Chatbot ELME for Everyday Life Mindfulness Experience: The effects of a chatbot-based intervention on stress and health-related parameters in a stressed sample

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Abstract

Background: Stress levels and the prevalence of mental disorders in the general population have been rising in recent years. Chatbot-based interventions represent novel and promising digital approaches to improve health-related parameters However, there is a lack of research on chatbot-based interventions in the area of mental health.

Objective: The present study investigated the effects of a three-week chatbot-based intervention guided by the chatbot ELME, aiming to reduce stress and to improve various health-related parameters in a stressed sample.

Methods: In this multicenter, two-armed randomised controlled trial, 118 individuals with a medium to high stress levels were randomised to the intervention group (n = 59) or to a treatment-as-usual control group (n = 59). Chatbot ELME guided participants of the intervention group through three weeks of training based on the topics stress, mindfulness and interoception with practical and psychoeducative elements with two daily interactive intervention sessions via smartphone (á 10-20 min.). The primary outcome perceived stress and secondary outcomes mindfulness, interoception (interoceptive sensibility), psychological well-being, and emotion regulation (subfacets reappraisal and suppression) were assessed pre-intervention (t1), post-intervention (t2; after three weeks), and follow-up (t3; after six weeks). During both conditions, participants also underwent ecological momentary assessments of stress and interoceptive sensibility.

Results: There were no significant changes in perceived stress (?03 = -.018; SE = .329; p = .956) and momentary stress. Mindfulness and the subfacet reappraisal significantly increased due to the intervention over time. Interoceptive sensibility and the subfacet suppression did not change; well-being increased in both groups. Momentary interoceptive sensibility increased in both groups over time.

Conclusions: To the best of our knowledge, the present study is the first chatbot-based intervention integrating contents of the health-related parameters stress, interoception, and mindfulness in an interactive format which provides a flexible use in everyday life. To gain insight into how the intervention can be improved to achieve its full potential for stress reduction, moderating and mediating variables could be examined. Clinical Trial: The trial is registered at the WHO International Clinical Trials Registry Platform via the German Clinical Trials Register (DRKS00027560; date of registration: 06 January 2022).

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Conclusions: To gain insight into how the intervention can be improved to achieve its full potential for stress reduction, besides a longer intervention duration, specific samples should be considered. The chatbot-based intervention seems to have the potential to improve mindfulness and emotion regulation in a stressed sample. Future chatbot-based studies and interventions in health care should be designed based on the latest previous findings on the efficacy of rule-based and AI-based chatbots.

Trial registration: The trial is registered at the WHO International Clinical Trials Registry Platform via the German Clinical Trials Register (DRKS00027560; date of registration: 06 January 2022).

Key words: chatbot, intervention, stress, interoception, interoceptive sensibility, mindfulness, emotion regulation

Background

Stress levels and the prevalences of mental disorders in the general population have been rising in recent years and accelerated by the COVID-19 pandemic [1]. Digital mindfulness-based interventions were indicated as promising approaches to improve mental health outcomes such as stress (e.g., 5–7), mindfulness (e.g., 5,6), or subjective well-being (e.g., 6), highlighting the crucial role of emotion regulation [8]. Thereby, guided online interventions are of high relevance, as they showed higher adherence rates compared to unguided interventions [11–14]. Novel digital approaches of increasing interest include the support by chatbots [15–17] which can be used anonymously, regardless of time and location, and easily integrated in individuals' everyday lives [11,20–23].
Considering chatbot-based interventions aiming to improve mental health outcomes, there is evidence for decreases in distress [27,30–32] or increased subjective and psychological well-being [30,33,34]. Importantly, randomised controlled trials in the context of mental health are sparse and inconsistent [17,19,32,39,40] and there is still a lack of research in the efficacy of chatbot-based interventions [19,32,39], in particular, for emotion regulation and interoception [41,42]. Due to the facts of impaired interoceptive abilities in mental disorders (e.g., 55,56) or long-term stress [47], to train interceptive abilities is essential, e.g., via mindfulness-based interventions (e.g., 57,58).

To summarize, there is a need for research on chatbot-based interventions respecting diverse characteristics and guidelines. Furthermore, so far, interoception was not in the focus of previous research on chatbot-based interventions, neither as intervention contents nor implemented as ecological momentary assessment (EMA) measures. EMA represents a flexible approach to measure real-time data, e.g. health data, in everyday life [61]. Therefore, we developed a new chatbot-based intervention fostering the abilities interoception, mindfulness, and stress management in everyday life.

The aim of the present study was to investigate the effects of a 3-week chatbot-based intervention on stress, mindfulness, interoception, subjective well-being, and emotion regulation in individuals with medium to high stress levels. Therefore, and based on the described previous findings, perceived stress was chosen as a primary outcome. Further details are described in the study protocol of the present study [67].
We hypothesized that

1) the primary outcome perceived stress will be reduced in the intervention group compared to the treatment as usual control group over time – as assessed at pre-, post-intervention and follow-up and via EMA.
2) the secondary outcomes mindfulness, interoception (interoceptive sensibility), subjective well-being, and emotion regulation will be improved in the intervention group compared to the control group – as assessed at pre-, post-intervention and follow-up. Momentary interoceptive sensibility and stress was also assessed via EMA.

