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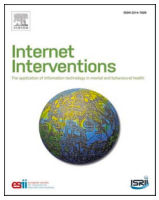

A smartphone app for the prevention and early intervention of body dysmorphic disorder: Development and evaluation of the content, usability, and aesthetics

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ABSTRACT

Body dysmorphic disorder (BDD) is an impairing condition characterized by excessive appearance concerns that frequently begin in adolescence, thus making this phase an eminent target for prevention and early intervention. We developed a cognitive-behavioral app-based program (AINA) intended for prevention and early intervention of BDD. As part of the iterative development process, perceptions of usability, aesthetics, and content were investigated. A sample of 38 adolescents and young adults aged between 14 and 21 years tested the app in a laboratory setting and completed a survey of diagnostic and user experience questionnaires. Overall, usability, aesthetics, and content of the app received positive evaluations. Regression analyses did not point to any large effects of age, gender, years of education, self-esteem, or BDD symptom severity on user evaluations. On average, participants had no concerns about privacy or data security of the app, indicating that these aspects will presumably not act as barriers to usage. Altogether, the present results are encouraging. Future research needs to examine whether AINA is an efficacious measure for prevention and early intervention of BDD.

1. Introduction

Body dysmorphic disorder (BDD) is characterized by a preoccupation with perceived defects in one's own appearance and ritualistic behaviors (e.g., checking, camouflaging) or mental acts (e.g., comparing one's own appearance to that of others) in response to these concerns (American Psychiatric Association, 2013). To warrant a clinical diagnosis, perceived flaws must either not be visible to others or appear minimal, with symptoms causing marked impairment in social functioning (e.g., avoidance of social situations) and reduced quality of life (Kelly et al., 2017). Without treatment, BDD tends to be chronic (Phillips et al., 2005, 2006, 2013) and is associated with high rates of comorbidities (Gunstad and Phillips, 2003) and suicidality (Angelakis et al., 2016; Buhlmann et al., 2010; Phillips, 2007). Thus, effective and accessible prevention and treatment programs are needed.

Cognitive-behavioral therapy (CBT) and pharmacotherapy are considered empirically supported treatments for BDD (Harrison et al., 2016; Ipser et al., 2009). Besides well-established treatment manuals for adults (Veale and Neziroglu, 2010; Wilhelm et al., 2013), cognitive-behavioral treatment protocols have also been adapted for adolescents (Greenberg et al., 2010, 2016; Krebs et al., 2017; Mataix-Cols et al., 2015). However, individuals with BDD report various barriers to treatment, such as shame of discussing their appearance concerns with a therapist or difficulties of finding a therapist specialized in diagnosing and treating BDD, and scheduling therapy sessions (Buhlmann, 2011; Marques et al., 2011; Schulte et al., 2020).

To address the aforementioned barriers, the development of technology-based treatment approaches for BDD has received increasing scientific attention in the last years. As part of a stepped care approach, such approaches may be particularly appropriate for individuals with mild or moderate BDD symptom severity and low risk of suicide (Enander et al., 2016). To date, two comprehensive technology-delivered treatment programs for BDD in adults have been subject to scientific evaluation. BDD-NET, an internet-based treatment program involving therapist support, was found to significantly improve BDD symptom severity, depressive symptoms, global functioning, and quality of life (Enander et al., 2014, 2016, 2019; Gentile et al., 2019). Further, the smartphone-delivered treatment program Perspectives demonstrated promising effects on BDD symptom severity, functional impairment, and quality of life in a first open trial, showing a response rate of

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90% (Wilhelm et al., 2020). Given the brief amount of therapist time needed during the 12-week treatment, the effects appear to be even more remarkable. Recently, a promising internet-based CBT treatment for adolescents and young adults has also been developed and is currently under investigation (Hartmann et al., 2021). Besides, more circumscribed technology-based interventions for BDD and body dissatisfaction are targeted at modifying appearance-related cognitive biases (e.g., Dietel et al., 2020; Kollei et al., 2017; Wilver and Cougle, 2019) and underlying beliefs (e.g., Cerea et al., 2021). These interventions make use of gamified cognitive retrainings and generally produce small to moderate effects on symptom severity. Overall, these promising results illustrate the potential of technology-based intervention in the treatment of BDD.

In contrast, the prevention and early intervention of BDD remains widely unstudied, with no specific prevention programs existing to date. Möllmann et al. (2017) investigated a sample of non-clinical German adolescents and young adults ($N = 308$) aged between 15 and 21 years and found that 47.1% of them reported preoccupation with perceived defects and repetitive behaviors or mental acts. Prevalence of clinical BDD is estimated at 1.9% in community adult samples and 2.2% in adolescents (Veale et al., 2016). Considering the high prevalence of appearance concerns and BDD symptoms in adolescence and the frequent onset of BDD in this developmental phase (Bjornsson et al., 2013), prevention and early intervention need to target this age group. Moreover, providing interventions at early stages of the disorder may be more effective, since adolescents - as compared to adults - and individuals with a shorter lifetime duration of BDD appear to have a higher probability of full or partial remission from BDD (Phillips et al., 2013). Targeting the aforementioned gaps, we developed the app-based program AINA for the indicated prevention (Mrazek and Haggerty, 1994) and early intervention of BDD in adolescents and young adults.

