# POSITIVE PSYCHOLOGY APPS

A systematic review of the quality and characteristics
of a selection of current free-of-charge positive psychological apps
aiming to enhance resilience available in the Google Play Store

MASTER'S THESIS (10 EC)

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# Abstract

**Background:** Stress is a crucial factor for the formation of mental illnesses with the consequence of a need for intensive therapeutic treatment. In this respect, individual resilience can represent an important protective factor for stress-related long-term consequences. That is why also in the field of mental health apps self-help exercises of positive psychological interventions focus on strengthening resilience. The range of low-cost, so-called online positive psychology interventions (OPPIs) is growing steadily, and the number of apps currently available in the Google Play Store alone is enormous. However, little is known about the quality and characteristics of such apps aiming to enhance resilience.

**Objective:** The aim of this study is the investigation of the quality of several currently available free-of-charge apps in the Google Play Store that aim to enhance resilience.

**Methods:** A systematic review of 10 free-of-charge apps aiming to enhance resilience were conducted. Per app, several quality indicators were analysed: The theoretical background, persuasive technology elements and subjective user ratings. Coding schemes were designed to point out theoretical elements from positive psychology theories and models, and to investigate the implementation of persuasive system design elements.

For the analysis of the subjective quality, the user ratings of the Google Play Store and the corresponding download statistics were used. In addition, the apps were rated by two researchers using an expert rating scale to subsequently determine an intra-class correlation coefficient (ICC).

**Results:** A relatively high number of implemented scientific positive psychology aspects could be found within the selected and tested apps, although the theoretical basis varied widely between the 10 apps. Additionally, a moderate extent of implemented persuasive system design elements was found. The average expert ratings ($M$=3.84, $SD$=0.62) tended to be lower than the average user ratings in the Google Play Store ($M$=4.43, $SD$=0.34). A Spearman's rank-order correlation between the different quality indicators showed significant positive relations between the average expert rating scores and the amount of embedded scientific positive psychology features ($r_s$=.806, $p$<.01) and between the average expert rating scores and the extent of implemented persuasive system design elements ($r_s$=.718, $p$<.0.5). However, the average Appstore user ratings and download statistics showed only weak correlations with the other quality indicators.

**Conclusion:** The quality between apps aiming to enhance resilience in terms of embedded theoretical background and persuasive system design elements still differs widely. Subjective user ratings and download statistics do not seem to be a reliable indicator for the app's quality, so the implementation of a standardized quality seal, based on expert ratings, would be recommended. This study has made a first impression towards the development of such a framework.

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# 1. Introduction

Stress is the second largest reason for work-related health problems (Böhm & Böhm, 2004) and nearly 40 million European citizens are directly affected by those stress related impacts (Cox, Griffith, & Rial-González, 2000). According to Kaluza (2018) stress is one of the most important health risk factors individuals in modern western societies are confronted with, as he claims that 50-60% of all missed workdays are related to illnesses due to stress. This leads to an estimated cost of 20 billion euros each year due to cases of illness within the European Union (Kaluza, 2018).

Thus, not being flexible in handling daily stressful events and especially being inflexible in bearing painful and unexpected life-events may result in mental-illnesses, as studies show significant correlations between psychological stress and mental disorders like burn-out, depression (Berger, Schneller, & Maier, 2012; Tennant, 2001) and anxiety disorders (Salim, 2014). Kuo (2011) found that those perceived stressors increase rapidly from around the age of 20 due to the demand for independence, career goals and new social contacts. Furthermore, Diehl and Hay (2010) claim that negative effects on psychological well-being due to perceived daily stress are independent from age in adult individuals and they found significant correlational effects between perceived individual control in dealing with daily tasks and negative affects due to stress. Much research in the last years has therefore focused on possible prevention strategies for individuals in order to avoid the negative impact of stress on one's individual physical and psychological health and well-being including mental and physical long-term illnesses.

## 1.1 Dealing with stress and the concept of resilience

According to Green and Humphrey (2012) there is a "vicious circle" between perceived stress and individual resilience. They argue that effects of stress lower the individual's resilience, so other stressors become even more challenging, which in turn lowers resilience even more. Resilience has received much attention in research, as it describes the ability to successfully deal with stressful experiences and has proven to be a protective factor against the negative mental health impacts of stress, independent from age and racial and cultural background (McLaughlin, Doaen, Costiuc, & Feeny, 2009). Being resilient means having the ability to remain functional and mentally stable during stressful and experiences, and to respond flexibly and effectively to the stressors instead of experiencing psychological decompensation

(Redman & Kinzig, 2003). Furthermore, resilience is often considered a decisive protective factor against learned helplessness (Southwick & Charney, 2012) and depression over the lifespan (Elisei, Sciarma, Verdolini, & Anastasi, 2013) as it is an individual's ability to bounce back from negative stressful events without developing serious mental and physical health issues. Within resilience research, a distinction is made between the definition as a personality trait and as a process. In the first definition resilience is stated as a personal ability to overcome or adapt to stressors and to grow with stressful experiences in life (e.g., Flach, 1997). The second definition summarizes resilience as a dynamic adaptation process of the individual to stressful circumstances and life events (Pan & Chan, 2007). However, there is a clear trend towards favouring the process definition within resilience research, as the interactive and dynamic basis of this definition offers observable possibilities for the practical and theoretical implementation of resilience-focused interventions (Margalit, 2004).

The need to strengthen resilience in order to prevent the development of long-term mental disorders has become an increasingly important aspect of global health care in recent decades. According to a WHO report, the prevention of mental illness includes the development and support of individual strengths, a crucial element in the early prevention of mental suffering (World Health Organization, 2004). As Pan and Chan (2007) state, risk factors like stress cannot be avoided completely but protective factors in terms of resilience against those risks can be strengthened.

### 1.2 Enhancing resilience with positive psychology interventions

In the predominant therapy approaches within cognitive behavioural therapy (CBT), successes have been achieved in the treatment of the possible sequelae of lacking or deficient resilience, for instance in the treatment of affective disorders and depressive episodes (Padesky & Mooney, 2012). However, in addition to the disorder-oriented approaches such as CBT, the role of positive psychology and the associated influence of positive emotions on well-being has been emphasized in the past decades (Tugade, Frederickson, & Feldman, 2004).

Within positive psychology, mental health is considered as more than the mere absence of mental disorders. The focus is on promoting wellbeing and optimal functioning (Bohlmeijer, Bolier, Westerhof, & Walburg, 2015). Four crucial elements positive psychology relies on are: (1) positive emotions, (2) positive traits and their protective values, (3) positive interpersonal contacts, and (4) positive institutions like workplaces and schools (Seligman & Csikszentmihalyi, 2014). As recent studies show, the individual's promotion of resilience can

be enhanced in terms of building core protective factors like self-efficacy (e.g., Norman, 2000), giving one's life a purpose and meaning and making plans and goals for the future (Masten & Reed, 2002). Therefore, several theories and (treatment) models that include such ideas and elements of positive psychology are specifically relevant in relation to resilience and stress.

First, one important theory in positive psychology also focussing on improving resilience is reflected in the Broaden and Build theory developed by B. Frederickson, which assumes that people can develop new and thus resilient characteristics and behaviours (build) by perceiving positive emotions and events (broaden) (Frederickson, 2004; 2011).

Furthermore, positive psychology elements can also be found within well-known and long-established, primarily problem-oriented therapy methods, such as Acceptance and Commitment therapy (ACT). The main goal of ACT is to help the individual develop a positive and meaningful outlook on life while effectively dealing with everyday stressors that life brings (Harris, 2019). Six elements of ACT aim to achieve mental flexibility, defined as the ability to act based on one's own values and to remain capable of action. Those elements are the acceptance of unpleasant thoughts, detachment of ruminations, flexible handling of the self, attention to the present moment, formulating values and investing in those values.

Finally, according to Elisei, Sciarma, Verdolini and Anastasi (2013) focusing on and enhancing of positive affects has a major effect on building up coping mechanisms against stress and are also connected to faster recovery processes from negative influences on the psychological well-being. Some specific positive psychology elements that predict an individual's ability to build resilience are summarized in the predictive 6-Factor Resilience Scale (PR6) from Roussouw and Roussouw (2016), based on Davidson and Begley's six dimensions of emotional styles (2012). It includes positive psychological aspects within five different domains concerning psychological resilience and a sixth domain in relation to physiological health that need to be fulfilled to predict the individual's capability of positive adaption in cases of stressful events, defined as resilience by Kong, Wang, Hu and Liu (2015).

Contemporary approaches to therapy continue to rely in many ways on face-to-face treatment and the availability of professionals, such as psychotherapists and coaches. However, a representative study from Germany by Albani, Blaser, Rusch, and Brähler (2013) shows that the individual barriers to seeking psychotherapeutic treatment or support are still very widespread. Thus, 34% of the respondents stated that they would be embarrassed if their

social environment knew about the therapeutic support, 28% vehemently excluded psychotherapeutic support.

In this regard, positive psychology interventions (PPIs) have been developed, defined as self-help exercises that can be incorporated and integrated without much effort into everyone's daily lives. Several studies show the effectiveness of PPIs in the enhancement of well-being, behaviour change and reduction of depressive symptoms in the general and clinical population (Sin & Lyubomirsky, 2009; Bolier et al., 2013). Furthermore, PPIs were found to be effective in diminishing perceived stress and positively influencing performance of individuals in organizational work contexts (Meyers, van Woerkom, & Bakker, 2013). Seligman (2011) also claims that resilience can be enhanced by making use of positive psychology interventions like reframing negative thoughts and emotions with positive ones or helping individuals in building up optimism and signature strengths.

### 1.3 Positive psychology self-help exercises in mobile interventions

Thanks to information and communication technologies (ICTs), like the Internet and mobile devices such as smartphones and tablets, the number of online programs, interventions and apps in the health sector has also increased in recent years. According to a recent global mHealth report from April 2021, over 4.3 billion people worldwide actively and extensively use the internet via mobile devices, and the trend is rising (Ugalmugle & Swain, 2021). Mobile health (mHealth) is described by the World Health Organization (2011) as a digital way to support individuals regarding practices in public and medical health. Increasingly, also Online Positive Psychology Interventions (OPPIs) are developed and implemented, as a cost-effective and easily accessible way to improve wellbeing in the population (Kelders, 2019). OPPIs try to combine the aspects of positive psychology with the opportunities offered by ICTs, and there is already some evidence for their effectiveness within younger and older age groups (Baños et al., 2017). In comparison with face-to-face training, web-based psychological interventions have advantages when it comes to cost- and time-efficiency, because they are independent from time and location (Tate & Zabinski, 2004) and have also shown to be more effective in terms of personal development and learning (Sitzmann, Kraiger, Stewart, & Wisher, 2006).

The range of mHealth applications on offer today is enormous and now clearly integrated in the population. In 2018 alone, approximately 4.1 billion mHealth applications were downloaded (Statista, 2021a), and over 325,000 health apps are now available across all app markets (Pohl, 2019), with the Google Play Store taking the largest market share with

101344 health and fitness apps in 2020 (Statista, 2021b).

Since nearly everybody can create an own app, the possibility to evaluate the effectiveness of already accessible OPPIs is limited (Baños et. al., 2017). This can have an impact on the quality of the content of the apps and the reliability of the information provided about the app, as the large number of health apps on the market makes it difficult to tell which app was developed by layman and which by actual experts (van Velsen, Beaujean, van Gemert-Pijnen, 2013).

The quality of OPPIs could be judged by different indicators. First of all, research has shown that the use of theoretical and scientific elements in technological health interventions positively influences motivational aspects and outcomes for users (Bolier and Abello, 2014; Donker et al., 2013). To date, however, little is known about the actual use of evidence-based theoretical content in available resilience-focussed OPPIs.

Furthermore, Bolier and Abello (2014) highlight the importance of persuasive elements within mHealth apps to improve their effectiveness as well as to increase adherence in the usage of the apps. Kelders, Kok, Ossebaard and Van Gemert-Pijnen (2012) have shown in a systematic review that end-user adherence is significantly increased when more persuasive elements are implemented in online interventions. Additionally, the implementation of interactive features was found to have a positive influence on interest, adherence and user comprehension of the system's content (Abbott, Klein, Hamilton & Rosenthal, 2009).

Finally, actual subjective user ratings can be taken in consideration when it comes to the evaluation of an app's value for the end-user. App stores like the Apple Store or Google Play store provide several options to examine user statistics of existing apps including the stated number of downloads and user ratings. This gives users and developers the opportunity to communicate suggestions for improvement, to point out bugs but also positive aspects (Guzman, Oliviera, Steiner, Wagner, & Glinz, 2018).

However, recent studies show that user ratings are often purposely faked to boost the app's ranking within the respective app store. It was found that positive feedback and download number directly influence user's decisions to download a certain app (Kuehnhausen & Frost, 2013; Maartens & Maalej, 2019). Moreover, it is often unclear on what aspects of the app, or which experiences, the ratings are exactly based.

Therefore, a validated standardized and transparent expert rating tool to measure subjective quality could be considered. Stoyanov et al. (2015) recently developed the Mobile

App Rating Scale (MARS), aiming to offer researchers the possibility to make own subjective expert ratings of a mobile health app's quality. It is however still unclear how MARS expert ratings compare to actual user ratings and download numbers and whether they can serve as an additional and validated quality evaluation opportunity of currently existing apps that promise to enhance resilience.

### 1.4 Objective and Research Questions

This study presents a review of currently available apps that claim to focus on strengthening personal resilience. Additionally, it aims to create a basis for further elaboration and possible improvement of existing OPPIs that focus on enhancing resilience.

For this, a selection of currently available apps is examined based on their use of evidence-based principles from positive psychology models relevant for resilience, their use of described persuasive system design elements, and their subjective user evaluations and download statistics and expert quality ratings. The following sub-questions are formulated to achieve this objective:

**What is the quality of currently available apps aimed at strengthening resilience?**

1) Which apps aiming to enhance resilience are currently available in the Google Play Store?

2) To what extend do those apps offer self-help exercises that are based on a scientific basis?

3) In how far do those apps implement evidence based elements from positive psychology to enhance resilience?

4) To what extend do those apps make use of Persuasive System Design elements?

5) How do the different quality indicators in terms of user evaluations of the apps, including download counts and overall ratings, subjective expert ratings, used theoretical elements and Persuasive System Design elements correlate with each other?

# 2. Methods

For the initial assessment of the available apps, the elements of the Broaden-and-Build theory (Frederickson, 2004) as well as the theoretical background and principles of the Acceptance and Commitment Therapy (ACT) approach by Hayes, Strosahl and Wilson (1999) and the principles of the Predictive 6-Factor Resilience Scale (PR6) from Roussouw & Roussouw (2016) were considered within the analysis of the theoretical background of each app as they present clear criteria to enhance individual resilience in consideration of the value of positive emotions.

Next, the design principles of the universal "Persuasive Systems Design" (PSD) framework by Oinas-Kukkonen and Harjumaa (2009) were utilised to evaluate the persuasive elements in the app, because of their application for general quality evaluation of apps without taking specialised content into account.

Finally, all apps were analysed in terms of their subjective quality ratings based on user ratings in the Google Play Store, and additionally conducted ratings based on the Mobile Application Rating Scale (MARS) questionnaire.

## 2.1 Search and selection Process

According to Statista (2021c) the most two prominent download platforms for apps are currently the Google Play Store and Apple App Store. With a total market share of 71.93%, the mobile operating system Android continues to lead the worldwide mobile OS market. With this in mind, and the fact that Apple App Store distributes proportionally more chargeable apps (7.1%) than its competitor (3.3%), the Google Play Store was chosen for selecting potential apps aimed at increasing or enhancing resilience. A Figure concerning the distribution of free of charge apps within both concurrent app stores can be found in Appendix A.

To identify and narrow down potential test apps, the first step was to analyse five different keywords around resilience enhancement regarding their ASO quality. ASO stands for App Store Optimization and aims –as SEO (Search Engine Optimization) - to increase traffic through higher placement in search engine results (Wyllie, 2015).
The following keywords related to the term resilience were identified within the literature, considering the target group for this study: *positive mind, positive psychology, stressed, resilience* and *coping*. Comparing these search terms using Google Trends, showed that the terms *stressed*, *resilience* and *coping* are used more frequently in web searches than positive

mind and positive psychology (*Figure 1*). On August 30, 2021, these three selected terms provided 250 matching apps in the Google Play store that were free of charge (Appendix A). It should be mentioned at this point that the maximum number of results on Google Play is 250 and therefore more matching apps could be available in the store than those listed in the Google Play search results.