Furthermore, adherence, dropout reasons, usability, and user feedback regarding the intervention were assessed, to potentially further improve the intervention for future research.

Methods and Analysis

Setting and recruitment

The data collection took place between February and September 2022. German speaking people were recruited via offline and online recruitment strategies. As an incentive, participants could take part in the intervention for free and received the chance to win a € 25 gift card from an online shop or, as a student participant, to receive 5 course credits as

expense allowance for completing the questionnaires. A further incentive was the possible access to two relaxing exercises and to get individual summaries regarding the change in the participants' health-related parameters in the from pre- to follow-up intervention after completing the t3 questionnaire. Participants were included into the study if they (a) were 18 years or older, (b) had sufficient knowledge of the German language, (c) owned a smartphone (Android or iOS) with internet access, (d) possessed a valid smartphone number, (e) possessed a valid mail address, (f) experienced a middle to high perceived stress (PSS-10 score ≥ 14, assessed at t0), (g) were not diagnosed with any mental disorder, (h) did not undertake psychotherapy, and (i) did not currently participate in another mental health online-intervention.

Study design

The intervention group conducted a three-week online-based intervention guided by the chatbot ELME. The control group received treatment as usual, i.e., no content and just answered the questionnaires and the ecological momentary assessments. Primary and secondary outcomes were assessed in both groups at screening (t0), pre-intervention (t1), daily during the intervention (between t1 and t2), post-intervention (t2), as well as follow-up three weeks after t2 (t3). The design of the present study and the usability of the chatbot were successfully tested in a previous feasibility study. The trial was registered a priori at the WHO International Clinical Trials Registry Platform via the German Clinical Studies Trial Register (DRKS00027560; date of registration: 06 January 2022). The detailed design of the present two-armed, parallel randomised controlled trial is presented in the study protocol [67].

Study procedure

Figure 1 represents the study procedure including the final numbers of participants.

***** Insert Figure 1 *****

Figure 1. Flow chart of the study procedure.

Intervention

ELME is a rule-based chatbot, implemented as a web-based mobile application. ELME offered psychoeducation, exercises in real-time dialogues with the chatbot, audio files, and individual feedback. Sessions were held twice a day (á 10–20 min) over three weeks and with flexible timing. Participants could postpone exercises and receive SMS reminders. For more detailed intervention information and the detailed procedure see descriptions in the study protocol [67]. Exemplary dialogues of the interaction with the chatbot and a participant are depicted in Figures 2 and 3.

***** Insert Figures 2 and 3 *****

Figures 2 and 3. Sample dialogues of the chatbot interacting with a participant (in German language).

Outcome assessment

Primary Outcome: Perceived Stress

The 10-item Perceived Stress Scale (PSS-10; 85) was used as a screening questionnaire. At t1 to t3, perceived stress was assessed via the 4-item short scale (PSS-4). The ratings on both scales ranging from 0 = "never" to 4 = "very often" were calculated as sum scores with higher scores representing higher perceived stress.

Secondary outcomes

Mindfulness

The 14-item short version of the Freiburg Mindfulness Inventory (FMI; 86) was used to assess mindfulness. Answers were rated on the 4-point Likert scale ranging from 1 = “rarely” to 4 = “almost always”. A sum score (range: 14-56) was calculated with higher scores indicating higher mindfulness.

Interoceptive sensibility

Interoceptive sensibility was measured by German versions of the Interoceptive Accuracy Scale (IAS; 87) and the subscale “Awareness” of the Body Perception Questionnaire (BPQ; 88). The 21-item IAS was rated on a 5-point Likert scale ranging from 1 = “disagree strongly” to 5 = “strongly agree”. Higher sum scores (range: 21-105) indicate greater interoceptive sensibility. The subscale “Awareness” of the BPQ consists of 45 items, rated on 5-point Likert scale ranging from 1 = “never” to 5 = “always”.

Subjective well-being

The 5-item WHO Well-Being Index (WHO-5; 89; 90) was used to assess subjective well-being. Participants responded on a 5-point Likert scale ranging from 5 = “all of the time” to 0 = “at no time”. A total sum score (range: 0-100; 100 = best well-being) was calculated from raw scores (range: 0-25) and multiplied with 4.

Emotion regulation

The German version [91] of the Emotion Regulation Questionnaire [92] was used to assess emotion regulation. The 10-item questionnaire included 6 items representing the emotion regulation strategy reappraisal and 4 items assessing the emotion regulation strategy suppression, rated on a 7-point Likert scale ranging from 1 = “strongly disagree” to 7 = “strongly agree”. Accordingly, the mean scores reflect the use of and preferences for the emotion regulation strategies.

Ecological Momentary Assessment

Momentary perceived stress and momentary interoceptive sensibility were measured via ecological momentary assessments twice a day (in the morning and in the afternoon). Momentary perceived stress was assessed via two adapted items for the momentary use of the Perceived Stress Scale Short form (PSS-4; 85): “Do you feel that things are going your way?” and “Do you find you can cope with all the things that you have to do?”. The items “How present do you feel at the moment?” and “How aware are you of your own body at the moment?” [57,66] measured body awareness. To assess interoceptive sensibility, we used a self-developed question, taking the heartbeat perception task by Schandry (1981) into account: “How intense do you perceive your heartbeat in the moment?” aiming at interoceptive sensibility. All rating scales were presented as visual analogue scales ranging from 0 “= not at all” to 100 = “very much”.

