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Smartphone-based emotion recognition skills training for alexithymia - A randomized controlled pilot study

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ABSTRACT

Background: Neurobiological studies suggest that deficits in emotion recognition are common phenomena in alexithymia. Thus, effective treatments for alexithymia often include skills training in the domain of emotion recognition. Given that smartphone-based interventions (SBIs) offering skills training have been shown to be promising adjuncts to psychological treatments, a blended SBI facilitating the training of emotional skills might be effective in reducing alexithymia.

Methods: In this pilot trial, $N = 29$ individuals reporting elevated alexithymia levels were randomly assigned to a blended SBI including a psychoeducation session and 14 days of training with the mindtastic alexithymia app (MT-ALEX) or a psychoeducation-only control condition. Primary outcome was emotion recognition skills as assessed in a computer-based two-choice task paradigm.

Results: On average, participating in the SBI was associated with a significant increase in computer-assessed emotion recognition skills compared to the control condition ($d = 0.97$).

Conclusions: Study findings provide preliminary evidence that SBIs can improve emotion recognition skills in alexithymic individuals. Research using larger samples and targeting clinical populations is necessary to further evaluate the potential of MT-ALEX.

1. Introduction

Alexithymia denotes cognitive and affective deficits and is a common experience in the general population. Prevalence studies indicate that approximately 10% of the general population are affected by alexithymia (e.g., Salminen et al., 1999; Samur et al., 2013). Adding to its earliest definition by Sifneos (1973) as the inability to discriminate between one's own feelings and physical sensations, neurobiological studies indicate that alexithymia is associated with deficits in both inter- (Jongen et al., 2014; Moriguchi and Komaki, 2013) and intraindividual (Karlsson et al., 2008; Páez et al., 1999) recognition of emotions.

Research has demonstrated a strong link between alexithymia and a variety of mental disorders such as depression (Bamonti et al., 2010), posttraumatic stress disorder (Brady et al., 2017), schizophrenia (van't Wout et al., 2007), eating disorders (D'Agata et al., 2015; Minnich et al., 2017), and personality disorders (Berenson et al., 2016). Moreover, alexithymia is known to predict the course of symptoms in depression (Günther et al., 2016) and to negatively influence well-being (Timoney and Holder, 2013). Furthermore, research shows that alexithymia is likely to interfere with psychological interventions and is, thus, associated with less favorable outcome when treating other psychiatric disorders (Ogrodniczuk et al., 2005; Porcelli et al., 2017).

Despite the large number of individuals suffering from alexithymia, research focusing on psychological treatments for alexithymia is still scarce. A number of studies in the available literature suggest the training of emotion recognition skills to be an effective therapeutic ingredient for the reduction of alexithymia. For example, Beresnevaite (2000) found an intervention that offered 4-months of weekly comprehensive group therapy, in which the training of skills such as identifying and recognizing emotions played an important role, to significantly reduce alexithymia in post-myocardial infarction patients when compared to a control group receiving two group-based psychoeducation sessions ($d = 1.03$). Moreover, an uncontrolled study by Kennedy and Franklin (2002) demonstrated a skill-based treatment focusing on recognizing and expressing emotions (16–24 sessions) to significantly reduce alexithymia ($d = 1.73$).

Given the rising cost pressure in the mental health domain, skills trainings for various psychological problems have increasingly and successfully been offered as scalable online-based interventions (e.g.,