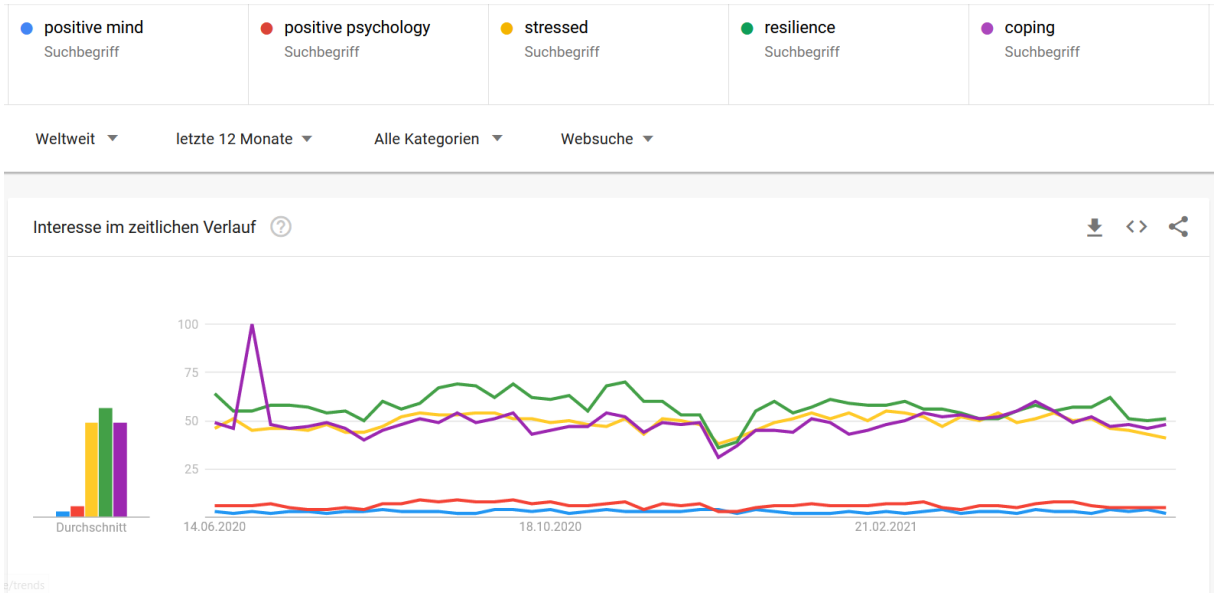


*Figure 1*. Comparison of Search Terms by Google Trends. Adapted from Google Trends (2021).

To further limit the results, consecutive randomly selected applications were analysed with respect to several exclusion criteria presented in *Table 1*. Finally, 10 apps were included for the analytic purposes as this number was considered reasonably representative and feasible for the scope of this study.

**Table 1:** Exclusion criteria for the app selection process

| Exclusion criteria | Reason for exclusion |
|---|---|
| 1. Incorrect focus | If the App did not show an apparent link to increasing resilience and decreasing or coping with stress it was excluded. |
| 2. Not free of charge | The app should be available for everyone, thus only free of charge apps were included. |
| 3. Not available in the English language | To analyse different Apps, it was necessary that they are provided in the same language. Only then the way of addressing the user and explaining content could be compared. Thus, English was chosen as the international basic language. |
| 4. Less than 10.000 Downloads | Apps that have been downloaded often are likely to be more attractive to users and therefore more interesting for the research. Additionally, those Apps often provide more ratings which were necessary for the subjective analysis section. |
| 5. No ratings available | Subjective ratings are needed for the subjective quality rating analyses. |
| 6. One-sided focus only | All apps were excluded that do not provide diversity in methods and techniques and a wider range of possibilities to enhance resilience through various options such as relaxing exercises, psychological reports, daily tasks, video calls with experts, mood tracking or community (e.g., apps that focus on only one element such as mindfulness, gratitude, or meditation). |
| 7. App is not theoretically grounded | Apps that have no link to profound psychological knowledge and for instance have a religious context were excluded. |
| 8. Last update not older than 1 year | This is to ensure regular support which means that technical issues are more improbable on the one hand and that the app more likely will be offered in the future on the other hand. This exclusion was directly addressed to the importance of regular updates within the apps from Kelders et al. (2012) |

The final 10 selected apps after applying the exclusion criteria were Driven Resilience App (*Hello Driven Pty. Ldt.*), Happify (*Happify, Inc.*), InnerHour (*Mindcrescent Wellness*), Iona Mind – Guided Mental Health Journal (*Iona Mind LTD*), Mindspa (*Mind Solutions Ltd.*),

Moodfit (*Roble Ridge Software LLC*), MyPossibleSelf (*My Possible Self Ltd.*), Remente (*Remente AB*), What's Up? (*Jackson Tempra*), and Wysa (*Touchkin eServices Pvt. Ltd.*). A table with detailed descriptions of each selected app can be found in Appendix B.

## 2.2 App Evaluation

The selected apps were installed and tested by the researcher for a period of 2 weeks in order to obtain a comprehensive picture of their quality, content and functioning and to be able to evaluate persuasive functions like reminders.

### 2.2.1 Theoretical Foundation

To assess the evidence-based nature and theoretical background of the apps, a coding scheme was designed based on overlapping elements of the 6-Factor Resilience Scale by Roussouw and Roussouw (2016), Acceptance and Commitment Therapy principles by Hayes, Strosahl and Wilson (1999) and the Broaden-and-Build Theory by Frederickson (2004). Based on the designed coding scheme, the offered features within the 10 selected apps were subsequently assessed over two weeks by the researcher.

Based on the above-mentioned theoretical background, a coding scheme was developed to analyse the usage of evidence-based features to enhance resilience within the apps, determining whether a defined feature is *included (+)* or *not included (-)* in terms of offered tasks, exercises or features within the apps (*Table 2*). Therefore, the availability or non-availability of theoretically based features (e.g., whether the app includes clearly formulated mindfulness tasks or is making use of visual content like emoticons or pictures to promote positive emotions, or not) was measured with the following scores: (+) = 1 point, (-) = 0 points.

**Table 2.** Coding scheme concerning included theoretically based features within the apps

| Formulated feature | Explanation and theoretical foundation |
|---|---|
| 1. Accept the present moment (*APM*) | Focus on features to strengthen the acceptance of current stressors and associated negative feelings. This feature is fundamentally found in "Defusion," "The self (as context)" and "Contact with the present moment (be here)" of the ACT (Hayes et al., 1999), the "Composure" and "Tenacity" domains of the 6-Factor Resilience Scale (Roussouw & Roussouw, 2016), and within the broaden-effect on "attention" within the broaden-and-build theory (Frederickson, 2004). |
| 2. Mindfulness (*MF*) | A key concept of helping to accept a present moment and helping to stay calm and flexible in dealing with current and future stressors. Features related to this include meditation exercises or instructions for relieving (also physical) activities within the apps. This concept is based on the "Composure", "Tenacity" and "Health" aspects of the 6-Factor Resilience Scale (Roussouw & Roussouw, 2016), "Acceptance", "Defusion", "The self (as context)" and "Contact with the present moment (be here)" within the ACT (Hayes et al., 1999) and the broadening-effect regarding experienced positive events and feelings within the Broaden-and-Build theory (Frederickson, 2004). |
| 3. Creation of positive emotions (*CPE*) | Based on the core of the broaden-and-build theory (Frederickson, 2004) and the strengthening effect of positive emotions on individual functioning levels and flexible and resilient coping with stressors. These can be targeted within the apps, for example, through visual features in the form of pictures and videos. This aspect is also reflected in "Reasoning" and "Collaboration" of the 6-Factor Resilience Scale (Roussouw & Roussouw, 2016). |
| 4. Promoting strengths (*PS*) | Focus on the app's internal features for finding and reinforcing individual strengths, which emerges as crucial factors in "Vision" in the 6-Factor Resilience Scale by Roussouw and Roussouw (2016), the key principles of ACT (Hayes et al., 1999), and Broaden-and-Build theory (Frederickson, 2004). |

| Formulated feature | Explanation and theoretical foundation |
|---|---|
| 5. Generating plans and goals (*GPG*) | Focus on app features that support the user in formulating concrete, individual and, above all, positive goals for their own life, with the aim of reorientation within the framework of plannable and step-by-step implementation and the building of motivation and energy to be able to overcome current as well as future stress factors and stressors. This approach is formulated as "Values" and "Committed action (do what it takes)" in the ACT (Hayes et al., 1999). In the context of the Broaden-and-Build theory, this aspect is found in the context of the build-effect (Frederickson, 2004) and includes the step of "Reasoning" within the 6-Factor Resilience Scale (Roussouw & Roussouw, 2016). |

### 2.2.2 App Structure: Persuasive Systems Design (PSD)

The design principles of the Persuasive Systems Design (PSD) framework developed by Oinas-Kukkonen and Harjumaa (2009) is based on Fogg's functional triad and provides, in contrast to other models, a systematic overview for developing persuasive software solutions. Since the model explains methods to how to transform proposed design principles into actual software requirements, it focuses not only on information content but also on software functionalities. In general, the model is based on four categories (*Primary Task Support*, *Dialogue Support*, *System Credibility Support* and *Social Support*), which in turn are each structured into seven persuasive system principles. The principles within the first category focus on embedded system features to give users an overview of first steps and tasks. Dialogue Support principles are directed to give users guidance and feedback during usage process. System Credibility Support focuses on the persuasive background of the system's features like scientific and authentic sources. The last category includes principles concerning offered system features in terms of social interaction (Oinas-Kukkonen & Harjumaa, 2009).

For the analysis of the 10 apps, a counting of embedded principles for each persuasive system design category was done. The goal was to get an overall view of the present or predominantly implemented PSD-elements, summarized as a total score (*t*), ranging from 0-7 points for each app and PSD-category.

Furthermore, a second, more detailed score (*k*) was developed with the aim of taking partially or poorly included PSD-elements also into account. This was done, because in some

apps PSD-features were implemented to a rather limited extent in comparison to other apps. For example, in terms of personalization, some apps only offered options to personalize design elements whereas other apps also implemented options to personalize individual settings like usernames and demographic data. Therefore, this second score was designed to capture whether individual persuasive system principles are *fully or predominantly implemented (+)* = 2 points, *partly implemented (/)* = 1 point or *little to not at all implemented (-)* = 0 points, giving each app a score range between 0 and 14 points per PSD-category.
A full description of the PSD elements and the results of the app analysis based on the PSD principles was tabulated for comparability reasons and can be found in Appendix C.

### 2.2.3 Subjective Quality: User Ratings, number of downloads & expert ratings

To assess the subjective quality of the apps, download statistics and user ratings of the apps in the Google Play Store were examined. In the Google Play Store, users can give a rating in the form of 1 to 5 stars, with 5 stars being the best possible rating for an app. In addition, users can comment on their rating, which enables a more detailed evaluation. The average rating of an app can also be viewed in the app store, even before downloading an app.

Since the criteria of the respective user ratings are unclear, an additional instrument was used for this review to assess the subjective quality of the individual apps. The Mobile App Rating Scale (MARS) developed by Stoyanov et al. (2015) is a reliable and validated expert rating scale. This instrument, in the form of 23 items distributed over 5 different sections (*Engagement*, *Functionality*, *Aesthetics*, *Information* and *Subjective Quality*), is specifically designed for the assessment of mobile health applications. The 23 items are rated on a 5-point Likert scale, ranging from inadequate (1) to excellent (5). In addition, a mean score of all items is calculated for each item group in order to be able to make an overall assessment of the respective section, and to obtain an overall mean score for all items and sections. A template of the MARS can be found in Appendix E.

The aim was to compare the average user ratings and the number of downloads of the individual apps with the subjective assessment of the expert rating scale. All 10 selected apps in this study were evaluated using the MARS ($M$=3.70, $SD$=0.65), with the researcher taking the role of a potential user and using each app over a 14-day period. A second independent researcher with an engineering master's degree evaluated the apps using the MARS over the same usage period ($M$=3.98, $SD$=0.61) to establish the inter-rater reliability of the MARS ratings. Subsequently, the intra-class correlation coefficient (ICC) was calculated regarding

the average total MARS scores. The scores of both raters can be found in *Figure 2*. A high reliability was observed between the two expert ratings with an absolute agreement for single measures of .864 with a 95% confidence interval in a range between .064 and .973 ($F(17.73)= 34.930$, $p=.002$). For the analysis of the subjective quality in terms of expert ratings the average score of both researchers were used, which can be seen in Table 3.

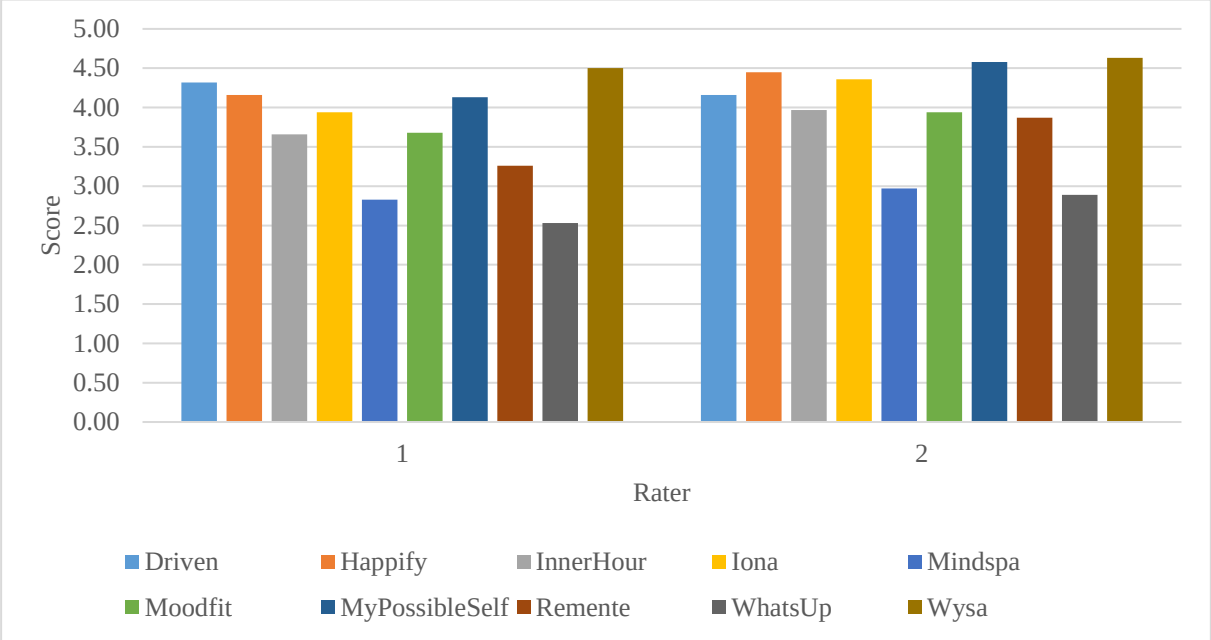


*Figure 2: Average MARS rating scores from both raters for each app.*

# 3. Results

In this section, the results of the analysis of the various quality indicators of the 10 tested apps are presented.

## 3.1 Theoretical Foundation

The 10 selected apps for this study were analysed regarding to the integration of the formulated five evidence-based features of the ACT model, Broaden-and-Build theory, and the 6-Factor Resilience Scale domains. Overall, 8 of the 10 apps stated that the theoretical basis of the respective app was based on elements of Cognitive Behavioural Therapy. Only the apps Inner Hour and Happify additionally mentioned an integration of elements from positive psychology. Driven made a direct reference by mentioning the embedded theoretical basis through the 6-Factor Resilience Scale, and What's Up? mentioned implementing aspects from Acceptance & Commitment Therapy (ACT). In the apps Mindspa and Remente, no explicit information was given on specific theoretical foundations.

In total, 32 implemented features of the investigated five theoretical foundations could be identified through the applied coding scheme. An overview of the completed coding scheme, together with a description of the embedded elements can be found in Appendix D.

In 8 of the 10 apps, features related to Accept the present moment (*APM*), Mindfulness (*MF*) and Creation of positive emotions (*CPE*) were identified. The use of *APM* features took place, for example, by offering grounding techniques and the targeted reframing of currently stressful thoughts. Mindfulness, if present, was explicitly mentioned in the apps and not only implicitly used, for example through writing-tasks or sound guides. Primarily with visual and acoustic stimuli, but also by writing-tasks and the introduction of emoticons, 8 of the examined apps specifically focused on strengthening positive emotions of the users. Features concerning the generation of plans and goals (*GPG*) were implemented in 5 apps, in terms of for example the user's possibility to create and track individual (daily) goals or through guidance within exercise-tracks. However, all apps offered *GPG* features in the premium version. The lowest implementation was found for Promoting Strengths (*PS*) features (n=3).