1.1. AINA

AINA (i.e., "*Aussehen Ist Nicht Alles*"/Appearance is not everything) was conceptualized using well-established interventive strategies from cognitive-behavioral therapy (e.g., Wilhelm et al., 2013) which were adapted for preventive purposes in adolescents. AINA is targeted at adolescents and young adults with appearance concerns and potential repetitive or avoidance behaviors. Thus, it addresses individuals with first subclinical BDD symptoms or early stages of BDD who do not suffer from marked functional impairment or distress. Regarding the treatment rationale, the focus of AINA lies on psychoeducation and cognitive techniques. Currently, there are only few studies investigating cognitive or metacognitive therapy without behavioral interventions for BDD in rather small samples. However, these studies suggest that (meta-) cognitive interventions are effective for BDD (Geremia and Neziroglu, 2001; Rabiei et al., 2012; Taillon et al., 2013) as well as for obsessive-compulsive disorder (e.g., Wilhelm et al., 2009). Overall, cognitive interventions may be more accepted and less often refused than exposure and response prevention (Wilhelm et al., 2009).

Across modules, AINA pursues the aim of fostering awareness of resources and (re-)defining and enhancing self-esteem. Relatedly, recent meta-analytic evidence revealed a moderately negative relationship between BDD symptoms and self-esteem and suggested that low self-esteem is an important hallmark of BDD beyond the influence of depressive symptoms (Kuck et al., 2021). It seems that individuals with BDD build their self-esteem predominantly on their appearance. The corresponding core beliefs (e.g., "If my appearance is defective, then I am worthless.") are described in cognitive-behavioral models of BDD (Baldock and Veale, 2017; Veale, 2004; Wilhelm et al., 2013). According to Turner and Cadman (2017), developing a broader definition of the self may be a useful strategy for relapse prevention in adolescents. Furthermore, addressing self-esteem is important because of its reciprocal relation with insight in BDD (Schulte et al., 2021). Particularly, low self-esteem appears to fuel more strongly held convictions in appearance beliefs (Schulte et al., 2021), hence, impeding response to or engagement with a prevention or treatment program (Greenberg et al., 2019; Schulte et al., 2020). In general, enhancing self-esteem might have a preventive effect, since adolescents with low self-esteem may be at particular risk to develop mental disorders later on (Trzesniewski et al., 2006). Furthermore, activation of resources offers a great potential to increase efficacy of CBT interventions (Munder et al., 2019).

Concerning implementation, we intended AINA to be (1) broadly disseminated, (2) attractive for adolescents and young adults, (3) highly used, and (4) effective. Therefore, AINA was developed as a smartphone app. First, app-based programs can be broadly disseminated without geographical constraints, thus engaging a large number of eligible and hard-to-reach individuals. AINA does not include therapist contact, so that the number of users is not restricted by therapists' capacities. Given the costs linked to in-person prevention programs, app-based equivalents may offer a comparatively cost-efficient, scalable and easily stratifiable solution (Cuijpers et al., 2012; de Oliveira et al., 2020). Second, app-based interventions allow for the implementation of gamification principles, such as embedding into stories, reward systems and feedback mechanisms (see Brown et al., 2016, for a review). Such gamified interventions have been shown to promote task engagement, motivation, deep learning, symptom relief and behavior change (e.g., Fleming et al., 2017; Lumsden et al., 2016). Further, they may be particularly well suited to younger users who are more acquainted with gaming environments (Boendermaker et al., 2017). During the development of AINA, we sought to incorporate gamification and reward features to increase attractiveness for the target group. Third, an app appears to be the ideal medium to reach adolescents and young adults, as they demonstrate substantial smartphone usage and increased acceptance of technology (Bakker et al., 2016), but also high levels of autonomy during help-seeking (Wilson et al., 2011). Additionally, usage may be increased because apps provide low-threshold support and allow for a seamless transference of treatment elements into everyday life. Moreover, app-based interventions may reduce barriers associated with face-to-face treatments – for instance, stigma, discomfort and restricted access – as they allow for anonymity, immediate availability and flexibility of use (Bakker et al., 2016). Fourth, they may be more easily administered in a standardized, experimentally controlled form, even when delivered throughout different settings and devices. This should preclude therapist drift and positively impact effectiveness in non-scientific contexts.

AINA is composed of seven consecutive levels (see Table 1 and Fig. 1). Throughout the app, female and male fictitious characters and examples are used (e.g., see Fig. 2). AINA has a reward system so that users can earn virtual gold coins for working on the exercises. Since the AINA target group does not necessarily display marked distress, the reward system is supposed to extrinsically enhance motivation for using the app and to support the gaming character. Another feature is the diary where users can add comments or save helpful app contents. Moreover, further contact and support possibilities are provided.

1.2. Development process

The app AINA was developed as collaboration project between the Department of Psychology and the Department of Computer Science at the University of Münster. In a first step, the app-based program was conceptualized by the first author (NK) under supervision of the last author (UB). Subsequently, it was elaborated by a team of psychologists (NK, FAD and others), psychotherapists specialized in treating BDD, a designer, and students of psychology. The modeling and implementation of AINA was done during a capstone project supervised by JV at the Department of Computer Science during the summer term of 2016. Throughout this term, the authors (JV, NK, FAD and UB intermittently) and the students conducted weekly meetings in which technical and multidisciplinary aspects were discussed. Hence, the development of the exercises, texts, videos, and graphics was influenced by expertise from

Table 1
Overview of the app modules.

