphism with the goal of designing a mental health application as a usable alternative for human therapy. The researchers developed Woebot, a conversational agent for individuals aged 18-28, who claim to have anxiety or depression [63]. The application is a standalone self-help “choose your own adventure” guide. Even with a name that suggests Woebot is a (ro)bot, the test participants were referring to it as “he” or “a friend”. The researchers concluded that a text-based conversational agent has the potential to offer an alternative method of delivering CBT for students in the USA. The application was tested in a field test of two weeks with a limited number of participants, which was okay to study the feasibility of the design. Participants reported that they like the content or features regarding accountability, empathy, educational media, and conversation, while technical problems, the usage of emojis and repetitive conversational content were not appreciated as much.

### 3.2.1 Artificial pets

Artificial pets can perform several roles in applications. It can invite the user to develop and practice their nurturing tendencies [25]. For example, Paro is a therapeutic robot companion seal for elderly people with dementia [109,191]. It has been shown that the robot seal improved the mood and depression of the elderly in care houses [162]. Also, the interaction and social interaction with both caregivers and the other residents were improving during Paro’s presence [163]. We also see opportunities to let users take care of an artificial pet by persuading them to do certain actions. The attachment users can

develop to their virtual pet enables prolonged engagements [65]. Deedee et al. [47] developed a health game which utilizes that theory to persuade users to break users' sedentary lifestyle. Their prototype includes a dog with needs. In order to fulfill those needs, the player has to interact with their seat physically. Another use case for artificial pets is emotional blackmail. Macdonald et al. [105] use a digital pet blob, Tabu, to enable emotional reinforcement in a gamified to-do list. The shown mood of Tabu is reflected in a hidden point system: high scores make them happy while low scores make him sad. Test users reported to be emotionally attached to the blob and to be more motivated to complete their to-do items.

### 3.3 Gamification

We can use gamification to make applications in a non-game context (such as health and training) more enjoyable, motivating, and engaging [82]. Even though it provides motivation for self-management for stress and self-care, improving resilience and lowering stress, there are only a limited number of stress management apps available that incorporate gamification techniques (or even other behavioral change techniques) [82]. On top of that, Bakker et al. recommended to use game elements in future mental health applications as they support positive reinforcement and behavioral conditioning [8].

The calendar by Berehir et al. (also mentioned in Section 3.1) uses gamification techniques [20]. The prototype utilizes challenges, a social reward system and badges in order to motivate students to cope with stress by problem-solving methods, problem-focused coping, time-management, etc. We repeat that, even though they are based on theory, the effectiveness of the included techniques have not been evaluated.

SPARX is an e-therapy game that teaches young people between 12 and 19 years old skills that are helpful to combat depression and anxiety in a (fictional) 3D environment [112]. The game has a number of modules in each which the player has to complete interactive challenges about interpersonal skills, dealing with strong emotions and problem-focused coping. SPARX can address the issue of those people experiencing depression who are not able or not willing to access professional help.

### 3.4 User-centered software engineering

In order to increase the user experience of the resulting application, we will base us on a multidisciplinary user-centered software engineering (UCSE) process framework called MuiCSer [76]. By referring to this framework, we aim to increase the accessibility and usability of the resulting prototype. The process framework consists of five stages (see Figure 10):

1. New or legacy system
2. Structured interaction analysis
3. Low fidelity prototype
4. High Fidelity prototype
5. Final user interface

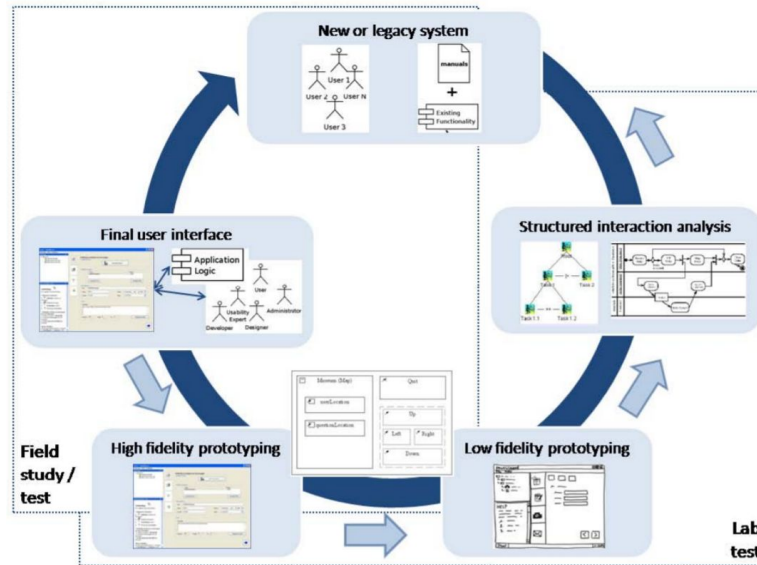


Figure 10: the MuiCser process [76]

For the thesis, we will use the process as a point of reference in order to improve the user experience and to design and develop a prototype with content and features for students in higher education.





# Chapter 4: User and context analysis

In order to learn more about stress management and the stress university students experience, we use a number of qualitative and quantitative methods. More specifically, we interview psychologists and teaching staff of Hasselt University, launch a survey for students, do a focus group with students, and participate in mindfulness sessions that are organized by the psychologists. We also give a summary of the results from each and mention the lessons we learned.

## 4.1 Ethical committee

We have received permission from the *Sociaal-Maatschappelijke Ethische Commissie* (social-ethical committee - SMEC) of UHasselt to hold a focus group and publish the survey. The collected data has been stored anonymously on a Google Team Drive, as requested by the committee.

## 4.2 Interviews

Before the start of the design of the application, we held six semi-structured interviews: two with experts in psychology (two student psychologists and one student coach) and four with four teaching staff members at Hasselt University (two from computer science and two from law faculty). We interviewed these people with the assumption they have experience with stressed students and the context students experience them in.

### 4.2.1 School psychologists

Because stress is a topic from psychopathology, we interview two student psychologists at UHasselt. Our goal is to gather some information about stress, stress detection, stress management, their current way of counseling at the university, and to get some feedback on our current findings of stress and its related topics. The psychologists at UHasselt deal with students on the campus and provide support and initial assistance with themes such as anxiety, self-consciousness, stress, problematic home situation, etc. [158], which is why we think they can provide us helpful insight at the start of the thesis.

#### 4.2.1.1 Questions

We draft a list of questions for the semi-structured interview with the two student psychologists. We want to find a starting point regarding a possible direction towards a digital solution that supports students in stress management. While we may have a global idea of how they assist students, we would like to know more about how they support students in managing their issues in a more structured way. We also ask them about stress detection, even though the focus of the thesis is aimed at stress management. The starting questions are related to the contents and goals of both the intake interview and forms. The following questions are related to the type of students, possible treatment, and frequent situations they encounter. We also want to ask the psychologists about a possible procedure they follow when they detect a problem with the student's stress

level, external factors such as high expectations, and possible group sessions in respect of stress management. At the end of the interview, we showed them concepts of existing applications to gauge their opinion on them and give them a short overview of the direction of the thesis. The full list of questions can be found in Appendix B.

#### 4.2.1.2 Outcomes

The interview's outcomes provide us with very useful information regarding the psychologist's workflow and elements that we can take into consideration during the design of the application. While coming up with questions, we supposed that the psychologists use intake forms for first-time visitors. We now know this is not the case at UHasselt, but questionnaires are helpful to screen students on symptoms and monitor the progress over time. Progress in time is more important than finding an instant solution for the current situation, which also does not seem like the usual method of stress management. Examples of questionnaires include DASS, WHOQoL, SCL-90, and General Anxiety Disorder (GAD) [192]. The proven reliability of these materials is a big advantage as (self-)reporting similar but unconnected symptoms (e.g. feeling rushed) is a bad way of assessing stress or stress-related illnesses. Therapists also have an impression of the student's body language and speech. Furthermore, it helps both the student and the psychologists to let the student talk about their past situation and the timeline during which it takes place. This leads to finding the root(s) of the stress and can be used as a starting point for the conversation.

We think it would be interesting to keep current barriers towards looking for help in mind. It is human nature to postpone reaching out to help and usually come in when the aftermaths of the original stressors have happened. It would be helpful for students to check in earlier before stressful events eventually show their effects (e.g. during exam periods). The process of reaching out or making an appointment does not seem to help with that problem: the student may need to make an e-mail or has to find an open slot (which may not always be available in the first following days). A self-help application can be a lower hurdle for seeking help and may give students the feeling that they can actually do something right now. The application may also be able to tunnel them towards (professional) help if needed.

We have a general idea of the therapists' own preferences as for a concept of the application. Between a chatbot, self-management application, and a virtual space for counseling sessions, they would lean towards a self-management application. The therapists also see potential in the idea of including "Tamagotchi-like" elements in the future prototype.

The psychologists organize every year several group programs related to stress management (e.g. assertiveness or cognitive-based mindfulness training). They allow us to participate in one of the training programs. Because of the trust relationship between participants, we cannot simply observe.

## 4.2.2 Student coach

The main task of a student coach at Hasselt University is to help students adjust to their study situations. They advise undergraduates and postgraduates dropping by about processing (a lot of) study materials, making schedules, studying and preparing for exams and other study-related subjects. Because of their repeated contact with students, we think it would be interesting to interview one of the student coaches of UHasselt to better understand some of the experienced study-related stress at the university and how they try to solve it.

### 4.2.2.1 Questions

Since the student coach is more involved in helping with study-related problems, we have the opportunity to ask questions about possible study contexts which can be causing stress with students. We also want to know more about possible strategies they use to help students with study-related issues. The prepared questions can be found in Appendix C.

### 4.2.2.2 Outcomes

We find several similarities between the answers by both the student psychologists and the student coach. They both mention the importance of making the application accessible and giving the students the feeling they can actually do something “right now”. It is advisable to avoid heavy or professional messages like “you are depressed” and “cognitive behavioral therapy”, and to provide tips or advice which are actionable (e.g. “exercise one time a week”).

The student coach explains that one of the causes of the threshold to find help or ask for help is partly due to some practicalities. For example, students are used to communicating by digital channels (such as e-mail and Blackboard) with the teaching staff. Even though personal interaction is also important, a lot of communication between students and staff members seems to happen digitally.

Comparable with the approach by the student psychologists, the student coach tries to find the root of the problem that brings the student there. By looking at what has gone right, the student may be able to think positively about taking steps to solve the problem, or the student coach and the student can think together about possible solutions. For example, the student may perceive one of their courses too hard or has too much work. Even though they cannot directly lower the workload, coming up with a plan together may help spark the student's efficacy to finish the required work. We must not assume that “they cannot study”, but we need to approach the problem as “How can we let them study (efficiently)”. She also knows that structure helps in the life of a student to help diminish some of the stressors.

Another interesting point is that external factors can impact the study methods negatively. Social pressure (e.g. “my dad is a lawyer”), motivation, and insecurity (e.g. “Does this field of study suit me?” or “Which field of study do I belong to?”) may lower the student’s performance.

#### 4.2.3 Teaching staff

Teaching staff members are confronted with students. Whether they give lectures or coach new students, we believe we can get new insights after having interviews with some members. Because the target users for the application are university students in general, we choose to interview staff members from two different faculties: law and computer science. We hypothesize that those have different causes of stress because of their study activities. While students in computer science are dealing with multiple projects and deadlines, law students may deal with a high load of study material and competitiveness between students.

##### 4.2.3.1 Questions

We ask the teaching staff general questions regarding stress and how they perceive and handle students experiencing a lot of stress. There are small differences between the questions asked to different members. For example, one of the law professors has submitted a project proposal to do something for the current situation of the stress of students, so it would make less sense to ask the other members why they have submitted a proposal. The prepared questionnaires can be found in Appendix D and E for the teaching staff members for law and computer science respectively.

##### 4.2.3.2 Interviews with staff members of the faculty of law

We have two separate interviews: one with a professor that submitted a project proposal to battle the high amount students seem to have, and another professor that also acts as an ombudsperson for law students. We learn that the professor who has submitted the proposal notices students experience stress. In one of his courses, he has group conversations with his students. Most sources of stress he provides are external factors such as problems at home or social media. We also have the impression that law students deal with competition. Even though a degree in law seems to be really helpful during one’s job search, the wanted jobs are limited in number and the students already have signed a contract months before graduation. Furthermore, we notice that the professor is a really big fan of mindfulness and thinks that unmindfully perceiving negative social media posts and getting constant notifications or emails contribute to students’ high levels of stress.

We observe a big contrast with the answers of the professor-ombudsman. While the first professor seems convinced that there is a problem that needs to be addressed, the other professor’s answers show us he thinks that there is no issue regarding the students’ level of stress as he has not perceived any elements that may be an indicator of the problem. However, this does not mean that the professor thinks learning about law or practicing

law is without stress. In an article he shares with us, he mentions that practicing law may consist of working with people and being in unpredictable situations and lists the benefits of integrating mindfulness in law education.

#### 4.2.3.3 Interviews with staff members of Computer Science

We have an interview with a professor and a teaching assistant who are both involved in the department of computer science. As they are each teaching a number of subjects and regularly interact with their students (whether as a group or during oral examinations), we believe they are able to provide us more information about their experiences with stressing students or their perception of the potential problem regarding students' stress. On top of that, both members organize coaching sessions with new students in order to ease their integration into the curriculum. We emphasize that we may be unwillingly biased: we already have an image of the staff members because we have already been confronted with them. On top of that, we have a better understanding of the contents of the courses and types of projects in the curriculum, as we have been following the computer science courses.

### 4.3 Survey

In order to have a better view of the student, their perceived stress, their resulting behavior (e.g. stress management methods), and the context, we composed an online survey for the students of UHasselt. Before submitting a request for approval to SMEC, we discussed the questions and possible answers of the survey with one of the student psychologists and the student coached mentioned in Section 4.2 and edited its content based on their input. The responses were anonymously collected and processed.

#### 4.3.1 Design

The survey touches on the following subjects:

- Background information (i.e. age, field of study, gender, current study-work situation)
- Smartphone use
- Definition of stress
- Stressors
- Coping methods
- Visiting a professional

The questions about stressors and coping methods use five-point Likert-type scales with respect to values of frequency and amount of importance. The participant has the option to select "Other" and enter their own answer. The questions about smartphone use and visiting a professional require a binary option on each statement. The survey also asks the participant to enter their definition of stress in an open question. Looking back, we use different values to indicate the frequency of a stressor in two different parts of the survey: one related to university-specific stressors and the other related to general

stressors. This makes comparing results between the different kinds of questions more difficult.

We want to explore which features and topics would be most suitable to include in the application. We may go for a general stress management application or target specific areas (e.g. quitting bad behavior or supporting the communication with therapists), depending on the information we gather from the survey.

We understand that talking about stress (or its related disorders) or the context people experience in is not an easy subject for everyone. Participants are informed that they can stop their participation anytime and that their data will not be processed in that case. Almost every question can be left unanswered. The only exceptions are the questions regarding the participants' background information.

Because of our lack of expertise in psychotherapy, we asked the student psychologists and the student coach we interviewed to check the contents in order to prevent or edit questions or answers that may evoke negative emotions or may be formulated incorrectly. The most important remarks are:

- The first question in one of the first drafts asks if the participant has visited a professional before. Starting the survey with this question could be somewhat difficult to digest for the participants and may lead to dropouts. We moved this question to the back of the question list.
- We deleted a question about other disorders or illnesses from the participant. As this may be a sensitive subject and potentially not giving us useful information, we decided not to include it.

The full survey can be found in Appendix F.

#### 4.3.2 Results

There are 208 responses, among which 24 responses come from law students and 12 from computer science students. 121 participants (58.2%) identify as female, 85 (40.9%) as male and 2 participants (0.9%) selected X. The mean age of the participants is 20.54 years. 60 respondents (28.85%) completed the survey during their first academic year in higher education.

##### 4.3.2.1 Usage of smartphone applications

We are curious about the type of applications students use. Based on the results, we may generate relevant ideas to tackle stress or support them with stress management. As we have expected, students use their smartphones mostly for social media or messaging (92.3% and 97.1% respectively). A possible concept for a smartphone application would be to create an application that supports blocking social media applications, as one of the professors in law thinks social media are one of the big sources of stress. However,

blocking certain applications could possibly result in eliminating a source, but does not teach or help the user directly in stress management.