Mental Health App Usability Questionnaire

To assess the usability of the chatbot as a mental health App, a self-translated German version of the 18-item Mental Health App Usability Questionnaire (MAUQ; 93) was used, rated on a scale ranging from 1 = “strongly agree” to 7 = “strongly disagree”. The questionnaire comprises the three subscales „ease of use“ (5 items), „interface and satisfaction“ (7 items) and „usefulness“ (6 items). Mean scores for each subscale were calculated as a total mean score with lower mean scores reflecting higher usability.

Adherence, potential dropout reasons and user feedback

Adherence to the intervention was operationalized by the percentage of completed modules of the intervention. Reasons for potential dropout reasons were assessed via the Dropout Reasons Questionnaire for Internet Interventions [94]. User feedback questions asking the participants if they liked the training (range: 1-10) and judging the extent of the training (1 = too short; 12 = too long) were assessed.

Data analysis

Data analyses were conducted according to the intention-to-treat principle. Due to the nested longitudinal data structure, hierarchical linear regression models were calculated to investigate the intervention effects over time. The measurement points (level 1) were nested within the participants (level 2). The regression analyses include the three measurement points pre-intervention (T1), post-intervention (T2) and follow-up (T3). We analysed hierarchical linear models and model comparisons in R using the packages lme4 [95], lmerTest [96] and r2mlm [97]. The predictor variable time had an interpretable zero point and the dichotomous predictor group was dummy-coded. Due to assumed interindividual and intraindividual differences in all outcome variables, random intercept and random slopes models were calculated. The Restricted Maximum Likelihood estimator was applied for parameter estimation, as it is generally considered as less biased compared to the maximum likelihood estimation [98]. In this manuscript, the main results are reported to answer the research questions 1) and 2*).* The significance level for all analyses was $p \leq .05$.

Results

A total sample of N = 118 was randomised to the intervention group (n = 59, 72 % female) and to the control group (n = 59, 81 % female). The relevant descriptive statistics at T1 depicted in Table 1. There were no significant differences between the groups at T1.

Table 1. Relevant descriptive statistics at T1.

	Intervention group (n = 59) Mean (SD)	Control group (n = 59) Mean (SD)	t(116)	p
Age	33.117 (11.778)	33.085 (13.853)	-.014	.989
Perceived stress	8.017 (2.701)	7.627 (2.355)	-.836	.405
Mindfulness	34.271 (5.825)	34.051 (6.957)	.187	.852
IS (IAS)	82.220 (10.992)	80.475 (9.233)	-.934	.352
IS (BPQ)	3.252 (.793)	3.305 (.561)	.443	.658
Well-being	41.153 (17.341)	42.780 (17.297)	.510	.611
Emotion regulation - reappraisal	4.130 (1.139)	4.429 (.934)	1.561	.121
Emotion regulation - suppression	3.725 (1.260)	3.339 (1.227)	-1.684	.095

Note. SD, standard deviation; *BMI*, body mass index; *IS*, interoceptive sensibility; *IAS*, Interoceptive Accuracy Scale; *BPQ*, Body Perception Questionnaire.

Perceived stress

Table 3. Random intercept and random slope model for perceived stress with the predictors time, group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		8.135	.337	122.119	24.141	< .001***
	Level 1						
		Time	-.341	.222	141.471	-1.538	.126
	Level 2						
		Group	.172	.478	123.037	.359	.720
	Cross-level-interaction		-.018	.329	140.501	-.055	.956
		Time* group					
			σ²	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		3.243	1.801			
	σ^2_{u01j} (Time)		.017	.132			
	σ^2_{rij} (Residual)		3.916	1.979			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

According to the model regarding perceived stress, the non-significant fixed effect of the level-1-predictor time (β_{01} = -.341; *SE* = .222; *p* = .126) indicates that the stress levels did not change over time (from T1 to T3). The fixed effect of the level-2-predictor group (β_{02} = .172; *SE* = .478; *p* = .720) and the cross-level-interaction of the variables time and group (β_{03} = -.018; *SE* = .329; *p* = .956) were not significant. The results of the two models predicting momentary perceived stress showed neither significant effects of time and group nor significant interactions (see Tables A1 and A2).

Mindfulness

Table 4. Random intercept and random slope model for mindfulness with the predictors time,

group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		34.362	.826	115.647	41.589	< .001***
	Level 1						
		Time	.078	.350	68.640	.223	.842
	Level 2						
		Group	-.080	1.170	116.058	-.069	.945
	Cross-level-interaction						
		Time* group	1.130	.521	71.363	2.171	.033*
			σ^2	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		31.906	5.649			
	σ^2_{u01j} (Time)		.113	.336			
	σ^2_{rij} (Residual)		9.461	3.076			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

The results of the model regarding mindfulness showed no significant fixed effects time (β_{01} = .078; *SE* = .350; *p* = .842) and group (β_{02} = -.080; *SE* = 1.170; = .945). However, the cross-level-interaction of time and group (β_{03} = 1.130; *SE* = .521; *p* = .033) was significant.