Level	Description
Videos	Participants can watch psychoeducational animated videos in which the difference between ordinary and clinically distressing appearance concerns is described using the examples of two fictitious characters. In the next step, the development and maintenance of distressing appearance concerns are explained according to the cognitive-behavioral model by Wilhelm et al. (2013).
Thought Swiper	Users learn how to differentiate between helpful and not helpful appearance-related thoughts. For this purpose, they may access an explanatory video which is based on the ABC-theory from rational emotive behavior therapy (Ellis and MacLaren, 2014). They are then invited to decide whether various thoughts are helpful (swipe to the right) or not helpful (swipe to the left), receiving feedback on their decision and an explanation detailing the categorization.
Find the error	Participants learn about different cognitive errors concerning the body and appearance. Definitions of cognitive errors are presented alongside with icons to visualize them. Afterwards participants can play a quiz game in which they are asked to assign different thoughts to the cognitive error categories.
Be fair to yourself	Participants may begin to challenge their own dysfunctional cognitions by means of the question: "How would you answer a good friend who tells you this thought?".
Inner Critic	A cartoon illustrates the interplay between inner critic and inner advocate. Subsequently, participants may practice to strengthen the inner advocate (write a speech of your inner advocate) and to weaken the inner critic (detecting and stopping the inner critic by developing an individual stop signal, trying a new perspective, or by redirecting attention) via exercises.
Resource box	Participants are asked to pack their own resource box with activities they like to do, their abilities, and persons who support them. Prompts appear to motivate participants to use their resources (e.g., do activities they like) and collect more (e.g., What was good today?, What are you proud of?).
Self-esteem pie	Users are invited to reflect on and redefine their self-esteem with reduced impact of body image (cf., Wilhelm et al., 2013). In this level, we adapted the self-esteem pie intervention from the treatment manual by Wilhelm et al. (2013).

computer scientists on app interface and program architecture. The implementation of data security was discussed throughout the project as it represents an indispensable aspect when designing technology-based mental health interventions. All students had to declare confidentiality and all students agreed to the usage of the app-based program.

As part of the iterative development process, we investigated adolescents' and young adults' perceptions of the usability, aesthetics, and content of the first version of AINA. In this respect, Wilhelm et al. (2020) reported a multidisciplinary development process which also incorporates feedback by the target group. Moreover, to ensure age-appropriateness, gathering feedback in early phases of intervention development appears to be crucial (Wozney et al., 2015). Research on user evaluation of websites demonstrated that perceptions of usability, aesthetics, and content have an important impact on the first and overall impression, as well as on the intention to revisit and recommend a website (Thielsch et al., 2014a). Aesthetics in particular appeared to be decisive for the first impression, whereas the intention to revisit and recommend a website was mainly influenced by perceptions of the content (Thielsch et al., 2014a). Furthermore, mental disorder symptoms, specifically depressive symptoms, might negatively affect subjective user experience leading to possibly altered requirements for mental health interventions (Thielsch and Thielsch, 2018). Therefore, we aimed to optimize usability, design, and content according to the needs and preferences of the target group. This should be of particular importance in internet- and app-based interventions since even an efficacious intervention may not have any or only very few effects if it is not numerously used. Additionally, we intended to explore further potential barriers to usage such as privacy or data security concerns.

Altogether, the research questions of the current study were as follows:

1) How do adolescents and young adults evaluate the usability, aesthetics, and content of AINA?
2) Does AINA match the needs and preferences concerning usability, aesthetics, and content of users with varying age, gender, education, self-esteem, and BDD symptom severity?
3) How do adolescents and young adults rate the different levels concerning usability, aesthetics, and content?
4) How do they evaluate their personal benefit, privacy, and data security of the app?

2. Methods

The study protocol was approved by the local ethics committee. Data were collected between July 2017 and March 2018.

2.1. Participants

Participants were recruited through announcements and flyers posted in local newspapers and social networks, university buildings, supermarkets, sports clubs, coffee shops, youth centers or groups, and tutoring centers. Study advertisements contained information on the topic of the app (i.e. appearance concerns and self-esteem) and the purpose of the study (i.e. to test and give feedback on the newly developed app). The only inclusion criterion was being aged between 14 and 21 years. Interested individuals received detailed study information and had to provide written informed consent before participation. For participants under the age of 18, consent was also obtained from the parents. Participants were compensated by either receiving course credit (for university students) or 10€ per hour.

Altogether, 38 adolescents and young adults aged between 14 and 21 years (21 females, 17 males) participated in the current study. The mean age was 17.82 (2.25) years, with 16 participants being underage. For 36 participants, German was their first language. Twelve participants were in a relationship. On average, participants had 11.68 (2.18) years of education. Regarding level of education, 15 participants were still attending school, whereas 23 participants had already graduated from school. Twenty-one participants possessed a high-school degree and 16 participants prospectively intended to receive a high-school degree. Furthermore, one participant had a secondary school diploma and one a vocational diploma. Seventeen participants were currently performing a professional education or studies. None of the participants had a professional degree.

2.2. Material and measures

2.2.1. Study version of AINA

Considering the prospective use of AINA as an integrative instrument for intervention and research data gathering, the implementation was based on a client-server architecture. The client-side application was implemented in Java whereas the server-side backend was implemented using JavaScript and PHP. The server is accessed to download the most recent version of the levels and – if used in a controlled research study – to upload the usage logs from the clients. For the latter, app users need to explicitly grant permission which they can revoke any time. To secure the communication, only (encrypted) https-accesses are allowed. On the server side, various administrator privileges are access-controlled and password-protected. For this study, AINA was installed on a smartphone (LG-H815, Android 6.0) with a 5.5-inch display and 1.440 × 2.560 resolution. Any level restrictions were removed so that all levels could immediately be accessed. For this usability study, all uploads to the server were disabled such that participants could freely experiment with the app.