The highest number of implementations of theoretical elements (n=4) was found for 5 apps, namely Happify, Inner Hour, Iona, My Possible Self and Wysa. In comparison, in the free version of Moodfit only a single theoretical feature (n=1) was found in terms of Mindfulness.

### 3.2 Persuasive System Design elements

A total of 137 Persuasive System Design elements were identified within the 10 apps. An overview of all coded PSD features and predominantly implemented elements per category and app is shown in *Figure 3*. The most PSD elements were found in the app Wysa (*t*=21), closely followed by Driven (*t*=20), Happify (*t*=20) and Iona (*t*=20). The fewest Persuasive System Design elements were implemented in the apps Moodfit (*t*=3) and What's Up? (*t*=4).

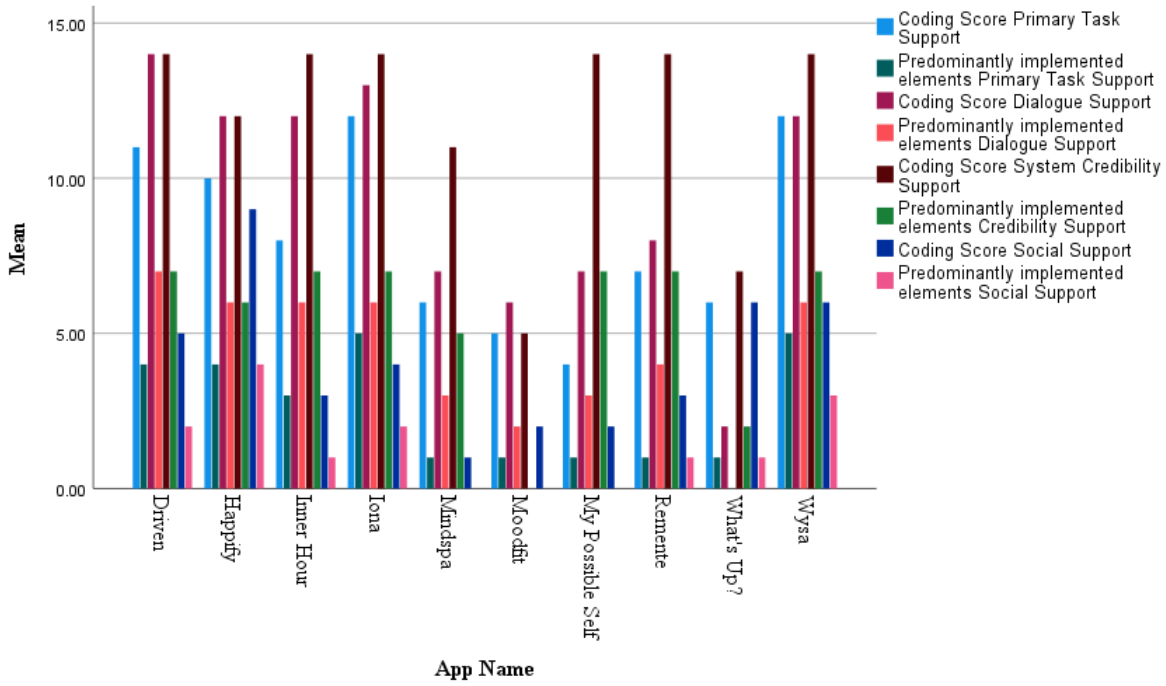


*Figure 3:Total coding scores (k) and predominantly implemented elements (t) of the four Persuasive System Design categories for each app.*

#### 3.2.1 Primary Task Support

A total (*t*) of 26 predominantly implemented primary task support elements were found in the 10 apps, with an overall coding score (*k*) of 81 points, indicating that individual primary task support elements were only found partly within the apps. Only the principle "Reduction" was used to its full extent in all apps, as in each app care was taken to ensure a clear and simple use of individual app functions. "Tailoring" was the least used principle (*k* =5) and was only predominantly implemented in the app Wysa, through a wide range of tailored features for the user, like individual tasks and reactions concerning the user's written answers within the chat-bot-feature. The highest coding scores (*k*=12) and the most predominantly implemented elements (*t*=5) were observed in the apps Iona Mind and Wysa, the lowest coding score was found in the analysis of My Possible Self (*k*=4) and only one predominantly implemented

Primary Task Support feature was observed in the apps Mindspa, Moodfit, My Possible Self, Remente and What's Up?.

### 3.2.2 Dialogue Support

Dialogue Support elements were implemented to great extend in 43 instances within the apps with a total coding score of 93. The highest coding scores were observed for the principles "Suggestions" (*k*=19) and "Liking" (*k*=18). Only partial elements of "Liking" were found in Moodfit and What's Up, and all apps except What's Up? fully implemented "Suggestions", mostly in terms of tasks aiming at behaviour change. The principle "Similarity", on the other hand, was predominantly implemented in three apps, while seven apps used no real-life reference at all in their features. The app Driven showed a complete integration of all principles of this category, but not a single Dialogue Support element was used to a great extent in What's Up?. *Figure 4* shows some examples of received “Reminders” from several apps and the “Praise” feature in the app Mindspa.

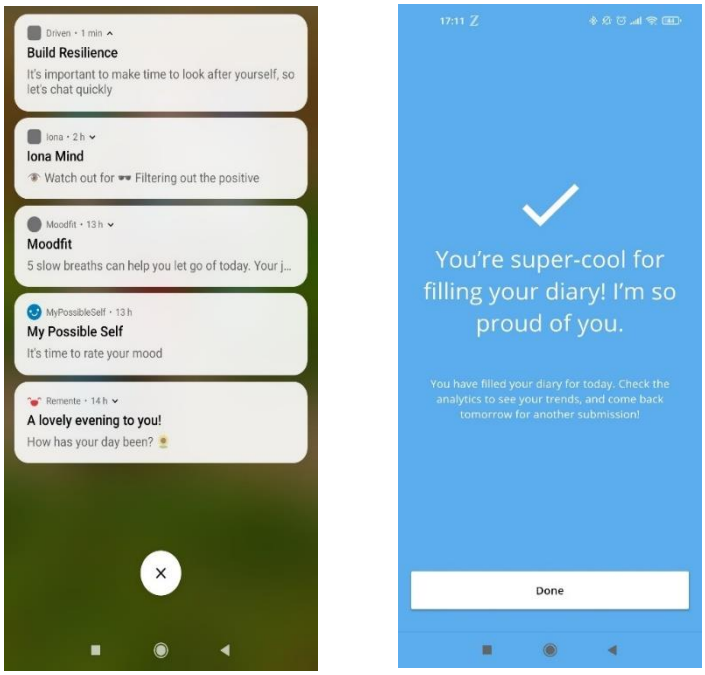


*Figure 4: Examples of received “Reminders” and “Praise” (Mindspa)*

### 3.2.3 System Credibility Support

Completely integrated elements of this category were most frequently identified (*t*=55) and coded (*k*=119) within the ten apps. The principles "Trustworthiness" and "Expertise" were broadly implemented in all apps, except for Moodfit and What's Up? The principle "Verifiability", together with "Authority", represented the lowest percentage of use within the

System Credibility Support category, each with a coding score of 16 points. Both Moodfit and What's Up? had no use of verifiable references within the app or associated website. In the apps Driven, Inner Hour, Iona, My Possible Self, Remente and Wysa, all principles of System Credibility Support were used extensively ($k$=14), in the app Moodfit only individual partial elements were integrated ($k$=5).

### 3.2.4 Social Support

Within this category, the fewest predominantly implemented principles were found ($t$=14) with the lowest overall coding score ($k$=41). The principle "Cooperation" was only partially implemented in the app Driven, as it states the importance of cooperating with other people in terms of building individual resilience, while not offering actual means for it. However, this element was not found in any other app. The highest coding score within this category was achieved for the principle "Recognition" ($k$=12), as 50% of the apps represent personal user experiences within the apps or on the associated website. The highest overall coding score in social support was achieved by the app Wysa ($k$=6) with three fully implemented principles, the lowest coding score was determined for Mindspa ($k$=1).

## 3.3 Subjective app quality

A large variability was found between the average number of downloads between the apps, ranging from around ten thousand downloads (e.g., Moodfit) to over a million downloads (e.g., Wysa and Remente). In comparison to the mean scores of the expert ratings calculated with the MARS scale ($M$=3.84, $SD$=0.62), the average rating of all apps by user ratings in the App store was relatively high ($M$=4.43, $SD$=0.34). Wysa and My Possible Self were rated highest in user ratings ($M$=4.8), while Happify received the lowest averaged overall rating ($M$=3.7), while this app achieved the fourth highest score in the MARS expert rating ($M$=4.31, $SD$=0.21). The biggest difference between the user and MARS ratings was for the app Mindspa, which had the second lowest score in the expert rating ($M$=2.90, $SD$=0.99), but the second highest score in the user ratings. ($M$=4.6). *Table 3* shows the overall outcomes of the subjective quality analysis of all 10 apps.

**Table 3.** Subjective Quality of expert- and user ratings and number of downloads

| App Name | Mars | | Average rating in app store, (n raters) | Number of downloads |
|---|---|---|---|---|
| | *M* | *SD* | | |
| Driven | 4.24 | 0.11 | 4.2 (75) | 10000+ |
| Happify | 4.31 | 0.21 | 3.7 (2812) | 500000+ |
| Inner Hour | 3.82 | 0.22 | 4.6 (630) | 10000+ |
| Iona Mind | 4,15 | 0.30 | 4.6 (15563) | 1000000+ |
| Mindspa | 2.90 | 0.99 | 4.6 (2362) | 100000+ |
| Moodfit | 3.81 | 0.18 | 4.5 (534) | 10000+ |
| My Possible Self | 4.36 | 0.32 | 4.8 (413) | 50000+ |
| Remente | 3.57 | 0.43 | 4.3 (11136) | 1000000+ |
| What's up? | 2.71 | 0.26 | 4.2 (3445) | 500000+ |
| Wysa | 4.57 | 0.09 | 4.8 (98513) | 1000000+ |

### 3.4 Correlations between different indicators

In order to determine possible correspondence between the different quality indicators Spearman's rank-order correlations were calculated (Table 4 & Table 5). The strengths of the correlations were interpreted in terms of no to low correlational effect ($0.0 \leq r_s \leq 0.2$), weak to moderate correlational effect ($0.2 \leq r_s \leq 0.5$), strong correlational effect ($0.5 \leq r_s \leq 0.9$) and high to perfect correlational effect ($0.9 \leq r_s \leq 1.0$).

A strong and significant positive correlation was found between the total amount of implemented theoretical features and the average expert rating conducted with MARS ($r_s$=.806, $p$<.01), while only a moderate positive correlation between theoretical implementation and subjective user ratings ($r_s$=.367, $p$=.23) and a weak positive correlation with the number of downloads ($r_s$=.155, $p$=.67) could be detected.

Furthermore, the total numbers of used theoretical elements and Persuasive System Design elements showed a significant and strong positive relationship ($r_s$=.644, $p$<.05). However, the correlational analysis showed no correlation between the total number of PSD elements and user ratings ($r_s$=.094, $p$=.80) and download frequency ($r_s$=.133, $p$=.71)

Additionally, the amount of embedded CPE features was significantly related to the average total MARS scores ($r_s$=.696, $p$<.05), but had no significant relation to the subjective user ratings ($r_s$=.133, $p$=.71) nor the number of downloads ($r_s$=-.045, $p$=.90).

Also, there was no significant correlation between the amount of downloads and the subjective user ratings ($r_s$=.086, $p$=.81), and an even weaker correlational effect between the average MARS scores and the amount of downloads ($r_s$=.062, $p$=.86).

It is also notable that the average MARS scores correlated strongly, but non-significantly, with the number of implemented APM features ($r_s$=.522, $p$=.12), while there was no correlational effect at all between the embedded APM features and the subjective user ratings ($r_s$<.001, $p$=1.0).

**Table 4.** Overview of Spearman's rank-order correlations between the different quality indicators

| Variable | 1. | 2. | 3. | 4. |
|---|---|---|---|---|
| 1. Subjective User Ratings | | | | |
| 2. Mean MARS scores | .358 | | | |
| 3. Number of Downloads | .086 | .062 | | |
| 4. Total implemented PSD elements | .094 | .718* | .385 | |
| 5. Total implemented theoretical elements | .367 | .806** | .155 | .644* |

*$p$<.05., **$p$<.01.

**Table 5**. Overview of Spearman's rank-order correlations between the different quality sub-indicators

| Variable | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Subjective User Ratings | | | | | | | | | | | |
| 2. Mean MARS | . 358 | | | | | | | | | | |
| 3. Download numbers | .086 | .062 | | | | | | | | | |
| 4. PTS elements | .086 | .638** | .318 | | | | | | | | |
| 5. DS elements | -.045 | .596 | .042 | .825* | | | | | | | |
| 6. SCS elements | .400 | .567 | .225 | .502 | .700* | | | | | | |
| 7. SS elements | -.321 | .499 | .455 | .850** | .732* | .358 | | | | | |
| 8. APM | .000 | .522 | -.269 | .467 | .225 | .049 | .358 | | | | |
| 9. MF | .399 | .609 | -.403 | .467 | .450 | .147 | .090 | .375 | | | |
| 10. CPE | .133 | .696* | -.045 | .467 | .586 | .588 | .358 | .375 | .375 | | |
| 11. PS | -.155 | .341 | .625 | .286 | .275 | .214 | .586 | -.218 | -.218 | .327 | |
| 12. GPG | .177 | -.244 | .215 | -.224 | -.216 | .353 | -.215 | .000 | -.500 | .000 | -.218 |

*$p$<.05., **$p$<.01.

**Abbreviations**: Primary Task Support (PTS), Dialogue Support (DS), System Credibility Support (SCS), Social Support (SS), Accept the present moment (APM), Mindfulness (MF), Creation of positive emotions (CPE), Promoting strengths (PS), Generating plans and goals (GPG).

# 4. Conclusion & discussion

This study aimed to give an impression of the quality and availability of currently existing apps that claim to strengthen resilience. In general, the quality of the tested and analysed apps varied widely. The results show that most of the apps themselves indicated that they were theoretically based, with elements of Cognitive Behavioural Therapy being primarily mentioned. Nonetheless, a relatively high number of implemented aspects from the positive psychology theories of the Broaden-and-Build theory, Acceptance and Commitment Therapy and the 6-Factor Resilience Scale could be identified in the apps. The proportion of fully or predominantly implemented Persuasive System Design elements proved to be moderate, although the combination with the number of partially implemented PSD features indicated above-average integration within the apps. Furthermore, the findings show that subjective user ratings and number of downloads did not seem to be correlated with standardized expert quality ratings, use of positive psychology evidence-based content or PSD elements.

## 4.1 Evaluation of all quality indicators for the selected apps

Across the applied three quality indicators, the Wysa app achieved the highest scores overall, compared to the other 9 apps analysed and tested in this study. Although only the limited free version was evaluated, and the paid premium version would likely improve the assessment even further, Wysa achieved the highest overall scores in terms of both the implemented theoretical principles, the PSD elements, and the expert ratings, conducted with the MARS scale. In addition, Wysa was also rated among the best in terms of user ratings in the app store and had one of the highest number of downloads, although these statistics do not differentiate between premium and free versions.

Two other apps also achieved relatively high overall scores (Happify and Iona Mind) and only scored lower than Wysa on the number of implemented PSD elements and the average MARS expert ratings, although Happify had more social support features overall than Wysa. All three apps offered several interactive features, like a well implemented chat-bot or even games. Furthermore, the variety of available content within the free version of those apps was higher in most cases in comparison with other apps with lower total scores. Interestingly, contrary to the high overall rating of the various quality indicators in this study, the subjective user ratings for the Happify app were by far the lowest.

The apps with the lowest overall ratings were Moodfit and What's up? which in both cases contradicted the subjective user ratings. One reason for the low overall ratings might be the lack of interactive options for both apps. For example, the free version of

Moodfit was very limited. Therefore, the positive user ratings in the app store may be based on the premium version of the app, which appears to have far more and higher quality features to offer. What's up?, on the other hand, did not offer a premium version, so this could not explain the high user ratings for this app. Furthermore, the actual features offered within the app were very one-dimensional, limited to written information and some quotes, and offered little to no interaction options for the user. However, What's up? offered an integrated community, which may have had a positive influence on the user ratings.

### 4.2 Evaluation of the theoretical foundation

One specific important quality indicator for the effectiveness and motivation for behaviour change has been highlighted in terms of the underlying theoretical and scientific basis of the implemented intervention features (e.g., Donker et al., 2013). Therefore, the apps tested in this study were examined in terms of implemented scientific foundations from positive psychology theories or models.