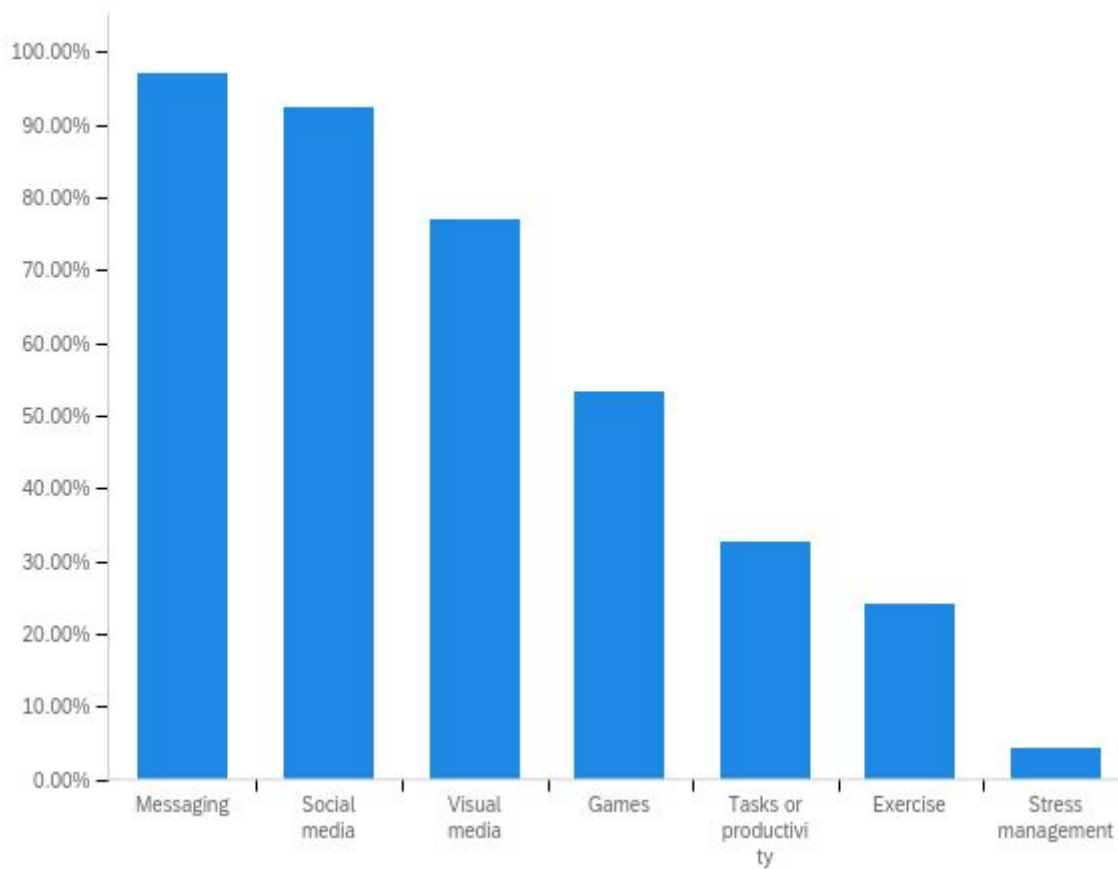


Figure 11: Percentage of respondents that state they use a certain type of application

53% of the respondents use their smartphone to play games (C.I. 99% [0.4659, 0.6002]). This gives us more confidence to include game elements into the application. The most played genres of smartphone games by students are puzzle (27.66%), action/platform (15.6%), strategy (13.83%) and education (13.83%). However, as the survey results from one specific year, we cannot assure that the participants were playing popular games. It is a possibility to include game elements in the prototype that use some elements of the popular genres.

We also see only 33% of students use one or more applications to manage their tasks or that supports their productivity (C.I. 95% [0.2495, 0.4151]). We may go for a stress management application that proposes default times for reminders or notifications as most students do not seem to use their smartphone to manage their tasks. A visual overview can be seen in Figure 11.

#### 4.3.2.2 Definition of stress

We ask participants to describe stress. From the 208 responses, twelve were empty or irrelevant and thirteen are a description of the participant's own subjective feeling of stress. We write about our findings of the remaining 183 responses. 49 responses (27%) contain words related to pressure ("spanning" and "druk"). The most used terms are



related to pressure. Descriptions about the feeling of unease (“onrust” or “geen/niet rust(ig)”) are present in 22 responses (12%). 23 responses (12%) state that stress is uncontrollable. 5% of the responses contain “anxiety” (“angst”) and another 5% contain “panic” (“paniek”). The word “pain” is mentioned in 5 answers (2.5%).

Even though there is no real consensus about what stress is (according to the participants), we see in the responses that most of them are mentioning pressure or a description that links stress with negative feelings or thoughts (failure, uncertainty, worry, “unpleasant, “bad”, no control). We see that some students recognize they are experiencing stress by physiological symptoms (sweating, raising heartbeat, body aches...). Stress is perceived differently by different people. Students may perceive stress-related symptoms such as anxiety as stress, which is why including a questionnaire that also screens on those symptoms can be helpful, such as DASS.

#### 4.3.2.3 Stressors

By looking at the results of the survey, we can check which stressors are most prevalent and decide on the content that is most appropriate for the “average” student. For example, if we had the impression that students are mostly stressed due to social pressure, we would focus on features and content that would help them tackle this stressor.

To analyze the results, we use a one-sample t-test. Based on the sample means, the most prominent stressful university related activities are participating in oral exams (sample mean = 4.2, true mean > 4 (“stress is experienced more than often”),  $p = 0.001763 < 0.05$ ), presenting (sample mean = 3.96, true mean > 3 (“stress is experienced more than sometimes”),  $p = 2.2e-16 < 0.05$ ), completing written exams (sample mean = 3.96, true mean > 3 (“stress is experienced more than sometimes”),  $p = 2.899e-09 < 0.05$ ) and studying during exam periods (sample mean = 3.46, true mean > 3 (“stress is experienced more than sometimes”),  $p = 0.0004385 < 0.05$ ).

It may be useful to prepare the student weeks before the start of the exams or the date the presentation. According to the psychologists, the exam periods are one of the busiest periods and a last minute appointment will probably not result in a quick solution. A mobile application can help students prepare to deal with the stressors weeks beforehand or nudge them into making an appointment with a student coach/psychologist.

##### 4.3.2.3.1 Differences between computer science and law students

We have 24 responses by law students and 12 responses by computer science students. We explore if there are significant differences between the answers of both groups. One of the hypotheses we have is: that law students feel more stressed by academic competitiveness than computer science students.

$H_0$ : “Law students and computer science students feel the same stress by academic competitiveness with peers.”

$H_A$ : “Law students feel more stressed by academic competitiveness than computer science students”.

The medians of law and computer science students are 1 and 2 respectively. The means of both groups are 2.125 and 2.5 respectively. Even without statistical analysis, it seems that we will not be able to reject the null hypothesis or accept the alternative hypothesis. The p-value after running a Mann-Whitney’s U test to evaluate the difference is 0.3768, which is higher than 0.05. We cannot conclude that law students experience more stress by academic competitiveness compared to computer science students. In the end, we do not find any significant differences in stressors between the two groups.

#### 4.3.2.4 Stress management

By analyzing the results on how students cope with stress, we may include features or content that is useful for preventing or forgetting bad coping techniques. We do not see any potential results that indicate a (big) proportion of students has a problem. Exercise is a less popular method for dealing with stress than sedentary alternatives (sampled mean of 2.94 and 3.59 respectively (min. = 1, max. = 5)). We run a Mann-Whitney’s U test to check if there is a difference in the responses of active or sedentary ways of dealing with stress. We find there is a significant difference (p-value =  $1.912e-08 < 0.05$ ). Even though the mean for exercising is relatively high, 40% of the respondents state that they exercise less than “sometimes”. We do not have any significant indication if our statement reflects reality (p-value =  $0.23 > 0.05$ ).

## 4.4 Participation group sessions mindfulness

During the first interview with the psychologist, we asked if it would be possible to observe a training or workshop they organized. Due to practical implications (privacy concerns, lack of group bonding, the structure of the training...), only participation would be allowed. This academic year, it would be possible to attend a program regarding resilience, mindfulness, performance anxiety, etc. Ms. Klomp and we decided the mindful behavioral cognitive therapy/training (or “mindfulness training”) would be the most interesting and practical in terms of the planning of the programs and the thesis, and the scope of the thesis.

The training took place every Tuesday from 5 p.m. to 7 p.m. in October and November. During these sessions, the participants do several exercises regarding mindfulness such as audio-guided body scan meditation<sup>2</sup> and breathing exercises<sup>3</sup>. Even though these exercises may give a participant a temporary feeling of ease, the participants do not notice instant results on their actions. Even though the moderator (one of the therapists) explains the usefulness of the exercises and mentions the participants should not expect

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<sup>2</sup> <https://mindful.stanford.edu/additional-resources/self-care/body-scan-meditation/>

<sup>3</sup> [https://ggia.berkeley.edu/practice/mindful\\_breathing](https://ggia.berkeley.edu/practice/mindful_breathing)

instant results, most participants seem to be skeptical and question the (unnoticeable) effects.

## 4.5 Focus group

Next to the survey, we organize a focus group with students. This approach gives us the opportunity to gain more insights into the context students experience stress in or come up with new ideas, which we have not thought about before. We originally hoped to organize two focus group sessions: one with computer science students and one with law students. Unfortunately, students were not interested in joining as zero participants showed up. Instead, we now ask two PhD students and one (recently) graduated student in computer science to participate in the focus group. The focus group is organized in the form of an affinity diagramming session.

### 4.5.1 Method

We prepare a number of questions regarding stress, sources of stress, stress management and mobile application usage. When starting the workshop, we explain what an affinity diagramming session is to the participants. We ask them to take one to two minutes to come up with thoughts or answers on those questions and write them on a post-it note. After answering all the questions, the participants create clusters with their answers while discussing (“are these answers the same/similar?”, “should this answer be in this cluster?”, etc.), give the clusters a name, group the clusters together and give those groups a name.

### 4.5.2 Results

The resulting state of the post-its and named groups and clusters gives us a good overview of the factors that cause stress. Most clusters about sources of stress are related to (academic) work.

### 4.5.3 Limitations

The three participants already obtained a master’s degree in computer science. By not having current bachelor or master students, we are likely missing several answers and thus also new insights on the current situation (e.g. difficulty or being new to university). On top of that, we cannot assume that the resulting answers, groups and clusters apply for university students in general as we only have answers of people with a master’s degree in computer science.

# Chapter 5: Design

In this chapter, we explain the design of the application and the design choices we make.

## 5.1 Anthropomorphic elements

As mentioned in Section 3.2, anthropomorphic elements can significantly contribute to the user experience of applications in general and take a big role in the design of health applications. We can also use them to include elements supported by research in psychology such as social support.

Based on academic findings that animals have a positive effect on mental health and past literature in HCI, we include a digital pet in order to improve the experience of stress management and the adherence to learning stress management skills, as stress management skills do not give instant results most of the time. As the user regularly opens the application and interacts with it, the behavior of the in-app pet changes to reward the user.

### 5.1.1 Social support and psychoeducation

The agents provide the users with text that may belong to emotional, informative or appraisal support. We illustrate possible lines of texts the digital agents use to communicate with the user and the kind of support it is linked to:

#### **Emotional support:**

- We feel sad that you feel sad.
- We are here to help.
- “How was your exam today”

#### **Informative support:**

- Stress is a signal to fight or flight.
- Explaining what stress, depression and anxiety are and what their role is

#### **Appraisal support:**

- We can do something about it
- It's okay to be sad.
- Exams are stressful for most of us.

In the texts that serve as informative support, we include information about stress which also serves as psychoeducation. The digital agents also display suitable facial expressions (Figure 12b), based on the text and the current context of the text.

## 5.2 Emotion tracking

We include emotion tracking into the design of the application. The user rates their day, selects their corresponding emotions, and is asked to provide a description of the event(s) that are linked to that emotion (Figure 12).

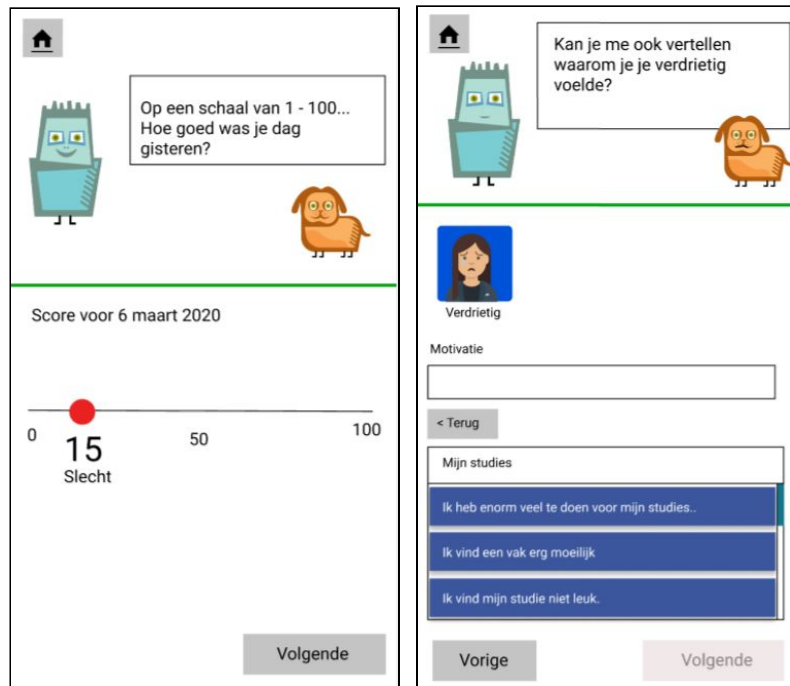


Figure 12: (a) the user can rate their day (left), (b) log their emotions and motivate them (right).

The colors are based on 'The Ekman's' Atlas of Emotions [147] and are carefully chosen so they are distinguishable by users with color blindness. We use Nichols' tool to carefully select colors that can be distinguished by both users with and without color blindness (Figure 13) [123]. The Atlas attributes the emotions, sadness, anger, fear and enjoyment to the colors blue, red, purple and yellow respectively. The four color values we use are respectively #009eef, #ff3100, #841082 and #f3e500.

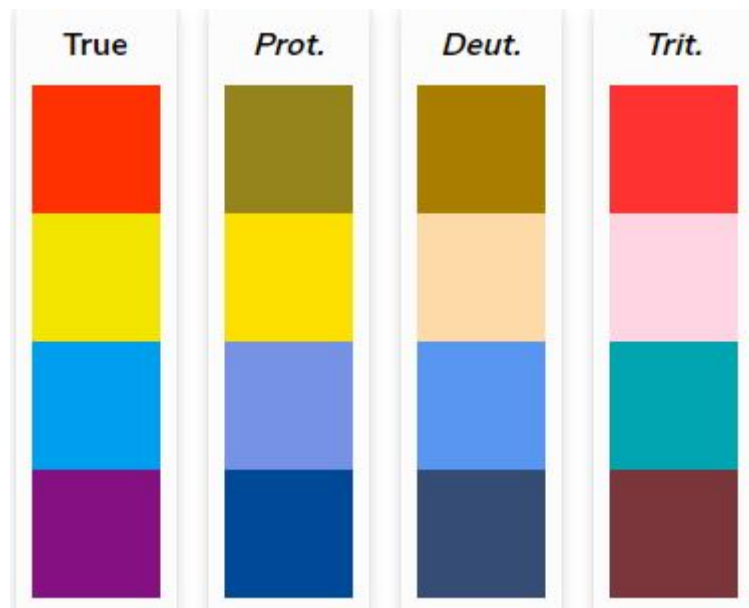


Figure 13: The colors below “True” represent the perceived colors by a user without color blindness. The other palettes are the colors perceived by a user with color blindness. From top to bottom, the true colours correspond to the values #ff3100 (anger), #f3e500 (enjoyment), #009eef (sadness) and #841082 (fear) [123].

### 5.2.1 Reflection

The prototype contains a calendar in which the user’s past entries are visualized (Figure 14). Each day with an entry has a color that corresponds to the selected emotion of that day. This should give the user more insight about their stressors and patterns, and allows them to take action to lower their negative emotions in the future.



Figure 14: The user has an overview of their past entries

### 5.3 Stress indications and actions

The student will be regularly asked to fill in the DASS questionnaire (Figure 15). Based on these results, the application can advise different actions. For example, if the results state the user shows symptoms of extreme levels of stress, depression or anxiety, the app will propose to consult a professional.



Figure 15: The application calculates the severity of the user's current symptoms of stress, depression and anxiety with the DASS questionnaire.

### 5.3.1 Levels of stress

As mentioned in Section 2.2.1.1, the results of the DASS questionnaire consist of the indications of the level of stress, depression and anxiety each. For the scope of the thesis, we group the five different indications in three groups in the application: low, medium and high. The “Normal” result of the DASS questionnaire is grouped as “low”, “Mild” and “Moderate” are grouped as “average”, and “Severe” and “Extremely Severe” are grouped as “High”.

### 5.3.2 Recommended strategies

Based on the results of the DASS questionnaire, the application gives suggestions on what to do. If at least one of the dimensions is labeled as “high” by the application, the application would advise the user to make an appointment with a student psychologist. If the application perceives the user's stress as “normal”, it may give the user suggestions to take a walk before studying or to visit a student coach. The student coach still can refer the student to other professionals if needed. The applications can also refer to in-app exercises that cover a certain subject. These subjects can be suggested based on the experiences the user enters in their emotion diary (Figure 16).