2.2.2. Diagnostic measures

The Body Dysmorphic Symptoms Inventory ("Fragebogen körperdysmorpher Symptome", FKS; Buhlmann et al., 2009) was used to

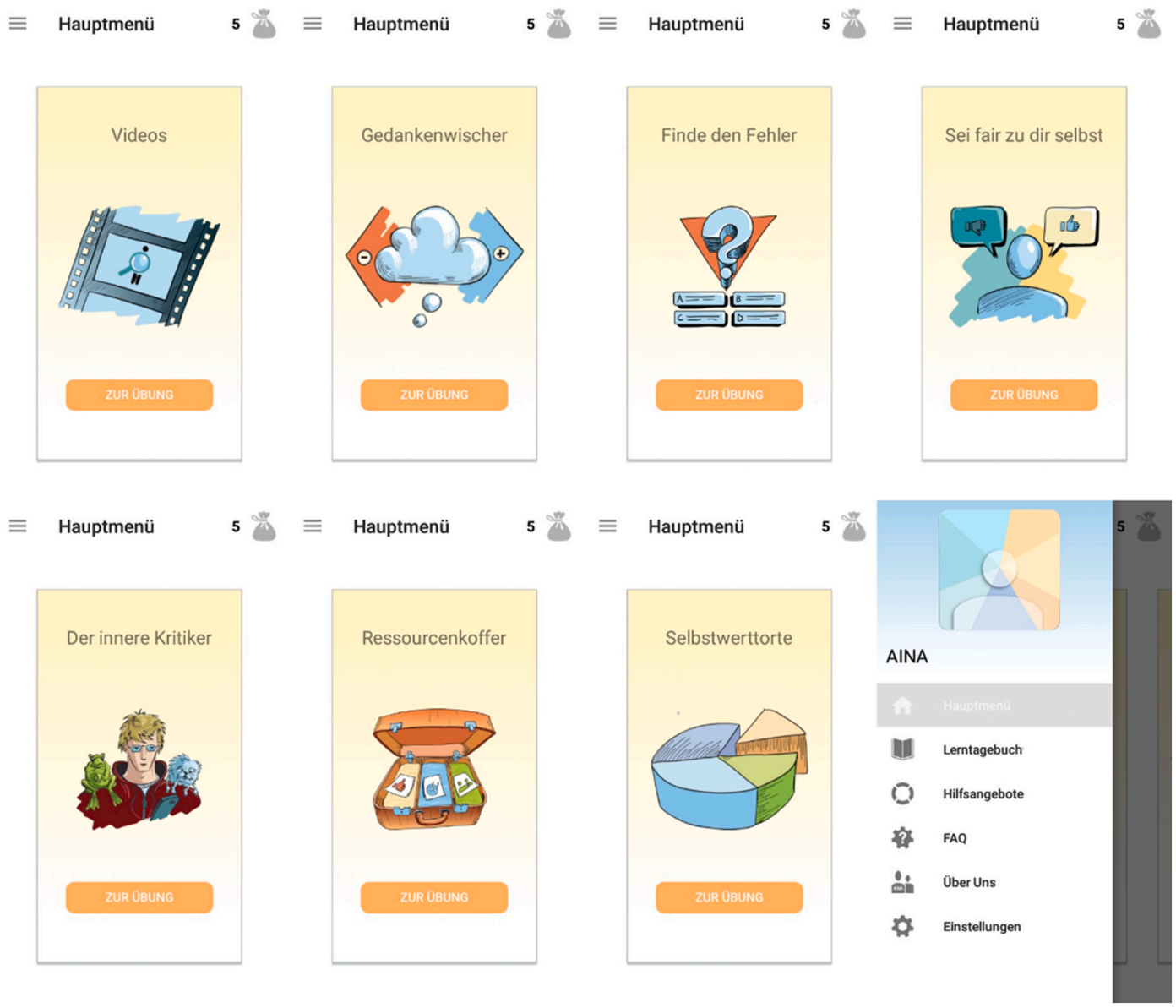

Fig. 1. Overview of the level representations in the main menu.
Note. Hauptmenü = main menu; Gedankenwischer = Thought Swiper; Finde den Fehler = Find the error; Sei fair zu dir selbst = Be fair to yourself; Der innere Kritiker = Inner Critic; Ressourcenkoffer = Resource box; Selbstwerttorte = Self-esteem pie; Lerntagebuch = diary; Hilfsangebote = contact and support possibilities; Über uns = About us; Einstellungen = settings; zur Übung = start exercise.

assess body dysmorphic symptom severity in the last week. Sum scores on this 18-item scale range between 0 and 64, with higher scores indicating increased symptom severity. Internal consistency in the current sample was $\alpha = 0.72$.

We employed the 10-item Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965; von Collani and Herzberg, 2003) to assess trait self-esteem. Sum scores on this scale range between 0 and 30, with higher scores indicating higher self-esteem. Internal consistency in the current sample was $\alpha = 0.85$.

2.2.3. *User experience measures*

The System Usability Scale (SUS) is a 10-item self-report measure for the perceived usability of a system (Brooke, 1996, 2013). Total scores range from 0 to 100 with higher scores representing greater subjective usability. According to Bangor et al. (2009), systems which were perceived as 'good' received a mean score of 71.4 on the SUS, whereas those rated as 'excellent' had a score of 85.5 on average. Using back-translation, the SUS was translated into German and the word 'system' was replaced by 'app' for this study. Internal consistency in the current sample was $\alpha = 0.78$.