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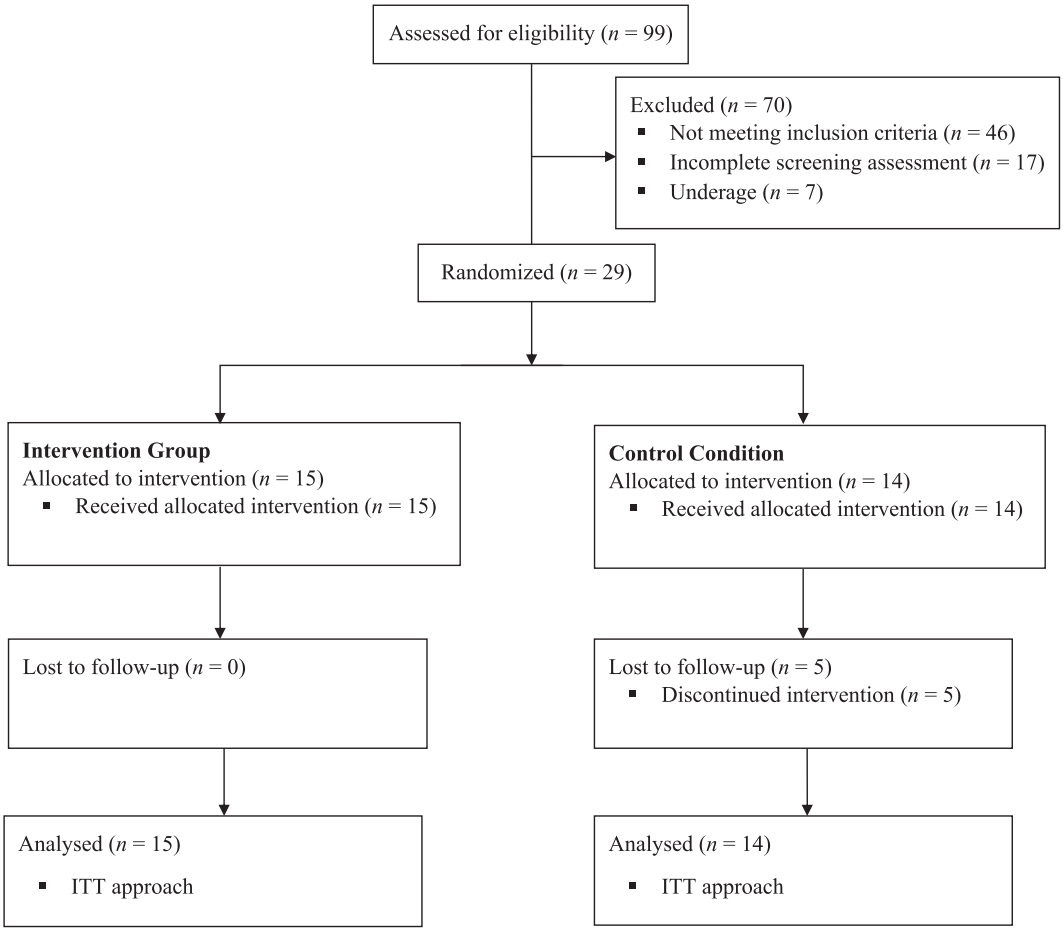

Fig. 1. CONSORT flow diagram.

Clarke et al., 2009; Rychtarik et al., 2015). Given that alexithymic individuals often display concern with regard to relational interactions as experienced in traditional therapy, online interventions may be particularly helpful to this patient group (Mahapatra and Sharma, 2018). However, our review did not yield any studies on online-based skills trainings for alexithymia. Regarding online-based training of emotion recognition skills, available interventions focus distinctly on providing support to children and adolescents suffering from autism spectrum disorder (e.g., Ramdoss et al., 2012; Thomeer et al., 2015).

Due to ongoing technological advantages, skills trainings are increasingly offered on smartphone devices. Here, research demonstrated promising results for smartphone-based interventions (SBIs) delivering skills trainings for substance disorders (Gajecki et al., 2017) and depression (Ly et al., 2014). This shift to SBIs can be explained by various factors. For example, the ubiquitous use of smartphones makes them constant companions in everyday life and allows patients to use them independently from time and location (Smith, 2015). Moreover, smartphones are already owned by a large number of patients, which allows for the easy dissemination of SBIs to various patient groups (Boschen and Casey, 2008). Their rising popularity in clinical research and practice (Payne et al., 2012) can be further explained by the fact that smartphones allow patients to continuously interact with SBIs and to receive just in time notifications, reminders or alerts, thereby allowing for an increase in both frequency and intensity of treatment (Ben-Zeev et al., 2015; Ly et al., 2012).