Interoceptive Sensibility

The results of the model predicting interoceptive sensibility (assessed via the Interoceptive Accuracy Scale) revealed neither significant effects of time and group nor a significant interaction (see Table A3). Similarly, assessments via the Body Perception Questionnaire showed no significant effects (see Table A4.)
Momentary IS increased on average by β_{01} = .229 (*SE* = .076; *p* = .003) from measurement point to measurement point in both groups. The effects for group and the cross-level-interaction of time and group were not significant (see Table A5).

Well-being

Table 5. Random intercept and random slope model for well-being with the predictors time,

group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		42.150	2.236	115.591	18.848	< .001***
	Level 1						
		Time	4.237	1.479	74.662	2.865	.005**
	Level 2						
		Group	-.032	3.168	116.363	-.010	.992
	Cross-level-interaction						
		Time* group	2.312	2.189	78.034	1.056	.294
			σ^2	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		185.17	13.608			
	σ^2_{u01j} (Time)		26.580	5.156			
	σ^2_{rij} (Residual)		124.180	11.144			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

Subjective well-being improved over time in both groups on average by β_{01} = 4.237 (*SE* = 1.479; *p* = .005). There were neither significant differences in the groups (β_{02} = -.031; *SE* = 3.168; = .992) nor significant changes over both time and group (β_{03} = 2.312; *SE* = 2.189; *p* = .294).

Emotion regulation – subfacet reappraisal

Table 6. Random intercept and random slope model for emotion regulation, subfacet reappraisal, with the predictors time, group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		4.426	.133	116.328	33.297	< .001***
	Level 1						
		Time	.022	.064	127.10	.347	.729
	Level 2						
		Group	-.255	.188	116.819	-1.353	.179
	Cross-level-interaction						
		Time* group	.223	.096	127.085	2.331	.021*
			σ^2	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		.775	.880			
	σ^2_{u01j} (Time)		.006	.075			
	σ^2_{rij} (Residual)		.302	.550			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

The results of the model concerning the subfacet reappraisal of emotion regulation revealed neither a significant effect of time (β_{01} = .022; *SE* = .064; *p* = .729) nor of group (β_{02} = -.255; *SE* = .188; = .179). The cross-level-interaction of time and group (β_{03} = .223; *SE* = .986; *p* = .021) was significant.

Emotion regulation – subfacet suppression

Results regarding the subfacet suppression of emotion regulation revealed no significant changes (see Table A6).

Adherence, dropout reasons and user feedback

The mean adherence was 58 % (n = 59). n = 23 skipped intervention units; as the main reason for skipping intervention units, time reasons were reported (n = 19). Separately, n = 22 reported technical problems. The answer rates of the EMA questions are 48 % on average in the intervention group and 66 % in the control group. The overall rating of the question if the participants liked the training was 6.95 (SD = 1.86). The extent of the training was rated with 7.62 on average.

Usability

The mean usability (total score) was 2.55 (SD = .68), with means of the subscales „ease of use“ M = 1.85 (SD = 1.01), „interface and satisfaction“ M = 2.62 (SD = 1.08), and „usefulness“ M = 3.2 (SD = .94).

Discussion

Principal Results

The present study aimed to examine the effects of a three-week chatbot-based intervention on perceived stress and various health-related parameters in stressed individuals. Results show no significant changes in perceived stress. There was a significant increase in mindfulness and in emotion regulation as assessed by the subfacet reappraisal in the intervention group over time. The subfacet suppression did not change. Well-being and momentary interoceptive sensibility increased in both groups over time.

Comparison with Prior Work

Effects on perceived stress

The non-significant reduction in perceived stress is in line with the findings of similar intervention studies by 99 and the pilot study by 34; 99, however, considering statistical power problems of these studies. The intervention duration or intensity might be one factor for interpreting the missing effects of the present study. Another explanation could be that, at first, there might be a higher focus on stress perception and potentially buffering stress reducing effects due to the intervention. This approach is supported by findings due to psychotherapeutic interventions [101,102] showing the assumed effects on psychological outcomes later because of the confrontation with emotionally charging topics. Furthermore, such as the results by 103 and 104 indicate, the effects on perceived stress might become (more) visible after a longer duration of the intervention.

The results regarding momentary perceived stress are in line with studies based on 3-month mindfulness-based interventions [63,64]. Moreover, the mean adherence regarding the present intervention of 58 %, the mean answer rates of the EMA questions need to be considered when interpreting the results.

Effects on mindfulness

The significant increase in mindfulness is in line with previous findings due to online mindfulness-based interventions (e.g., 6; 5), indicating that the 3-week chatbot-based intervention comprising mindfulness-based contents has the potential to increase mindfulness over time in a stressed sample. A possible mechanism might be that the contents of the intervention addressing mindfulness, stress, and interoception support mindfulness. Nevertheless, mindfulness needs to be interpreted as a secondary outcome in the present study.