The Visual Aesthetics of Websites Inventory (VisAWI; Moshagen and Thielsch, 2010) is an 18-item questionnaire measuring visual aesthetics on four scales: simplicity, diversity, colorfulness, and craftsmanship. Mean scale and overall scores range between 1 and 7, with higher scores representing more positive evaluations. An overall evaluation of 4.5 or higher can be regarded as good (Hirschfeld and Thielsch, 2015). The VisAWI has also been used for the evaluation of other graphical interfaces (Thielsch et al., 2014b). Accordingly, for the current study the word 'website' was changed to 'app'. Cronbach's alpha amounted to $\alpha = 0.91$ for the overall scale and ranged from 0.80 to 0.88 for the subscales.

The 12-item WebCLIC questionnaire (Thielsch and Hirschfeld, 2019) measures how users perceive website content on four facets (clarity, likeability, informativeness, and credibility). Mean scale and overall scores range between 1 and 7, with higher mean scores indicating more

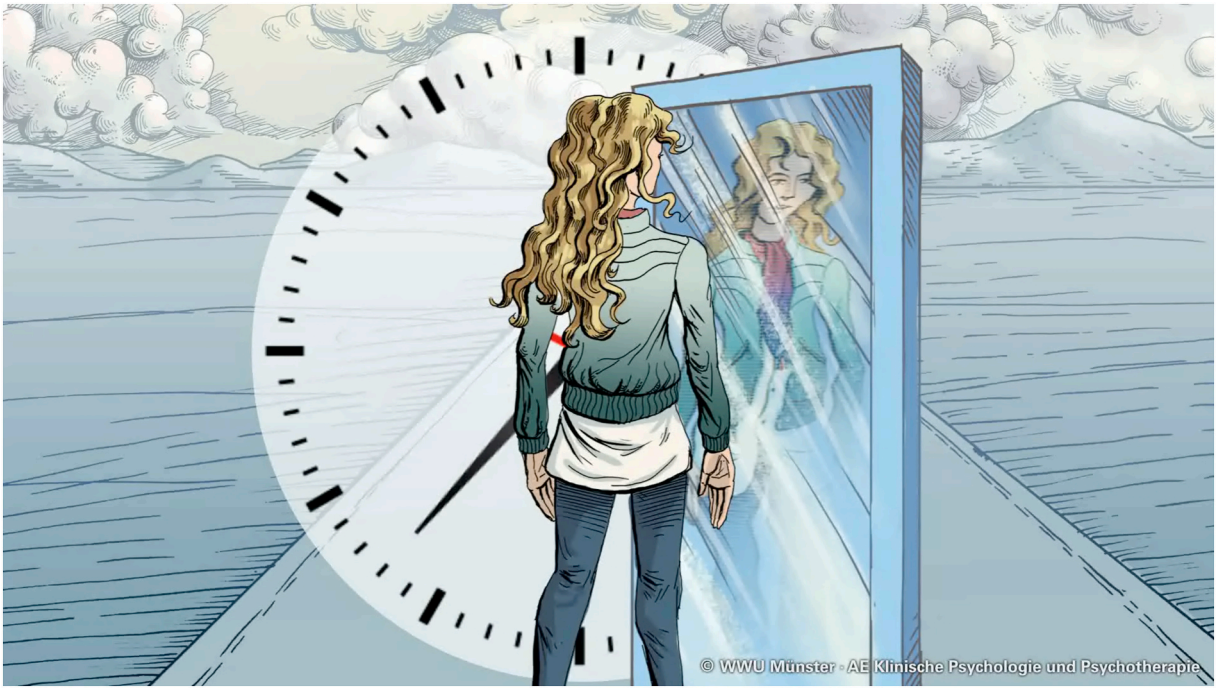

Fig. 2. Exemplary scene from the psychoeducational videos.

positive evaluations. Thielsch and Hirschfeld (2019) found a cut-off of 4.58 to best distinguish websites rated as good from those rated as bad. Again, the word 'website' was substituted by 'app' for the present study. Internal consistencies of $\alpha = 0.81$ for the total questionnaire and 0.38 for the subscale clarity, 0.81 for likeability, 0.69 for informativeness, and 0.75 for credibility were reached in this study.

For each level, feedback on aesthetics, usability, and content was captured via star ratings ranging from 1 star (very bad) to 5 stars (very good). The following questions were used: How do you rate the design and layout of this level? How do you rate the usability of this level? How interesting was the content of this level? How helpful was the content of this level? For the last two questions, response format reached from 1 star (not interesting/helpful at all) to 5 stars (very interesting/helpful). Participants also had the opportunity to give comments. Additional items concerning usability of certain features, personal benefit, age-appropriateness, motivation for app usage, privacy, data security, name and logo of AINA were formulated and could be answered from 1 (strongly disagree) to 5 (strongly agree). The videos and cartoons as well as the diary and reward system were also evaluated using the aforementioned response scale. To collect additional information on objective usability, participants were instructed to draw a self-esteem pie with given categories and percentages.

2.3. Procedure

Individual appointments were made with each participant. Data were collected in a laboratory of the Department of Psychology. A smartphone on which AINA had been installed was given to participants for the duration of the study. Questionnaires and instructions were administered via a computer-assisted survey. An experimenter was seated in the same room out of the participant's view and without being able to see the participant's responses. Participants started the survey before taking a look at the app. The survey consisted of three parts. First, demographic questions and the diagnostic measures (FKS, RSES) were presented. Second, participants consecutively accessed the levels and were instructed to try out the exercises. Moreover, participants were directed to other features of the app such as the diary, the reward system, and frequently asked questions and gave feedback. Third, the whole app was evaluated via the user experience questionnaires (SUS, VisAWI, WebCLIC) as well as additional items (described in Section 2.2.3.). The mean duration of the survey was 103.96 min (range: 60.02–166.90 min). Afterwards, participants were debriefed and recompensated.