A significant and strong relationship was found between the number of used theoretical features and the total number of implemented persuasive system design elements. This shows that the number of theory-based features and exercises within the apps is associated with the number of PSD elements to increase user adherence. This might be seen as an additional quality indicator for certain apps because they may arguably more thought-through in terms of both theory-based content and technical features. This conclusion may be affirmed by the strong positive correlation found between Primary Task Support elements and scientific features. It could indicate that apps with technical expertise in terms of user-friendly designs, easy handling and personalized features are more likely to be based on scientific expertise as well.

Another strong positive correlation was found between the average number of implemented theoretical elements and the average score of existing System Credibility Support features. These findings may possibly be related to the fact that the elements of this PSD-category aim at the integration of reliable information by experts and professionals and may thus represent an overlap with theoretical foundations.

Furthermore, it was found that implemented theoretical features concerning the Creation of positive emotions were significantly related to the expert quality ratings. This finding suggests that the creation of positive emotions may also have influenced the expertise subjective ratings of the overall app quality, because research shows that experiencing positive or negative emotions may lead to a generally more positive respectively negative

view (Dreisbach, 2008). Furthermore, some items of the MARS are directly asking to rate the entertainment of app features (e.g., Section A: Engagement), which can thus be seen as an overlap with the creation of positive emotions while using certain app features.

Although only weak correlational effects were identified between theoretical foundation and the number of downloads, an interestingly strong positive correlation could be detected between features concerning the promotion of strengths (PS) and download quantities. This finding may lead to the assumption that the analysed apps within this study already stated a promotion of strengths in their description, and some users may have especially searched for ways to enhance personal strengths, so they were possibly more likely to download them. However, the app's descriptions mention tasks to promote strengths only very limited, so the strong relation may just be caused randomly.

### 4.3 Evaluation of the implementation of Persuasive System Design elements

In this study, the use of Persuasive System Design elements (Oinas-Kukkonen & Harjumaa, 2009) was included as a second quality indicator, since according to Bolier and Abello (2014) they are supposed to improve both effectiveness and adherence in the use of apps.

Overall, a moderate implementation of PSD elements was found within the 10 apps analysed and tested, with implementations varying greatly within the four categories. The most implemented category of elements was related to System Credibility Support, with the principles "Trustworthiness" and "Expertise" in particular being identified to a large extent in almost all apps. This is in line with the finding that most of the analysed apps provided clear references to the theoretical background and thus presented trustworthy and professional information.

The fewest applied principles were found in the Social Support category within the tested apps, which likely reflects that the implementation of some sort of social network is difficult and cost intensive. Some apps at least offered the possibility to share content via external social media channels and to view personal experience reports of other users via the app or the associated website. In comparison, the integration of principles from the Primary Task Support category, for example, likely represented less effort for the developers. For example, "Reduction" was embedded in all 10 apps analysed, since the simplification of the structure and content of the apps also makes them easier to implement in the development process.

Moderate scores for implemented PSD elements were found for the categories Primary Task Support and Dialogue Support. This results from the finding that some principles were

only partially implemented in most apps. Wysa, for example, was the only app that implemented the principle of tailoring on a large scale. This can also be explained by the technical difficulty of extensively tailoring the system to the user and reacting flexibly to their interactions. However, based on the app's descriptions, it can be assumed that this principle could be integrated within the premium versions of some apps.

Interestingly, a significant relationship between the overall number of implemented PSD elements and the average expert rating with the MARS scale was found. This suggests that the overall expert rating of an app with the MARS scale tends to be higher as more PSD elements are implemented and vice versa. This may be explained on the hand of MARS items like Customisation and Interactivity (section A, items 3 and 4) or items concerning the graphical design of the certain apps (section C). Those sections are overlapping with elements from PSD categories such as Primary Task Support and Dialogue Support, which was also underlined due to the finding of strong relationships between those two categories and the average expert ratings.

### 4.4 Evaluation of the subjective quality

The analysis did not reveal any significant correlation between the number of downloads and the average user ratings. Only the app Wysa showed an overlap between high user ratings and high download numbers. The app store user ratings as well as the download numbers did also not correlate at all with theory base and implementation of PSD-elements. This suggests that user ratings or a high number of downloads does certainly not correspond well with more standardized theory-based or expert-based indicators of quality. These findings may contradict the expectations of the app store users, who are likely to expect a rather low number of downloads or low rating to reflect a low quality of the app. This assumption of a lack of meaningfulness of the user ratings is also confirmed by the lack of significant correlation with the average expert ratings. For an actual quality assessment for users, it is therefore clearly advisable to implement an assessment based on professional standards for apps, such as the MARS, because both user ratings and the download numbers don't seem to be a valid quality indicators.

The expert rating scores determined using the MARS scale (Stoyanov et al., 2015) showed notable differences compared to the average app store user ratings, and no significant correlation was found between the two subjective quality indicators. For example, the app Mindspa, had the second-best rating of all apps for this study based on the user ratings, while the app received almost the worst rating in the expert rating. This finding could support

Kuehnhausen and Frost's (2013) assumption that apps are often rated by fake reviews to increase their attractiveness to potential users. On the other hand, according to Maartens and Maalej (2019), this would automatically suggest a higher number of downloads, which could also not be proven by the lack of correlation between download quantities and subjective user ratings in this study. Therefore, it is recommended to conduct further research regarding the importance and value of user ratings and download quantities for OPPIs.

Finally, the study found a high inter-rater reliability coefficient for the MARS scores and a significant correlation between the MARS expert ratings and implemented persuasive system design elements as well as theoretical features. Those findings suggest that the MARS scale is a robust indicator for multi-layered quality features of OPPIs. Thus, the MARS scale seems to be a feasible, reliable, and valid standardized possibility for future research on the quality of OPPIs.

### 4.5 Strengths and limitations

The aim of this study was to generate more accurate insights into the quality of currently available apps aiming to enhance resilience within the Google Play Store. This was extensively examined using several quality indicators, in terms of theoretical backgrounds from elements of positive psychology, the Persuasive System Design elements and the MARS expert rating scale, with additional consideration of user ratings and number of downloads.

So far, no previous studies have explored the quality of free-of-charge OPPIs focussed on improving resilience. As stated in the literature (e.g., Baños et al., 2017), there are still major deficits in standardized quality indicators for mental health apps and especially in terms of OPPIs. Potential users can get a deeper impression of the quality of the apps examined here, which may simplify the choice of an app that would otherwise only have to be decided based on unreliable download statistics or user ratings.

The high inter-rater reliability between the two raters of the MARS expert rating scale can be seen as a clear strength for the respective outcomes for subjective quality ratings of this study. However, the lack of inter-rater reliability testing for the quality indicators other than the MARS, such as the coding scheme of the scientific background and the evaluation of implemented PSD elements, are one specific limitation of this study. Both the theoretical basis and availability of PSD elements were observed by only one researcher, using self-developed coding schemes, and scoring rules. This may have led to possible systematic and unsystematic biases could have been uncovered by a second researcher. In particular, the evaluation of PSD elements proved to be quite difficult. Therefore, a second researcher may

detect some PSD elements the first researcher may have missed. Determining a mean score of the results of both raters may have led to a higher reliability and reproducibility. For future research it would be helpful to add another researcher to discuss possible disagreements in the analysis of implemented PSD elements. For example, in a study from Halcomb (2019) three researchers from different professions discussed the detection of PSD elements regularly in face-to-face sessions to maximize clarification of the features of the PSD model.

There are also some limitations of this study concerning the search for and selection process of the included apps. The chosen sample size for this study was rather small, so it would be recommended to create more representative impression of available apps that aim to enhance resilience with a greater sample size in following studies. This may also be done by including other app stores in the selection criteria, as this study only made use of the Google Play Store, which may also have limited the overall impression of currently actually available mental health apps concerning resilience. A larger sample size would also increase the power of for instance the correlational analyses.

A related limitation is the selected language within the Google Play Store, which was searched and installed in Germany, which possibly also caused limited results, so a selection of apps in the native language would certainly be recommended. Furthermore, the relatively short testing period of 2 weeks may have resulted in only a limited exposure to individual app elements in some apps since these were sometimes recommended for longer periods of use.

Finally, only free-of-charge apps were implemented in this study to specifically investigate apps that are usable by everyone regardless of financial means. However, many features within the apps appeared to be only available in the premium version, so that they could not be considered in the analysis, which could presumably also have an influence on the quality assessment.

### 4.6 Recommendations

Overall, it can be concluded that further research in the area of mental health apps with the goal of strengthening resilience is recommended. Perhaps, such apps already offer possibilities to get effective help by means of positive psychology interventions and without the help of professionals like therapists and coaches. The choice of available apps is huge, but so are the qualitative differences between individual apps. Thus, it would be interesting to conduct more extensive studies with a larger number of apps over a longer duration of time.

Particularly the significant relationships between the individual quality indicators, provide a possible basis for app developers to consider persuasive system design elements as

well as scientific and theoretical aspects when implementing different features in OPPIs to increase the quality and the verified evaluation based on transparent and standardized criteria. For app developers, the results of this study show that it is recommended to consider the integration of PSD elements when developing future mental health apps. In the context of this study, it became clear that especially Primary Task Support elements can promote assessment by expert quality ratings to a high degree. However, additional inter-rater reliability testing is recommended regarding all quality indicators, such as the coding scheme of the scientific background as well as the evaluation of implemented PSD elements.

Further resilience research in the area of implemented OPPIs in apps could thus reduce the mental health gap, thus the gap between available and necessary research on preventive and acute mental help (WHO, 2011), in the long term. In addition, some of the major negative effects of stress-related mental disorders mentioned by Kaluza (2018) could be prevented at an early stage and, above all, at low cost. However, an important prerequisite for this would be the implementation of a transparent and valid quality rating seal to be able to offer users trustworthy and professional quality assessments and thus effective self-help options via apps.

### 4.7 Overall conclusion

The present assessment of the quality of currently available mental health apps aimed at enhancing resilience indicate that there is still space for improvement. The quality characteristics analysed in this study show that app store ratings and download statistics are not very reliable indicators of quality. This study may therefore give a first idea towards the development of a standardized quality seal for mental health apps in the long term. This should include an assessment of reliable and scientific backgrounds as well as a large scope of implemented PSD elements, especially to enhance user adherence. That way, in the future, every individual may be able to have access to high quality support in terms of building resilience and learning to cope with daily stressors with in-app online positive psychology interventions. Although it might be a long way for e-mental health apps to establish as high quality treatment, and prevention option for mental health issues, there is clearly the potential, like David Dobbs noted in an interview with Tom Insel, a former director of the National Institute of Mental Health:" We're not going to reach all those people by hiring more psychiatrists,' says Insel. But we might reach them with smartphones." (Dobbs, 2017).

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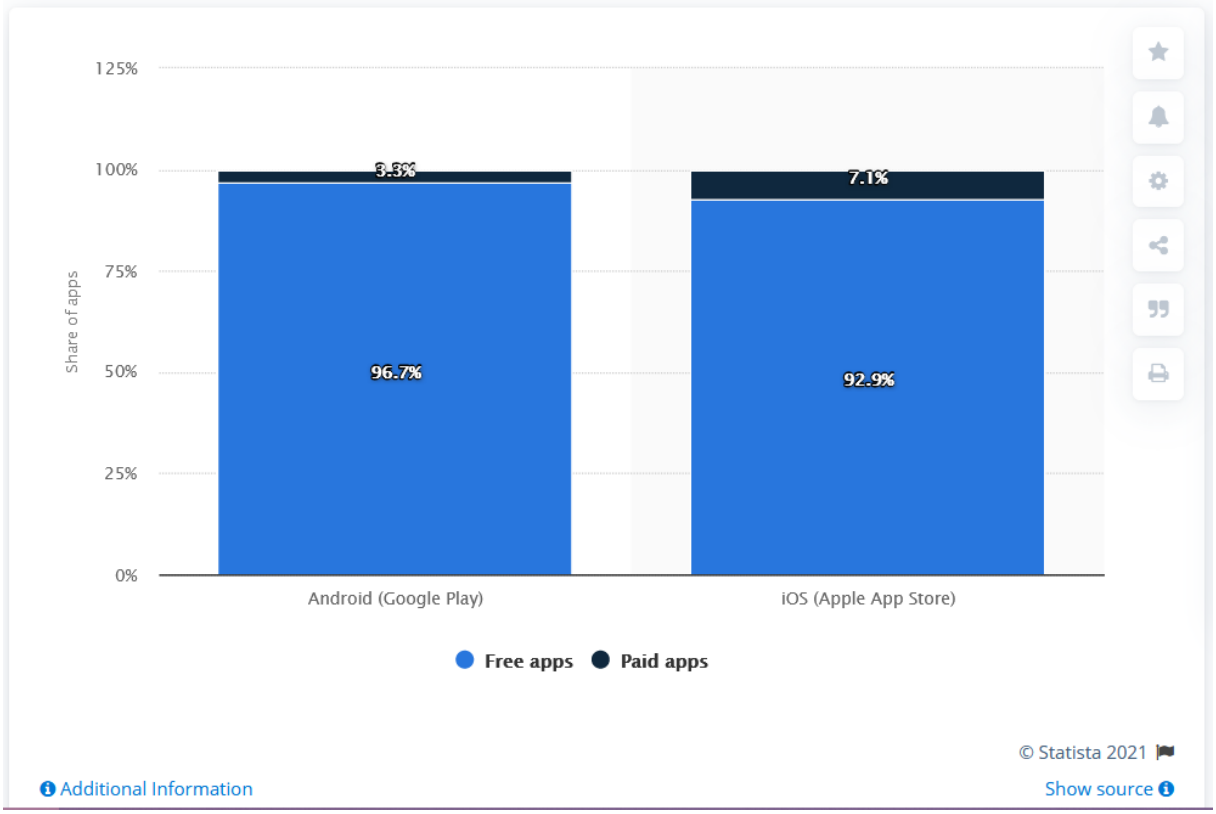
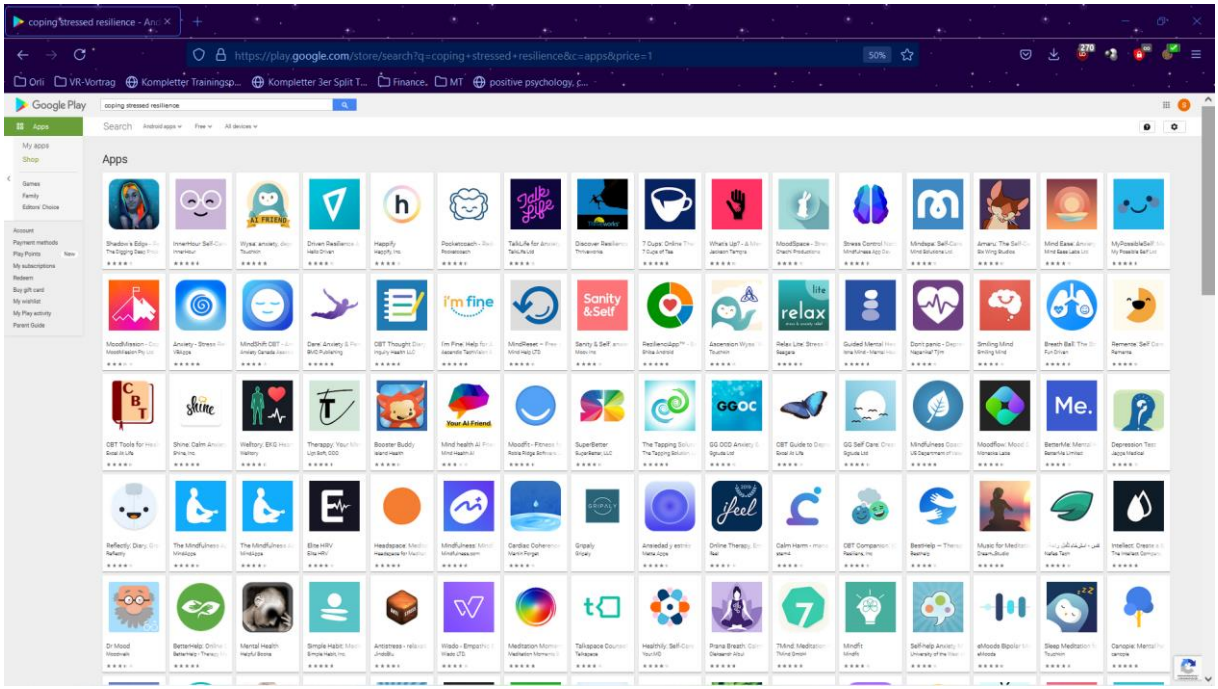
# Appendix A: Distribution of free and paid apps in the Apple App Store and the Google Play Store