Effects on interoceptive sensibility

The missing effects are contrary to previous positive effects on interoceptive abilities due to diverse mindfulness-based interventions (e.g., 57; 105; 58). However, these effects were found in the context of interventions lasting at least eight weeks. In particular and in line with the present findings, a one-week mindfulness-based intervention [58] or a 3-week heartbeat perception training [60] could not improve interoceptive abilities. The present findings support the approach by 105, 57, and 60 supposing that to improve interoceptive abilities, a longer intervention might be necessary. Moreover, previous studies differ in their methods to assess diverse dimensions of interoceptive abilities (e.g., 43,106). Last but not least, a longer intervention design of the present, innovative intervention might be only reasonable after first trials with a shorter intervention design like the duration of three weeks in the present study.

Due to the innovative EMA questions of the present study and another study design not including an intervention, results are not comparable to the previous EMA study by 65. The significant increase in momentary interoceptive sensibility could be explained by a training effect of frequent EMA which took place twice a day over three weeks.

Effects on emotion regulation

In line with the results regarding reappraisal, in a recent systematic review and meta-analysis on mental health apps to promote emotion regulation and positive mental health in the general population [107], a medium effect of $g = .49$ was reported for emotion regulation compared to control conditions. It needs to be emphasized that this effect is based on only $n = 6$ studies, reflecting that there is still a lack of RCT's on s chatbot-based interventions addressing emotion regulation.

Effects on well-being

The increase in well-being is in line with comparable previous studies [30,33,34,37], considering differences in the study designs and samples. However, well-being in the control group of the present study was also improved, which might be also induced by the daily ecological momentary assessments as potential positive triggers or observational processes.

Strengths and Limitations

To the best of our knowledge, the present study is the first chatbot-based intervention including contents and assessments on interoception, as well as its association with mindfulness and stress. Further strengths of the study are the highly standardized design in line with the CONSORT guidelines [110,111] and ecological momentary assessments of interoceptive sensibility [65,66,112]. Furthermore, the design and the usability of the chatbot were successfully tested in a previous feasibility study. Therefore, the chatbot fulfills the required standards for chatbots for mental health support [11]. Finally, the results could show a high usability of the chatbot.

Limitations of the present study should be mentioned and considered for the design of future studies. Firstly, the adherence of 58 % of the intervention was limited. Nevertheless, this adherence rate is on average as compared to online-mindfulness-based interventions with adherence rates ranging from 35% to 92% [113]. It needs to be noted that adherence rates of digital or chatbot-based interventions were often not reported or operationalised by diverse assessments [32,114] and lacking long-term user engagement in e-Health is a common problem [115,116]. Secondly, 77 % of the participants were female. Therefore, future intervention studies should consider diverse strategies to specifically address male participants. Thirdly, the present study exclusively assessed self-report data. Due to potential

differences to objective physiological data [119], future studies should assess subjective and objective data, especially regarding stress and interoception. Lastly, a text- and rule-based chatbot as used in this study might lack on human appearance regarding, e.g, the type of interaction between the chatbot and the user. Recent meta-analyses [120,121] showed that chatbot-based studies are more effective when diverse input and output modalities are combined.. A multimodal chatbot might be superior because it appears more lively and flexible in dialogues [122] and ready to interact.

Conclusions and Future Research

To gain insight into how the intervention can be improved to achieve its full potential for stress reduction, besides a longer intervention duration, specific samples should be considered, e.g., employees, diverse age groups, clinical or subclinical populations, aiming to adapt to individual needs and preferences in every-day life. The chatbot-based intervention seems to have the potential to improve mindfulness and emotion regulation in a stressed sample. Additional factors such as the participants' social motivation regarding the guidance by the chatbot and the personality of the chatbot [115,123] would be of further interest to foster the alliance or a therapeutic relationship between the user or a patient and the chatbot. Future studies should also investigate in detail which elements such as psychoeducation or exercises have the greatest effects to improve diverse health parameters. Future research should implement large language models to provide and further develop diverse artificially intelligent (AI) chatbots in digital mental health interventions [127,128]. Latest findings like AI-based chatbots being more effective in clinical or subclinical populations [121] need to be considered. Nevertheless, besides the chances of AI-based chatbots for the professional mental health service, emerging reputational risks of AI-based chatbots such as safety and data privacy issues [129,130], gender, ethnical and socio-economic biases [131], limited empathy and emotional awareness as compared to a human counterpart [132] and hallucinations [133] should be discussed extensively. To sum up, based on the numerous chances of chatbots in the psychological and medical field such as counselling, psychotherapy, diagnostic assessment and interventions [19,134,135], future studies are needed to derive robust implications in these fields.