2.4. Data analysis

Data were analyzed using SPSS 27 (IBM Corp., 2020). The main focus was on descriptive analysis of users' evaluations. Pearson or pointbiserial correlations were calculated. Bias corrected and accelerated 95% confidence intervals of the correlations were estimated using bootstrapping based on 1000 samples. We exploratively conducted regression analysis to detect any potential strong effects of age, gender, years of education, self-esteem, and BDD symptom severity on usability, aesthetics, and content. As this study forms part of the initial testing of AINA, we did not set up hypotheses. Instead, given the explorative character and the small sample size, we mainly used 95% - confidence intervals of regression coefficients for estimating the magnitude of potential effects. Diagrams were created using R (R Core Team, 2021).

3. Results

Means, standard deviations, and bivariate correlations of demographic variables, diagnostic questionnaires, and user experience measures can be retrieved from Table 2. The mean FKS score amounted to 12.03 ($SD = 5.25$), indicating the presence of appearance concerns in the sample. Participants were concerned about their skin ($n = 15$), size and shape of their muscles ($n = 9$), breasts or chest ($n = 8$), nose ($n = 8$), mouth ($n = 5$), legs ($n = 5$), genitals ($n = 3$), feet ($n = 3$), hair ($n = 2$), ears ($n = 1$), buttocks ($n = 1$), stomach ($n = 1$), and beard growth ($n = 1$).

3.1. Evaluation of AINA

The sample means of the VisAWI and WebCLIC (cf. Table 2) were both above the respective cutoffs for websites rated as 'good' (cf., Hirschfeld and Thielsch, 2015; Thielsch and Hirschfeld, 2019). On the individual level, the overall ratings of 29 participants (76%) turned out

Table 2
Means, standard deviations, and correlations of demographic variables, diagnostic measures, and user experience questionnaires.

Variable	*M* (*SD*)	Bivariate correlations 95% CI [LL, UL]						
		Age	Gender	Education	RSES	FKS	SUS	VisAWI
Age	17.82 (2.25)	–						
Gender	1.45 (0.50)	0.08 [−0.27, 0.40]	–					
Education	11.68 (2.18)	0.76** [0.52, 0.95]	−0.07 [−0.39, 0.27]	–				
RSES	23.21 (5.24)	0.12 [−0.18, 0.44]	0.19 [−0.16, 0.58]	0.12 [−0.11, 0.35]	–			
FKS	12.03 (5.25)	0.13 [−0.21, 0.43]	−0.54** [−0.74, −0.26]	0.28 [−0.08, 0.57]	−0.39* [−0.60, −0.19]	–		
SUS	82.70 (11.31)	0.19 [−0.14, 0.52]	−0.12 [−0.48, 0.19]	0.13 [−0.17, 0.43]	0.01 [−0.18, 0.22]	0.09 [−0.29, 0.43]	–	
VisAWI	5.25 (0.87)	0.03 [−0.25, 0.30]	−0.18 [−0.50, 0.11]	0.11 [−0.17, 0.38]	0.07 [−0.24, 0.36]	−0.09 [−0.42, 0.26]	0.44** [0.10, 0.75]	–
WebCLIC	5.62 (0.62)	−0.09 [−0.46, 0.25]	−0.21 [−0.49, 0.11]	0.03 [−0.33, 0.35]	−0.03 [−0.27, 0.29]	0.16 [−0.16, 0.43]	0.64** [0.37, 0.80]	0.55** [0.33, 0.73]

Note. RSES = Rosenberg Self-Esteem Scale; FKS = Body Dysmorphic Symptoms Inventory; SUS = System Usability Scale; VisAWI = Visual Aesthetics of Websites Inventory; WebCLIC = Website – Clarity, Likeability, Informativeness, and Credibility Questionnaire. Education = Years of Education. Gender was coded 1 for female and 2 for male.
* $p < .05$ (two-tailed).
** $p < .01$ (two-tailed).

to exceed the VisAWI cut-off and 36 overall content ratings (95%) outreached the WebCLIC cut-off. The mean SUS rating was between the means for good and excellent systems (cf., Bangor et al., 2009). Scatterplots of the overall user experience ratings and age, gender, years of education, self-esteem, and BDD symptom severity did not point to any linear effects in this sample (see Figs. A.1–A.15 in the Appendix). Similarly, the results of the regression analyses predicting overall usability, aesthetics, and content ratings did not suggest any large effects of sociodemographic or psychometric variables (see Table B.1 in the Appendix).

The VisAWI and WebCLIC subscale means (and standard deviations) amounted to 5.87 (0.88) for simplicity, 4.46 (1.22) for diversity, 5.15 (1.25) for colorfulness, 5.52 (1.01) for craftsmanship, 6.09 (0.66) for clarity, 4.76 (1.11) for likeability, 5.32 (0.94) for informativeness, and 6.29 (0.64) for credibility. An overview of the bivariate correlations between the subscales and demographic and diagnostic variables can be found in the Appendix (Table B.2). Participants' responses to the additional items concerning usability, personal benefit, age-appropriateness, motivation for app usage, privacy, data security, name and logo of AINA are presented in Table 3. In addition, participants were asked to rate the age range for which they would recommend the app. AINA was frequently rated as suitable for 12- to 18-year-olds with peaks around 13 and 14 years of age (see Fig. B.1 in the Appendix).