Figure 16: The application proposes suggestions based on the data the user provides

## 5.4 Context awareness

The user has the possibility to authorize the application to access their Google Calendar data and their location. The application can suggest action based on their schedule or location. For example, by scanning the calendar entries, the application can send a reminder to the student to prepare for the exams or make an appointment with a student coach, one month before their first exams. This gives them the opportunity to not only work on managing their exam stress, but also give them some time to come up with a solution for potential stress just before or after an exam (Figure 17).



Figure 17: The application can mention possible stressful periods in the future in order to help them prepare for potential stress at the right time

## 5.5 Stress management exercises

The application contains exercises that use the theory of CBT (Figure 18). The main aim of the application is to guide the user towards appropriate action. The prototype has a few predefined exercises to show the concept, but the user can start with an empty template and adapt the exercise for a personal or less general situation.

The exercise starts with a situation that leads to certain thoughts, feelings and behavior. The user needs to find a “weak” point in one of those elements and come up with a strategy that can help find a way to a structured solution. This exercise also helps by recognizing bad thoughts (see Section 2.1.3.2) and replacing them with useful/productive thoughts



Figure 18: Example of the contents of the CBT exercise in the application

# Chapter 6: Development

We develop a prototype with the gathered information and past research in mind. We use React.js<sup>4</sup> and Ionic<sup>5</sup> to realize the prototype. We use Pixi.js to visualize the elements related to anthropomorphism and the in-app virtual environment.

## 6.1 Recommendation of actions

We extract the user's sentences and extract keywords. We can use these keywords to guess the subject of their input and check which strategies or recommendations are suitable for the extracted keywords. Words are considered as keywords if they are not in the Balucha's list of possible stopwords [10].

The algorithm for finding the recommended items is as follows:

1. Extract keywords from the provided text and store them in a list.
2. For every available item
  - 2.1. Get the set of associated keywords for that specific item and the current context (state of the application, location, time and estimated stress/anxiety/depression level by DASS)
  - 2.2. If there is no set provided, this item cannot be recommended in the current context
  - 2.3. If the set is empty, this item can always be recommended in the current context
  - 2.4. If the set is not empty, the item can be recommended if all elements in at least one subset are present in the list of extracted keywords

We can also illustrate the algorithm by using an example.

If the user has provides the text “Ik moet veel leren tegen morgen” (I have a lot to study by tomorrow), we get a list consisting of three items: “veel”, “leren” and “morgen” (“lot”, “study” and “tomorrow” respectively). We assume there is only one item called *strategy* that can be recommended in every possible context. The set of keyword sets for *strategy* is  $S_{\text{strategy}}$  with

$$S_{\text{strategy}} = \{(\text{veel, doen}), (\text{veel, werk}), (\text{veel, projecten}), (\text{overweldigend})\}$$

1. We have the extracted keywords “*veel*”, “*leren*” and “*morgen*” and store them in a list *Keywords*
2. For the item *strategy*
  - 2.1. We get the associated set  $S_{\text{strategy}}$
  - 2.2.  $S_{\text{strategy}}$  is set, so it cannot be unset. We go to 2.3

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<sup>4</sup> <https://reactjs.org/>

<sup>5</sup> <https://ionicframework.com/>

- 2.3.  $S_{\text{strategy}}$  is not empty because it contains four items (which is higher than 0 items). We go to 2.4
- 2.4. The  $S_{\text{strategy}}$ 's subset (veel, doen) contains all words in the *Keywords*, so this item is a recommendation

## 6.2 Schedule awareness

We allow users to authorize the application to get their personal schedule from their personal Google Calendar account. After authentication, the application gathers the data in JSON format through the Google Calendar API and attributes a label to each of the scheduled blocks. The labels are determined by the title and/or the description and need to be confirmed by the user before actually attributing them (Figure 19). Each event in the coming weeks is analyzed by their titles and descriptions. If one of the words in those strings matches with one or more of the predefined labels (or synonyms or abbreviations that are pre-stored in the application), the application labels the event automatically. For example, an event that has “demo” in the title would be labeled as “presentatie” (“presentation”) as the defined alternatives for the label are stored in the array [*demo*, *pres*, *presentatie*, *presentation*, *present*, *voorstel*], which contains “demo”. The user can also assign labels manually and remove the (auto-assigned) labels.

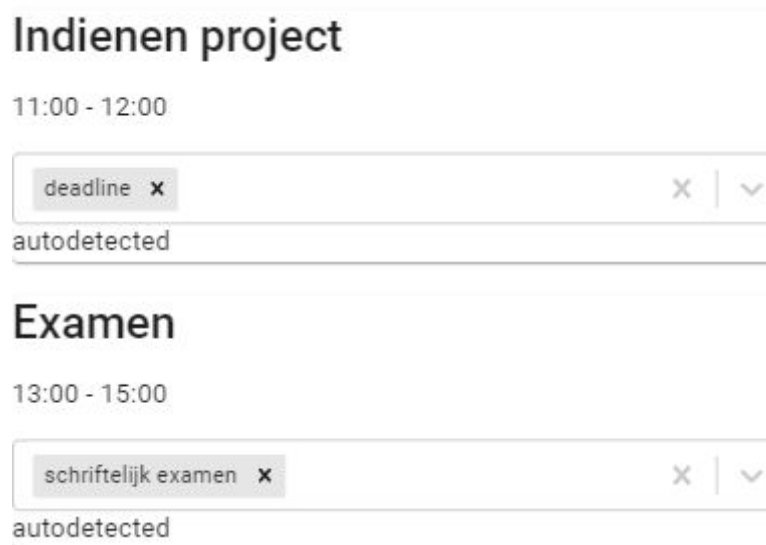


Figure 19: The events in the user’s Google Calendar are read and may be automatically labeled based on the predefined labels or given alternatives for that label.

# Chapter 7: Future work

We briefly explain the prepared protocol for the user testing and possible future work.

## 7.1 User testing

Due to the COVID-19 situation, we decided to cancel our plans regarding a usability and a field test. However, there is already a draft of the protocol for both a lab and field test. A draft version without the introduction can be found in Appendix G. We briefly discuss the contents of the protocol in this section.

### 7.1.1 Usability test in a lab setting

The first phase would be a usability test in a lab setting. We want to know if the application contains usability or other issues. The test also gives us the opportunity to get the participants' opinions on the concept. Based on the results, we can make changes to the application before starting the field test.

The planned location for the test was the building of the Expertise centre for Digital Media (EDM) (Wetenschapspark 2 - 3590 Diepenbeek, Belgium). For each test user, we reserve a time block of 60 minutes (30 minutes for testing, 13 minutes for briefing and debriefing, 12 minutes for completing the System Usability Scale (SUS) questionnaire and interview, and 5 minutes for unforeseen circumstances). Next to the SUS questionnaire, we want to conduct a short interview with the participant regarding their opinion on the features.

During the lab test, we want to find an answer on the following questions:

- Which pieces of texts does the test user understand without external help (from other people or (digital) sources)?
- Which elements in the prototype are not user friendly?
- What is the test user's opinion on the following features of the prototype:
  - Virtual environment (digital rewards)
  - CBT-based exercise
  - Emotion diary
  - Integration of personal Google Calendar account
  - Custom in-app messages and notification based on location and time/schedule
  - Personal avatar reflecting the user
  - Digital agents
    - Pet
    - Guide

We start the test with a briefing and let the participant sign a consent form. Recorded material and other data will be saved in a shared Google Drive folder that is owned by

Hasselt University. For the usability test, a scenario was prepared that touches most features in the application. After the test itself, we ask the participant to fill in the SUS questionnaire and ask him a few more questions regarding their opinion on the features. For the full plan of the test and hypotheses, we kindly refer to Appendix G.

### 7.1.2 Field test

We ask students (independent of their history or perception of stress) to participate in the field test. We prefer students that would not have participated in the lab test to avoid bias, but we do not exclude them for participating. We ask each participant to install the application on their personal smartphone. They are free to use the application however they want for six weeks. After that period, we invite them to have an interview about their experience and let them complete the SUS questionnaire. User data is encrypted and cannot be consulted outside of the application (unless someone cracks the encryption). For the full plan of the test and hypotheses, we kindly refer to Appendix G.

## 7.2 Integrating physiological elements

The prototype only uses contextual and user-provided information to provide personal recommendations and tips to support the user in stress management. As stress also results in physiological symptoms, it would be helpful to keep track of the user's heart rate to detect stressful moments [169]. However, we need to keep in mind that a high heart rate can also have other causes such as exercise [169]. Possible solutions we might consider are letting the user confirm the cause of the physiological effects [169] or monitoring other elements such as their facial expressions or voice [80].

# References

- [1] Brian K. Ahmedani. 2011. Mental Health Stigma: Society, Individuals, and the Profession. *J. Soc. Work Values Ethics* 8, 2 (Autumn 2011), 41–416. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/22211117>
- [2] Serap Akgun and Joseph Ciarrochi. 2003. Learned Resourcefulness Moderates the Relationship Between Academic Stress and Academic Performance. *Educ. Psychol. Rev.* 23, 3 (2003), 287–294. DOI:<https://doi.org/10.1080/0144341032000060129>
- [3] Sarah F. Allen, Mark A. Wetherell, and Michael A. Smith. 2020. Online writing about positive life experiences reduces depression and perceived stress reactivity in socially inhibited individuals. *Psychiatry Res.* 284, (February 2020), 112697. DOI:<https://doi.org/10.1016/j.psychres.2019.112697>
- [4] Gerhard Andersson and Pim Cuijpers. 2009. Internet-based and other computerized psychological treatments for adult depression: a meta-analysis. *Cogn. Behav. Ther.* 38, 4 (2009), 196–205. DOI:<https://doi.org/10.1080/16506070903318960>
- [5] Randy P. Auerbach, Philippe Mortier, Ronny Bruffaerts, Jordi Alonso, Corina Benjet, Pim Cuijpers, Koen Demyttenaere, David D. Ebert, Jennifer Greif Green, Penelope Hasking, Elaine Murray, Matthew K. Nock, Stephanie Pinder-Amaker, Nancy A. Sampson, Dan J. Stein, Gemma Vilagut, Alan M. Zaslavsky, Ronald C. Kessler, and WHO WMH-ICS Collaborators. 2018. WHO world mental health surveys international college student project: Prevalence and distribution of mental disorders. *J. Abnorm. Psychol.* (September 2018). DOI:<https://doi.org/10.1037/abn0000362>
- [6] Elizabeth Austin, Donald Saklofske, and Sarah Mastoras. 2010. Emotional intelligence, coping and exam-related stress in Canadian undergraduate students. *Australian Journal of Psychology* 62, 42–50. DOI:<https://doi.org/10.1080/00049530903312899>
- [7] Erin E. Ayala, Jeffrey S. Winseman, Ryan D. Johnsen, and Hyacinth R. C. Mason. 2018. U.S. medical students who engage in self-care report less stress and higher quality of life. *BMC Med. Educ.* 18, 1 (August 2018), 189. DOI:<https://doi.org/10.1186/s12909-018-1296-x>
- [8] David Bakker, Nikolaos Kazantzis, Debra Rickwood, and Nikki Rickard. 2016. Mental Health Smartphone Apps: Review and Evidence-Based Recommendations for Future Developments. *JMIR Ment Health* 3, 1 (March 2016), e7. DOI:<https://doi.org/10.2196/mental.4984>
- [9] J. C. Ballenger. 2007. Anxiety Disorders and Risk for Suicidal Ideation and Suicide Attempts: A Population-Based Longitudinal Study of Adults. *Yearbook of Psychiatry and Applied Mental Health* 2007, (2007), 249–250. DOI:[https://doi.org/10.1016/s0084-3970\(08\)70548-6](https://doi.org/10.1016/s0084-3970(08)70548-6)
- [10] Balucha. 2014. Stop words. *Stop words*. Retrieved 24 July 2020 from <https://code.google.com/archive/p/stop-words/>
- [11] Aaron Bangor, Philip T. Kortum, and James T. Miller. 2008. An Empirical Evaluation of the System Usability Scale. *International Journal of Human-Computer Interaction* 24, 574–594. DOI:<https://doi.org/10.1080/10447310802205776>
- [12] Azy Barak, Liat Hen, Meyran Boniel-Nissim, and Na 'ama Shapira. 2008. A Comprehensive Review and a Meta-Analysis of the Effectiveness of Internet-Based Psychotherapeutic Interventions. *Journal of Technology in Human Services* 26, 109–160. DOI:<https://doi.org/10.1080/15228830802094429>
- [13] Andrew Baum. 1990. Stress, intrusive imagery, and chronic distress. *Health Psychol.* 9, 6 (1990), 653–675. DOI:<https://doi.org/10.1037//0278-6133.9.6.653>
- [14] Roy F. Baumeister, Kathleen D. Vohs, C. Nathan DeWall, and Liqing Zhang. 2007. How emotion shapes behavior: feedback, anticipation, and reflection, rather than direct causation. *Pers. Soc. Psychol. Rev.* 11, 2 (May 2007), 167–203. DOI:<https://doi.org/10.1177/1088868307301033>
- [15] Amy L. Baylor. 2009. Promoting motivation with virtual agents and avatars: role of visual presence and appearance. *Philos. Trans. R. Soc. Lond. B Biol. Sci.* 364, 1535 (December 2009), 3559–3565. DOI:<https://doi.org/10.1098/rstb.2009.0148>
- [16] Judith S. Beck. 2011. *Cognitive Behavior Therapy: Basics and Beyond*. Retrieved from [https://books.google.com/books/about/Cognitive\\_Behavior\\_Therapy.html?hl=&id=e97cxAEACAAJ](https://books.google.com/books/about/Cognitive_Behavior_Therapy.html?hl=&id=e97cxAEACAAJ)
- [17] Ina Beintner, Bianka Vollert, Anna-Carlotta Zarski, Felix Bolinski, Peter Musiat, Dennis Görlich, David Daniel Ebert, and Corinna Jacobi. 2019. Adherence Reporting in Randomized Controlled Trials Examining



- Manualized Multisession Online Interventions: Systematic Review of Practices and Proposal for Reporting Standards. *J. Med. Internet Res.* 21, 8 (August 2019), e14181. DOI:<https://doi.org/10.2196/14181>
- [18] David Benyon and Oli Mival. 2010. From human-computer interactions to human-companion relationships. *Proceedings of the First International Conference on Intelligent Interactive Technologies and Multimedia - IITM '10*. DOI:<https://doi.org/10.1145/1963564.1963565>
- [19] M. Berehil, K. Arrhioui, and S. Mbarki. 2017. Gamified Stress Management Calendar for Higher Education Students. *Proceedings of the 2nd international Conference on Big Data, Cloud and Applications*. DOI:<https://doi.org/10.1145/3090354.3090449>
- [20] M. Berehil, K. Arrhioui, and S. Mbarki. 2017. Gamified Stress Management Calendar for Higher Education Students. *Proceedings of the 2nd international Conference on Big Data, Cloud and Applications - BDCA'17*. DOI:<https://doi.org/10.1145/3090354.3090449>
- [21] P. L. Bernstein, E. Friedmann, and A. Malaspina. 2000. Animal-Assisted Therapy Enhances Resident Social Interaction and Initiation in Long-Term Care Facilities. *Anthrozoös* 13, 4 (2000), 213–224. DOI:<https://doi.org/10.2752/089279300786999743>
- [22] Bridgette Bewick, Gina Koutsopoulou, Jeremy Miles, Esther Slaa, and Michael Barkham. 2010. Changes in undergraduate students' psychological well-being as they progress through university. *Studies in Higher Education* 35, 6 (2010), 633–645. DOI:<https://doi.org/10.1080/03075070903216643>
- [23] Sara Birch, Maiken Stilling, Inger Mechlenburg, and Torben Bæk Hansen. 2017. Effectiveness of a physiotherapist delivered cognitive-behavioral patient education for patients who undergoes operation for total knee arthroplasty: a protocol of a randomized controlled trial. *BMC Musculoskeletal Disorders* 18. DOI:<https://doi.org/10.1186/s12891-017-1476-6>
- [24] Eva Bíró, Róza Adány, and Karolina Kósa. 2011. Mental health and behaviour of students of public health and their correlation with social support: a cross-sectional study. *BMC Public Health* 11, (November 2011), 871. DOI:<https://doi.org/10.1186/1471-2458-11-871>
- [25] Linda-Renée Bloch and Dafna Lemish. 1999. Disposable Love: The Rise and Fall of a Virtual Pet. *New Media & Society* 1, 283–303. DOI:<https://doi.org/10.1177/1461444992225591>
- [26] Christina L. Boisseau, Todd J. Farchione, Christopher P. Fairholme, Kristen K. Ellard, and David H. Barlow. 2010. The Development of the Unified Protocol for the Transdiagnostic Treatment of Emotional Disorders: A Case Study. *Cogn. Behav. Pract.* 17, 1 (February 2010), 102–113. DOI:<https://doi.org/10.1016/j.cbpra.2009.09.003>
- [27] Guilherme Borges, Matthew K. Nock, Josep M. Haro Abad, Irving Hwang, Nancy A. Sampson, Jordi Alonso, Laura Helena Andrade, Matthias C. Angermeyer, Annette Beautrais, Evelyn Bromet, Ronny Bruffaerts, Giovanni de Girolamo, Silvia Florescu, Oye Gureje, Chiyi Hu, Elie G. Karam, Viviane Kovess-Masfety, Sing Lee, Daphna Levinson, Maria Elena Medina-Mora, Johan Ormel, Jose Posada-Villa, Rajesh Sagar, Toma Tomov, Hidenori Uda, David R. Williams, and Ronald C. Kessler. 2010. Twelve-month prevalence of and risk factors for suicide attempts in the World Health Organization World Mental Health Surveys. *J. Clin. Psychiatry* 71, 12 (December 2010), 1617–1628. DOI:<https://doi.org/10.4088/JCP.08m04967blu>
- [28] C. R. Brewin. 1996. Theoretical foundations of cognitive-behavior therapy for anxiety and depression. *Annu. Rev. Psychol.* 47, (1996), 33–57. DOI:<https://doi.org/10.1146/annurev.psych.47.1.33>
- [29] T. A. Brown, B. F. Chorpita, W. Korotitsch, and D. H. Barlow. 1997. Psychometric properties of the Depression Anxiety Stress Scales (DASS) in clinical samples. *Behav. Res. Ther.* 35, 1 (January 1997), 79–89. DOI:[https://doi.org/10.1016/s0005-7967\(96\)00068-x](https://doi.org/10.1016/s0005-7967(96)00068-x)
- [30] Chad M. Burton and Laura A. King. 2004. The health benefits of writing about intensely positive experiences. *Journal of Research in Personality* 38, 150–163. DOI:[https://doi.org/10.1016/s0092-6566\(03\)00058-8](https://doi.org/10.1016/s0092-6566(03)00058-8)
- [31] Gillian Cameron, David Cameron, Gavin Megaw, Raymond Bond, Maurice Mulvenna, Siobhan O'Neill, Cherie Armour, and Michael McTear. 2017. Towards a chatbot for digital counselling. DOI:<https://doi.org/10.14236/ewic/hci2017.24>
- [32] Tavis S. Campbell, Jillian A. Johnson, and Kristin A. Zernicke. 2013. Cognitive Appraisal. *Encyclopedia of Behavioral Medicine*, 442–442. DOI:[https://doi.org/10.1007/978-1-4419-1005-9\\_1115](https://doi.org/10.1007/978-1-4419-1005-9_1115)
- [33] Daniel W. Capron, Sarah J. Bujarski, Kim L. Gratz, Michael D. Anestis, Christopher P. Fairholme, and Matthew T. Tull. 2016. Suicide risk among male substance users in residential treatment: Evaluation of the