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Appendix

Momentary perceived stress by ecological momentary assessment, item "coping with things"

Table A1. Random intercept and random slope model for perceived stress (item "coping with things") as assessed via ecological momentary assessment the predictors time, group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		50.592	2.095	104.260	24.148	< .001***
	Level 1						
		Time	.033	.065	82.059	.512	.610
	Level 2						
		Group	2.696	3.051	111.176	.883	.379
	Cross-level-interaction						
		Time* group	.024	.010	92.408	.240	.811
			σ^2	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		211.530	14.544			
	σ^2_{u01j} (Time)		.124	.352			
	σ^2_{rij} (Residual)		244.343	15.632			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

Momentary perceived stress by ecological momentary assessment, item "feeling on top of things"

Table A2. Random intercept and random slope model for perceived stress (item "feeling on top of things") as assessed via ecological momentary assessment the predictors time, group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		52.364	2.307	102.647	22.699	< .001***
	Level 1						
		Time	-.018	.076	83.131	-.240	.811
	Level 2						
		Group	2.047	3.348	108.395	.061	.542
	Cross-level-interaction						
		Time* group	.084	.115	90.645	.727	.469
			σ^2	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		267.685	16.361			
	σ^2_{u01j} (Time)		.211	.459			
	σ^2_{rij} (Residual)		220.839	14.861			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

Interoceptive sensibility (Interoceptive Accuracy Scale)

Table A3. Random intercept and random slope model for interoceptive sensibility as assessed via the Interoceptive Accuracy Scale with the predictors time, group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		80.829	1.256	115.902	64.381	< .001***
	Level 1						
		Time	.268	.692	68.722	.387	.700
	Level 2						
		Group	1.555	1.778	116.575	.875	.384
	Cross-level-interaction						
		Time* group	-.197	1.026	71.524	-.192	.849
			σ^2	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		61.135	7.819			
	σ^2_{u01j} (Time)		1.252	1.119			
	σ^2_{rij} (Residual)		36.045	6.004			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

Interoceptive sensibility (Body Perception Questionnaire)

Table A4. Random intercept and random slope model for interoceptive sensibility as assessed via the Body Perception Questionnaire with the predictors time, group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		3.332	.081	115.571	40.974	< .001***
	Level 1						
		Time	.064	.052	61.720	1.220	.227
	Level 2						
		Group	-.057	.115	116.086	-.493	.623
	Cross-level-interaction						
		Time* group	.012	.077	64.980	.156	.877
			σ^2	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		.302	.549			
	σ^2_{u01j} (Time)		.056	.237			
	σ^2_{rij} (Residual)		.099	.315			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

Momentary interoceptive sensibility

Table A5. Random intercept and random slope model for momentary interoeptive sensibility, with the predictors time, group, and the interaction of time and group.

			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		37.901	2.477	98.989	15.300	< .001***
	Level 1						
		Time	.229	.076	81.461	3.018	.003**
	Level 2						
		Group	4.551	3.609	104.110	1.261	.210
	Cross-level-interaction						
		Time* group	-.137	.115	90.030	-1.189	.236
			σ²	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		284.540	16.868			
	σ^2_{u01j} (Time)		.158	.397			
	σ^2_{rij} (Residual)		330.894	18.191			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

Table A6. Random intercept and random slope model for emotion regulation, subfacet suppression, with the predictors time, group, and the interaction of time and group.

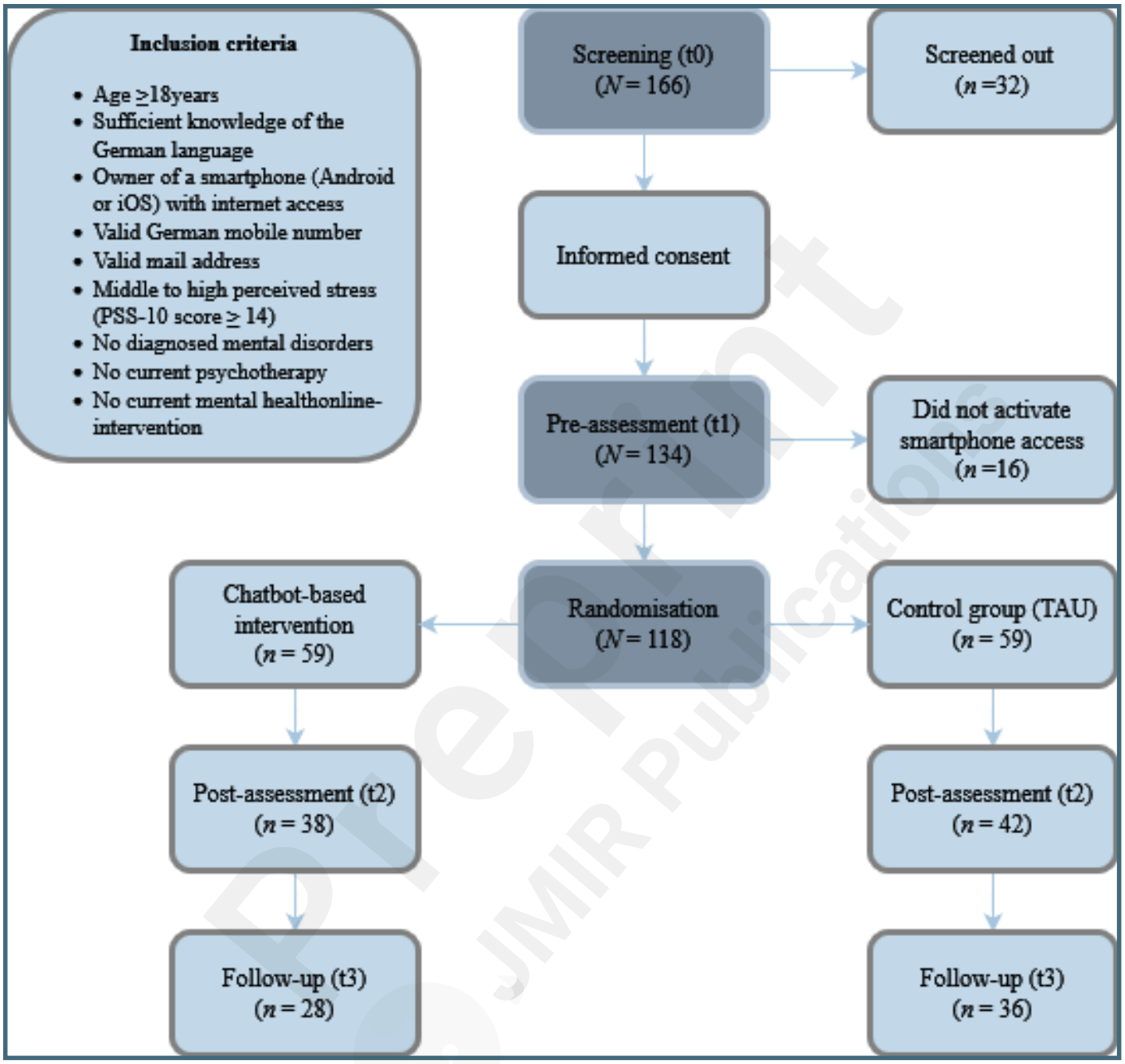
			Model				
			β	*SE*	*df*	*t*	*p*
Fixed effects							
	Intercept		3.326	.157	114.392	21.239	< .001***
	Level 1						
		Time	-.014	.090	72.059	-.150	.881
	Level 2						
		Group	.404	.222	114.947	1.820	.071
	Cross-level-interaction						
		Time* group	-.151	.133	75.692	-1.133	.261
			σ²	*SD*			
Random effects (Variance components)							
	σ^2_{u0j} (Intercept)		1.070	1.034			
	σ^2_{u01j} (Time)		.112	.334			
	σ^2_{rij} (Residual)		.425	.652			