Table 3
Means and standard deviations of additional items concerning usability, personal benefit, age-appropriateness, motivation for app usage, privacy, data security, name and logo of AINA.

Item	*M*	*SD*
The contents of the app are helpful to me	3.26	1.11
I learned something new by using the app	3.50	1.06
The app could be useful in my everyday life	3.13	1.17
I would recommend the app to others	3.55	0.98
The language is appropriate for my age	3.58	1.20
The graphics are appropriate for my age	3.37	1.20
The name of the app is appealing	3.21	1.02
The logo of the app is appealing	3.45	1.01
I would have concerns about data security	1.71	0.98
I would have concerns about my privacy	1.89	1.16
I would be uncomfortable telling others that I use the app	2.95	1.31
Trying out the app was fun to me	4.13	0.84
I quickly found the side menu (with diary, FAQs, advice services etc.)	4.89	0.31
I quickly understood how to navigate through the app (e.g., go from one level to the next or back)	4.66	0.63
I can easily find the individual exercises	4.63	0.68
The app is interactive	4.26	0.83

Note. Response format reached from 1 (strongly disagree) to 5 (strongly agree).

3.2. Evaluation of the levels

The mean ratings of the individual levels are shown in Fig. 3. For the level *Self-esteem pie*, we additionally employed an objective usability task. All participants were able to draw a self-esteem pie with given categories. Thirty-six participants tried to realize the given percentages, whereas one participant did not change the preset percentages and one did not show the self-esteem pie to the investigator. The standard deviations of the realized percentages were between 4.37 and 7.47 with maximum deviations from the given percentages between 1.1% and 10.6%. Concerning the diary, mean agreement was 4.71 (0.61) for “I quickly found the diary” and 2.95 (1.21) for “I would use the diary”. Mean evaluations of the reward system amounted to 4.79 (0.58) for “I quickly found the bag of gold”, 3.66 (0.97) for “Collecting gold coins would be an incentive for me to use the app”, and 3.71 (0.98) for “Collecting gold coins would be fun for me”. The video and cartoon ratings can be found in the Appendix (Table B.3).

4. Discussion

The aim of the present study was to investigate perceptions of usability, aesthetics, and content of the newly developed app-based prevention and early intervention program AINA as part of the iterative development process. Altogether, these aspects received good mean evaluations on user experience measures (research question 1). Participants highly agreed to our usability items, meaning that they quickly understood how to navigate through the app and could easily find the individual exercises. Consequently, the usability of AINA appears to be very good. Regarding aesthetics, diversity (i.e. inventiveness and dynamic of the layout) yielded the lowest rating. Thus, AINA might be improved by employing more diverse layouts and visualizations across all levels. We additionally asked for an opinion on the logo of the app which on average was perceived as neutral or rather appealing, thus leaving room for improvement. With regard to content, the high ratings of clarity, credibility and informativeness indicated that the information in the app seems to be easy to understand, trustworthy, and informative. Likeability received the lowest rating. A possible explanation might be

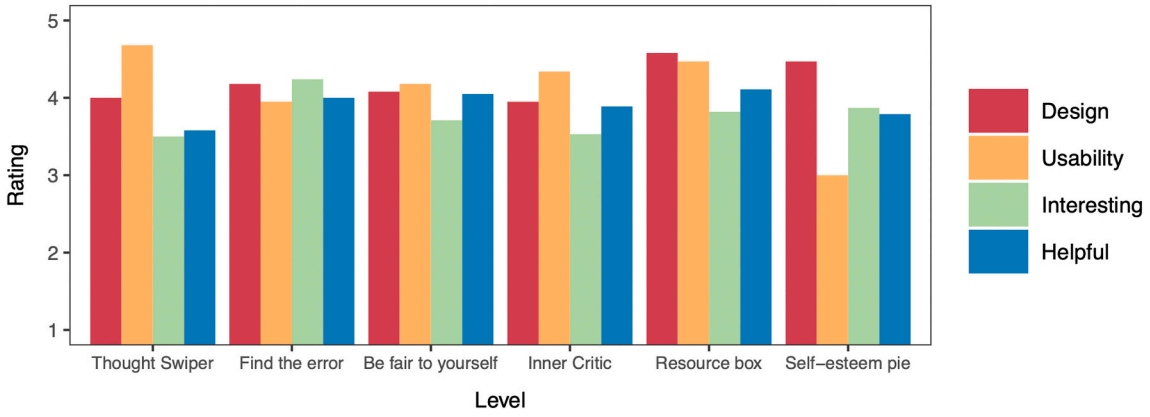

Fig. 3. Mean ratings of design, usability, and content of the levels.

that using a preventive and psychoeducational app is not equally exciting and enjoyable as an app for leisure purposes. Potentially, AINA might benefit from using even more gamification elements (e.g., providing brief games as part of the reward system, offering additional and shorter video clips and reducing written text, using avatars). Still, the likeability rating outreached the subscale cut-point (cf., Moshagen and Thielsch, 2010), suggesting satisfactory attractiveness for the target group.