- depression–distress amplification model. *Psychiatry Res.* 237, (2016), 22–26.  
DOI:<https://doi.org/10.1016/j.psychres.2016.01.060>
- [34] Luca Chittaro and Riccardo Sioni. 2014. Evaluating mobile apps for breathing training: The effectiveness of visualization. *Computers in Human Behavior* 40, 56–63. DOI:<https://doi.org/10.1016/j.chb.2014.07.049>
- [35] Joseph V. Ciarrochi and Frank P. Deane. 2001. Emotional competence and willingness to seek help from professional and nonprofessional sources. *Br. J. Guid. Couns.* 29, 2 (2001), 233–246.  
DOI:<https://doi.org/10.1080/03069880124843>
- [36] Sheldon Cohen, Ronald C. Kessler, and Lynn Underwood Gordon. 1997. *Measuring Stress: A Guide for Health and Social Scientists*. Oxford University Press on Demand. Retrieved from  
[https://books.google.com/books/about/Measuring\\_Stress.html?hl=&id=Xy\\_r37l0qzIC](https://books.google.com/books/about/Measuring_Stress.html?hl=&id=Xy_r37l0qzIC)
- [37] Karen Collins and Ruth Dockwray. 2018. Tamaglitchi. *Proceedings of the Audio Mostly 2018 on Sound in Immersion and Emotion - AM'18*. DOI:<https://doi.org/10.1145/3243274.3243275>
- [38] Bruce E. Compas, Pamela G. Orosan, and Kathryn E. Grant. 1993. Adolescent stress and coping: implications for psychopathology during adolescence. *Journal of Adolescence* 16, 331–349.  
DOI:<https://doi.org/10.1006/jado.1993.1028>
- [39] Anna L. Cox and Nadia Berthouze. 2018. Knowing What You're Doing or Knowing What to Do: How Stress Management Apps Support Reflection and Behaviour Change. In *CHI EA '18: Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, 6.
- [40] Michelle G. Craske and Murray B. Stein. 2016. Anxiety. *Lancet* 388, 10063 (December 2016), 3048–3059.  
DOI:[https://doi.org/10.1016/S0140-6736\(16\)30381-6](https://doi.org/10.1016/S0140-6736(16)30381-6)
- [41] John Crawford, Carol Cayley, Peter F. Lovibond, Peter H. Wilson, and Caroline Hartley. 2011. Percentile Norms and Accompanying Interval Estimates from an Australian General Adult Population Sample for Self-Report Mood Scales (BAI, BDI, CRSD, CES-D, DASS, DASS-21, STAI-X, STAI-Y, SRDS, and SRAS). *Australian Psychologist* 46, 3–14. DOI:<https://doi.org/10.1111/j.1742-9544.2010.00003.x>
- [42] John R. Crawford and Julie D. Henry. 2003. The Depression Anxiety Stress Scales (DASS): Normative data and latent structure in a large non-clinical sample. *British Journal of Clinical Psychology* 42, 111–131.  
DOI:<https://doi.org/10.1348/014466503321903544>
- [43] Molly K. Crossman, Alan E. Kazdin, and Krista Knudson. 2015. Brief Unstructured Interaction with a Dog Reduces Distress. *Anthrozoös* 28, 4 (2015), 649–659. DOI:<https://doi.org/10.1080/08927936.2015.1070008>
- [44] Christina Dahl. 2019. Warum es sich lohnt, gut für sich zu sorgen. *Prävention und Gesundheitsförderung* 14, 69–78. DOI:<https://doi.org/10.1007/s11553-018-0650-5>
- [45] Elise S. Dan-Glauser and James J. Gross. 2015. The temporal dynamics of emotional acceptance: Experience, expression, and physiology. *Biol. Psychol.* 108, (May 2015), 1–12.  
DOI:<https://doi.org/10.1016/j.biopsycho.2015.03.005>
- [46] Sarah DeArmond, Russell A. Matthews, and Jennifer Bunk. 2014. Workload and procrastination: The roles of psychological detachment and fatigue. *Int. J. Stress Manag.* 21, 2 (2014), 137–161.  
DOI:<https://doi.org/10.1037/a0034893>
- [47] A. Min Deedee, Kim Yaejin, A. Jang Sung, Young Kim Keun, Jung Su-Eun, and Lee Ji-Hyun. 2015. Pretty Pelvis: A Virtual Pet Application That Breaks Sedentary Time by Promoting Gestural Interaction. *CHI EA '15* (April 2015). DOI:<https://doi.org/https://dl.acm.org/doi/10.1145/2702613.2732807>
- [48] Matt Dennis, Judith Masthoff, and Chris Mellish. 2016. Adapting Progress Feedback and Emotional Support to Learner Personality. *International Journal of Artificial Intelligence in Education* 26, 877–931.  
DOI:<https://doi.org/10.1007/s40593-015-0059-7>
- [49] Leonard R. Derogatis. Symptom Checklist-90-Revised. *Pearson*. Retrieved 5 April 2020 from  
<https://www.pearsonassessments.com/store/usassessments/en/Store/Professional-Assessments/Personal-ity-%26-Biopsychosocial/Symptom-Checklist-90-Revised/p/100000645.html>
- [50] L. R. Derogatis, R. S. Lipman, and L. Covi. 1973. SCL-90: an outpatient psychiatric rating scale--preliminary report. *Psychopharmacol. Bull.* 9, 1 (January 1973), 13–28. Retrieved from  
<https://www.ncbi.nlm.nih.gov/pubmed/4682398>
- [51] F. S. Dhabhar. 2009. A hassle a day may keep the pathogens away: The fight-or-flight stress response and the augmentation of immune function. *Integr. Comp. Biol.* 49, 3 (2009), 215–236.  
DOI:<https://doi.org/10.1093/icb/icp045>
- [52] Liesje Donkin, Helen Christensen, Sharon L. Naismith, Bruce Neal, Ian B. Hickie, and Nick Glozier. 2011.

- A systematic review of the impact of adherence on the effectiveness of e-therapies. *J. Med. Internet Res.* 13, 3 (August 2011), e52. DOI:<https://doi.org/10.2196/jmir.1772>
- [53] Liesje Donkin, Ian B. Hickie, Helen Christensen, Sharon L. Naismith, Bruce Neal, Nicole L. Cockayne, and Nick Glozier. 2013. Rethinking the Dose-Response Relationship Between Usage and Outcome in an Online Intervention for Depression: Randomized Controlled Trial. *Journal of Medical Internet Research* 15, e231. DOI:<https://doi.org/10.2196/jmir.2771>
- [54] David J. A. Dozois and Keith S. Dobson. The prevention of anxiety and depression: Introduction. *The prevention of anxiety and depression: Theory, research, and practice.*, 1–6. DOI:<https://doi.org/10.1037/10722-001>
- [55] Marcus Eckert, David D. Ebert, Dirk Lehr, Bernhard Sieland, and Matthias Berking. 2016. Overcome procrastination: Enhancing emotion regulation skills reduce procrastination. *Learn. Individ. Differ.* 52, (2016), 10–18. DOI:<https://doi.org/10.1016/j.lindif.2016.10.001>
- [56] Janet L. Edwards and Dimity A. Crisp. 2017. Seeking help for psychological distress: Barriers for mental health professionals. *Australian Journal of Psychology* 69, 218–225. DOI:<https://doi.org/10.1111/ajpy.12146>
- [57] Paul Ekman. 1992. Are there basic emotions? *Psychological Review* 99, 550–553. DOI:<https://doi.org/10.1037/0033-295x.99.3.550>
- [58] Nicholas Epley, Adam Waytz, and John T. Cacioppo. 2007. On seeing human: A three-factor theory of anthropomorphism. *Psychological Review* 114, 864–886. DOI:<https://doi.org/10.1037/0033-295x.114.4.864>
- [59] Kristina Fenn and Majella Byrne. 2013. The key principles of cognitive behavioural therapy. *InnovAiT: Education and inspiration for general practice* 6, 579–585. DOI:<https://doi.org/10.1177/1755738012471029>
- [60] Mark Le Fevre, Mark Le Fevre, Gregory S. Kolt, and Jonathan Matheny. 2006. Eustress, distress and their interpretation in primary and secondary occupational stress management interventions: which way first? *Journal of Managerial Psychology* 21, 547–565. DOI:<https://doi.org/10.1108/02683940610684391>
- [61] Thomas A. Field, Eric T. Beeson, and Laura K. Jones. 2015. The New ABCs: A Practitioner’s Guide to Neuroscience-Informed Cognitive-Behavior Therapy. *Journal of Mental Health Counseling* 37, 3 (July 2015), 206–220. DOI:<https://doi.org/10.17744/1040-2861-37.3.206>
- [62] Aubrey H. Fine. 2010. *Handbook on Animal-Assisted Therapy: Theoretical Foundations and Guidelines for Practice*. Academic Press. Retrieved from <https://market.android.com/details?id=book-2PruqyaDw6wC>
- [63] Kathleen Kara Fitzpatrick, Alison Darcy, and Molly Vierhile. 2017. Delivering Cognitive Behavior Therapy to Young Adults With Symptoms of Depression and Anxiety Using a Fully Automated Conversational Agent (Woebot): A Randomized Controlled Trial. *JMIR Ment Health* 4, 2 (June 2017), e19. DOI:<https://doi.org/10.2196/mental.7785>
- [64] Molly Fitzpatrick, Maja Nedeljkovic, Jo-Anne Abbott, Michael Kyrios, and Richard Moulding. 2018. ‘Blended’ therapy: The development and pilot evaluation of an internet-facilitated cognitive behavioral intervention to supplement face-to-face therapy for hoarding disorder. *Internet Interventions* 12, 16–25. DOI:<https://doi.org/10.1016/j.invent.2018.02.006>
- [65] B. J. Fogg and G. E. Fogg. 2003. *Persuasive Technology: Using Computers to Change What We Think and Do*. Morgan Kaufmann. Retrieved from [https://books.google.com/books/about/Persuasive\\_Technology.html?hl=&id=9nZHbxULMwgC](https://books.google.com/books/about/Persuasive_Technology.html?hl=&id=9nZHbxULMwgC)
- [66] Susan Folkman and Judith Tedlie Moskowitz. 2004. Coping: pitfalls and promise. *Annu. Rev. Psychol.* 55, (2004), 745–774. DOI:<https://doi.org/10.1146/annurev.psych.55.090902.141456>
- [67] Joanne Frattaroli. 2006. Experimental disclosure and its moderators: a meta-analysis. *Psychol. Bull.* 132, 6 (November 2006), 823–865. DOI:<https://doi.org/10.1037/0033-2909.132.6.823>
- [68] Nico H. Frijda. 2016. The evolutionary emergence of what we call ‘emotions’. *Cogn. Emot.* 30, 4 (March 2016), 609–620. DOI:<https://doi.org/10.1080/02699931.2016.1145106>
- [69] S. Fröjd, M. Marttunen, and R. Kaltiala-Heino. 2010. FC02-02 - Why do late adolescents not seek professional help for mental health problems? *European Psychiatry* 25, 182. DOI:[https://doi.org/10.1016/s0924-9338\(10\)70182-6](https://doi.org/10.1016/s0924-9338(10)70182-6)
- [70] N. Garnefski, V. Kraaij, and P. Spinhoven. 2001. Negative life events, cognitive emotion regulation and emotional problems. *Personality and Individual Differences* 30, 1311–1327. DOI:[https://doi.org/10.1016/s0191-8869\(00\)00113-6](https://doi.org/10.1016/s0191-8869(00)00113-6)
- [71] Namni Goel, Hengyi Rao, Jeffrey S. Durmer, and David F. Dinges. 2009. Neurocognitive consequences of sleep deprivation. *Semin. Neurol.* 29, 4 (September 2009), 320–339. DOI:<https://doi.org/10.1055/s-0029-1237117>

- [72] Philippe R. Goldin, Michal Ziv, Hooria Jazaieri, Kelly Werner, Helena Kraemer, Richard G. Heimberg, and James J. Gross. 2012. Cognitive reappraisal self-efficacy mediates the effects of individual cognitive-behavioral therapy for social anxiety disorder. *J. Consult. Clin. Psychol.* 80, 6 (December 2012), 1034–1040. DOI:<https://doi.org/10.1037/a0028555>
- [73] Li Gong. 2008. How social is social responses to computers? The function of the degree of anthropomorphism in computer representations. *Comput. Human Behav.* 24, 4 (July 2008), 1494–1509. DOI:<https://doi.org/10.1016/j.chb.2007.05.007>
- [74] Simeng Gu, Department of Psychology, Nanjing University of Chinese Medicine, Nanjing, 210023 China, Fushun Wang, Tifei Yuan, Benyu Guo, and Jason H. Huang. 2015. Differentiation of Primary Emotions through Neuromodulators: Review of Literature. *International Journal of Neurology Research* 1, 43–50. DOI:<https://doi.org/10.17554/j.issn.2313-5611.2015.01.19>
- [75] Simeng Gu, Fushun Wang, Nitesh P. Patel, James A. Bourgeois, and Jason H. Huang. 2019. A Model for Basic Emotions Using Observations of Behavior in *Drosophila*. *Frontiers in Psychology* 10. DOI:<https://doi.org/10.3389/fpsyg.2019.00781>
- [76] Mieke Haesen, Karin Coninx, Jan Bergh, and Kris Luyten. MuiCSer: A Process Framework for Multi-disciplinary User-Centred Software Engineering Processes. *Engineering Interactive Systems 2008*, 150–165. DOI:[https://doi.org/10.1007/978-3-540-85992-5\\_14](https://doi.org/10.1007/978-3-540-85992-5_14)
- [77] Julie M. Haggerty and Megan Kiely Mueller. 2017. Animal-assisted Stress Reduction Programs in Higher Education. *Innovative Higher Education* 42, 5-6 (2017), 379–389. DOI:<https://doi.org/10.1007/s10755-017-9392-0>
- [78] G. M. Hägg and A. Aström. 1997. Load pattern and pressure pain threshold in the upper trapezius muscle and psychosocial factors in medical secretaries with and without shoulder/neck disorders. *Int. Arch. Occup. Environ. Health* 69, 6 (1997), 423–432. DOI:<https://doi.org/10.1007/s004200050170>
- [79] Mohsen Haghbin, Adam McCaffrey, and Timothy A. Pynchyl. 2012. The Complexity of the Relation between Fear of Failure and Procrastination. *J. Ration. Emot. Cogn. Behav. Ther.* 30, 4 (2012), 249–263. DOI:<https://doi.org/10.1007/s10942-012-0153-9>
- [80] Hyewon Han, Kyunggeun Byun, and Hong-Goo Kang. 2018. A Deep Learning-based Stress Detection Algorithm with Speech Signal. *Proceedings of the 2018 Workshop on Audio-Visual Scene Understanding for Immersive Multimedia - AVSU'18*. DOI:<https://doi.org/10.1145/3264869.3264875>
- [81] Matthew Blake Hargrove, Debra L. Nelson, and Cary L. Cooper. 2013. Generating eustress by challenging employees. *Organ. Dyn.* 42, 1 (2013), 61–69. DOI:<https://doi.org/10.1016/j.orgdyn.2012.12.008>
- [82] Alexandra Hoffmann, Corinna A. Christmann, and Gabriele Bleser. 2017. Gamification in Stress Management Apps: A Critical App Review. *JMIR Serious Games* 5, e13. DOI:<https://doi.org/10.2196/games.7216>
- [83] Charles J. Holahan, David P. Valentiner, and Rudolf H. Moos. 1995. Parental support, coping strategies, and psychological adjustment: An integrative model with late adolescents. *Journal of Youth and Adolescence* 24, 633–648. DOI:<https://doi.org/10.1007/bf01536948>
- [84] Victoria Hollis, Artie Konrad, and Steve Whittaker. 2015. Change of Heart: Emotion Tracking to Promote Behavior Change. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems - CHI '15*, ACM Press, New York, New York, USA, 2643–2652. DOI:<https://doi.org/10.1145/2702123.2702196>
- [85] Justin Hunt and Daniel Eisenberg. 2010. Mental health problems and help-seeking behavior among college students. *J. Adolesc. Health* 46, 1 (January 2010), 3–10. DOI:<https://doi.org/10.1016/j.jadohealth.2009.08.008>
- [86] Rachael E. Jack, Oliver G. B. Garrod, and Philippe G. Schyns. 2014. Dynamic facial expressions of emotion transmit an evolving hierarchy of signals over time. *Curr. Biol.* 24, 2 (January 2014), 187–192. DOI:<https://doi.org/10.1016/j.cub.2013.11.064>
- [87] M. L. Jennings. 2009. Medical student burnout: interdisciplinary exploration and analysis. *J. Med. Humanit.* 30, 4 (December 2009), 253–269. DOI:<https://doi.org/10.1007/s10912-009-9093-5>
- [88] K. S. Kendler, L. M. Karkowski, and C. A. Prescott. 1998. Stressful life events and major depression: risk period, long-term contextual threat, and diagnostic specificity. *J. Nerv. Ment. Dis.* 186, 11 (November 1998), 661–669. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/9824167>
- [89] Basel Kikhia and Josef Hallberg. 2013. Visualizing and managing stress through colors and images. *Proceedings of the 4th International SenseCam & Pervasive Imaging Conference on - SenseCam '13*.

DOI:<https://doi.org/10.1145/2526667.2526680>

- [90] Andrea Konig, Alison Eonta, Stephanie R. Dyal, and Scott R. Vrana. 2014. Enhancing the benefits of written emotional disclosure through response training. *Behav. Ther.* 45, 3 (May 2014), 344–357. DOI:<https://doi.org/10.1016/j.beth.2013.12.006>
- [91] Ilse Kranner, Farida V. Minibayeva, Richard P. Beckett, and Charlotte E. Seal. 2010. What is stress? Concepts, definitions and applications in seed science. *New Phytol.* 188, 3 (November 2010), 655–673. DOI:<https://doi.org/10.1111/j.1469-8137.2010.03461.x>
- [92] Kelly G. Lambert. 2007. Handbook of Emotion Regulation. *JAMA* 298, 1805. DOI:<https://doi.org/10.1001/jama.298.15.1808>
- [93] Catherine Penny Hinson Langford, Juanita Bowsher, Joseph P. Maloney, and Patricia P. Lillis. 1997. Social support: a conceptual analysis. *Journal of Advanced Nursing* 25, 95–100. DOI:<https://doi.org/10.1046/j.1365-2648.1997.1997025095.x>
- [94] Charlotte A. Larsson, Bo Gullberg, Lennart Råstam, and Ulf Lindblad. 2009. Salivary cortisol differs with age and sex and shows inverse associations with WHR in Swedish women: a cross-sectional study. *BMC Endocr. Disord.* 9, (June 2009), 16. DOI:<https://doi.org/10.1186/1472-6823-9-16>
- [95] M. A. Lazar. 2005. How Obesity Causes Diabetes: Not a Tall Tale. *Science* 307, 5708 (2005), 373–375. DOI:<https://doi.org/10.1126/science.1104342>
- [96] R. S. Lazarus. 1993. Coping theory and research: past, present, and future. *Psychosomatic Medicine* 55, 234–247. DOI:<https://doi.org/10.1097/00006842-199305000-00002>
- [97] Mark Le Fevre, Jonathan Matheny, and Gregory S. Kolt. 2003. Eustress, distress, and interpretation in occupational stress. *Journal of Managerial Psychology* 18, 7 (2003), 726–744. DOI:<https://doi.org/10.1108/02683940310502412>
- [98] James R. Lewis. 2018. The System Usability Scale: Past, Present, and Future. *International Journal of Human-Computer Interaction* 34, 577–590. DOI:<https://doi.org/10.1080/10447318.2018.1455307>
- [99] Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A stage-based model of personal informatics systems. *Proceedings of the 28th international conference on Human factors in computing systems - CHI '10*. DOI:<https://doi.org/10.1145/1753326.1753409>
- [100] Nan Lin, Walter M. Ensel, Ronald S. Simeone, and Wen Kuo. 2019. Social Support, Stressful Life Events, and Illness: A Model and an Empirical Test. *Social Capital, Social Support and Stratification*, 107–118. DOI:<https://doi.org/10.4337/9781789907285.00012>
- [101] P. F. Lovibond and S. H. Lovibond. 1995. The structure of negative emotional states: comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behav. Res. Ther.* 33, 3 (March 1995), 335–343. DOI:[https://doi.org/10.1016/0005-7967\(94\)00075-u](https://doi.org/10.1016/0005-7967(94)00075-u)
- [102] S. H. Lovibond and Peter F. Lovibond. 1996. *Manual for the Depression Anxiety Stress Scales*. Retrieved from [https://books.google.com/books/about/Manual\\_for\\_the\\_Depression\\_Anxiety\\_Stress.html?hl=&id=mXoQHAAACAAJ](https://books.google.com/books/about/Manual_for_the_Depression_Anxiety_Stress.html?hl=&id=mXoQHAAACAAJ)
- [103] Sonia J. Lupien, Robert-Paul Juster, Catherine Raymond, and Marie-France Marin. 2018. The effects of chronic stress on the human brain: From neurotoxicity, to vulnerability, to opportunity. *Front. Neuroendocrinol.* 49, (April 2018), 91–105. DOI:<https://doi.org/10.1016/j.yfrne.2018.02.001>
- [104] Sonia J. Lupien, Bruce S. McEwen, Megan R. Gunnar, and Christine Heim. 2009. Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nat. Rev. Neurosci.* 10, 6 (June 2009), 434–445. DOI:<https://doi.org/10.1038/nrn2639>
- [105] Shaun Alexander Macdonald and Stephen Brewster. 2019. Gamification of a To-Do List with Emotional Reinforcement. *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. DOI:<https://doi.org/10.1145/3290607.3313060>
- [106] Sara Mackenzie, Jennifer R. Wiegel, Marlon Mundt, David Brown, Elizabeth Saewyc, Eric Heiligenstein, Brian Harahan, and Michael Fleming. 2011. Depression and Suicide Ideation Among Students Accessing Campus Healthcare. *Am. J. Orthopsychiatry* 81, 1 (January 2011), 101. DOI:<https://doi.org/10.1111/j.1939-0025.2010.01077.x>
- [107] Bill Mah. 2011. Depression and Anxiety. *Palliative Care*, 145–161. DOI:<https://doi.org/10.1016/b978-1-4377-1619-1.00010-x>
- [108] Gin S. Malhi and J. John Mann. 2018. Depression. *Lancet* 392, 10161 (2018), 2299–2312. DOI:[https://doi.org/10.1016/s0140-6736\(18\)31948-2](https://doi.org/10.1016/s0140-6736(18)31948-2)

- [109]Francisco Martín, Carlos E. Agüero, José M. Cañas, Meritxell Valenti, and Pablo Martínez-Martín. 2013. Robototherapy with Dementia Patients. *International Journal of Advanced Robotic Systems* 10, 10. DOI:<https://doi.org/10.5772/54765>
- [110]B. S. McEwen. 2000. Protective and damaging effects of stress mediators: central role of the brain. *Prog. Brain Res.* 122, (2000), 25–34. DOI:[https://doi.org/10.1016/S0079-6123\(08\)62128-7](https://doi.org/10.1016/S0079-6123(08)62128-7)
- [111]Herbert L. Meiselman. 2017. Emotion measurement: Theoretically pure or practical? *Food Quality and Preference* 62, 374–375. DOI:<https://doi.org/10.1016/j.foodqual.2017.05.011>
- [112]Sally N. Merry, Karolina Stasiak, Matthew Shepherd, Chris Frampton, Theresa Fleming, and Mathijs F. G. Lucassen. 2012. The effectiveness of SPARX, a computerised self help intervention for adolescents seeking help for depression: randomised controlled non-inferiority trial. *BMJ* 344, (April 2012), e2598. DOI:<https://doi.org/10.1136/bmj.e2598>
- [113]Howard Mertz. Stress and the Gut. Retrieved from <https://www.med.unc.edu/ibs/files/2017/10/Stress-and-the-Gut.pdf>
- [114]H. Miranda, E. Viikari-Juntura, R. Martikainen, E. P. Takala, and H. Riihimäki. 2001. A prospective study of work related factors and physical exercise as predictors of shoulder pain. *Occup. Environ. Med.* 58, 8 (August 2001), 528–534. DOI:<https://doi.org/10.1136/oem.58.8.528>
- [115]David C. Mohr, Michelle Nicole Burns, Stephen M. Schueller, Gregory Clarke, and Michael Klinkman. 2013. Behavioral Intervention Technologies: Evidence review and recommendations for future research in mental health. *General Hospital Psychiatry* 35, 332–338. DOI:<https://doi.org/10.1016/j.genhosppsych.2013.03.008>
- [116]Wesley G. Moons, Naomi I. Eisenberger, and Shelley E. Taylor. 2010. Anger and fear responses to stress have different biological profiles. *Brain Behav. Immun.* 24, 2 (February 2010), 215–219. DOI:<https://doi.org/10.1016/j.bbi.2009.08.009>
- [117]Elaine Mordoch, Angela Osterreicher, Lorna Guse, Kerstin Roger, and Genevieve Thompson. 2013. Use of social commitment robots in the care of elderly people with dementia: a literature review. *Maturitas* 74, 1 (January 2013), 14–20. DOI:<https://doi.org/10.1016/j.maturitas.2012.10.015>
- [118]Margaret E. Morris, Qusai Kathawala, Todd K. Leen, Ethan E. Gorenstein, Farzin Guilak, Michael Labhard, and William Deleeuw. 2010. Mobile therapy: case study evaluations of a cell phone application for emotional self-awareness. *J. Med. Internet Res.* 12, 2 (April 2010), e10. DOI:<https://doi.org/10.2196/jmir.1371>
- [119]P. Mortier, P. Cuijpers, G. Kiekens, R. P. Auerbach, K. Demyttenaere, J. G. Green, R. C. Kessler, M. K. Nock, and R. Bruffaerts. 2017. The prevalence of suicidal thoughts and behaviours among college students: a meta-analysis. *Psychol. Med.* 48, 04 (2017), 554–565. DOI:<https://doi.org/10.1017/s0033291717002215>
- [120]Philippe Mortier, Koen Demyttenaere, Randy P. Auerbach, Pim Cuijpers, Jennifer G. Green, Glenn Kiekens, Ronald C. Kessler, Matthew K. Nock, Alan M. Zaslavsky, and Ronny Bruffaerts. 2017. First onset of suicidal thoughts and behaviours in college. *J. Affect. Disord.* 207, (January 2017), 291. DOI:<https://doi.org/10.1016/j.jad.2016.09.033>
- [121]V. Muirhead and D. Locker. 2008. Canadian dental students' perceptions of stress and social support. *Eur. J. Dent. Educ.* 12, 3 (August 2008), 144–148. DOI:<https://doi.org/10.1111/j.1600-0579.2008.00512.x>
- [122]Susanne van Mulken, Elisabeth André, and Jochen Müller. 1998. The Persona Effect: How Substantial Is It? *People and Computers XIII*, 53–66. DOI:[https://doi.org/10.1007/978-1-4471-3605-7\\_4](https://doi.org/10.1007/978-1-4471-3605-7_4)
- [123]David Nichols. Coloring for Colorblindness. Retrieved 13 August 2020 from <http://www.davidmathlogic.com/colorblind/>
- [124]Ioannis Nikolaou and Ioannis Tsaousis. 2002. Emotional Intelligence in the Workplace: Exploring its Effects on Occupational Stress and Organizational Commitment. *The International Journal of Organizational Analysis* 10, 327–342. DOI:<https://doi.org/10.1108/eb028956>
- [125]Paulo Novais, Davide Carneiro, Marco Gomes, and José Neves. 2013. The Relationship between Stress and Conflict Handling Style in an ODR Environment. In *Lecture Notes in Computer Science*. 125–140. DOI:[https://doi.org/10.1007/978-3-642-39931-2\\_10](https://doi.org/10.1007/978-3-642-39931-2_10)
- [126]Nicole D. Ottenbreit and Keith S. Dobson. 2004. Avoidance and depression: the construction of the cognitive-behavioral avoidance scale. *Behav. Res. Ther.* 42, 3 (March 2004), 293–313. DOI:[https://doi.org/10.1016/S0005-7967\(03\)00140-2](https://doi.org/10.1016/S0005-7967(03)00140-2)
- [127]Fatih Ozbay, Douglas C. Johnson, Eleni Dimoulas, C. A. Morgan, Dennis Charney, and Steven Southwick.

2007. Social support and resilience to stress: from neurobiology to clinical practice. *Psychiatry* 4, 5 (May 2007), 35–40. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/20806028>
- [128] Ramona Paloş, Laurenţiu P. Maricuţoiu, and Iuliana Costea. 2019. Relations between academic performance, student engagement and student burnout: A cross-lagged analysis of a two-wave study. *Studies in Educational Evaluation* 60, 199–204. DOI:<https://doi.org/10.1016/j.stueduc.2019.01.005>
- [129] A. K. H. Pau, R. Croucher, R. Sohanpal, V. Muirhead, and K. Seymour. 2004. Emotional intelligence and stress coping in dental undergraduates — a qualitative study. *British Dental Journal* 197, 205–209. DOI:<https://doi.org/10.1038/sj.bdj.4811573>
- [130] E. S. Paykel. 1994. Life events, social support and depression. *Acta Psychiatr. Scand. Suppl.* 377, (1994), 50–58. DOI:<https://doi.org/10.1111/j.1600-0447.1994.tb05803.x>
- [131] Matthew D. Pickard, Catherine A. Roster, and Yixing Chen. 2016. Revealing sensitive information in personal interviews: Is self-disclosure easier with humans or avatars and under what conditions? *Computers in Human Behavior* 65, 23–30. DOI:<https://doi.org/10.1016/j.chb.2016.08.004>
- [132] Herman M. van Praag. 2005. Can stress cause depression? *World J. Biol. Psychiatry* 6 Suppl 2, (2005), 5–22. DOI:<https://doi.org/10.1080/15622970510030018>
- [133] Carlos W. Pratt, Kenneth J. Gill, Nora M. Barrett, and Melissa M. Roberts. 2014. Course, Treatment, and Outcome of Severe Mental Illnesses. *Psychiatric Rehabilitation*, 75–102. DOI:<https://doi.org/10.1016/b978-0-12-387002-5.00003-2>
- [134] Alison M. Radcliffe, Mark A. Lumley, Jessica Kendall, Jennifer K. Stevenson, and Joyce Beltran. 2010. Written Emotional Disclosure: Testing Whether Social Disclosure Matters. *J. Soc. Clin. Psychol.* 26, 3 (May 2010), 362–384. DOI:<https://doi.org/10.1521/jscp.2007.26.3.362>
- [135] Mohammed Mostafizur Rahman, Charlotte K. Callaghan, Christian M. Kerskens, Sumantra Chattarji, and Shane M. O'Mara. 2016. Early hippocampal volume loss as a marker of eventual memory deficits caused by repeated stress. *Sci. Rep.* 6, (July 2016), 29127. DOI:<https://doi.org/10.1038/srep29127>
- [136] Akbar Rezaei and Elnaz Mousanezhad Jeddi. 2018. Relationship between wisdom, perceived control of internal states, perceived stress, social intelligence, information processing styles and life satisfaction among college students. *Curr. Psychol.* (February 2018), 1–7. DOI:<https://doi.org/10.1007/s12144-018-9804-z>
- [137] Ryan E. Rhodes and Gert-Jan de Bruijn. 2013. What predicts intention-behavior discordance? A review of the action control framework. *Exerc. Sport Sci. Rev.* 41, 4 (October 2013), 201–207. DOI:<https://doi.org/10.1097/JES.0b013e3182a4e6ed>
- [138] Rachel A. Ross, Simmie L. Foster, and Dawn F. Ionescu. 2017. The Role of Chronic Stress in Anxious Depression. *Chronic Stress* 1, (2017), 247054701668947. DOI:<https://doi.org/10.1177/2470547016689472>
- [139] Kapil Sayal, Stuart Checkley, Melinda Rees, Catherine Jacobs, Tirril Harris, Andrew Papadopoulos, and Lucia Poon. 2002. Effects of social support during weekend leave on cortisol and depression ratings: a pilot study. *J. Affect. Disord.* 71, 1-3 (September 2002), 153–157. DOI:[https://doi.org/10.1016/s0165-0327\(01\)00414-1](https://doi.org/10.1016/s0165-0327(01)00414-1)
- [140] Ibrahim Senay, Mustafa Cetinkaya, and Muhammet Usak. 2012. Accepting test-anxiety-related thoughts increases academic performance among undergraduate students. *Psibologija* 45, 4 (2012), 417–432. DOI:<https://doi.org/10.2298/psi1204417s>
- [141] Zulfiqar Ali Shah. 2012. *Book-in-Brief: Anthropomorphic Depictions of God: The Concept of God in Judaic, Christian, and Islamic Traditions: Representing the Unrepresentable*. International Institute of Islamic Thought (IIIT). Retrieved from <https://play.google.com/store/books/details?id=164ZDAAAQBAJ>
- [142] Nancy Shields. 2001. Stress, Active Coping, and Academic Performance Among Persisting and Nonpersisting College Students. *Journal of Applied Biobehavioral Research* 6, 65–81. DOI:<https://doi.org/10.1111/j.1751-9861.2001.tb00107.x>
- [143] C. J. P. Simons, J. A. Hartmann, I. Kramer, C. Menne-Lothmann, P. Höhn, A. L. van Bommel, I. Myin-Germeys, P. Delespaul, J. van Os, and M. Wichers. 2015. Effects of momentary self-monitoring on empowerment in a randomized controlled trial in patients with depression. *European Psychiatry* 30, 900–906. DOI:<https://doi.org/10.1016/j.eurpsy.2015.09.004>
- [144] Michael A. Smith, Alexandra Thompson, Lynsey J. Hall, Sarah F. Allen, and Mark A. Wetherell. 2018. The physical and psychological health benefits of positive emotional writing: Investigating the moderating role of Type D (distressed) personality. *Br. J. Health Psychol.* 23, 4 (November 2018), 857–871. DOI:<https://doi.org/10.1111/bjhp.12320>