However, research has yet to produce convincing evidence for use of SBIs in the reduction and treatment of mental health problems. Available meta-analyses (Firth et al., 2017a; Firth et al., 2017b) have shown that SBIs can reduce symptoms of depression and anxiety, but that effect sizes are only ranging between small to medium when compared to heterogeneous control conditions ($g = 0.33$ for anxiety; $g = 0.56$ for depression). Although there is still a lack of experimental validation of SBIs (Bakker et al., 2016), SBIs have recently been used as technological adjuncts to traditional therapy as an attempt to balance both cost-effectiveness and adherence to psychological treatments (e.g., Clough and Casey, 2015; Garrison et al., 2015). For example, in a study by Schatz et al. (2015), a SBI-based skills training was combined with a single session of traditional therapy to decrease pain and increase coping in pediatric sickle cell disease. Participants in the intervention group showed reduced pain intensity ($d = 0.81$) and increased coping ($d = 2.32$) when compared to a control condition. However, our review of the literature did not yield any studies examining stand-alone or blended SBIs targeting emotion recognition skills and/or alexithymia.

Given that blended SBIs utilizing approach-avoidance modification trainings (AAMTs) have shown merit in the reduction of procrastination ($\eta^2 = 0.15$; Lukas and Berking, 2017) and body dissatisfaction ($d = 0.62$; Kollei et al., 2017), we developed a SBI-based AAMT that facilitates emotion recognition skills training for alexithymia (mindtastic alexithymia; MT-ALEX). MT-ALEX is a blended intervention that combines a psychoeducation session with 14-days of SBI training. The 1.0 version of MT-ALEX used in this study aims at improving both inter- and intraindividual recognition of emotions by utilizing a categorization game that is based on the AAMT approach. Thus, we hypothesized MT-ALEX to significantly improve emotion recognition skills and to significantly reduce alexithymia when compared to a psychoeducation-only control condition. We also evaluated whether possible reductions in alexithymia were stable at a 1-month follow-up.

2. Materials and method

2.1. Participants and procedures

Recruitment of participants was conducted via several social media channels, the university's website, and flyers on public and campus sites. Interested individuals were asked to complete an online screening questionnaire assessing the following inclusion criteria: (a) heightened levels of alexithymia (scores ≥ 51 on the Toronto Alexithymia Scale 20; TAS-20; Bagby et al., 1994), (b) age 18 or above, (c) access to a smartphone using Android (version 4.0 or above), and (d) sufficient German language skills. To maximize external validity there were no exclusion criteria. Fig. 1 illustrates the flow of participants throughout the study. Of the 99 respondents we assessed for eligibility, 46 individuals scored below the cutoff for the TAS-20, 17 failed to complete the screening assessment, and seven were under the age of 18. The 29 individuals meeting all inclusion criteria were contacted by e-mail and received additional written information about study procedures. The mean age of the final sample was $M = 27.14$ ($SD = 8.19$) with the majority of participants being female (55,2%). Participants were assigned to the SBI ($n = 15$) or a psychoeducation-only control group ($n = 14$) using block randomization, which was conducted by a master's degree student (via randomization.org). The student generated the assignment sequence and enrolled participants. Pre-treatment and post-treatment data were assessed at the department's outpatient clinic, while the 1-month follow-up data was assessed using an online assessment tool (www.soscisurvey.de). All study procedures complied with the human research guidelines of the Helsinki Protocol and were approved by the ethics committee of the German Psychological Society. The trial was registered at the German Clinical Trial Registry (DRKS00014641).