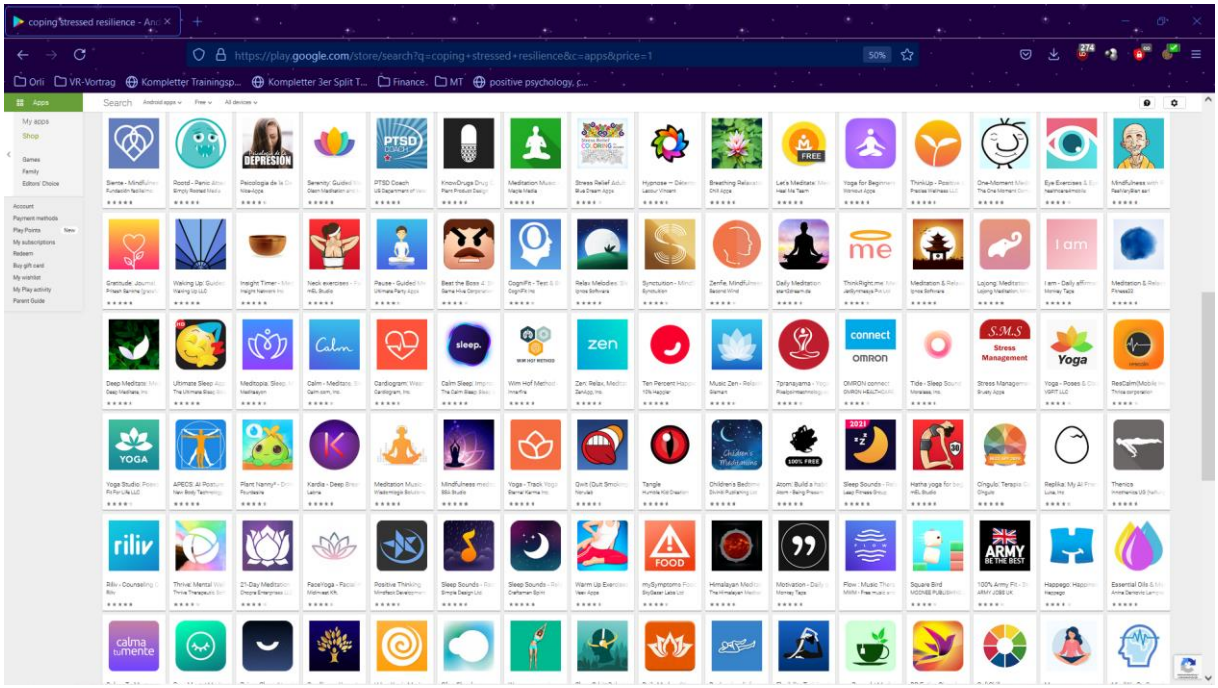


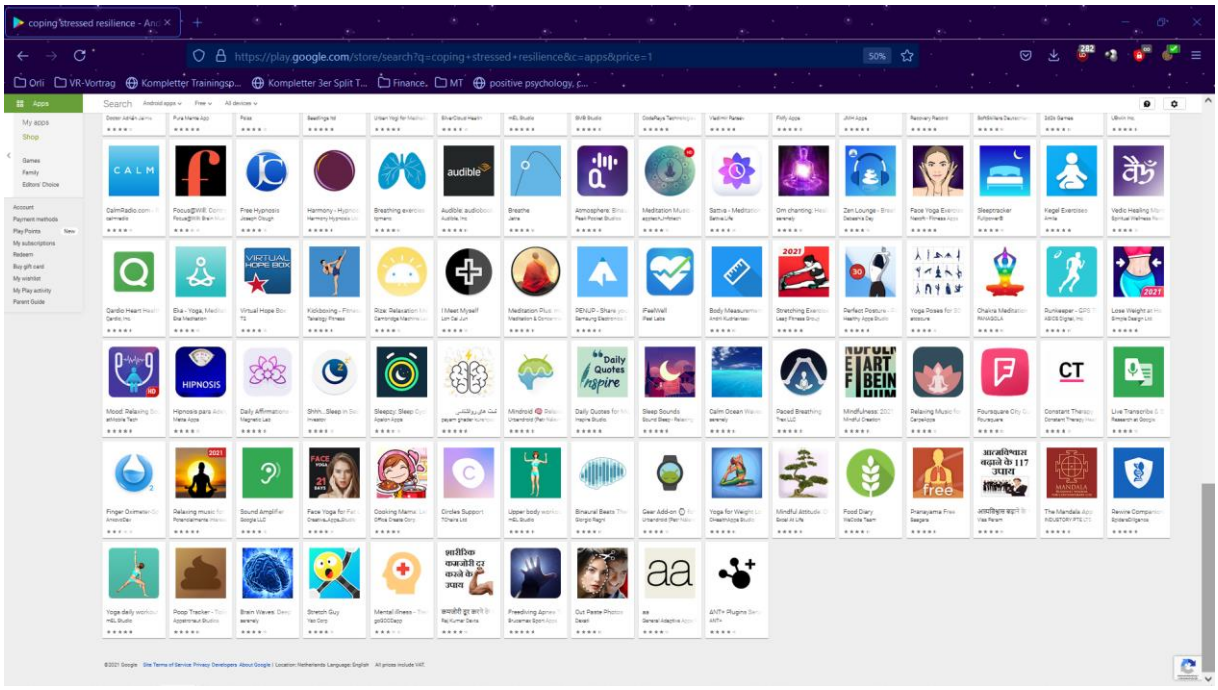

Retrieved from Statista (2021c).

# Appendix B: Screenshots of Searchterms and detailed app descriptions

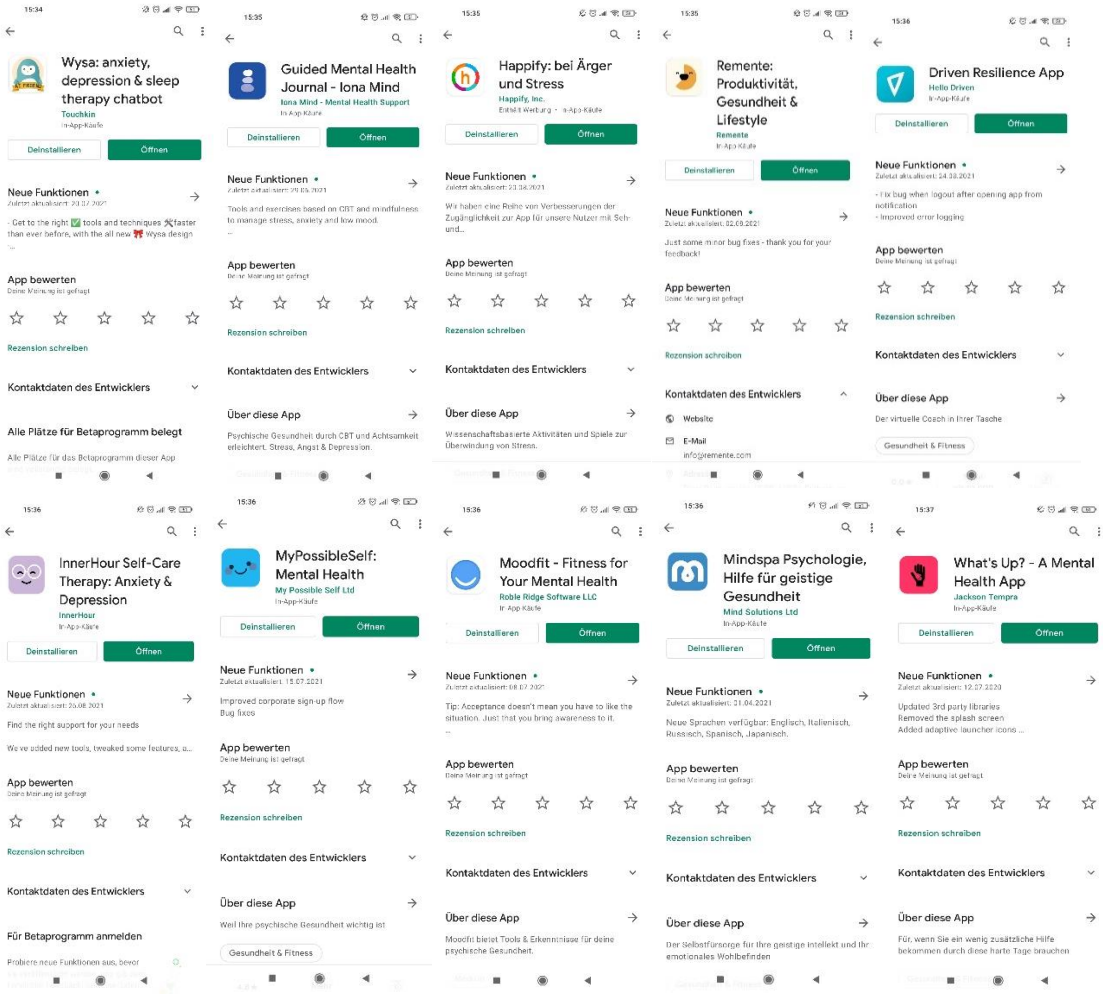
## 1. Searchterm in GooglePlay (Android AppStore): Coping, Stressed, Resilience







## 2. Screenshots of selected apps for the analysis



## 3. Detailed App description

| | Driven Resilience App | Happify | InnerHour | Iona Mind - Guided Mental Health Journal | Mindspa | Moodfit | MyPossibleSelf | Remente | What's Up? | Wysa |
|---|---|---|---|---|---|---|---|---|---|---|
| Initial release | 26.06.2019 | 30.04.2015 | 22.08.2017 | 07.07.2020 | 30.01.2020 | 04.01.2017 | 12.03.2021 | 11.02.2015 | 04.03.2015 | 06.10.2016 |
| Version (Android) | 2.3.165 | 1.68.6-ddc3fee0b227 | 03.05.2001 | 1.035 | 1.0.59 | 2.24.2 | 3.2.0 | 1.9.3 | 2.3.6 | 2.9.2 |
| Last update (Data from 30.08.2021) | 24.08.2021 | 20.08.2021 | 31.08.2021 | 29.06.2021 | 01.04.2021 | 01.09.2021 | 15.07.2021 | 02.08.2021 | 12.07.2020 | 20.07.2021 |
| User Rating PlayStore | 4,2 (74) | 3,7 (2.803) | 4,6 (14.847) | 4,6 (603) | 4,6 (2.316) | 4,5 (510) | 4,8 (419) | 4,3 (11.073) | 4,2 (3.427) | 4,7 (98.266) |
| | | | | | | | | | | |
| Downloads | 10.000+ | 500.000+ | 1.000.000+ | 10.000+ | 100.000+ | 10.000+ | 50.000+ | 1.000.000+ | 500.000+ | 1.000.000+ |
| USK (App Store) | 0 (4) | 0(4) | 0 (17) | 0 (12+) | 0 (17) | 0 (12) | 0 (12) | 13 (12) | 0 (4) | 0 (12) |
| Developer | Hello Driven Pty. Ldt. Australia | Happify, Inc. USA | Mindcrescent Wellness Ventures Privat Limited India | Iona Mind LTD UK | Mind Solutions Ltd | Roble Ridge Software LLC USA | My Possible Self Ltd. UK | Remente AB Sweden | Jackson Tempra Australia | Touchkin eServices Pvt. Ltd. UK, India, |
| Language | English | German, Englisch, French, Italian, Japanese, Portuguese, Spanish, simple Chinese | English | English | English, Italian, Russia | English | English | German, English, Italian, Swedish, Spanish | English | English |

### 1. Driven Resilience App

Driven promises to enhance resilience, reduce stress and to cope with daily problems. The app contains the menus driven daily, chat, explore, my stats, account, and helplines. The following functions are available in the driven daily: section: Reflection on the current state of health, overview of the resilience score, which is based on the six domains of resilience, overview of favourites, and feedback on the app functions. In the chat area, the user is encouraged to interact about feelings, worries, etc. with the help of an AI-driven chatbot. In chat, the chatbot provides suggestions and help on various topics. In the explore area, courses are offered on various topics such as health, resilience, and composure. In addition, articles on various topics can be found there. In my stats an overview of the mood development is given as well as measurements about personality traits, mental health, finance, work & employment. In the account section, settings can be made for the subscription, personal data and reminders. In the helplines section you can find numbers, institutions for different issues e.g. depression, suicide, police, emergency, grief, help for men.

### 2. Happify

Happify is an App for improving one's mental health and mood and includes the menus Instant Play, Explore Tracks, Happify Daily, Community, and Profile features. Instant Play is about various activities to increase well-being by covering various topics such as Savor, Give, Empathize, Revive, Aspire, and Thank. Explore Tracks, like Instant Play, is also about various activities to increase well-being based on the above themes. However, Explore Tracks

selects or suggests specific activities in order to get closer to a goal by means of points. For example, activities to increase empathy are suggested in the form of a step plan (tracks). The variety of activities is large and ranges from knowledge transfer via text to sports exercises and meditation music. In the Happify Daily section, current articles on a wide variety of topics can be read. The Community section is about receiving and giving encouragement and feedback from other users. For this purpose, there is the possibility of public posts. In the Profile area, the collected points and previously mentioned answers to the known topics are displayed. In the general settings options, various settings can be made, such as notification medium, animation, contrast, access permissions etc.

### 3. InnerHour

InnerHour is an app for stress management and stress reduction. The app consists of the following levels: Home, Goals, Relief Bot and Profile. In the Home menu, the free version displays the measured stress level as well as courses, recommended activities, mood tracker, resources such as articles and the Well-being Guide, which explains the topic of dealing with stress on the basis of various aspects. In the Goals menu, daily goals for tackling stress or living happier can be scheduled. In the Relief Bot menu, chats can be held with an AI bot that is embodied by an avatar. In the chat itself, you can choose from predefined answers and thus answer questions. In the Profile menu, all activities such as completed goals, read resources, collected happiness points, etc. are displayed. In addition, the Daily Reminder, name and profile picture can be set. In addition to the menus, there is also the Log area, which provides information about the progress of plans, courses, and the mood.

### 4. Iona Mind

Iona is an AI app which is based on CBT and advertises a high individuality factor resulting from personalized plans to achieve personal mental wellbeing goals.
The main functions of Iona consist of a journal which in turn consists of "Checking & Mood Journal" and "Gratitude Journal", an AI driven chat where personal goals and plans are created, theories and methods are explained and the user's state of mind is asked for, a topic area where exercises on meditation & mindfulness, calming, gratitude and mindfulness can be found and an account area where the set goals progress is documented. Message Speed and Notification Time can be customized through settings.

### 5. Mindspa

The Mindspa app is designed to improve mental health and emotional wellbeing. The app includes the Feed, Diary, Psychosutra, Courses and More sections. The Feed section contains articles on various topics related to mental and physical health. In the Diary section, daily experiences can be recorded via posts. A time frame provides information about the average of one's own mood, self-care and self-harm over a period of one or two weeks. Furthermore, seven questions about personal feelings and self-care are asked, which in turn can be answered freely. In the area of Psychosutra, one deals with a current feeling, in which five tasks are to be mastered. In the free version, however, often only one or two tasks are accessible. In the Courses section, a distinction is made between the personally selected tasks and all tasks. The 33 courses last between one week and one month and cost up to 99.99 US dollars. In the More section, you can find emergency numbers and locations, personality tests, and saved articles that are stored in a library. In the settings, the notification function can be switched on or off.

### 6. Moodfit

The app Moodfit promises to improve mental health by reflecting on one's mood and thus identifying triggers for mood-changes. Moodfit includes the menus Home, Tools, Notices, History and Insights.

In the Home area, the degree of achievement of the daily goals and the number of consecutive days on which the mood was set are displayed for motivation. In addition, current reminders and daily goals are displayed, as well as specially selected activities on 14 topics such as socializing, sleep, CBT, working or gratitude.

In the Tools section, the free version provides various methods such as background knowledge, activities, advice, etc. for reducing stress and increasing mental health on 11 topics. In the Notices section, input is given in the form of journals or background knowledge on various given topics. The Insights section is mainly for the commercial version and has only in the free version the function of mood tracking. Reminders and notifications can be set in the Settings area.