- [145]Nudrat Sohail. 2013. Stress and academic performance among medical students. *J. Coll. Physicians Surg. Pak.* 23, 1 (January 2013), 67–71. DOI:<https://doi.org/01.2013/JCPSP.6771>
- [146]Sonja T. P. Spoor, Marrie H. J. Bekker, Tatjana Van Strien, and Guus L. van Heck. 2007. Relations between negative affect, coping, and emotional eating. *Appetite* 48, 3 (May 2007), 368–376. DOI:<https://doi.org/10.1016/j.appet.2006.10.005>
- [147]Stamen Design. The Ekman's Atlas of Emotion. *The Ekman's Atlas of Emotions*. Retrieved 30 July 2020 from <http://atlasofemotions.org/>
- [148]S. M. Stewart, T. H. Lam, C. L. Betson, C. M. Wong, and A. M. Wong. 1999. A prospective analysis of stress and academic performance in the first two years of medical school. *Med. Educ.* 33, 4 (April 1999), 243–250. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/10336754>
- [149]Clara Strauss, Jenny Gu, Nikki Pitman, Cavita Chapman, Willem Kuyken, and Adrian Whittington. 2018. Evaluation of mindfulness-based cognitive therapy for life and a cognitive behavioural therapy stress-management workshop to improve healthcare staff stress: study protocol for two randomised controlled trials. *Trials* 19. DOI:<https://doi.org/10.1186/s13063-018-2547-1>
- [150]Steve Sussman and Jeffrey Jensen Arnett. 2014. Emerging Adulthood: Developmental Period Facilitative of the Addictions. *Eval. Health Prof.* 37, 2 (June 2014), 147–155. DOI:<https://doi.org/10.1177/0163278714521812>
- [151]Steve Sussman and Jeffrey Jensen Arnett. 2014. Emerging Adulthood: Developmental Period Facilitative of the Addictions. *Eval. Health Prof.* 37, 2 (June 2014), 147–155. DOI:<https://doi.org/10.1177/0163278714521812>
- [152]Shawn Talbott. 2004. *The Cortisol Connection Diet: The Breakthrough Program to Control Stress and Lose Weight*. Hunter House. Retrieved from [https://books.google.com/books/about/The\\_Cortisol\\_Connection\\_Diet.html?hl=&id=tKsZA1bm8YkC](https://books.google.com/books/about/The_Cortisol_Connection_Diet.html?hl=&id=tKsZA1bm8YkC)
- [153]Marie Pierre Tavoracci, Joel Ladner, Sebastien Grigioni, Laure Richard, Herve Villet, and Pierre Dechelotte. 2013. Prevalence and association of perceived stress, substance use and behavioral addictions: a cross-sectional study among university students in France, 2009–2011. *BMC Public Health* 13, (August 2013), 724. DOI:<https://doi.org/10.1186/1471-2458-13-724>
- [154]Miranda A. L. van Tilburg. Stress Effects on the Body: Gastrointestinal System. *American Psychological Association*. Retrieved 8 February 2019 from <https://www.apa.org/helpcenter/stress/effects-gastrointestinal>
- [155]Linda A. Travis, Jeffrey M. Lyness, Cleveland G. Shields, Deborah A. King, and Christopher Cox. 2004. Social Support, Depression, and Functional Disability in Older Adult Primary-Care Patients. *The American Journal of Geriatric Psychiatry* 12, 265–271. DOI:<https://doi.org/10.1097/00019442-200405000-00005>
- [156]Allison S. Troy, Amanda J. Shallcross, Anna Brunner, Rachel Friedman, and Markera C. Jones. 2018. Cognitive reappraisal and acceptance: Effects on emotion, physiology, and perceived cognitive costs. *Emotion* 18, 1 (February 2018), 58–74. DOI:<https://doi.org/10.1037/emo0000371>
- [157]Bert N. Uchino. 2004. *Social Support and Physical Health: Understanding the Health Consequences of Relationships*. Yale University Press. Retrieved from [https://books.google.com/books/about/Social\\_Support\\_and\\_Physical\\_Health.html?hl=&id=VxUgC6S255wC](https://books.google.com/books/about/Social_Support_and_Physical_Health.html?hl=&id=VxUgC6S255wC)
- [158]UHasselt. Studentenpsychologen. Retrieved 26 July 2020 from <https://www.uhasselt.be/studentenpsychologen>
- [159]Simone J. W. Verhagen, Laila Hasmi, Marjan Drukker, J. van Os, and Philippe A. E. G. Delespaul. 2016. Use of the experience sampling method in the context of clinical trials. *Evid. Based. Ment. Health* 19, 3 (August 2016), 86–89. DOI:<https://doi.org/10.1136/ebmental-2016-102418>
- [160]Samuel J. Vine, Lee J. Moore, and Mark R. Wilson. 2016. An Integrative Framework of Stress, Attention, and Visuomotor Performance. *Front. Psychol.* 7, (November 2016), 1671. DOI:<https://doi.org/10.3389/fpsyg.2016.01671>
- [161]David L. Vogel, Stephen R. Wester, and Lisa M. Larson. 2007. Avoidance of Counseling: Psychological Factors That Inhibit Seeking Help. *Journal of Counseling & Development* 85, 4 (2007), 410–422. DOI:<https://doi.org/10.1002/j.1556-6678.2007.tb00609.x>
- [162]K. Wada, T. Shibata, T. Saito, K. Sakamoto, and K. Tanie. 2005. Psychological and Social Effects of One Year Robot Assisted Activity on Elderly People at a Health Service Facility for the Aged. *Proceedings of the 2005 IEEE International Conference on Robotics and Automation*.



- DOI:<https://doi.org/10.1109/robot.2005.1570535>
- [163] K. Wada, K. Wada, and T. Shibata. 2007. Living With Seal Robots—Its Sociopsychological and Physiological Influences on the Elderly at a Care House. *IEEE Transactions on Robotics* 23, 972–980. DOI:<https://doi.org/10.1109/tro.2007.906261>
- [164] Fushun Wang and Alfredo Pereira. 2016. Neuromodulation, Emotional Feelings and Affective Disorders. *Mens Sana Monogr.* 14, 1 (January 2016), 5–29. DOI:<https://doi.org/10.4103/0973-1229.154533>
- [165] Emma Ward-Griffin, Patrick Klaiber, Hanne K. Collins, Rhea L. Owens, Stanley Coren, and Frances S. Chen. 2018. Petting away pre-exam stress: The effect of therapy dog sessions on student well-being. *Stress Health* 34, 3 (August 2018), 468–473. DOI:<https://doi.org/10.1002/smi.2804>
- [166] Monica S. Webb, Denise Rodríguez de Ybarra, Elizabeth A. Baker, Isildinha M. Reis, and Michael P. Carey. 2010. Cognitive-behavioral therapy to promote smoking cessation among African American smokers: a randomized clinical trial. *J. Consult. Clin. Psychol.* 78, 1 (February 2010), 24–33. DOI:<https://doi.org/10.1037/a0017669>
- [167] Thomas Ashby Wills. 1991. Social support and interpersonal relationships. In *Prosocial behavior*. Sage Publications, Inc, 265–289.
- [168] Joanna F. Wing, Nicola S. Schutte, and Brian Byrne. 2006. The effect of positive writing on emotional intelligence and life satisfaction. *J. Clin. Psychol.* 62, 10 (October 2006), 1291–1302. DOI:<https://doi.org/10.1002/jclp.20292>
- [169] Johnny Chun Yiu Wong, Jun Wang, Eugene Yujun Fu, Hong Va Leong, and Grace Ngai. 2019. Activity Recognition and Stress Detection via Wristband. *Proceedings of the 17th International Conference on Advances in Mobile Computing & Multimedia*. DOI:<https://doi.org/10.1145/3365921.3365950>
- [170] World Health Organization. 1998. *Whoqol User Manual: Programme on Mental Health*. Retrieved from [https://books.google.com/books/about/Whoqol\\_User\\_Manual.html?hl=&id=3HMJtwAACAAJ](https://books.google.com/books/about/Whoqol_User_Manual.html?hl=&id=3HMJtwAACAAJ)
- [171] David Scott Yeager and Carol S. Dweck. 2012. Mindsets That Promote Resilience: When Students Believe That Personal Characteristics Can Be Developed. *Educational Psychologist* 47, 302–314. DOI:<https://doi.org/10.1080/00461520.2012.722805>
- [172] 2017. Therapy: Counseling for Mental Health and Illness. *Journal of Midwifery & Women's Health* 62, 781–782. DOI:<https://doi.org/10.1111/jmwh.12683>
- [173] 2017. Therapy: Counseling for Mental Health and Illness. *Journal of Midwifery & Women's Health* 62, 781–782. DOI:<https://doi.org/10.1111/jmwh.12683>
- [174] 2017. Cognitive Behavioral Therapy (CBT). *American Psychological Association*. Retrieved 2 June 2020 from <https://www.apa.org/ptsd-guideline/treatments/cognitive-behavioral-therapy>
- [175] What is Cardiovascular Disease? *American Heart Association*. Retrieved 18 August 2018 from [http://www.heart.org/HEARTORG/Support/What-is-Cardiovascular-Disease\\_UCM\\_301852\\_Article.jsp](http://www.heart.org/HEARTORG/Support/What-is-Cardiovascular-Disease_UCM_301852_Article.jsp)
- [176] The top 10 causes of death. Retrieved 17 February 2019 from <https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death>
- [177] Studentenpsychologen. *UHasselt*. Retrieved 20 September 2019 from <https://www.uhasselt.be/studentenpsychologen>
- [178] Studentenpsychologen. *Universiteit Gent*. Retrieved 20 September 2019 from <https://www.ugent.be/student/nl/studeren/studiebegeleiding/studentenpsychologen>
- [179] Psychologen en Psychiaters. Retrieved 20 September 2019 from <https://www.kuleuven.be/studentenvoorzieningen/gezondheid/psy/index>
- [180] The Future of Therapy: A Unified Treatment Approach. *Psychology Today*. Retrieved 9 June 2020 from <http://www.psychologytoday.com/blog/insight-therapy/201101/the-future-therapy-unified-treatment-approach>
- [181] Sterfte per leeftijd (2016). *Agentschap Zorg & Gezondheid*. Retrieved 29 December 2018 from <https://www.zorg-en-gezondheid.be/zelfdoding-per-leeftijdsgroep-2016>
- [182] Stress Effects on the Body. *American Psychological Association*. Retrieved 8 February 2019 from <https://www.apa.org/helpcenter/stress-body>
- [183] Studentenpsychologen. *UHasselt*. Retrieved 20 September 2019 from <https://www.uhasselt.be/studentenpsychologen>
- [184] Studentenpsychologen. *Universiteit Gent*. Retrieved 20 September 2019 from <https://www.ugent.be/student/nl/studeren/studiebegeleiding/studentenpsychologen>

- [185]Psychologen en Psychiaters. Retrieved 20 September 2019 from <https://www.kuleuven.be/studentenvoorzieningen/gezondheid/psy/index>
- [186]What is Cognitive Behavior Therapy | Beck Institute. *Beck Institute for Cognitive Behavior Therapy*. Retrieved 2 June 2020 from <https://beckinstitute.org/get-informed/what-is-cognitive-therapy/>
- [187]Cognitive Distortions Affecting Stress. Retrieved 10 June 2020 from <https://www.mentalhelp.net/cognitive-disorders/stress/>
- [188]Emotional Acceptance | Counseling and Wellness | Wright State University. Retrieved 10 June 2020 from <https://www.wright.edu/student-affairs/health-and-wellness/counseling-and-wellness/workshops-and-self-help/emotional-acceptance#:~:text=Emotional%20Acceptance%20refers%20to%20our,living%20in%20a%20mindful%20way.>
- [189]Overview of the DASS and its uses. Retrieved 1 April 2020 from <http://www2.psy.unsw.edu.au/dass/over.htm>
- [190]emotion. *APA Dictionary of Psychology*. Retrieved 11 May 2020 from <https://dictionary.apa.org/emotion>
- [191]PARO Therapeutic Robot. Retrieved 9 March 2019 from <http://www.parorobots.com>
- [192]GAD-7 (General Anxiety Disorder-7). Retrieved 20 August 2020 from <https://www.mdcalc.com/gad-7-general-anxiety-disorder-7>



# Appendices

## Appendix A

Dutch translation of DASS21 by Dr. Edwin de Beurs.

Website: <http://www2.psy.unsw.edu.au/dass/Dutch/Dutch.htm>

1. Ik vond het moeilijk tot rust te komen nadat iets me overstuur had gemaakt
2. Ik transpireerde merkbaar (bijv. zweethanden) terwijl het niet warm was en ik me niet inspande
3. Ik was niet in staat om enig plezier te hebben bij wat ik deed
4. Ik had moeite met ademen (bijv. overmatig snel ademen, buiten adem zijn zonder me in te spannen)
5. Ik vond het moeilijk om het initiatief te nemen om iets te gaan doen
6. Ik had de neiging om overdreven te reageren op situaties
7. Ik merkte dat ik beefde (bijv. met de handen)
8. Ik was erg opgefokt
9. Ik maakte me zorgen over situaties waarin ik in paniek zou raken en mezelf belachelijk zou maken
10. Ik had het gevoel dat ik niets had om naar uit te kijken
11. Ik merkte dat ik erg onrustig was
12. Ik vond het moeilijk me te ontspannen
13. Ik voelde me somber en zwaarmoedig
14. Ik had volstrekt geen geduld met dingen die me hinderden bij iets dat ik wilde doen
15. Ik had het gevoel dat ik bijna in paniek raakte
16. Ik was niet in staat om over ook maar iets enthousiast te worden
17. Ik had het gevoel dat ik als persoon niet veel voorstel
18. Ik merkte dat ik nogal licht geraakt was
19. Ik was me bewust van mijn hartslag terwijl ik me niet fysiek inspande (bijv. het gevoel van een versnelde hartslag of het overslaan van het hart)
20. Ik was angstig zonder enige reden
21. Ik had het gevoel dat mijn leven geen zin had



## Appendix B

Prepared questions for the semi-structured interview with UHasselt's student psychologists

### Detection

1. What are the most important signs of stress overload?
2. How do you start analyzing the student who is coming for some counseling?
3. What is the intake interview<sup>6</sup> like?
4. Can I have a copy of the intake form(s)?
5. What kind of information do you want to gather from the intake interview and form(s)?
6. How is stress measured on a scale?  
Example: no stress, average stress levels, high stress levels? (qualitative)  
If not like in the example: how should the stress level be "measured" or perceived?
7. Do students with a higher stress level get a different treatment than students with a lower stress level? If yes: what are the differences?
8. Do the students themselves come to you with the problem? (Do they already know they have a high level of stress?)
9. Which types of people are more sensitive to a high level of stress?
10. Should the personality be taken in account, too? (if question 10 is answered && notnull)
  
11. Can you give me the most recurrent or important situations when students of UHasselt come to you for stress (or the anxiety they get as a result)?

### Managing

12. What's your advice or procedure if you detect there's a problem with the stress management of the student?
13. Sometimes stress can come from an overload of projects or other external factors like high expectations or competition. What do you advice students to handle their stress with those factors?
14. Why is it good advice? (on questions 12 & 13)
15. Do the pieces of advice differ from the advice for the general population?
16. Are there any disadvantages about that kind of advice or procedure?
17. Could stress sometimes be managed in groups? If yes, how?
  
18. Are there any workshops planned at school that would be interesting for me for this thesis?
19. How do statistics have a role in stress detection or management (if any)?
  
20. What do you think of the existing examples?
20. What would you like to see in a stress management application?

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<sup>6</sup> Purpose intake interview: establishing and diagnosing the potential problems of the client ( Kramer, Geoffrey P., Douglas A. Bernstein, and Vicky Phares. Introduction to Clinical Psychology. 7th edition. Upper Saddle River, NJ: Pearson Prentice Hall, 2009. 117-118.)



# Appendix C

Prepared questions for the semi-structured interview with one of UHasselt's student coaches

## Basic background

1. Can you give me an overview of the main tasks of your job?
2. How are students getting to a point of making an appointment/coming to you?
3. At what time of the year do you meet the biggest amount of students?

## Meeting with the student counselor

4. What are the most important subjects that you're guiding students with?
5. Why or what are the main causes?
6. What are general study guidelines that you can give every student?

## Stress

7. How do you detect what the actual problem is? (like stress)
8. How do you handle those students? (having too much stress)
9. When do you refer students to a student psychologist?
10. It's possible that there are a lot of deadlines or a lot of projects at one time. How do you handle that kind of problem?
11. Are there students feeling pressured? (parents, competition, money...)
  - a. By what?
12. Which types of people are the most likely to meet with you?
13. What do you handle advice with substance abuse?
14. Do you refer people to applications/do you use applications?
15. What would you like to see in an app for stress management?





## Appendix D

Prepared questions for the semi-structured interview with professors of law (UHasselt)

1. Hoe zou u stress omschrijven?
2. Wanneer vormt stress een probleem?
3. Wat was uw motivatie om het projectvoorstel in te dienen?
  - a. Stress bij studenten opgemerkt
  - b. Studenten kwamen het zelf aangeven
  - c. Artikel in het nieuws
  - d. Eigen ervaring
  - e. Anders
4. Waarom denkt u dat studenten een te hoog stresslevel hebben?
  - a. Factoren?
  - b. Verkeerde aanpak?
5. In welke situaties merkt u dat er een hoog stresslevel is bij één of meerdere studenten?
  - a. Bepaalde opleidingsonderdelen
  - b. Bepaalde situaties als examens, presentaties, taken, groepswerk...
    - i. Wat is een typische (groeps)opdracht voor een rechtenstudent?
6. Hoe gaat u om met studenten waarbij u merkt dat ze een probleem hebben met stress?
7. Zijn er bepaalde type studenten waarbij u meer stressproblemen ziet dan bij anderen?
8. Hoe zou het probleem opgelost kunnen worden (met of zonder applicatie)?
9. Wat zou u willen zien in de applicatie?



## Appendix E

Prepared questions for the semi-structured interview with two teaching staff members of computer science (UHasselt)

### Algemene vragen

1. Hoe zou u stress omschrijven?
2. Wanneer vormt stress een probleem?
3. Denkt u dat studenten vaak stress hebben?
4. Waarom denkt u dat studenten een te hoog stresslevel hebben?
  - a. Factoren?
  - b. Verkeerde aanpak?
5. In welke situaties merkt u dat er een hoog stresslevel is bij één of meerdere studenten?
  - a. Bepaalde opleidingsonderdelen
  - b. Bepaalde situaties als examens, presentaties, taken, groepswerk...
6. Hoe gaat u om met studenten waarbij u merkt dat ze een probleem hebben met stress?
7. Zijn er bepaalde type studenten waarbij u meer stressproblemen ziet dan bij anderen?
8. Hoe zou het probleem opgelost kunnen worden (met of zonder applicatie)?



## Appendix F

Survey about stress, stressors, coping and smartphone usage. The survey has been approved by the social ethical committee (UHasselt).

Legende:

- Één antwoord mogelijk
- Meerdere antwoorden mogelijk
- ★ Een waarde van 1 - 5

De vragenlijst wordt online ter beschikking gesteld.

### 1. Achtergrond

- Leeftijd
- Studiejahr (professionele bachelor eerste jaar, master tweede jaar)
- Studierichting (informatica, rechten, architectuur...)
- Geslacht
  - M
  - V
  - X
- Statuut
  - Full time student (meer dan of gelijk aan 30 SP)
  - Part time student (minder dan 30 SP)
  - Andere (met invulveld)
- Heb je een (studenten)job?
  - Nee
  - Ja, gelijk aan of meer dan 72 uur per maand doorheen het schooljaar
  - Ja, minder dan 72 uur per maand doorheen het schooljaar
- Dit is mijn eerste jaar in het hoger onderwijs:
  - Ja
  - Nee

### 2. Welke type toepassingen (mobiele app of website) gebruik je op je smarttoestel? (meerdere antwoorden mogelijk)

- Games
  - Puzzel (Candy Crush, Mahjong...)
  - Strategie (Clash Royale, Radiant Defense...)
  - Games die beweging vereisen (Pokémon GO, Zombies, Run!...)
  - Simulatie (Plague Inc., Animal Crossing Pocket Camp...)
  - RPG/rollenspel (Might & Magic, Final Fantasy...)
  - Management (Farmville...)
  - Actie/Platform (Super Mario Run, Temple Run...)
  - Educatief (Brain-traininggames, taalleergames..)
- Sociale media (Facebook, Twitter...)
- Messaging (Messenger, WhatsApp, Discord...)
- Stressmanagement (Headspace, fitinjehoofd...)

- Sport of beweging (Google Fit, Couch to 5K - C25K, ...)
- Taken of productiviteit (Te-doenlijsten, Evernote...)
- Visuele media (eBooks lezen, YouTube...)
- Auditieve media (muziek, podcasts, audioboeken...)
- eCommerce (Bol.com, Domino's Pizza App...)
- School of werk (e-mail, Google Docs...)
- Gezondheid en voeding (MyFitnessPal, Sleep as Android...)
- Andere (met invulveld)

3. Hoe beoordeel je jezelf op onderstaande vlakken?

(1-5: 1 = geen ik geen aandacht aan, 5 = geef ik veel aandacht aan)

- ★ Sociaal leven (met vrienden afspreken, praten...)
- ★ Gebalanceerd eten (ongezonde voeding beperken, de nodige voedingsstoffen innemen...)
- ★ Ontspanning (muziek beluisteren, spellen spelen,...)
- ★ Beweging (sport, wandelen...)
- ★ Goede nachtrust (lang genoeg slapen, ongestoord slapen...)

4. Hoe zou je stress omschrijven?

Open vraag (invulveld)

5. Ik voel me gestrest tijdens...

(waarde van 1 tot 5: 1 = nooit, 3 = soms, 5 = altijd)

- ★ schriftelijke examens
- ★ mondelinge examens
- ★ studieperiode voor de examens ("blokperiode")
- ★ Het studeren buiten de blokperiode
- ★ projecten die individueel gemaakt moeten worden
- ★ groepsprojecten of -taken
- ★ mondelinge presentaties
- ★ werksittingen of interactieve responsiecolleges
- ★ de rit naar school
- ★ Andere (met invulveld)

6. Hoe vaak vind je jezelf terug in onderstaande situaties?

(oordeel van 1-5: 1 = nooit, 3 = maandelijks, 5 = dagelijks)

- ★ Uitstellen van leren of maken van taken
- ★ Praktische zaken uitstellen zoals handboeken kopen, onderwijsteam e-mailen...
- ★ Geen of weinig tijd aan ontspanning besteden als er meer werk te doen is
- ★ Geen of weinig tijd aan sociaal contact besteden als er meer werk is
- ★ Slaap opofferen om de leerstof te verwerken/project af te maken
- ★ Niet bijwonen van niet-verplichte relevante lessen
- ★ Niet bijwonen van verplichte lessen, presentaties of examens (zonder wettige reden)

7. Ik voel me gestrest door...

(oordeel van 1 tot 5 1 = nooit - 3 = maandelijks - 5 = dagelijks)

- ★ de nieuwe (school)omgeving
- ★ financiële redenen (schulden, laag inkomen...)

- ★ mijn woonsituatie (te kleine ruimte om in te leven, huishouden...)
- ★ familiale redenen of thuissituatie (ondergewaardeerd, geen goede relatie met ouders...)
- ★ verwachtingen van anderen (bijv.: van familie, vrienden...)
- ★ mijn kijk op de toekomst van de studie (twijfel juiste richting, jobzekerheid...)
- ★ mijn gedachten (onzekerheid, denken dat ik niet goed genoeg ben...)
- ★ verwachtingen van mezelf (bijv.: steeds hoge punten halen, perfectionisme...)
- ★ mijn beperkte zelfzorg (te weinig slaap, ongezonder eten...)
- ★ mijn lichamelijke gezondheidstoestand
- ★ mijn psychische gezondheidstoestand
- ★ mijn angsten (sociale angst, pleinvrees...)
- ★ chaos in mijn leven (te druk leven, alles loopt mis...)
- ★ weinig tijd te hebben (combinatie school-privé moeilijk, geen tijd meer voor hobby's...)
- ★ mijn studies (te veel studeren, te moeilijk, te veel deadlines...)
- ★ competitie met medestudenten
- ★ (mede)studenten op sociaal vlak (pesten, conflicten, je kan ze niet hebben...)
- ★ leden van het onderwijsteam (conflicten, ondergewaardeerd, je kan ze niet hebben...)
- ★ sociaal leven (eenzaamheid, populariteit, conflicten, relatieproblemen...)
- ★ de digitale wereld (altijd je smartphone op zak willen hebben, sociale media, e-mails checken...)
- ★ andere reden (met invulveld)

8. Ik ga om met stress door...

(1-5: 1 = Doe ik niet/geen behoefte aan, 5 = doe ik altijd)

- ★ ademhalingsoefeningen, meditatie of mindfulness te doen
- ★ te sporten of te bewegen (zoals door te voetballen, fitnessen...)
- ★ niet-fysieke hobby's te doen (bijv. tv-series kijken)
- ★ applicaties of websites te raadplegen (bijv. zelfhulpprogramma's, fitinjehoord.be...)
- ★ sociaal contact op te nemen met een vriend of familielid
- ★ bezig te zijn met (huis)dieren
- ★ te negeren en te blijven doordoen met de taak
- ★ te stoppen met de taak/activiteit waar de stress vandaan komt
- ★ alcohol of recreatieve drugs te gebruiken
- ★ Andere (met invulveld)

9. Heb je ooit een psychotherapeut, psycholoog of een andere gelijkaardige professionele hulpverlener geraadpleegd?

(één antwoord mogelijk)

- Ja, en ik heb nog één of meerdere afspraken in de toekomst (ga naar vraag 10 en sla vraag 11 over)
- Ja, maar ik ga niet meer (ga naar vraag 11b)



- Nee, maar ik volg een (online) zelfhulpprogramma ter vervanging van therapie (iCare Prevent, mijnkwartier.be...) (ga naar vraag 11c)
- Nee en ik volg ook geen (online) zelfhulpprogramma ter vervanging van therapie (ga naar vraag 11a)
- Ik beantwoord deze vraag liever niet. (ga naar vraag 12)

10. Indien ja, waarom?

(meerdere antwoorden mogelijk)

- Ik vind dat het echt helpt.
- Ik heb of had steun of hulp nodig.
- Ik ben mezelf kwijtgeraakt.
- Ik word gepusht of gedwongen door mijn naaste omgeving (vrienden, familie...).
- Een vriend of familielid heeft het me aangeraden.
- Ik werd doorverwezen door iemand buiten mijn naaste omgeving (studiebegeleider, onderwijsteam, maatschappelijk assistent, OCMW-medewerker...).
- Ik beantwoord deze vraag liever niet.
- Andere reden (met invulveld)

11a. Waarom ben je nooit gegaan?

11b. Waarom ga je niet meer? 11c. Waarom ben je nooit gegaan? (volg online hulpprogramma)

(meerdere antwoorden mogelijk)

- De therapie is beëindigd (alleen een optie bij 5b).
- Ik heb daar geen behoefte aan.
- Ik durf niet.
- Ik weet het niet.
- Het kost te veel.
- Ik heb geen tijd.
- Het helpt niet.
- Het heeft geen zin.
- Ik wil niemand lastig vallen.
- Ik neem medicatie die het probleem al behandelt.
- Ik probeer zelf mijn stress te managen met technieken (bijv.: apps, meditatie, mindfulness...).
- Ik los problemen liever helemaal zelf op.
- Ik volg een (online) zelfhulpprogramma ter vervanging van “echte” therapie (iCare Prevent, mijnkwartier.be...) (enkel 5c).
- Ik ben bang dat anderen het te weten komen.
- Ik praat liever met vrienden of familie over problemen.
- Ik praat niet met een vreemde over mijn problemen.
- Ik beantwoord deze vraag liever niet.
- Andere (met invulveld)

12. Verdere opmerkingen  
(tekstveld) (niet verplicht om in te vullen)



## Appendix G

Draft of the test protocol, which was supposed to be sent to the ethical committee for request for approval. We decided to not go through with user testing due to COVID-19. Remark: the attachments (“Bijlage”) mentioned in this draft are not included in this text.

### Doelstellingen

In dit project willen we de haalbaarheid onderzoeken voor de ontwikkeling van een mobiele applicatie voor universiteitsstudenten die hen ondersteunt in het managen van hun stress. Daarvoor zouden we testen willen uitvoeren in twee fases: een usabilitytest en een fieldtest.

## Fase 1: Usabilitytest

Het prototype wordt eerst getest in een labomgeving. Met deze test willen we nagaan of de applicatie makkelijk te gebruiken is en begrijpbaar is. Daarnaast gebruiken we deze test om de standpunten te peilen tegenover het concept en het gebruik van de applicatie.

### Onderzoeksvragen waar we een antwoord op zoeken tijdens deze fase:

- Welk teksten zijn begrijpbaar voor de testgebruiker?
- Welke elementen in het prototype zijn niet gebruiksvriendelijk?
- Wat zijn de standpunten van de gebruikers rond de verschillende onderdelen van het prototype?
  - Creatie van avatar
  - Antropomorfe eigenschappen
  - Game-elementen
  - Oefening in CBT-achtige toestand
  - Emotiediaryng
  - Notificaties die afhangen van de ingegeven data en/of locatie en tijd
  - Integratie van agenda
- Wat zijn de standpunten van de gebruikers in verband met het gebruik van de applicatie voor stressmanagement?
- Bied de visualisaties de gebruiker een begrijpbaar overzicht over zijn eigen emoties en stress?

## Methodologie

### Populatie

De doelgebruikers zijn studenten in het hoger onderwijs. Voor deze fase vragen we (doctoraats)studenten (onafhankelijk van eventuele omgang met stress) om deel te nemen aan deze test.

## **Locatie**

De usabilitytesten worden gehouden in één van de lokalen op het Expertise centre for Digital Media (EDM) (Wetenschapspark 2 - 3590 Diepenbeek).

## **Tijdljn**

Deze fase neemt plaats midden/einde van maart. De exacte data hangen af van beschikbaarheden van de testgebruikers, datum van goedkeuring voor de studie en beschikbaarheden en de beschikbaarheid van de lokalen in het EDM.

Er wordt 60 minuten voorzien voor elke sessie. Een sessie zou gebeuren in één deel zonder pauzes:

10 minuten: onthaal (inclusief tekenen van een informed consent).

30 minuten: aan de gebruiker wordt gevraagd om een aantal taken uit te voeren in het prototype

7 minuten: Invullen van de vragenlijst *System Usability Scale* (SUS) en zelf (zie Bijlage 5)

3 minuten: Debriefing

De overige 10 minuten worden beschouwd als een marge in geval van onvoorziene omstandigheden (bv. gebruiker heeft meer tijd nodig tijdens een van de onderdelen, debriefing loopt uit...).

Elke sessie wordt steeds voorafgegaan door een voorbereiding van 20 minuten waarbij de testgebruiker niet aanwezig is. Deze tijd wordt gebruikt om de testomgeving klaar te zetten.

## **Mogelijke risico's**

In dit onderdeel van het project zijn er geen mogelijke of gekende risico's voor de testgebruikers.