2.2. Interventions

2.2.1. Psychoeducation

All participants received one session of psychoeducation prior to the training with MT-ALEX. The psychoeducation sessions were scheduled one day before the SBI group started the 14-days training period with MT-ALEX. The sessions lasted 45 min and consisted of three parts. Psychoeducation sessions started with the provision of general information on the role of emotion recognition skills for mental health and alexithymia in particular. In this sequence, participants were systematically led to discover both possible disadvantages resulting from deficits in emotional competencies and possible advantages of possessing (or developing) emotional competencies. For this purpose, counselors were trained to make use of the therapeutic techniques *Guided discovery* and *Socratic dialogue*. After this sequence, participants were educated about the broad range of existing emotions by introducing the Emo-Check, an emotion inventory consisting of 50 fundamental emotions (Berking and Znoj, 2008). In this sequence of the psychoeducation session, participants were also asked to rate and label their current emotional state using the Emo-Check. Participants then received the Emo-Check inventory as a worksheet and were asked to further train their emotion recognition skills at home by rating and labeling their emotional state on a daily basis for the next 14 days. Psychoeducation sessions were delivered by two intensively trained master's degree students in rooms of the department's outpatient clinic. As means to ensure quality of treatment and adherence to the treatment protocol, training and supervision was provided at regular intervals by a graduate psychologist and a professor in clinical psychology. Regarding the training of students delivering the psychoeducation, students received three training sessions prior to the start of the intervention. Training sessions each lasted about 120 mins. In the training sessions, students received information about the general structure of the psychoeducation and were then asked to practice the utilization using several case vignettes in group-works. Supervision was offered weekly during the intervention period and mainly addressed difficulties experienced by the students while delivering the psychoeducation sessions.

2.2.2. MT-ALEX

Following the session, participants in the SBI group were introduced to MT-ALEX, asked to install the app on their smartphones, and were then instructed in its handling. In 14 emotion-specific workouts, the 1.0 version of MT-ALEX aimed at training inter- and intraindividual recognition of seven basic emotions (referred to as target emotions in the manuscript), namely fear, anger, disgust, sadness, joy, pride, and surprise. Participants in the SBI group were asked to train with the app for 14 consecutive days, so that two workouts were dedicated to every target emotion over the course of the intervention. Daily standardized text messages announced the target emotion to be trained on that particular day and served as reminders to improve treatment adherence.

Each of the 14 workouts started with a mood induction rationale. In this rationale, participants were asked to read and/or listen to a short story and to view picture material that was designed to induce the respective target emotion in the participant. Afterwards, the app asked participants to put themselves in the position of the story's protagonist. For every target emotion, a male and female version of the short story was available to adapt for gender. Female stories were read out by a female voice and vice versa. Support for the utilization of mood induction rationales over the internet comes from research showing their effectiveness in adult populations (Ferrer et al., 2015; Göritz and Moser, 2006). After completing the mood induction, the app started a categorization game in which participants had to react to stimulus material by either swiping away distractor stimuli or pulling target stimuli towards them. Each categorization game presented 24 stimuli (18 pictures and six text statements) in randomized order, out of which 12 stimuli aimed at improving intraindividual recognition of emotions and the other 12 aimed at improving interindividual emotion recognition. The 12 stimuli aiming at improving intraindividual emotion recognition consisted of six stimuli portraying or describing situations typically associated with the target emotion and six distractor stimuli. The 12 stimuli used for improving interindividual recognition of emotions showed individuals posing either six target emotions or six distractors. In the categorization game, stimuli appeared on the smartphone screen first small and then increased in size until they filled almost the entire screen. On average, completion of a workout took about 7 min.

MT-ALEX utilizes mechanisms from operant conditioning through the systematic reinforcement of training effects as a means for molding unconditioned responses and improving the training by maintaining high user motivation (Siang and Rao, 2003). This was achieved by providing immediate feedback upon correct or false processing of a stimulus. When correct, a smiling emoticon and the word “Correct!” appeared on the screen. When false, a frowning emoticon, the word “Wrong!”, and a short vibration of the smartphone occurred. Given research demonstrating the effectiveness of electronic gaming in psychotherapy and first evidence that the use of gamification may foster engagement and intervention adherence (Horne-Moyer et al., 2014; Kauer et al., 2012; Merry et al., 2012), MT-ALEX utilized gaming principles during the categorization game. For example, participants were reinforced by presenting a smiling emoticon for every correct answer given. Furthermore, participants gained stars that were automatically collected for every five correct answers given.