Regression analyses did not point to any large effects of age, gender, years of education, self-esteem, and BDD symptom severity on evaluations of usability, aesthetics, and content (research question 2). These findings suggest that AINA has a high potential of meeting needs and preferences of adolescents and young adults in these areas irrespective of sociodemographic and psychometric features. Overall, this could qualify AINA as an app-based program for prevention and early intervention at different developmental and psychopathological stages. The participants' feedback gave slight indications for this conclusion. However, this potential implication must be regarded with caution since we cannot rule out small or medium effects of some predictors due to the small sample size. Additionally, we asked participants for a general age recommendation. Most participants would recommend AINA to individuals between the age of 12 and 18, with peaks around 13 and 14 years of age, indicating that AINA might be particularly suitable for this age group. Since this age span also reflects findings on the frequent age of onset of BDD (cf., Bjornsson et al., 2013), we should consider directing AINA particularly to adolescents.

On the whole, mean evaluations of the individual levels were positive (research question 3). Assessments of subjective and objective usability revealed that the level *Self-esteem pie* may be improved. Evaluation of the diary and reward system demonstrated that these features were easy to find. However, a mixed picture emerged concerning whether participants would use the diary. This may result from individual preferences and should not necessarily influence the effectiveness of AINA. Furthermore, one might consider enhancing the attractiveness of the diary by a more appealing design, more functions, and a better integration (e.g., by prompts) into the program. On average, participants tended to agree that the reward system would be an incentive to use the app. Future trials could test how strongly the reward system impacts frequency and time of usage.

Participants varied in how helpful and useful they would find the app (research question 4). The individual judgements amounted to an average, slightly positive rating. Thus, the perceived personal benefit seems to vary according to individual factors. These aspects warrant further investigation in longer clinical trials with profound usage of the app. On average, participants reported no concerns about their privacy or data security of the app (research question 4). Hence, these aspects would probably not act as barriers to usage in adolescents and young adults. However, almost half of the participants indicated that they would be rather uncomfortable telling others that they used the app whereas the other half was either neutral or not uncomfortable. On the one hand, this emphasizes the importance of already existing privacy settings such as the password. Participants should also have the possibility to decide whether prompts appear on their home screen and disable them. On the other hand, promoting a preventive rather than therapeutic image of AINA by designing resource-oriented and gamified exercises might dispel corresponding concerns. Thus, it remains to be seen how privacy concerns are handled when AINA is disseminated under naturalistic conditions.

4.1. Limitations

The present study has some limitations. First, due to the small sample size, generalizability of the results is limited. Specifically, we cannot rule out small or medium effects in regression analyses, as would have been possible in a study with higher power. Consequently, results have to be regarded as a first preliminary feedback which was exactly the purpose of the study during the development process. Second, the only inclusion criterium was being aged between 14 and 21 years. Thus, the results reflect perceptions of usability, aesthetics, and content of a rather inclusive sample comprising individuals with appearance concerns in varying degrees. Recruitment of adolescents and young adults without restrictions concerning BDD symptom severity still yielded a sample in which appearance concerns were present. This corresponds to high rates of appearance concerns in this age group (cf., Möllmann et al., 2017). We chose this procedure to examine whether AINA is equally suitable for prevention in individuals with mild appearance concerns and for early intervention in individuals with more pronounced BDD symptoms. To address this aspect, we investigated effects of BDD symptom severity on user experience. Third, given reduced variation of educational degrees in this sample, we cannot determine whether the results apply to adolescents and young adults attending different school types. However, regression analyses did not point to any large effects of years of education on user experience. Fourth, we did not assess any comorbidities and thus cannot determine their impact on the results. Although we employed the World Health Organization Well-Being Index (Bech et al., 2003; Brähler et al., 2007), its low internal consistency in this study (Cronbach's $\alpha = 0.55$) did not allow to investigate effects of subjective psychological well-being. Fifth, the WebCLIC subscale clarity did not show acceptable internal consistency in this study, thus, limiting reliability of corresponding results. Still, the single item means of this subscale demonstrated positive evaluations of all aspects assessed. Sixth, the procedure of a single appointment to test the app might have influenced the results as participants only tested each exercise for a few minutes and did not have the opportunity to profoundly work on their concerns. Future trials need to check whether the results can be replicated in repeated everyday usage of AINA. Moreover, although we

explicitly asked participants for their honest opinion, we cannot rule out that evaluations might have been affected by social desirability.

4.2. Future directions

Concerning app development, the next step will be to revise AINA according to the present results. A particular focus may be set to further elaboration of gamification features and the reward system. Regarding scientific evaluation, the acceptability, feasibility, and efficacy need to be investigated. With regard to further elaboration of AINA, one might consider adding new modules, for example from compassion-focused approaches (Veale and Gilbert, 2014), as different strategies (e.g., cognitive restructuring, acceptance/mindfulness, distraction) can be effective to target negative body image-related thoughts (Hartmann et al., 2015). Prospectively, we should also examine potential additional effects of exposure and response prevention exercises in this subclinical target group. In accordance with the suggested body image disorders spectrum (Hartmann et al., 2020), we may add examples of weight-based concerns to the exercises in order to test whether individuals at risk of an eating disorder can also benefit from AINA. In general, future studies should examine differential effects of the modules and strategies in dismantling designs.

4.3. Conclusions

Altogether, our findings on usability, aesthetics, and content of AINA are highly encouraging. This preliminary study forms part of an iterative development process which is vital to adjust AINA as best as possible to the preferences of its target group. Therefore, some minor revisions are to be made in order to prospectively direct AINA particularly to adolescents. Pending a more thorough evaluation of its efficacy, AINA thus holds promise to effectively augment extant prevention and early intervention tools for BDD.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.invent.2022.100521.

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