Note. β = fixed effect coefficients; σ^2 = variance of random effect coefficients; *SE* = standard errors; *SD* = standard deviations.

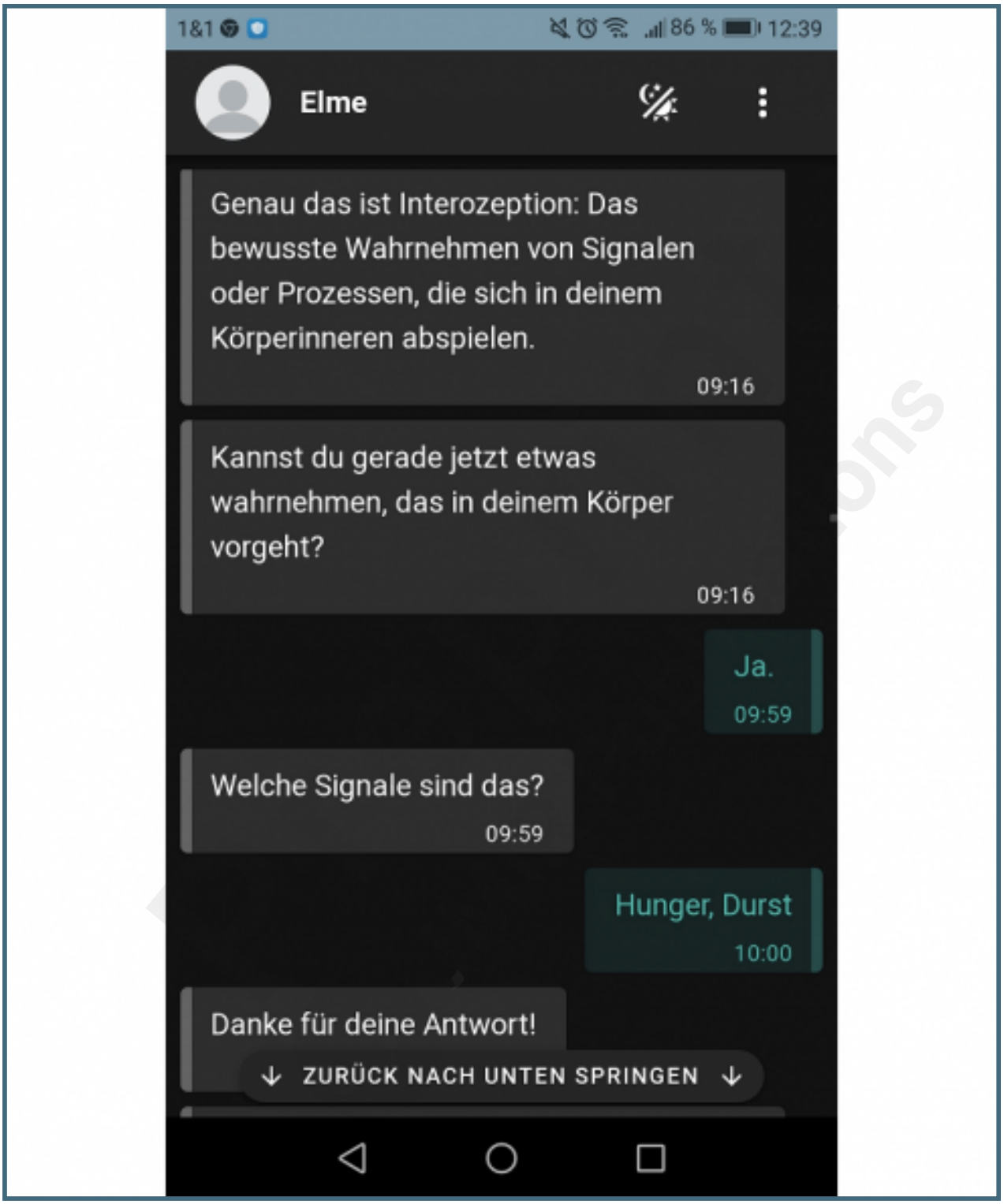
Supplementary Files

Figures

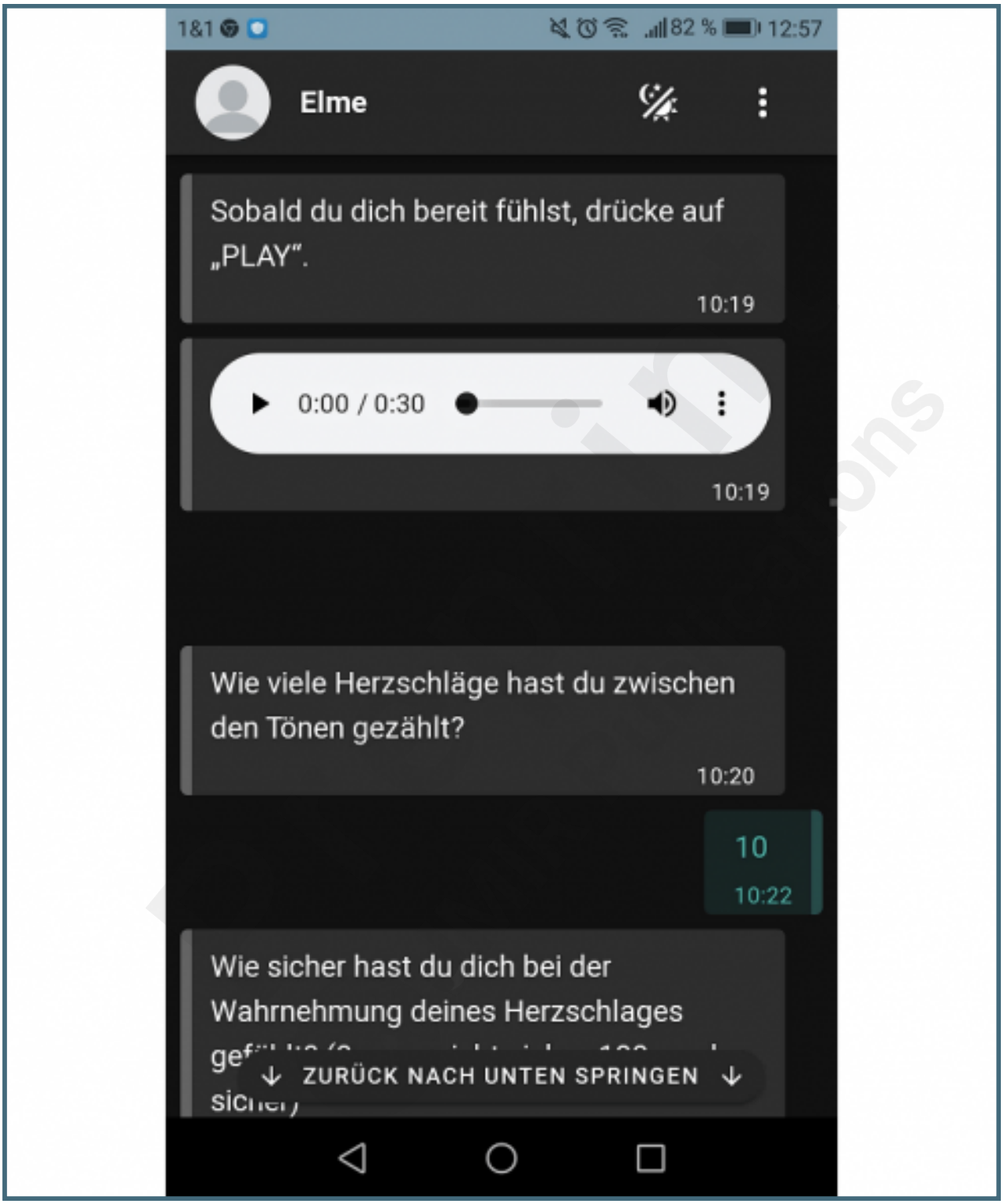
Flow chart of the study procedure.



Sample dialogue of the chatbot interacting with a participant.



Sample dialogue of the chatbot interacting with a participant.



Multimedia Appendixes

Supplementary Material.
URL: http://asset.jmir.pub/assets/eb5316043ac00a8bc92e481606310de3.docx