2.3. Outcomes

2.3.1. Primary outcome measure

Primary outcome was emotion recognition skills as assessed by number of correct pairings in a computer-based two-choice task paradigm. The computer test was similar to the Implicit Association Test (IAT; Greenwald et al., 1998) as it asked participants to rapidly categorize pictures portraying two different facially expressed emotions

with the correct label (e.g., categorizing pictures of faces showing the emotions "fear" and "disgust" with the label "fear"). The pictures used in the test were taken from the Pictures of Facial Affect-Ulm inventory (PFA-U; Limbrecht-Ecklundt et al., 2013a). The PFA-U is a well-researched and highly standardized picture set that can be used to measure both inter- and intraindividual emotion recognition skills, assess deficits in such skills, and train emotion recognition skills (Jongen et al., 2014; Limbrecht-Ecklundt et al., 2013b). In the current study, the internal consistency for correct pairings was $\alpha = 0.87$.

2.3.2. Secondary outcome measure

Alexithymia was assessed with the TAS-20 global score. The TAS-20 (Bagby et al., 1994) is a well-established self-report inventory for the assessment of alexithymia containing 20 items on three scales: Difficulty Describing Feelings (five items), Difficulty Identifying Feelings (seven items), and Externally Oriented Thinking (eight items). Higher scores indicate higher levels of alexithymia. The psychometric properties of the TAS-20 are well reported with good internal consistencies ranging from $\alpha = 0.77$ to $\alpha = 0.88$ in clinical and non-clinical populations, respectively (e.g. Bagby et al., 1994). In the present study, the internal consistency was $\alpha = 0.70$.

2.4. Statistical analyses

The evaluation of intervention effects followed an intention-to-treat approach. Missing data were imputed using a Markov Chain Monte Carlo multivariate imputation algorithm with ten estimations per missing value (Schlomer et al., 2010). We conducted repeated-measures-ANOVAs to test the effect of the intervention by analyzing the interaction between group membership and time. To test the hypothesis that the intervention effects persisted through follow-up, we included time (post-treatment vs. follow-up) as the within-subjects factor, and pre-treatment values as covariates in the ANOVA model. As effect sizes we calculated Cohen's *d* based on Thalheimer and Cook (2002) and defined 0.20/0.50/0.80 as small/moderate/large effects (Cohen, 1988).

3. Results

3.1. Preliminary analyses

All statistical assumptions (independence, normality, and homoscedasticity) for using the ANOVA were met. At baseline, there were no significant group differences in any of the demographic or outcome variables. Results of these analyses are displayed in Table 1.

3.2. Intervention adherence

All participants in the SBI group completed the intervention, while five participants in the psychoeducation-only control condition dropped out from the study before the post-assessment (see Fig. 1). On average, participants in the SBI group used the app for 10.93 days ($SD = 2.43$, range 4–14), played 5.48 min/day ($SD = 0.42$, range = 4.80–6.45) and completed 22.92 workouts over the 14 days ($SD = 10.47$, range 9–57).

3.3. Primary outcome

Table 2 shows empirical means and standard deviations for the primary and secondary outcome. The analyses on computer-assessed emotion recognition skills revealed a significant interaction of time and group membership in favor of the intervention group ($F(1,27) = 6.40$; $p = .018$; 95%-CI = 0.00–0.42) with a large effect ($d = 0.97$).

3.4. Secondary outcome

Regarding alexithymia, ANOVA results showed a significant interaction of time and group in favor of the intervention group ($F(2,54) = 8.70$; $p = .001$; 95%-CI = 0.06–0.40) with a large effect size ($d = 1.14$). When testing a possible stability of effects, ANCOVA results indicated a significant interaction of time and group ($F(1,26) = 23.43$; $p = .000$; 95%-CI = 0.18–0.65) suggesting further improvements in favor of the intervention group with a large effect size ($d = 1.95$).