## **Vragenlijsten**

Nadat we met de testgebruiker alle taken hebben overlopen, vragen we hem om nog een zelfvertaalde versie van de System Usability Scale (SUS) om de gebruiksvriendelijkheid om een kwantitatieve manier te analyseren [11]. De resultaten worden in zijn geheel en zonder persoonlijke data verwerkt in de thesistekst.

Daarna houden we een semi-gestructureerd interview over zijn standpunt over en zijn ervaring met de inhoud en het concept van het prototype. De vragen zijn terug te vinden in Bijlage 5.

## Stappenplan

### Voor de test

- Onthaal
  - Er wordt uitleg gegeven aan de gebruiker in verband met de test zelf (zoals het onderwerp, doelgebruiker en hoe de test zal verlopen, toestel waarop het prototype zal getest worden....)
  - Aan de testgebruiker wordt gevraagd om een consent form te tekenen.

### Tijdens de test

Tijdens de test wordt aan de gebruiker om een aantal taken te voltooien in de applicatie. De taken zijn:

1. Je mag starten met het gebruik van de applicatie
2. Link de kalenderdata en duid de periodes aan wanneer je les hebt.
3. Stel campus Diepenbeek in als de universiteitslocatie.
4. Maak de gegeven avatar na.
5. Je mag verdergaan met het gebruik van de applicatie
6. De applicatie gaat je nu drie vragen stellen. Per vraag heb ik een beschrijving van een situatie. Probeer de optie aan te duiden die het er meest bij past.
  - a. Het is de afgelopen week één keer voorgekomen.
  - b. Het is de afgelopen week niet voorgekomen.
  - c. De laatste dagen is dit constant voorgekomen.
7. Kun je me vertellen wat de resultaten zijn van de test?
8. Je voelt je niet zo goed en zou dit willen melden aan de applicatie.
  - a. Je voelt je verdrietig dat je nog veel moet doen een vak.
  - b. Vandaag had je ook file en daar werd je enorm kwaad door.
9. Je wilt de oefening nu doen. De andere optie (wandelen) wil je inplannen na een lesdag.
10. Maak de oefening
11. Je hebt een wandeling gemaakt, maar je hebt er je twijfels bij.
12. Je hebt werken aan het project voor een uitgesteld. Je voel je je heel slecht en zou een oefening willen maken.
13. Maak de oefening aan de hand van de gegeven antwoorden (de antwoorden voor deze oefening kunnen als persoonlijk gezien worden, we voorzien daarom zelf de antwoorden)

### Post-test

- We vragen de gebruiker om een vragenlijsten in te vullen (SUS-test) zodra we alle taken overlopen hebben.
- Na het invullen van de vragenlijst wordt er een semigestructureerd interview gehouden in verband met de standpunt van de gebruiker tegenover de elementen in het prototype.

## Verzamelen en opslaan van data

Indien de gebruiker akkoord gaat, worden er een beeld- en een geluidsopname gemaakt bij de usabilitytest. De resulterende mediabestanden (of delen ervan) zijn enkel beschikbaar voor de promotor, begeleiders en de student van de masterthesis. Terwijl de gebruiker de taken uitvoert, zal een observator notities maken over zijn observaties, die enkel gebruikt worden voor deze thesis. Daarnaast worden bestanden of notities niet gelinkt met persoonlijke gegevens. Informatie en resultaten worden zonder persoonlijke gegevens in de thesistekst verwerkt. Ook de ingevulde vragenlijsten en bestanden met de vastlegging van het interview (video, notities...) zullen niet verspreid worden en worden anoniem verwerkt in de tekst.

Er is een Team Drive voorzien op een *Shared drive* op Google Drive, waarbij de aanwezige bestanden eigendom zijn van Universiteit Hasselt. Op deze plaats zullen de opgenomen digitale bestanden tijdens deze fase worden bewaard.

## Hypotheses

1. De gebruiker begrijpt de teksten in de applicatie.
  - a. De gebruiker snapt wat de resultaten van de DASS-test betekenen zonder externe hulp.
  - b. De gebruiker begrijpt de instructies die in de applicatie voorzien worden zonder externe hulp.
2. De oefeningen in de applicatie zijn begrijpbaar en makkelijk te doen.
  - a. De gebruiker begrijpt welke interacties hij moet uitvoeren om de oefening te voltooien.
  - b. De gebruiker kan de oefeningen voltooien zonder hulp van een andere persoon.
3. De gebruiker staat open in het gebruik van de applicatie.
  - a. De gebruiker denkt dat deze applicatie gebruikt kan worden om hem te helpen bij stressmanagement.
  - b. De gebruiker vindt dat de aanwezigheid van de virtuele agent/begeleider een meerwaarde is.
  - c. De gebruiker vindt de aanwezigheid van het virtueel huisdier een meerwaarde.
4. De applicatie geeft een vertrouwd gevoel aan de gebruiker.
  - a. De gebruiker vertrouwt het om zijn emoties te loggen in de applicatie.
  - b. De gebruiker vertrouwt het om zijn gedachten te loggen in de applicatie.
5. De applicatie is gebruiksvriendelijk.
  - a. Er worden geen problemen geobserveerd bij het uitvoeren van de taken tijdens de usabilitytesten door de gebruiker.
  - b. De score op de SUS-vragenlijst is 70 of hoger [11].
  - c. De gebruiker maakt drie of minder fouten in het navigeren naar de juiste elementen.





## Fase 2: field study

Na de usabilitytest in fase 1 worden er aan de hand van de resultaten aanpassingen gemaakt aan het prototype. Met deze nieuwe versie willen we een fieldstudy organiseren waarbij we het gebruik, motivatie en de gebruikerservaring van de testgebruikers willen bestuderen bij het gebruik van het prototype gedurende zes weken en in een realistische context.

### Onderzoeksvragen waar we een antwoord op zoeken tijdens deze fase:

- Hoe oordeelt de gebruiker zijn eigen “capaciteiten” in zijn omgang met stress na het gebruiken van de applicatie na zes weken?
- Hoe vaak wordt de applicatie gebruikt?
- Hoe beïnvloedt de aanwezigheid van de antropomorfe elementen toe aan
  - de gebruikerservaring van de applicatie?
  - het vertrouwen in de applicatie?
  - de motivatie om de applicatie te blijven gebruiken?
  - de ondersteuning aan de testgebruiker voor stressmanagement?
- Welke van de aangeboden digitale agenten verkiest de gebruiker?
- Welk aangeboden virtueel huisdier verkiest de gebruiker?
- Wat zijn de effecten van de notificaties op basis van de locatie, de ingestelde strategieën en tijdstip?
  - Zijn notificaties de voornaamste triggers?
  - Laten ze de gebruiker eraan denken om/dat...?
    - zijn gedachten en emoties te loggen in de applicatie
    - hij de applicatie kan gebruiken voor stressmanagement
    - zijn geplande strategieën toe te passen
  - Welke functionaliteiten worden gebruikt na het krijgen van notificaties?
- Wat zijn de standpunten van de gebruikers rond de verschillende onderdelen van het prototype?
  - Creatie en gebruik van de avatar
  - Antropomorfe eigenschappen
  - Game-elementen
  - Oefening in CBT-achtige toestand
  - Emotiediarying
  - Notificaties die afhangen van de ingegeven data en/of locatie en tijd
  - Integratie van agenda
- Wanneer gebruikt de gebruiker de applicatie (en bepaalde elementen)?
  - Begin/einde van de dag?
  - Door de week/in het weekend?
  - Voor/na de les?
  - Na notificatie
  - Als de gebruiker zich niet goed voelt
  - Als een deadline nadert / na een deadline

- Bij projecten of taken: individueel, in groep
- Wat is het effect van de wekelijkse rapporten die de applicatie aanbiedt?

## **Methodologie**

### **Populatie**

De doelgebruikers zijn studenten in het hoger onderwijs. Voor deze fase vragen we (doctoraats)studenten (onafhankelijk van hun eventuele omgang met stress of vernomen stresslevel) om deel te nemen aan deze test. Studenten die reeds aan de usability test in de eerste fase hebben deelgenomen, mogen ook aan deze field study deelnemen.

Het prototype is ontwikkeld voor Android-toestellen en daardoor beschouwen we enkel studenten met een persoonlijke smartphone met Android op als potentiële testgebruikers voor de field study.

### **Locatie**

De briefing en debriefing voor de test zal plaatsvinden in een lokaal in het EDM (Wetenschapspark 2 - 3590 Diepenbeek). Indien de testgebruiker wenst of het makkelijker zou vinden, zou de briefing en/of debriefing op een andere locatie in een afgesloten omgeving (bv. een lokaal of kantoor in Gebouw D van Universiteit Hasselt) kunnen plaatsvinden. Het effectieve gebruik van het prototype heeft geen vaste locatie: de testgebruiker is vrij om de applicatie te gebruiken waar en wanneer hij wenst gedurende de zes weken.

### **Tijdslijn**

Per gebruiker worden zes weken gereserveerd. De test begint vanaf de dag dat de gebruiker de briefing bijwoont. De gebruiker wordt uitgenodigd om in week zes langs te komen in het EDM voor het invullen van de SUS-vragenlijst en een semi-gestructureerd interview.

### **Mogelijke risico's**

- De smartphone van de gebruiker kan gestolen worden waardoor de ingevoerde data in de applicatie door derden geraadpleegd kan worden.
- De geëncrypteerde data kan in verkeerde handen terecht komen (door bijvoorbeeld diefstal) en zou gedecrypteerd kunnen worden door indien iemand de decryptie kraakt, hij, indien de decryptiemethode een bekende kwetsbaarheid heeft of door een andere ongeautoriseerde methode de data kan decrypteren.

### **Vragenlijsten**

Aan het begin van de vragenlijst vragen we de gebruiker zijn ervaringen

- Persoonlijke informatie

- Leeftijd
- Geslacht
- Studierichting en -jaar
- Eigen oordeel van zijn/haar stressmanagementcapaciteiten
- Ervaring met technologie

Op het einde van de zes weken vragen we de testgebruiker om de SUS-test in te vullen. Bovendien wordt er ook gevraagd om deel te nemen aan een interview om meer inzicht te krijgen over de ervaringen van de testgebruiker gedurende de zes weken.

- Vragenlijst om interesse peilen
  - Effectieve hulp van stressmanagement
  - Standpunt tegenover de oefeningen
  - Standpunt tegenover emotiedagboek
  - Strategieën
  - Effecten van antropomorfe elementen
  - Effecten van gamificationelementen

## Stappenplan

### Pre-test

- Contacteren testgebruiker via e-mail
  - Bevestiging tijdstip
  - Bevestiging gebruiker bezit smartphone met Android-besturingsstelsel
  - Vermelding dat het om een test gaat van 6 weken met terugkoment in de zesde week
- Achtergrond technologie
- Gebruik smartphone

### Tijdens de test

- De gebruiker houdt zijn persoonlijke smartphone bij waarop het prototype op geïnstalleerd is.

### Post-test

- Aan de deelnemer wordt er gevraagd om twee vragenlijsten in te vullen
  - System Usability Scale (SUS) (Bijlage 1 in appendix)
  - Zelf opgestelde vragenlijst (Bijlage 2 in appendix)
- De deelnemer wordt geïnterviewd op basis van de antwoorden die hij/zij gaf op de zelf opgestelde vragenlijst.

## Verzamelen en opslaan van data

Gegevens die we op papier bijhouden (zoals ingevulde vragenlijsten, getekende informed consent...) worden bijgehouden in het EDM. Eventuele digitale kopieën of

samenvattingen van de informatie worden opgeslagen in de *Shared drive*. Gegevens die we enkel digitaal opslaan worden ook op die plaats opgeslagen.

Voordat de testgebruiker het prototype op zijn persoonlijk smarttoestel heeft, verzamelen we deze data:

- Contactgegevens van de testgebruiker (om bijvoorbeeld een afspraak maken voor (de)briefing...) (digitaal)
- Informed consent (op papier)
- Technische ervaring (op papier): hoeveelheid smartphone gebruik
- Algemene achtergrondgegevens
  - Leeftijd
  - Geslacht
  - Studierichting en -jaar

De vragenlijst is terug te vinden in Bijlage 5.

We verzamelen data in tijdens het gebruik van de applicatie. Gevoelige data zoals gelogde emoties en gedachten, antwoorden op de DASS-test en bijhorende indicatie van stress, angst of depressie worden geëncrypteerd en lokaal op het toestel van de gebruiker opgeslagen. Deze data worden niet bewaard in de logs en kunnen niet opgevraagd worden door de onderzoekers.

Voor de analyse van het gebruik kunnen enkel gegevens geëxporteerd worden in verband met de notificaties, locatie van de gebruiker, tijdstip van het gebruik, duratie en frequentie van gebruik van de verschillende functies en interactiekeuzes in het prototype.

Na de fieldtest vragen we de deelnemer om de twee vragenlijsten in te vullen

- System Usability Test (SUS) (op papier) (Bijlage 5)
- Zelf opgestelde vragenlijst in verband met de standpunten en ervaringen van de deelnemer op het gebruik van de applicatie (op papier) (Bijlage 5)

De antwoorden worden achteraf ook digitaal ingegeven. De resulterende digitale bestanden worden opgeslagen in de *Shared Drive*.

We vragen ook voor de deelname van een interview

- Audio wordt opgenomen (digitaal)
- Notities die gemaakt worden door de interviewer worden digitaal genoteerd of op papier. In het geval van papier worden de notities achteraf gedigitaliseerd en worden de papieren notities vernietigd.

De digitale bestanden worden opgeslagen in de *Shared Drive*.

## Hypotheses

1. De gebruiker heeft het gevoel dat de applicatie hem kan helpen in stressmanagement.

- a. De gebruiker heeft het gevoel dat hij iets kan ondernemen aan zijn stress.
  - b. De gebruiker vindt dat de drempel lager ligt om hulp te zoeken.
2. De gebruiker heeft inzicht in zijn emoties en gedachten.
  - a. De gebruiker weet waarom hij zich op een bepaalde manier voelt.
  - b. De gebruiker kan deze data gebruiken om veranderingen in zijn gedrag te plannen (indien hij dat nodig vindt).
3. De notificaties zorgen ervoor dat de gebruiker de applicatie blijven gebruiken.
  - a. De tijd- en plaatsafhankelijke (op basis van gebruikersvoorkeuren en verzamelde data) notificaties herinneren de gebruiker om de applicatie te gebruiken.
4. De antropomorfe elementen geven de gebruiker een goede gebruikerservaring.
  - a. De gebruiker vindt de aanwezigheid van die elementen positief.
  - b. De gebruiker voelt dat hij de applicatie kan *vertrouwen* door de aanwezigheid van de elementen.
  - c. De gebruiker vindt de betrekking van de elementen in de oefeningen positief.
  - d. De gebruiker vindt de betrekking van de elementen in de algemene navigatie van de applicatie positief.
  - e. De gebruiker vindt de betrekking van de elementen in het dagboekgedeelte van de applicatie positief.
5. De aanwezigheid van gamification motiveert de gebruiker om de applicatie te gebruiken ter ondersteuning van zijn stressmanagement.
  - a. Het verzamelen van elementen voor zijn persoonlijke virtuele omgeving geeft de gebruiker een gevoel van vooruitgang.
  - b. Het beheren van zijn virtuele omgeving geeft een gevoel dat het zijn eigen voortgang is.

### **Primaire uitkomsten**

1. De applicatie helpt de gebruiker met strategieën op te stellen ter ondersteuning van zijn stressmanagement.
2. De gebruiker heeft inzicht in zijn emoties en kan deze inzicht gebruiken ter ondersteuning van zijn omgang met stress.
3. De gebruiker weet via welke kanalen hij verdere hulp kan vinden als hij hulp zoekt voor stress.

### **Secundaire uitkomsten**

1. De gebruiker heeft het gevoel dat hij applicatie kan gebruiken met vertrouwen.
2. De applicatie motiveert de gebruiker om de applicatie regelmatig (minstens 3 keer per week) te gebruiken.
3. (de data kan gebruikt worden door de studentenpsychologen om inzicht te krijgen in het geval dat de gebruiker op gesprek gaat)

## Statistiek

- Voor de berekening van de score op de System Usability Scale (SUS) wordt *The System Usability Scale: Past, Present, and Future* door Lewis [98] als een richtlijn gebruikt.
- **Mann-Whitney's U test:**
  - SUS-score na labtest en na fieldtest vergelijken (verbeteringen toegepast na labtest hebben positief/geen/negatief effect?)
- **Person's coefficient:**
  - correlatie tussen gebruik van een feature/oefening en verband met de deelnemers waargenomen stressmanagementscapaciteiten
  - Correlatie tussen gebruik (in minuten) en SUS-score, waargenomen stressmanagementcapaciteiten
  - Correlatie tussen contextgerelateerde notificaties of evenementen en gebruik van de applicatie
  - Correlatie tussen SUS-score en mening op features (digitale agenten, game-elementen...)
- **ANOVA:**
  - Invloed van persoonlijke mening van agenten, oefeningen... en persoonlijke kenmerken (geslacht, leeftijd, studierichting...)
  - Invloed eventuele zelf aangegeven stressmanagementcapaciteiten en frequentie gebruik van de oefeningen