### 7. MyPossibleSelf

My Possible Self is designed to improve mental health. It consists of the Home, Series, Toolkit and Insights menus. In the Home menu, in addition to displaying the mood history

and the possibility of adding a current mood assessment, guided series or activities on various topics such as sleeping well and keeping active are presented. Furthermore, blogs on suicide prevention and exercises to improve mental health can be found. In the Series menu, you can access the activities for improving mental health through different topics. In the Toolkit menu, 26 different topics are covered, highlighting advice, knowledge and personal experience. In the Insights menu, all activity histories are displayed. Mood history, sleep summary, common thoughts, lifestyle score, food log, drink log, top physical activities, anxiety ratings, top physical symptoms, and symptoms and behaviour concerning stress are visually presented in tables and pictograms. The crisis function provides emergency numbers and locations for the UK and USA. Reminders can be customized in the settings area.

### 8. Remente

Remente is an app for improving self-control, reducing stress, anxiety and depression as well as enhancing self-esteem. 'The app Remente includes the menus Agenda, Goals, Journal, Resources and Account. In the Agenda, daily reflections can be made, a to-do list can be created, and a calendar can be created. In the Goals section, users can set and personalize their own or suggested goals, which are divided into active and completed goals, in order to be emotionally addressed and stay motivated. Personalization takes place in the form of addable photos or the like. The menu Journal is to spot trends and patterns in order to identify connections between wellbeing and actions. By reflecting on the mood & emotions as well as on life balance. Posts and quotes act as inspiration. Furthermore, there is a review of all activities in the app like goals, mood etc. In the Resources section you can find knowledge, life-hacks, and plans about how the brain works as well as courses, boosts and ready-made goals. In the account area, settings for privacy, security, language, notification & purchases can be made. In addition, there is a weekly mood scale, reports, and insights as well as the development of the life wheel. The life wheel considers the topics love & relationships, health & fitness, career & education, personal development, family, friends & social life, fun & recreation and finances.

### 9. What’s Up?

What's Up? contains the menus donation, help right now, coping strategies, information, personal and settings. Under help right now, the user will find a first aid measure to become emotionally calm and the get grounded game, where one must name five things about a topic to get out of ruminating or to have distraction, 3 breathing techniques, a problem scaling

function and forums. In the coping strategies section, there is a guide to break down and identify negative learned thought patterns, metaphors and stories that serve to illustrate thoughts, a worry manager where 10 ways to cope with problems are listed, and 12 ways to feel better emotionally. Under information, background knowledge and strategies about anger, anxiety, depression, self-esteem, stress are provided. In the personal section there are the functions diary for reflecting mood, feelings, and thoughts, tracking positive habits, notes and to do list, where negative habits that need to be resolved are entered. In the settings, themes, passwords, block users and cloud data can be customized.

**10. Wysa**

Wysa is making use of an AI-chatbot with the aim of reducing symptoms of stress, anxiety and depression and helping users in coping-techniques. When the app is launched, the user is instructed to "take a deep breath" and a motivating phrase. The user then finds himself on the app's home screen. There, in the upper right corner, an "SOS" button is visible, which, when selected, offers the option to contact the app's chatbot in cases of crisis in order to create a crisis plan or to calm panic attacks with the help of the chatbot. In addition, there are telephone numbers and external links to professional contact points for acute mental crisis states such as acute suicidal tendencies.

On the home screen, the user also finds a collection of previously started exercises that can be continued by touch. In addition, the user has the option of chatting directly with "Wysa" the chatbot or selecting "Pause" to be guided through visual and acoustic features for meditation and calming. Furthermore, the user has the possibility to contact the chatbot via voice chat, although this function is still in the beta phase. The exercise packs that have been started so far can be found under this function ("my packs"). In the lower third of the home screen, the user receives recommendations for further exercise packs, tailored to the user's actual progress.

In addition, direct contact to the team behind Wysa can be established via chat. At the bottom of the home screen, a continuously changing positive assessment of actual users about the app appears. In addition to the above-mentioned functions, the user can contact a therapist directly from the home screen, although this is only possible as a paying subscriber.

Furthermore, the "self-care" button provides an overview of all exercises offered in the app. A total of 31 "exercise packs" are listed here, each containing between 3 and 13 exercises with an expected duration time, of which in most cases only the first exercise can be completed in the free version of the app. There are also 21 "Sleep Stories" and 18 "Sleep Sounds", with one

sound or story available in the free version of the app. Finally, the user finds the option "Journal" where the user's progress so far is recorded with time and date and the achieved goal is mentioned (e.g., "Discovered new ways to reduce my tension").

# Appendix C: Description of the PSD-elements and coding scheme outcomes

## 1. Description of Persuasive System Design elements (Oinas-Kukkonen & Harjumaa, 2009)

| | |
|---|---|
| | **Primary Task Support** |
| Reduction | The user's effort in performance with features should be limited. |
| Tunneling | System should provide some sort of guidance and means for action. |
| Tailoring | Information should be tailored to the targeted users. |
| Personalization | Content should be able to be personalized. |
| Self-Monitoring | Users should be able to track their current performances. |
| Simulation | System should provide observations of cause and effects concerning targeted topics. |
| Rehearsal | Users should find means to rehearse focused behaviours within the system. |
| | **Dialogue Support** |
| Praise | Users should receive feedback in terms of praising words, symbols, images or sounds. |
| Rewards | Users should be able to receive some sort of rewards for their performance. |
| Reminders | Users should be reminded by the system to perform the targeted behaviour. |
| Suggestions | Users should receive suggestions in performing targeted behaviours in real-life. |
| Similarity | Users should feel imitated in some way by the system. |

| | |
|---|---|
| Liking | The design and appearance of the system should be appealing. |
| Social Role | A social model or role should be adopted within the system. |
| | **System Credibility** |
| Trustworthiness | Truthful, unbiased, and fair information should be provided by the system. |
| Expertise | System should show knowledge and competence behind provided information. |
| Surface Credibility | System should feel and look competent. |
| Real-world-feel | Users should be able to find information about the founders and people/organizations behind the system. |
| Authority | Users should find references to people or organisations of authority. |
| Third-party endorsements | System should endorse respected external sources. |
| Verifiability | Accuracy of presented information should be verified by external sources. |
| | **Social Support** |
| Social learning | Other users should somehow be observable in their performance of targeted behaviours within the system. |
| Social comparison | Comparison with other users should be enabled. |
| Normative influence | System should gather people with same goals and topics to provide them a feeling of being normal. |
| Social facilitation | The possibility of discerning other users should be provided by the system. |
| Cooperation | Means for cooperation should be provided. |
| Competition | Means for competing with other users should be provided. |
| Recognition | Users should be able to recognize people who already perform targeted behaviours within the system. |

## 2. Coding scheme of PSD-elements

### Table 1. Primary Task Support

| App | Reduction | Tunnelling | Tailoring | Personalization | Self-Monitoring | Simulation | Rehearsal | Score (*k*) | Used elements (*t*) |
|---|---|---|---|---|---|---|---|---|---|
| Driven | + | + | / | + | / | / | + | **11** | **4** |
| | Clear and easy to use, all options visually noticeable, no external devices or links necessary | The next feature is only available when completing the previous one | App is tailored to the need of building resilience in different aspects of life. Does not make use of e.g. examples or stories of representative others | Generation of an individual username and demographics, chat uses surname in salutation | Only daily mood and history of tasks is saved in the free version, other stats like personality, mental health, finance and work & employment stats and progress can only be tracked in the paid version of the app | Some sort of simulation due to different choices to answers in chat with explanations of possible outcomes concerning the given answers, some statistics about the effectiveness of the app on the website | The app offers several options to rehearse the targeted behaviour changes like asking questions about the learned backgrounds after exercises or meditation practices | | |
| Happify | + | + | - | + | / | / | + | **10** | **4** |
| | Clear and easy to use, all options visually noticeable, no external devices or links necessary | The next feature is only available when completing the previous one | | Generation of an individual username and other demographics, asks personal questions and saves the answers and „stats“ within the app. There is also a choice between a private – or a community mode | Personal progress is tracked and can be seen by the user. („explore tracks“) | Some statistics are mentioned concerning the effectiveness of the app’s tasks | The app offers several options to rehearse the targeted behaviour changes like games or meditation practices | | |
| Inner Hour | + | + | - | + | / | - | / | **8** | **3** |
| | Clear and easy to use, all options visually noticeable, no external devices or links necessary | The next feature is only available when completing the previous one (a task per course per day) | | Generation of an individual username, also presenting personal plans on the home screen and letting the user set own goals to follow | Mood logs are tacked and own goals, Relaxation -or Physical Activities can be chosen to be tracked daily, other activities and goals can only be tracked with a premium account | | The app offers some practices like PMR and breathing-techniques as audio-guides to rehearse | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Iona | + | + | / | + | + | / | + | **12** | **5** |
| | Clear and easy to use, all options visually noticeable | The next feature is only available when completing the previous one | App is saving characteristics, current moods and problems of the user and makes suggestions partly tailored to the mentioned problem via chatbot | Generation of an individual username and current problems, moods and user characteristics are saved for personalized next topics | App offers self-monitoring options with journal-entries (e.g., Gratitude Journal or Checking & Mood Journal) | Statistics about the effectiveness are mentioned („86% of users report feeling better after their first session with Iona Mind: the AI journal with empathy. “) | The app offers several options to rehearse due to for example meditation or writing exercises | | |
| Mindspa | + | / | - | / | / | / | - | **6** | **1** |
| | Clear and easy to use, all options visually noticeable, no external devices or links necessary | App offers a limited tunnelling option in the free version (only 2 workouts can be done each day); Intro workouts have to be done to follow with the next one | | Limited personalization in terms of diary entries | Self-monitoring limited available due to diary entries | On the app’s website some statistics about the effectiveness can be found within the FAQ-section | | | |
| Moodfit | + | / | - | / | / | - | - | **5** | **1** |
| | Clear and easy to use, all options visually noticeable, no external devices or links necessary | App offers limited tunnelling functions in the free version (e.g., mindfulness manuals are available in 2 days in a row, afterwards the premium version is necessary to continue) | | App offers only a few options that can be customized like setting own activities and reminders or daily goals | App offers a few self-monitoring options like tracking the user’s mood or setting daily goals and activities | | | | |

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|---|---|---|---|---|---|---|---|---|---|
| My Possible Self | + | - | - | - | / | - | / | **4** | **1** |
| | Clear and easy to use, all options visually noticeable, no external devices or links necessary | | | | Self-monitoring limited available due to the Insights section | | The app offers a few options and interactive tools to rehearse the targeted behaviour changes | | |
| Remente | + | / | - | / | / | / | / | **7** | **1** |
| | Clear and easy to use, all options visually noticeable, no external devices or links necessary | Courses need to be followed step by step. However very limited availability in the free version and next steps can be started by just clicking on them, no actual restrictions | | App offers a few personalization options like the individual agenda on the home screen with daily goals and activities | Daily goals and activities can be monitored in the journal-section | App uses some simulations due to pictures and written information concerning cause and effect of behaviour change | The app offers a few options and tools to rehearse the targeted behaviour changes | | |
| What' s Up? | + | / | / | / | - | - | / | 6 | 1 |
| | Simple choice between 4 topics with further sup content (Help Right now, Coping Strategies, Information, Personal) | Guidance from main topics to subtopics is simple and easy to use and understand but there is no progress needed to get to the next topic. | App offers external links to websites of the user's indicated country | Design elements can individually be changed (e.g., colour of background and text), users can present their location and nickname for community purpose, own notes, diary entries and habits can be written | | | App rehearses to „get grounded", or to stay „here & now" naming 5 animals or 5 things you see. | | |

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|---|---|---|---|---|---|---|---|---|---|
| Wysa | + | + | + | + | + | / | / | **12** | **5** |
| | Clear and easy to use all options are visually noticeable | The next feature is only available when completing the previous one, even in chat-based tasks | App offers a broad spectrum of tasks tailored to several needs and issues of users. The chat-bot gives tailored tasks to the individual answers and topics of the user | Generation of an individual username and other demographics, asks personal questions and saves the answers | App offers several (daily) tracking options within the individual journal | Some sort of simulation due to different choices to answers in chat with explanations of possible outcomes concerning the given answers, some statistics about the effectiveness of the app on the website | App offers a few rehearsal options for the users within the chat-bot tasks and also via different exercises (e.g., meditation exercises) | | |
| **Score (*k*)** | **20** | **14** | **5** | **14** | **11** | **6** | **11** | **81** | **26** |

+: fully or predominantly implemented
/: partly implemented
-: little to not at all implemented

## Table 2. Dialogue Support

| App | Praise | Rewards | Reminders | Suggestions | Similarity | Liking | Social Role | Score (*k*) | Used elements (*t*) |
|---|---|---|---|---|---|---|---|---|---|
| Driven | + | + | + | + | + | + | + | **14** | **7** |
| | Praising words and emoticons after completing a task and during chat-sessions | App uses a score-system for increasing mood due to done exercises | App sends reminders every day via push notifications, e-mail reminders are an additional choice | App offers suggestions in every task | App uses suggestive answer-choices that fit to similar problems in real-life settings | The app-system has a very appealing design and usage | App making use of a chat-bot functioning as a helping expert | | |
| Happify | + | + | + | + | - | + | + | **12** | **6** |
| | Praising words after completing a task | App uses a medal-system (silver and gold) for achieving new goals and skills | App sends reminders every day via e-mail and push notifications | App offers suggestions in every task | | Very fun to use and welcoming design elements | App making use of a chat-bot functioning as a helping expert | | |
| Inner Hour | + | + | + | + | - | + | + | **12** | **6** |
| | Some praising words and emoticons; users get rewards in terms of badges and Happiness Points | App uses a badge-system and Happiness Points for interacting with app-elements and for finishing courses | App sends reminders every day via e-mail and push notifications | App offers suggestions in every task | | The app-system has a very appealing design and usage | App making use of a chat-bot functioning as a helping expert | | |
| Iona | + | / | + | + | + | + | + | **13** | **6** |
| | App is making use of some praising words and emoticons during and after completing topics | App offers rewards just in terms of listed progress concerning check-ins, completed lessons and day streaks | App sends reminders every day via e-mail and push notifications | App offers suggestions in every task | App uses suggestive answer-choices that fit to similar problems in real-life settings | The app-system has a very appealing design and usage | App making use of a chat-bot functioning as a helping expert | | |

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|---|---|---|---|---|---|---|---|---|---|
| Mindspa | +<br>Praising words after completing a diary entry | - | /<br>Notifications can only be turned on via the phone settings, not directly within the app | +<br>App offers suggestions in every task | - | +<br>Visually attractive with some pictures and colourful design-elements | - | **7** | **3** |
| Moodfit | - | /<br>App offers rewards as achievements after doing daily activities a few days in a row | +<br>App sends reminders every day via push notifications | +<br>App offers suggestions in every task | - | /<br>App offers a few activity and goal options that repeat daily, simple design elements | - | **6** | **2** |
| My Possible Self | /<br>App uses praising words very rarely („Perfect, that's great") | - | +<br>App sends reminders every day via push notifications | +<br>App offers suggestions in several toolkits | - | +<br>App design is appealing, offers different stimuli in cases of visual and acoustic tools | - | **7** | **3** |
| Remente | +<br>Praising words after completing a task (e.g., daily reflection) | - | +<br>App sends reminders every day via push notifications | +<br>App offers suggestions in goal plans, courses and boosts | - | +<br>App offers an appealing and colourful design with pictures and symbols | - | **8** | **4** |
| What's Up? | - | - | - | /<br>App offers a few suggestions concerning behaviour change („Doing things differently") | - | /<br>Mostly written text with a few motivating and fun to use features | - | **2** | **0** |
| Wysa | +<br>Praising words and emoticons after completing a task and during chat-sessions | - | +<br>App sends reminders every day via push notifications | +<br>App offers suggestions in every task | +<br>App uses suggestive answer-choices that fit to similar problems in real-life settings | +<br>The app-system has a very appealing design, making use of several colours, emoticons, pictures, sounds and video samples | +<br>App making use of a chat-bot functioning as a helping expert | **12** | **6** |
| **Score (*k*)** | **13** | **8** | **17** | **19** | **6** | **18** | **10** | **93** | **43** |

+: fully or predominantly implemented
/: partly implemented
-: little to not at all implemented