4. Discussion

This pilot study evaluated the effects of a blended SBI that combined a psychoeducation session with 14 days of SBI-based emotion recognition skills training for alexithymia. When compared to a psychoeducation-only control condition, our findings suggest that participating in the SBI group led to a significant improvement in computer-assessed emotion recognition skills. Moreover, results indicate significant improvements in self-reported alexithymia over the intervention period in favor of the intervention group. Analyses show that improvements in alexithymic symptoms further increased over a follow-up period of 1-month in the intervention group, while symptoms deteriorated in the control condition.

To the best of our knowledge, this is the first study that evaluated the efficacy of a blended SBI targeting the training of emotion recognition skills for alexithymia. Study results indicate the superiority of a blended SBI over a traditional brief intervention. If replicated in the future, our findings could have important theoretical and practical implications. First, this study provides further evidence for the efficacy of blended SBIs for a broad range of mental health problems. Second, our results stress the important role emotion recognition skills play in alexithymia by demonstrating that the training of emotion recognition skills leads to reductions in alexithymia. Third, the fact that no dropouts occurred in the experimental group but almost a third of participants

Table 1
Sociodemographic and clinical characteristics of participants at baseline.

Variable	Intervention group	Control group	Test statistics	*p*
	(*n* = 15)	(*n* = 14)		
Age, *M* (*SD*)	26.80 (8.76)	27.51 (9.40)	$F(1, 27) = 0.007$	.935
Gender (female), *n* (%)	8 (53)	8 (57)	Fisher's exact test	1.00
Relationship status				
In relationship, *n* (%)	3 (20)	8 (57)	$\chi(1) = 0.003$	.628
No relationship, *n* (%)	12 (80)	5 (36)		
Education			Fisher's exact test	.540
< 10 years, *n* (%)	4 (28)	3 (21)		
> 10 years, *n* (%)	10 (66)	9 (65)		
University degree *n* (%)	1 (6)	2 (14)		
Correct pairing, *M* (*SD*)	86.93 (6.23)	88.57 (3.60)	$F(1, 27) = 0.74$	.398
TAS-20	63.61 (6.70)	58.50 (7.65)	$F(1, 27) = 3.66$	.066

Note. TAS–20: Toronto Alexithymia Questionnaire.

Table 2
Empirical means and standard deviations.

Outcome	Group	Pre-intervention *M* (*SD*)	Post-intervention *M* (*SD*)	Follow-up *M* (*SD*)
Correct pairing (computer paradigm)	Intervention	86.93 (6.23)	90.80 (5.27)	–
	Control	88.57 (3.61)	89.28 (4.04)	–
TAS-20 global score	Intervention	63.60 (6.70)	59.73 (6.62)	57.07 (8.63)
	Control	58.50 (7.65)	54.63 (7.08)	59.83 (7.47)

Note. TAS–20: Toronto Alexithymia Questionnaire.

dropped out in the control condition supports the notion that SBIs can increase treatment adherence when used as adjuncts to traditional treatments.

Despite the promising results of this pilot study, future research has to acknowledge the following limitations. Major limitations are (1) the use of a small sample size, (2) the lack of experimental manipulation of potential change mechanisms in MT-ALEX, (3) the utilization of an unevaluated outcome measure, and (4) no follow-up assessment of the primary outcome measure. Due to the small and homogeneous sample used in this study, effect sizes should be interpreted with caution as they are limited in generalizability (Howard et al., 2009; Ioannidis, 2008). Thus, future studies should include larger and preferably clinical samples. In addition, the effects of MT-ALEX are particularly challenging to assign to a discrete mechanism (mood induction, AAMT or operant conditioning). Future studies should use a multiple-arm research design to evaluate to what degree each of the mechanisms utilized by MT-ALEX induces change. Although computer assessments can deliver highly objective data, the paradigm used in this study as primary outcome was a slightly modified and, thus, unevaluated version of the IAT paradigm. This makes it difficult to compare study findings to the results from other studies using IAT paradigms. Therefore, future studies should utilize well-researched measures to allow for comparison between studies. Finally, due to the absence of follow-up assessment of the primary outcome, it is unclear whether assessed changes in emotion recognition skills maintained over the 1-month period. Thus, future studies should investigate the stability of the primary outcome over a follow-up period, preferably longer than the 1-month period used in this study.

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