## Table 3. System Credibility Support

| App | Trustworthiness | Expertise | Surface credibility | Real-world feel | Authority | Third-party endorsement | Verifiability | Score (*k*) | Used elements (*t*) |
|---|---|---|---|---|---|---|---|---|---|
| Driven | + | + | + | + | + | + | + | **14** | **7** |
| | Unbiased and truthful information provided | App is updated regularly and the app's website provides information about the theoretical background of their tasks as well as the professionals and founders behind the app | App includes no advertisements for other companies just asks to upgrade to the premium version of the app | Organization and professionals can be seen via the website and can also be contacted via e-mail | App's websites refer to cooperation with over 20 universities and refers to founder's and co-worker's professional background | App's website does offer theoretical backgrounds of third-party scientific sources behind the app's tasks and information (e.g., PR-6) | References and experts behind the app can be found on the website | | |
| Happify | + | + | + | + | + | - | + | **12** | **6** |
| | Unbiased and truthful information provided | App elements are based on scientific information and every task refers to a professional | App includes no advertisements for other companies just asks to upgrade to the premium version of the app | Organization and professionals can be seen within the app or via the website and can also be contacted via e-mail | App offers a picture and name of an expert for every task within the app | | References and experts behind the app can be found on the website | | |
| Inner Hour | + | + | + | + | + | + | + | **14** | **7** |
| | Unbiased and truthful information provided | App is updated regularly, and the app's website provides information about the theoretical background of their tasks as well as the professionals and founders behind the app | App includes no advertisements for other companies just asks to upgrade to the premium version of the app | Organization and professionals can be seen via the website and can also be contacted via e-mail or direct chat | App's website refers to founder's and co-worker's professional background | Credibility due to named external partnerships with organizations on the website (like *FinLearnAcademy*, *PocketAces and CurveTomorrow*) | References and experts behind the app can be found on the website | | |

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|---|---|---|---|---|---|---|---|---|---|
| Iona | + | + | + | + | + | + | + | **14** | **7** |
| | Unbiased and truthful information provided | App elements are based on scientific information (e.g., CBT) | App includes no advertisements for other companies just asks to upgrade to premium version ft he app | Founders can be found on the app's website and can be contacted via e-mail | On the App's website citations of recommendations of CEOs of other, external health professionals ft he usage ft he app can be found | App's website does offer theoretical backgrounds of third-party scientific sources behind the app's tasks and information (e.g., Oakland Search or IQHealthTech) | Verifiable recommendations can be found on the website | | |
| Mindspa | + | + | + | / | - | + | + | **11** | **5** |
| | Unbiased and truthful information provided | App is updated regularly, and the app's website provides information about the theoretical background (e.g., CBT) | App includes no advertisements for other companies just asks to upgrade to the premium version ft he app | App offers limited possibilities to directly contact the app's founders via direct message (concerning subjects like accounts issues, coupons and courses, payment issues or suggestions) | | On the app's website an Orcha certification for digital health can be found | On the app's website (FAQ-section) information about the selection process of the theoretical background before actual implementation is described | | |
| Moodfit | / | / | / | - | / | / | - | **5** | **0** |
| | App provides truthful and unbiased information | App notices theoretical background only broadly (e.g., CBT) | App includes no advertisements for other companies just asks to upgrade to the premium version ft he app; but the surface and features do not look competent | | App refers to received ratings by Verywell Mind (an online mental health publication platform) | App's website refers to its reward as „Best Overall Mental Health App of 2020 & 2021"by Verywell Mind (an online mental health publication platform); further information is missing | | | |
| My Possible Self | + | + | + | + | + | + | + | **14** | **7** |
| | Unbiased and truthful information provided | App is updated regularly, and the app's website provides information about the theoretical background | App includes no advertisements for other companies | Founders can be seen via the website and can be contacted in terms of issues or questions | The app's website refers to an external, professional partner organization (Priory Healthcare) | App's website does offer theoretical backgrounds of third-party scientific sources behind the app's tasks and information (working with Priory Healthcare, making use of CBT) | References and experts behind the app can be found on the website | | |

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|---|---|---|---|---|---|---|---|---|---|
| Remente | + | + | + | + | + | + | + | **14** | **7** |
| | Unbiased and truthful information provided | App elements are based on scientific information and courses are include links to scientific sources | App includes no advertisements for other companies just asks to upgrade to the premium version ft he app | Founders can be seen via the website and can be contacted in terms of issues or questions | The app's website shows won awards and achievements by external trusted sources (like Orcha) | Website shows achieved certificates from external organisations (e.g., Orcha) | App offers links to external scientific sources | | |
| What's Up? | / | / | - | + | / | + | - | **7** | **2** |
| | App provides truthful, and unbiased information but with external links to websites with advertisements | App offers external links to presented information but there is no direct link to the profession ft he founders | | App offers a „Credits"-function to get to know the founders better. Furthermore, users have the possibility to contact the organization via e-mail. | The names of the app founders are shown on the app's website, also showing their professional background | App offers direct links to third-parties after every task and feature (e.g. www.getselfhelp.co.uk or www.flaticon.com) and also has an own feature for it „Helpful websites", tailored to the user's country | | | |
| Wysa | + | + | + | + | + | + | + | **14** | **7** |
| | Unbiased and truthful information provided | App is updated regularly, and the app's website provides information about the theoretical background, videos about the app's creators | App includes no advertisements for other companies just asks to upgrade to the premium version ft he app for example additional individual therapy sessions | Organization and professionals can be seen within the app or via the website and can also be contacted via e-mail | The app's website refers to several received awards and certifications by mental health and other organisations, also referring to clinical studies and university employees | Website shows achieved certificates from external organisations (e.g., Orcha, Mental Health America or Mind) | The app's website provides several means verifying the accuracy of the app content due to links and video to external sources. The website also reports clinical validation and client case studies concerning the app's effectiveness | | |
| **Score (*k*)** | **18** | **18** | **17** | **17** | **16** | **17** | **16** | **119** | **55** |

+: fully or predominantly implemented
/: partly implemented
-: little to not at all implemented

## Table 4. Social Support

| App | Social learning | Social Comparison | Normative influence | Social facilitation | Cooperation | Competition | Recognition | Score (*k*) | Used elements (*t*) |
|---|---|---|---|---|---|---|---|---|---|
| Driven | - | - | +<br>App is making use of normative examples in everyday context | - | /<br>App offers an own section about the importance of collaboration in terms of building individual resilience, while not including actual means for co-operation | - | +<br>Personal experiences of users are shown on the app's website (in comments) | **5** | **2** |
| Happify | +<br>App offers a community where users can present their progress and react to it | +<br>App offers a community where social comparison on basis of the user's progress is possible | - | +<br>App offers a community where discussions with other users are possible. Furthermore, achievements can be shared on social media (e.g., Facebook) | - | +<br>Competition with other users in the community in terms have the chance to win prizes with a higher win rate based on achievements and completed tasks | /<br>Prize winners are presented with personal data within the app | **9** | **4** |
| Inner Hour | - | /<br>Users can directly share articles, tips, and inspirations via social media | - | - | - | - | +<br>Personal experiences of users are shown on the app's website (in comments) | **3** | **1** |
| Iona | - | - | +<br>App is making use of normative examples in everyday context | - | - | - | +<br>Personal experiences of other users are shown on the app's website (in comments and videos) | **4** | **2** |
| Mindspa | - | /<br>Users can share a few articles, tips and inspirations via social media | - | - | - | - | - | **1** | **0** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Moodfit | - | /<br>Users can share their activities via e-mail | - | /<br>App's website sends pop-up messages when another user bought a paid course (with surname and location ft he user) | - | - | - | **2** | **0** |
| My Possible Self | - | - | /<br>The app's website provides some general statistics about the amount of people with mental health issues („This means that you are not alone!") | - | - | - | /<br>Ratings and comments concerning the effectiveness of the app from other users are shown on the app's website | **2** | **0** |
| Remente | - | /<br>Advice within the app can be shared via e-mail | - | - | - | - | +<br>References are linked beneath courses within the app | **3** | **1** |
| What's Up? | /<br>App offers a community feature but no possibility to compare target behaviours and outcomes | /<br>App offers a community where users can exchange problems and subjects but there is no function to compare actual performances | /<br>App offers an in-app community where users can exchange subjects with each other but there is no control function concerning the topics users discuss | +<br>App offers a community where discussions with other users are possible | - | - | - | **6** | **1** |
| Wysa | - | +<br>Some features within the app can be shared via social media | +<br>App is making use of normative examples in everyday context | - | - | - | +<br>Personal experiences of other users are shown on the app's website (in comments and videos) | **6** | 3 |
| **Score (*k*)** | **3** | **8** | **8** | **5** | **1** | **2** | **12** | **41** | **14** |

+: fully or predominantly implemented

/: partly implemented

-: little to not at all implemented

## Appendix D: Coding scheme of embedded theoretical elements

**Table 6.** Coding scheme of Accept the present moment (*APM*)

| App Name | Description of Embedded Elements | Coding scheme (+ = *implemented* or - = *not implemented*) | Coding score (+ = *1 point, or* - = *0 points*) |
|---|---|---|---|
| Driven | App offers features in terms of „Focused Awareness“, „Reappraisal“ to enhance composure due to audio, video and chat-guides, which can be accomplished after rating the current mood on the home screen. | + | 1 |
| Happify | App is offering tracks like „Today’s victories“ to help users in accepting and reframing of current bad moods and stressful situations with guided focus on e.g. things the user is grateful for. This can be done with the free track „Conquer negative thoughts“, within the explore tracks function on the home screen. | + | 1 |
| Inner Hour | „Thought Diffusion“ is helping to detach from present unhelpful thoughts with a sound guide. Can be found within the „additional course“ section on the home screen. | + | 1 |
| Iona | App’s offering exercises like the „Iceberg Challenge“, to reframe current stressful situations and thoughts. Another example is the „Challenge thinking“ exercises, helping users to accept the reality detached from negative thoughts. | + | 1 |
| Mindspa | App is mostly giving physical guidance to release perceived negative emotions and tension. App does not include certain features or tasks that are tailored to the individual situation or problem the user must accept. | - | 0 |
| Moodfit | App does make use of tools like the „grounding“-technique to help users staying in the present moment and to release stressful patterns due to guided focus on different stimuli. Another APM exercise can be found in the „Low Mood“-tool, where the user is getting information about how to accept certain situations (e.g., Self compassion, „Thoughts aren’t always facts“ etc.). Users can find those features in the „Tool“-section on the home screen of the app. | + | 1 |

| | | | |
|---|---|---|---|
| My Possible Self | App is making use of „Grounding“ or „Affirmations“ to help the user be present in the moment and taking control over un-useful thoughts and patterns. Those can be done via the „Toolkit“ section within the app. | + | 1 |
| Remente | Only partly integrated, like Mindfulness there are only guided exercises in the paid version of the app accessible. | - | 0 |
| What's Up? | App offers „Coping Strategies“, like „Manage worries“ or „Thinking Patterns“ to reframe current negative thoughts and situations. | + | 1 |
| Wysa | App is making use of several exercises helping users to overcome present stressful and hurtful situations in terms of positive affirmations and reframing of thoughts (e.g., „De-clutter your mind“, exercise within the „Beat stress“ course, can be found in the „self-care“ section). | + | 1 |

**Table 7.** Coding scheme of Mindfulness (*MF*)

| App Name | Description of Embedded Elements | Coding scheme (+ = *implemented* or - = *not implemented*) | Coding score (+ = *1 point, or* - = *0 points*) |
|---|---|---|---|
| Driven | App offers features in terms of „Mindful listening“, „Mindful gratitude“, „Body Scan“, „Open Monitoring“ with guided sound elements between 5 and 10 minutes. Those features can either be chosen via the „explore“-button on the home screen or as a given choice after entering the current mood. | + | 1 |
| Happify | The App offers five free tracks concerning mindfulness and meditation. Those can be done through the „explore tracks“ function on the home screen. | + | 1 |
| Inner Hour | Daily goals include mindfulness tasks like „Fill my gratitude jar“ or „Practise Progressive Muscle Relaxation“. | + | 1 |
| Iona | App offers an own section in the category „Exercises“ concerning Meditation & Mindfulness. These functions can be accomplished via the option „Select Topic“. | + | 1 |

| | | | |
|---|---|---|---|
| Mindspa | Mindfulness tasks are used a lot within the different tasks like breathing exercises to calm down from disruptive emotions. Those can be found within the „psychosutra“-section on the home screen where different courses can be chosen, each containing five tasks. The free version offers two tasks a day. | + | 1 |
| Moodfit | App contains an own Mindfulness tool section (users can get there directly via the „Tools“ button on the home screen). Users have the possibility to write an own „manual“ about for example daily mindfulness exercises, which can also function as reminders, or to listen to audio-guides concerning mindfulness exercises. (Audio guides are tunnelled, a new tool a day after completing the previous one). | + | 1 |
| My Possible Self | App has an own „Toolkit“, concerning „Mindful practice exercises“ using several sound and video files to help the user in that concern. Can be accomplished by directing to the „Toolkit“-option on the home screen. | + | 1 |
| Remente | App includes several mindfulness courses and guidelines but they cannot be done by users of the free version (Included in the “Resources“ section). | - | 0 |
| What’s Up? | App is not referring to any information or exercises concerning mindfulness. | - | 0 |
| Wysa | App offers several mindfulness-exercises, which can be found in the „Self-Care“-section on the homescreen, like „Mindful Affirmations“, „Breathe in Calm“ or „Detach mindfully“, which is the last of nine exercises within the „For Health Anxiety“ course. | + | 1 |

**Table 8**. Coding scheme of Creation of positive Emotions (*CPE)*

| App Name | Description of Embedded Elements | Coding scheme (+ = implemented or - = not implemented) | Coding score (+ = 1 point, or - = 0 points) |
|---|---|---|---|
| Driven | App offers feature in terms of “Reappraisal“ to help the user focus on positive aspects of certain situations and life events due to video, audio and chat-guides. Those can directly be done via the „explore“ function or after adding the current mood. | + | 1 |

| | | | |
|---|---|---|---|
| Happify | This feature is e.g. embedded in a game („uplift“) where the user is challenged to click on positive words on balloons. | + | 1 |
| Inner Hour | Features like guided „doodling“, making use of videos, sounds and emoticons in chat-sessions with „Allie“ the chatbot are used frequently in terms of promoting positive emotions for the user. | + | 1 |
| Iona | App includes many features to create positive emotions inside the user, like a game where the user has to throw negative thoughts and resulting negative emotions in the trash and save good ones. Another example is the „Mood Booster“, (both exercises can be accomplished via „Select Topic“ in the category „Core Exercises“). | + | 1 |
| Mindspa | App offers features to challenge different negative emotions (or enhance positive ones) through guided tasks (within the „Psychosutra“-section). However, these tasks are very limited, because only written text is presented with some information about theoretical ideas to challenge current negative thoughts with only limited guidance and use of features to create positive emotions. | - | 0 |
| Moodfit | App contains several features concerning the creation of positive emotions. They can all be found in the „Tools“- section within the app. Examples are the „Gratitude journal“ where users are guided to focus on positive aspects in life or the „Express Yourself“ tool, where users are able to make use of smileys and other symbols to express their mood or wishes in a cheerful way. | + | 1 |
| My Possible Self | App is making use of several cheerful and features like symbols, emoticons, sound and videos. Furthermore, the app offers focused tasks within the „toolkit“ section to enhance positive emotions like writing down enjoyable activities in the eponymous task. | + | 1 |
| Remente | App offers several features to enhance positive emotions. This is due to offered „Goal Plans“ and „Boosts“ within the „Resources“ section | + | 1 |
| What’s Up? | App is giving some information but rather tips for users than guiding them in the creation of positive emotions. Furthermore, app does not make use of cheerful elements like sounds, videos, or pictures to promote positive emotions. | - | 0 |

| | | | |
|---|---|---|---|
| Wysa | App is making use of several cheerful elements like sounds, videos and images to improve the user's mood besides guided exercises concerning the promotion of positive emotions like making contact with Wysa the chatbot, which can be done via the according function on the home screen. | + | 1 |

**Table 9**. Coding scheme of Promoting Strengths (*PS*)

| App Name | Description of Embedded Elements | Coding scheme (+ = *implemented* or - = *not implemented*) | Coding score (+ = *1 point, or* - = *0 points*) |
|---|---|---|---|
| Driven | The premium version of the app offers features based on the PR-6, also referring to features and exercises to promote own strengths. However, those are not available in the free version of the app. | - | 0 |
| Happify | App is for example making use of Games like „Tranquil lake" to promote the user's strengths in attention to „small details" or some free tracks to „build your strengths to achieve goals". App is also summarizing individual developments of strengths due to absolved tasks, games and other features in the „My Stats" section. Another example are exercises like „Notice your impact on friends/family" where the user is focused on the value for other people. App also features an own section concerning user's individual strengths („Your Signature Strengths"). | + | 1 |
| Inner Hour | Only a few embedded features try to focus on promoting personal strengths but only to a small degree. More features in terms of promotion of personal strengths are available only available in the premium version. | - | 0 |
| Iona | Only partly integrated within several exercises, not actually focusing on enhancing strengths. | - | 0 |

| | | | |
|---|---|---|---|
| Mindspa | Not offering any real strength-based features within the free version of the app. | - | 0 |
| Moodfit | Just to some degree embedded due to the „Gratitude“ tool, but there is no complete exercise, guide or tool focusing on the promotion of individual strengths of the user. | - | 0 |
| My Possible Self | The promotion of individual strengths is only partly included within other tasks. The app is thus not offering an own section to promote individual strengths and abilities. | - | 0 |
| Remente | App is making use of courses like „Appreciate Yourself“, setting guided goals for the user to promote self-esteem and focus on individual strengths (e.g. Writing down three things the user appreciates about him/herself). | + | 1 |
| What's Up? | App does not refer to the promotion of individual strengths. | - | 0 |
| Wysa | App is making use of certain exercises to promote users individual strengths like „Mindful Affirmations“, which is guided with sound and text material to help the user to focus on personal strengths and abilities instead of self-limiting negative attitudes. | + | 1 |

**Table 10**. Coding scheme of Generating plans and goals (*GPG*)

| App Name | Description of Embedded Elements | Coding scheme (+ = *implemented* or - = *not implemented*) | Coding score (+ = *1 point, or* - = *0 points*) |
|---|---|---|---|
| Driven | The premium version of the app offers features based on the PR-6, also referring to features and exercises to generate new life plans and goals. However, those are not available in the free version of the app. | - | 0 |
| Happify | The app's features are not directly linked to actual goal-setting and individual step-by-step guidance. However, the app offers many tracks that can help with current and future problems or have certain informative background, without making use of actual generation of plans to achieve individual goals concerning certain topics. | - | 0 |

| | | | |
|---|---|---|---|
| Inner Hour | Daily goals are an embedded feature in the app, which can be created individually and tracked afterwards („Add goal“) by choosing example goals (e.g., meditation exercises or physical activities) or own goals, which can be written down within the app. Example goals can be achieved due to e.g. audio-guides concerning different subjects (e.g., „Self-compassion“). However, a full plan (over 4 weeks) can only be acquired in the premium version. | + | 1 |
| Iona | App offers personalized plans to set step-by-step goals in achieving individual mental health goals, like the „Beliefs and Goals“ task, focusing on stepwise reframing of e.g. individual „core beliefs“ with support of „The iceberg challenge“. Those can be found as core-exercises within the „Select Topic“-section. | + | 1 |
| Mindspa | Features to follow step-by-step courses and certain goals and plans can only be done in the premium / paid version of the app. | - | 0 |
| Moodfit | App just uses some reminders to let the user keep track on individual goals and plans but those are not really guided. For more tools and a guided and stepwise plan and goal-setting the premium version needs to be bought. | - | 0 |
| My Possible Self | App offers several options to create individual goals and plans concerning different subjects. Users can find help to reduce stress in step-by-step guidance („Managing my stress“ within „Series“ on the home screen). Other examples for guided plan and goal creation can be find in for example tools concerning gambling or risky drinking behaviours, where users can set plans and goals and track them frequently. (Can be found within the sections „Series“ and „Toolkit“). | + | 1 |

| | | | |
|---|---|---|---|
| Remente | Plans and goals can be set within the app but are limited to one active goal in the free version. Furthermore, only selected goal plans can be accomplished in the free version of the app. Those goals and plans can be created individually or by choosing set and guided goals (Examples are „goal plans“ like „Change my life in 3 days“, which can be found within the „Resources“-section. Those can be tracked afterwards in the in-app „Agenda“). | + | 1 |
| What’s Up? | The App is offering guidance in the creation of plans and goals due to handed information concerning for example „Positive Steps“, which can be found within the section „Coping Strategies“. In the „Personal“ section goals and plans as well as positive and negative habits can be tracked individually. | + | 1 |
| Wysa | Only partly integrated within the free version, actual guided plans and goals only available in the premium version of the app. | + | 1 |

# Appendix E: Mobile Application Rating Scale (MARS)

## Mobile Application Rating Scale (MARS)

## App Classification

The Classification section is used to collect descriptive and technical information about the app. Please review the app description in iTunes / Google Play to access this information.

**App Name:** _____

**Rating this version:** _____ **Rating all versions:** _____

**Developer:** _____

**N ratings this version:** _____ **N ratings all versions:** _____

**Version:** _____ **Last update:** _____

**Cost - basic version:** _____ **Cost - upgrade version:** _____

**Platform:** o iPhone o iPad o Android

**Brief description:** _____

_____

**Focus: what the app targets (select all that apply)**

- o Increase Happiness/Well-being
- o Mindfulness/Meditation/Relaxation
- o Reduce negative emotions
- o Depression
- o Anxiety/Stress
- o Anger
- o Behaviour Change
- o Alcohol /Substance Use
- o Goal Setting
- o Entertainment
- o Relationships
- o Physical health
- o Other _____

**Theoretical background/Strategies (all that apply)**

- o Assessment
- o Feedback
- o Information/Education
- o Monitoring/Tracking
- o Goal setting
- o Advice /Tips /Strategies /Skills training
- o CBT - Behavioural (positive events)
- o CBT – Cognitive (thought challenging)
- o ACT - Acceptance commitment therapy
- o Mindfulness/Meditation
- o Relaxation
- o Gratitude
- o Strengths based
- o Other _____

**Affiliations:**

o Unknown o Commercial o Government o NGO o University

**Age group (all that apply)**

- o Children (under 12)
- o Adolescents (13-17)
- o Young Adults (18-25)
- o Adults
- o General

**Technical aspects of app (all that apply)**

- o Allows sharing (Facebook, Twitter, etc.)
- o Has an app community
- o Allows password-protection
- o Requires login
- o Sends reminders
- o Needs web access to function

# App Quality Ratings

The Rating scale assesses app quality on four dimensions. All items are rated on a 5-point scale from "1.Inadequate" to "5.Excellent". Circle the number that most accurately represents the quality of the app component you are rating. Please use the descriptors provided for each response category.

## SECTION A

**Engagement – fun, interesting, customisable, interactive (e.g. sends alerts, messages, reminders, feedback, enables sharing), well-targeted to audience**

1. **Entertainment: Is the app fun/entertaining to use? Does it use any strategies to increase engagement through entertainment (e.g. through gamification)?**

   1 Dull, not fun or entertaining at all
   2 Mostly boring
   3 OK, fun enough to entertain user for a brief time (< 5 minutes)
   4 Moderately fun and entertaining, would entertain user for some time (5-10 minutes total)
   5 Highly entertaining and fun, would stimulate repeat use

2. **Interest: Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?**

   1 Not interesting at all
   2 Mostly uninteresting
   3 OK, neither interesting nor uninteresting; would engage user for a brief time (< 5 minutes)
   4 Moderately interesting; would engage user for some time (5-10 minutes total)
   5 Very interesting, would engage user in repeat use

3. **Customisation: Does it provide/retain all necessary settings/preferences for apps features (e.g. sound, content, notifications, etc.)?**

   1 Does not allow any customisation or requires setting to be input every time
   2 Allows insufficient customisation limiting functions
   3 Allows basic customisation to function adequately
   4 Allows numerous options for customisation
   5 Allows complete tailoring to the individual's characteristics/preferences, retains all settings

4. **Interactivity: Does it allow user input, provide feedback, contain prompts (reminders, sharing options, notifications, etc.)? Note: these functions need to be customisable and not overwhelming in order to be perfect.**

   1 No interactive features and/or no response to user interaction
   2 Insufficient interactivity, or feedback, or user input options, limiting functions
   3 Basic interactive features to function adequately
   4 Offers a variety of interactive features/feedback/user input options
   5 Very high level of responsiveness through interactive features/feedback/user input options

5. **Target group: Is the app content (visual information, language, design) appropriate for your target audience?**

   1 Completely inappropriate/unclear/confusing
   2 Mostly inappropriate/unclear/confusing
   3 Acceptable but not targeted. May be inappropriate/unclear/confusing
   4 Well-targeted, with negligible issues
   5 Perfectly targeted, no issues found

**A. Engagement mean score = _____**

## SECTION B

**Functionality – app functioning, easy to learn, navigation, flow logic, and gestural design of app**

6. **Performance: How accurately/fast do the app features (functions) and components (buttons/menus) work?**

    1 App is broken; no/insufficient/inaccurate response (e.g. crashes/bugs/broken features, etc.)
    2 Some functions work, but lagging or contains major technical problems
    3 App works overall. Some technical problems need fixing/Slow at times
    4 Mostly functional with minor/negligible problems
    5 Perfect/timely response; no technical bugs found/contains a 'loading time left' indicator

7. **Ease of use: How easy is it to learn how to use the app; how clear are the menu labels/icons and instructions?**

    1 No/limited instructions; menu labels/icons are confusing; complicated
    2 Useable after a lot of time/effort
    3 Useable after some time/effort
    4 Easy to learn how to use the app (or has clear instructions)
    5 Able to use app immediately; intuitive; simple

8. **Navigation: Is moving between screens logical/accurate/appropriate/ uninterrupted; are all necessary screen links present?**

    1 Different sections within the app seem logically disconnected and random/confusing/navigation is difficult
    2 Usable after a lot of time/effort
    3 Usable after some time/effort
    4 Easy to use or missing a negligible link
    5 Perfectly logical, easy, clear and intuitive screen flow throughout, or offers shortcuts

9. **Gestural design: Are interactions (taps/swipes/pinches/scrolls) consistent and intuitive across all components/screens?**

    1 Completely inconsistent/confusing
    2 Often inconsistent/confusing
    3 OK with some inconsistencies/confusing elements
    4 Mostly consistent/intuitive with negligible problems
    5 Perfectly consistent and intuitive

**B. Functionality mean score = _____**

## SECTION C

**Aesthetics – graphic design, overall visual appeal, colour scheme, and stylistic consistency**

10. **Layout: Is arrangement and size of buttons/icons/menus/content on the screen appropriate or zoomable if needed?**

    1 Very bad design, cluttered, some options impossible to select/locate/see/read device display not optimised
    2 Bad design, random, unclear, some options difficult to select/locate/see/read
    3 Satisfactory, few problems with selecting/locating/seeing/reading items or with minor screen-size problems
    4 Mostly clear, able to select/locate/see/read items
    5 Professional, simple, clear, orderly, logically organised, device display optimised. Every design component has a purpose

11. **Graphics: How high is the quality/resolution of graphics used for buttons/icons/menus/content?**

    1 Graphics appear amateur, very poor visual design - disproportionate, completely stylistically inconsistent
    2 Low quality/low resolution graphics; low quality visual design – disproportionate, stylistically inconsistent
    3 Moderate quality graphics and visual design (generally consistent in style)
    4 High quality/resolution graphics and visual design – mostly proportionate, stylistically consistent
    5 Very high quality/resolution graphics and visual design - proportionate, stylistically consistent throughout

12. **Visual appeal: How good does the app look?**

    1 No visual appeal, unpleasant to look at, poorly designed, clashing/mismatched colours
    2 Little visual appeal – poorly designed, bad use of colour, visually boring
    3 Some visual appeal – average, neither pleasant, nor unpleasant
    4 High level of visual appeal – seamless graphics – consistent and professionally designed
    5 As above + very attractive, memorable, stands out; use of colour enhances app features/menus

**C. Aesthetics mean score = _____**

## SECTION D

**Information – Contains high quality information (e.g. text, feedback, measures, references) from a credible source. Select N/A if the app component is irrelevant.**

13. **Accuracy of app description (in app store): Does app contain what is described?**

    1 Misleading. App does not contain the described components/functions. Or has no description
    2 Inaccurate. App contains very few of the described components/functions
    3 OK. App contains some of the described components/functions
    4 Accurate. App contains most of the described components/functions
    5 Highly accurate description of the app components/functions

14. **Goals: Does app have specific, measurable and achievable goals (specified in app store description or within the app itself)?**

    N/A Description does not list goals, or app goals are irrelevant to research goal (e.g. using a game for educational purposes)
    1 App has no chance of achieving its stated goals
    2 Description lists some goals, but app has very little chance of achieving them
    3 OK. App has clear goals, which may be achievable.
    4 App has clearly specified goals, which are measurable and achievable
    5 App has specific and measurable goals, which are highly likely to be achieved

15. **Quality of information: Is app content correct, well written, and relevant to the goal/topic of the app?**

    N/A There is no information within the app
    1 Irrelevant/inappropriate/incoherent/incorrect
    2 Poor. Barely relevant/appropriate/coherent/may be incorrect
    3 Moderately relevant/appropriate/coherent/and appears correct
    4 Relevant/appropriate/coherent/correct
    5 Highly relevant, appropriate, coherent, and correct

16. **Quantity of information: Is the extent coverage within the scope of the app; and comprehensive but concise?**

N/A There is no information within the app
1 Minimal or overwhelming
2 Insufficient or possibly overwhelming
3 OK but not comprehensive or concise
4 Offers a broad range of information, has some gaps or unnecessary detail; or has no links to more information and resources
5 Comprehensive and concise; contains links to more information and resources

17. **Visual information: Is visual explanation of concepts – through charts/graphs/images/videos, etc. – clear, logical, correct?**

N/A There is no visual information within the app (e.g. it only contains audio, or text)
1 Completely unclear/confusing/wrong or necessary but missing
2 Mostly unclear/confusing/wrong
3 OK but often unclear/confusing/wrong
4 Mostly clear/logical/correct with negligible issues
5 Perfectly clear/logical/correct

18. **Credibility: Does the app come from a legitimate source (specified in app store description or within the app itself)?**

1 Source identified but legitimacy/trustworthiness of source is questionable (e.g. commercial business with vested interest)
2 Appears to come from a legitimate source, but it cannot be verified (e.g. has no webpage)
3 Developed by small NGO/institution (hospital/centre, etc.) /specialised commercial business, funding body
4 Developed by government, university or as above but larger in scale
5 Developed using nationally competitive government or research funding (e.g. Australian Research Council, NHMRC)

19. **Evidence base: Has the app been trialled/tested; must be verified by evidence (in published scientific literature)?**

N/A The app has not been trialled/tested
1 The evidence suggests the app does not work
2 App has been trialled (e.g., acceptability, usability, satisfaction ratings) and has partially positive outcomes in studies that are not randomised controlled trials (RCTs), or there is little or no contradictory evidence.
3 App has been trialled (e.g., acceptability, usability, satisfaction ratings) and has positive outcomes in studies that are not RCTs, and there is no contradictory evidence.
4 App has been trialled and outcome tested in 1-2 RCTs indicating positive results
5 App has been trialled and outcome tested in $\geq$ 3 high quality RCTs indicating positive results

**D. Information mean score = _____ ***

* Exclude questions rated as "N/A" from the mean score calculation.

# App subjective quality

**SECTION E**

**20. Would you recommend this app to people who might benefit from it?**

| | | |
|---|---|---|
| 1 | **Not at all** | I would not recommend this app to anyone |
| 2 | | There are very few people I would recommend this app to |
| 3 | **Maybe** | There are several people whom I would recommend it to |
| 4 | | There are many people I would recommend this app to |
| 5 | **Definitely** | I would recommend this app to everyone |

**21. How many times do you think you would use this app in the next 12 months if it was relevant to you?**

1 **None**
2 1-2
3 3-10
4 10-50
5 >50

**22. Would you pay for this app?**

1 No
3 Maybe
5 Yes

**23. What is your overall star rating of the app?**

| | | |
|---|---|---|
| 1 | «□ | One of the worst apps I've used |
| 2 | « □□ | |
| 3 | «□«□«□ | Average |
| 4 | « □□ □□ □□ | |
| 5 | «□«□«□«□«¯ | One of the best apps I've used |

# Scoring

**App quality scores for**

SECTION

A: Engagement Mean Score = _____

B: Functionality Mean Score = _____

C: Aesthetics Mean Score = _____

D: Information Mean Score = _____

**App quality mean Score = _____**

**App subjective quality Score = _____**

# App-specific

These added items can be adjusted and used to assess the perceived impact of the app on the user's knowledge, attitudes, intentions to change as well as the likelihood of actual change in the target health behaviour.

**SECTION F**

1. **Awareness: This app is likely to increase awareness of the importance of addressing [insert target health behaviour]**

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

2. **Knowledge: This app is likely to increase knowledge/understanding of [insert target health behaviour]**

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

3. **Attitudes: This app is likely to change attitudes toward improving [insert target health behaviour]**

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

4. **Intention to change: This app is likely to increase intentions/motivation to address [insert target health behaviour]**

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

5. **Help seeking: Use of this app is likely to encourage further help seeking for [insert target health behaviour] (if it's required)**

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

6. **Behaviour change: Use of this app is likely increase/decrease [insert target health behaviour]**

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |