Efficacy of an internet and app-based gratitude intervention in reducing repetitive negative thinking and mechanisms of change in the intervention's effect on anxiety and depression: Results from a randomized controlled trial

Hanna Heckendorf[a], Dirk Lehr[a,*], David Daniel Ebert[b], Henning Freund[c]

[a] Department of Health Psychology and Applied Biological Psychology, Institute of Psychology, Leuphana University of Lueneburg, Universitaetsallee 1, 21335, Lueneburg, Germany
[b] Department of Clinical Psychology and Psychotherapy, Friedrich-Alexander-University of Erlangen-Nuremberg, Naegelsbachstr. 25a, 91052, Erlangen, Germany
[c] Department of Religion and Psychotherapy, Tabor Protestant University of Applied Sciences, Duererstraße 43, 35039, Marburg, Germany

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ABSTRACT

Repetitive negative thinking (RNT) has been identified as a transdiagnostic process that is involved in various forms of psychopathology, including anxiety and depression. This randomized controlled trial compared a 5-week internet and app-based gratitude intervention (intervention group; IG) with adherence-focused guidance against a wait list control group (WLG) in reducing RNT in a sample with elevated RNT.
Method: A total of 260 individuals were randomized to either the IG or the WLG. Data were collected at baseline (T1), within one week post intervention (T2), and at three (3-MFU) and six-months of follow-up (6-MFU; for IG only). The primary outcome was RNT. Secondary outcomes included other mental health outcomes and resilience factors.
Results: Participants of the IG reported significantly less RNT at T2 ($d = 0.61$) and 3-MFU ($d = 0.75$) as compared to WLG. Improvements were sustained until 6-MFU. Significant, small to moderate effect sizes were identified for most secondary outcomes at T2 and 3-MFU. Furthermore, results of mediation analyses revealed that the gratitude intervention exerts its effect on anxiety and depression by reducing the risk factor of RNT, while the mediating role of resilience was less clear.
Conclusions: The gratitude intervention investigated in this study was found to be effective in reducing RNT. Gratitude interventions might affect mental health by two parallel pathways: increasing resources and reducing risk factors.
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Clinical trial registration number: DRKS00011862.
The trial protocol can be assessed at: https://www.drks.de/.

Efficacy of an internet and app-based gratitude intervention in reducing repetitive negative thinking and mechanisms of change in the intervention's effect on anxiety and depression: Results from a randomized controlled trial[1].

Repetitive negative thinking (RNT) is a cognitive process that plays a role in various forms of psychopathology and is considered a transdiagnostic risk factor (Harvey, Watkins, Mansell, & Shafran, 2004). It has been shown to be involved in the development and maintenance of mood and anxiety disorders (for a review, see Watkins, 2008) and

partly explains their comorbidity (e.g., Drost, van der Does, van Hemert, Penninx, & Spinhoven, 2014). Therefore, interventions targeting the transdiagnostic process of RNT might have the potential to prevent the development and positively affect symptoms of depression and anxiety disorders.

Ehring and Watkins (2008) define RNT as a transdiagnostic cognitive process that is repetitive in nature, perceived as difficult to disengage from, and focused on negative content. In the past, it has largely been studied in the forms of worry (e.g., Borkovec, Robinson,

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Pruzinsky, & DePree, 1983) and rumination (e.g., Nolen-Hoeksema, 1991), often referred to as content-dependent forms of RNT. Evidence shows that content-dependent forms of RNT overlap extensively, and that common rather than content-dependent aspects of RNT predict depressive and anxiety symptoms (Spinhoven, Drost, van Hemert, & Penninx, 2015). Although there is no gold standard yet, meta-analytic evidence documented that interventions based on cognitive-behavioural (CBT) and mindfulness-based cognitive therapy (MBCT) can be effective at reducing RNT (Querstret & Cropley, 2013; Spinhoven et al., 2018). Moreover, the results of individual studies suggest that reductions in RNT predict depressive and anxiety symptom reductions (e.g., Kertz, Koran, Stevens, & Björgvinsson, 2015; Newby, Williams, & Andrews, 2014).

However, not only are studies investigating interventions that specifically target *transdiagnostic* RNT scarce, but so also are studies evaluating so called positive psychological or well-being interventions focusing on this transdiagnostic process.

Learning to disengage from negative information and training to shift one's attentional focus and to notice and appreciate positive things in life, is at the core of gratitude interventions (Wood, Froh, & Geraghty, 2010). Consistent with various theories of RNT, training to switch the attentional focus to a positive perspective might help to reduce RNT. For example, training to shift the attentional focus might reduce an impaired disengagement from negative aspects of life.

According to the impaired disengagement hypothesis, impaired disengagement may lead to increased RNT (Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Focusing on the positive could also induce a positive mood. According to the mood congruence cognition bias, positive mood decreases the likelihood of negative—mood incongruent—cognitions (Gaddy & Ingram, 2014; Matt, Vázquez, & Campbell, 1992). Besides the hypothesized effect of mood on the valence of cognition, attentional scope theory suggests that a positive mood broadens one's attentional scope and could, thereby, make repetitive thoughts less likely (Whitmer & Gotlib, 2013).

In line with this reasoning, previous randomized controlled trials (RCT) have uncovered beneficial effects of gratitude interventions on content-dependent forms of RNT, such as worry and rumination (e.g., Geraghty, Wood, & Hyland, 2010b; Otto, Szczesny, Soriano, Laurenceau, & Siegel, 2016; Shao, Gao, & Cao, 2016). Furthermore, beneficial effects of gratitude interventions have been discovered for mental conditions in which RNT is suggested to play a role, such as depression (Cheng, Tsui, & Lam, 2015; Lambert, Fincham, & Stillman, 2012) and anxiety (Kerr, O'Donovan, & Pepping, 2015).

Besides results indicating efficacy, positive interventions also might foster intervention uptake. By focusing on the positive, gratitude interventions might reduce emotional barriers that prevent some individuals from using existing interventions, such as a perceived misfit of therapy to needs, and stigma-related or emotional concerns (Mohr, Ho, et al., 2010). In addition to increasing uptake, individuals seem to easily understand, complete and enjoy gratitude interventions, like a gratitude journal (Davis et al., 2016; Geraghty, Wood, & Hyland, 2010a). Thus, such interventions may be especially indicated when adherence is challenging (Wood et al., 2010). With internet-interventions, particularly when users are provided with less personal guidance and support, this often is the case (Beatty & Binnion, 2016).

However, apart from the suggested potential for uptake and adherence and promising results gleaned from individual studies, two recent meta-analyses were only able to detect limited promise of gratitude interventions (Davis et al., 2016; Dickens, 2017). Nevertheless, Davis et al. (2016) claim that the full potential of gratitude interventions has not yet been achieved and call for further research on more effective interventions. Since previous gratitude interventions mostly included only one gratitude exercise (for an overview, see Davis et al., 2016; Dickens, 2017), one way to potentially increase effectiveness would be to combine multiple gratitude exercises.

Internet-based interventions are one way to offer a battery of gratitude exercises in a practical format. Besides being practical, offering interventions over the internet might reduce structural barriers to intervention uptake and dissemination (e.g., Casey, Wright, & Clough, 2014; Mohr, Siddique, et al., 2010).

GET.ON Gratitude is a newly-developed 5-session, internet and app-based gratitude intervention that specifically targets transdiagnostic RNT. Consistent with claims made by Davis et al. (2016), GET.ON Gratitude incorporates a variety of strategies that target different aspects of gratitude; rendering it more intensive than interventions used in previously-published studies and covering the complex psychological structure of gratitude. In the initial RCT evaluating this program, a fully-guided version of the intervention was found to be effective at reducing RNT (Lehr et al., submitted). Intensive guidance limits the reach of interventions, and less-intensive guidance formats, such as adherence-focused guidance, have been developed that include adherence monitoring and feedback on demand (Zarski et al., 2016). Less intensive guidance, like adherence-focused guidance, has been found to be effective at delivering internet interventions (e.g., Ebert et al., 2016), using fewer resources, thereby increasing the intervention's potential reach. Since less guidance tends to be associated with decreased adherence (for a review, see Beatty & Binnion, 2016) and smaller effect sizes (for a review, see Baumeister, Reichler, Munzinger, & Lin, 2014; Johansson & Andersson, 2012; Richards & Richardson, 2012), the first aim of the current study was to assess the efficacy of GET.ON Gratitude, combined with adherence-focused guidance, at reducing RNT.

Besides efficacy, little is known about the underlying mechanisms by which gratitude interventions impact mental health. Therefore, mediation analyses have been used to better understand the mechanisms through which gratitude interventions affect depression and anxiety. The impact of gratitude interventions on psychopathology can be described by two different pathways. Gratitude interventions can reduce psychopathology by reducing risk factors like RNT. This mechanism can be referred to as a "risk reduction pathway". As outlined above, in agreement with various theories of RNT, it seems plausible that a gratitude intervention could reduce RNT, and reduced RNT has been shown to predict reductions in depression and anxiety symptoms (Kertz et al., 2015; Newby et al., 2014). This reasoning is also supported by findings from Petrocchi and Couyoumdjian (2016), who found that forms of RNT about self mediated the impact of gratitude on depression and anxiety.

Gratitude interventions might also impact psychopathology by encouraging users to build up resources like resilience. This second mechanism can be labeled a "resource building pathway". There is some evidence to support the existence of this second pathway. In agreement with the positive activity model (Lyubomirsky & Layous, 2013), previous studies have identified positive processes as mediators of gratitude interventions' effect on well-being, such as gratitude, perceived friendship quality, positive affect, and positive coping strategies (Emmons & McCullough, 2003; Lambert et al., 2012; O'Connell, O'Shea, & Gallagher, 2017; Wood, Joseph, & Linley, 2007). These mediators all stand for different resilience factors (for an overview of resilience factors, see Helmreich et al., 2017), together representing resilience. Thus, another way by which a gratitude intervention could exert its effects on depression and anxiety might be by building transdiagnostic protective resources like resilience (e.g., Kalisch, Müller, & Tüscher, 2014).

Gratitude interventions might also work via both pathways; by decreasing risk factors and increasing resources in concert. We hypothesized a dual pathway by which the gratitude intervention examined here exerts its effect on psychopathology: first, by reducing RNT, as a transdiagnostic risk factor; and second, by increasing resilience, as a transdiagnostic protection factor. To the best of our knowledge, to date, neither a dual pathway of efficacy of gratitude interventions, nor RNT and resilience as mediating mechanisms, have been investigated together. For this reason, the second aim of the current study was to examine the mediating role of these transdiagnostic mechanisms in the

intervention's effects on the symptoms of depression and anxiety.

1. Methods

1.1. Study design

The current study was conducted as a two-arm, randomized controlled trial, examining the efficacy of a smartphone and online-based gratitude training (intervention group; IG), as compared to a wait list control group (WLG). Both groups had access to usual care. Participants in the WLG were given access to the intervention after the 3-month follow-up.

Based upon the effect sizes found in previous positive psychological interventions (Bolier et al., 2013; Davis et al., 2016; Dickens, 2017) and meta-analyses revealing lower effect sizes for studies with less guidance (Baumeister et al., 2014; Johansson & Andersson, 2012; Richards & Richardson, 2012), an effect size of $d = 0.35$ was anticipated. An a priori power analysis for a two-tailed test with 80% power and a significance level of 5%, indicated a required sample size of $N = 262$ individuals to detect an effect of that size.

The study was approved by the Ethics Committee of the University of Lueneburg, Germany and the trial was registered at the German Clinical Trials Registry (reference number: DRKS00011862).

1.2. Participants and procedures

All participants were recruited from the community, mainly via an article on gratitude in a well-known online German news magazine ("Spiegel-Online"). The article appeared in December of 2016 and contained information on gratitude, as well as a link that interested individuals could use to register for the study. Participants were assessed for eligibility if they expressed their interest between December 2016 and mid-February 2017. Once someone indicated their interest online, an individual profile on the training platform was created for them and they were directed to a screening questionnaire. This questionnaire assessed the following inclusion criteria: (a) elevated RNT, as indicated by a score > 33 on the Perseverative Thinking Questionnaire; (b) not on a waiting list to receive or currently receiving psychological help; (c) no changes in dosage of psychopharmacological treatment over the preceding 30 days; and (d) no reported acute suicidal tendencies or (e) dissociative symptoms. Individuals meeting these criteria were then directed to a baseline questionnaire (T1) and received further information regarding the conditions of participation, as well as an informed consent form.

After submitting their informed consent form and completing the baseline questionnaire, participants were randomized to one of the two study arms, using a computer-generated randomization list with a ratio of 1:1 and a block size of two. The randomization list was generated and randomization performed by two employees in our department who were not otherwise involved in the current study. Blinding to group allocation was not feasible. Participants in the IG received immediate access to the training program and a message from their eCoach informing them about adherence-focused guidance. Individuals in the WLG were promised access to the program after the 3-month follow-up.

1.3. Measures

All instruments were self-report measures assessed online and in German. Data assessment took place at the time of screening (T0), at baseline (T1), at post-intervention (six weeks after randomization; T2); at a 3-month follow-up (3-MFU); and, among subjects in the IG, at an additional 6-month follow-up (6-MFU). Demographic variables were collected at T0. Variables measuring participants' satisfaction with the intervention and usage of care as usual were collected at T2. Internal consistencies for this study are reported for T1, unless otherwise stated.

1.3.1. Primary outcome measure

The *Perseverative Thinking Questionnaire* (PTQ; Ehring et al., 2011) was used to measure RNT. This scale was conceptualized as a transdiagnostic measure and consists of 15 items (e.g., "My thoughts repeat themselves."). Items are rated with response options that range from 0 (*never*) to 4 (*almost always*). The total score of the scale ranges from 0 to 60, with higher scores indicating greater symptom severity. A score > 33 indicates an above-average level of RNT and a higher level of psychological distress. The PTQ scale has good psychometric properties, as demonstrated by a Cronbach's alpha of .95 in the validation sample (0.89 in the present sample) and high concurrent validity, with established measures of disorder-specific RNT. Items capture the core characteristics of RNT (repetitiveness, intrusiveness, difficulties to disengage), its unproductiveness, and the extent of mental capacity used.

1.3.2. Secondary outcome measures

1.3.2.1. Mental health outcomes.
Secondary mental health outcomes included depression severity, measured with the *Centre for Epidemiological Studies Depression scale* (CES-D; Hautzinger, Bailer, Hofmeister, & Keller, 2012; Radloff, 1977), consisting of 20 items, each rated from 0 to 3 ($\alpha = 0.87–0.92$; in the present sample 0.89). A total score ≥ 16 indicates subclinical levels of depression, while a score ≥ 23 suggests clinically-significant levels of depression.

Generalized anxiety severity was measured with the 7-item version of the *Generalized Anxiety Disorder scale* (GAD-7; Löwe et al., 2008), each item rated from 0 to 4, with a total score that ranges from 0 to 28 ($\alpha = 0.89$; in the present sample 0.80). A score from 5 to 9 indicates mild, from 10 to 14 moderate, and ≥ 15 severe levels of anxiety.

Resilience was measured with the 10-item *Connor-Davidson Resilience Scale* (CD-RISC; Campbell-Sills & Stein, 2007), that is measured on a 0–4 Likert scale ($\alpha = 0.85$; in the present sample 0.82).

Insomnia severity was measured with the *Insomnia Severity Index* (ISI; Morin, Belleville, Bélanger, & Ivers, 2011), which consists of seven items, each rated from 0 to 4 ($\alpha = 0.74$; in the present sample 0.86).

Worry was measured with the ultra-brief, 3-item version of the *Penn State Worry Questionnaire* (PSWQ; Berle et al., 2011), with response options for each item ranging from 0 to 6 ($\alpha = 0.85$; in the present sample, 0.82).

1.3.2.2. Resilience factors.
Perceived social support was measured with the perceived available support subscale of the *Berlin Social* Support *Scales* (BSSS; Schulz & Schwarzer, 2003). This subscale consists of eight items, each rated on a 1–4 Likert scale ($\alpha = 0.83$; in the present sample, 0.93).

Gratitude was measured with the *Gratitude Questionnaire-6* (GQ-6; McCullough, Emmons, & Tsang, 2002), which was adapted for retrospective assessments using a one-week time frame to capture more state than trait gratitude (e.g., "I have so much in life to be thankful for."). Unlike the original measure, in the present study the six items each were rated on a 1–5 Likert Scale. The 1–7 Likert version of the GQ-6 has shown good internal consistency $\alpha = 0.82$ (in the present sample, $\alpha = 0.81$ for the 1–5 Likert Scale).

Dispositional optimism was measured with the revised version of the *Life Orientation Test* (LOT-R; Glaesmer, Hoyer, Klotsche, & Herzberg, 2008), which consists of 10 items (four filler items that are not used for calculating the summation score), and has response options that range from 0 to 4 ($\alpha = 0.59$; in the present sample, 0.78).

1.3.2.3. Further measures.
To measure clients' satisfaction with the training, a validated version of the *Client Satisfaction Questionnaire* (Attkisson & Zwick, 1982), adapted to the online context, was used (CSQ-I; Boß et al., 2016). The CSQ-I consists of eight items (e.g., "The training has met my needs."), ranging from 0 to 4, with higher values corresponding to greater satisfaction. Reliability has been reported to be high, as indicated by McDonald's ω ranging from 0.93 to 0.95 (Cronbach's α in the current study's IG at T2: 0.95).

1.4. Study conditions

1.4.1. Wait list control group

Participants in the WLG had full access to whatever usual care was offered by routine healthcare services, and were offered access to the same training that the IG received after the 3-MFU.

1.4.2. Intervention group

Participants in the IG were offered immediate access to GET.ON Gratitude. The gratitude intervention combines an online gratitude training (weekly sessions) with a mobile gratitude app (daily exercises). The gratitude app should be used in a daily manner alongside the online sessions.

Throughout training, participants were in contact with an eCoach, from whom they received reminders to complete the next session, feedback on demand regarding difficulties or ambiguities in conducting individual exercises as well as support on demand with technical difficulties (referred to as adherence-focused guidance). The online gratitude training entailed five weekly sessions, each averaging 45–60 min in duration.

The training exercises address four core elements of gratitude, which were developed based upon an "upwardly-spiralling" working model of gratitude (Lehr, 2015). See Table 1 for an overview of the individual sessions. One main component of the exercises promotes the perception of positive moments in everyday life and within one's biography (Awareness). In further exercises, evaluating such events as being positive and thankworthy is encouraged and a modification of the users' dysfunctional cognitions concerning gratitude is offered (Cognition). A third element aims to intensify the emotional experience of gratitude (Emotion). The fourth core element encourages participants to express their feelings of gratitude and take action (Behavior). At the end of each session, participants summarize their own take-home message. Meanwhile, at the beginning of the second through fifth session, they review their progress with the last week's exercises. These exercises were designed, based upon positive psychological, resource-oriented and cognitive-behavioural principles, and were adapted to the gratitude realm.

In the first session of the online training, participants were instructed to install the Gratitude-App on their mobile devices and to use the app daily from then on in addition to the weekly online sessions. The app is a modification of the "count-your-blessings" exercise (Emmons & McCullough, 2003). During the day, participants were encouraged to use the app as a gratitude journal and to take photos or write short notes recording positive moments. In the evening, participants had the opportunity to reflect on their positive moments and their sources, aided by their collected photos, notes and a gratitude meditation.

1.5. Statistical analyses

Data were analysed on the intention to treat-sample (ITT). Data analysis was performed using R (version 3.5.2). Additional sensitivity analyses were performed for the primary outcome. A two-tailed significance level of $p \leq .05$ was used for all inferential tests.

1.5.1. Missing data and study drop-outs

Missing data were estimated with multiple imputations, with 100 estimates calculated for each missing datum. All existing data of the primary and secondary outcomes, as well as the grouping variable, were used in the imputation model. Pooled means and standard deviations are reported. Statistical analyses were performed for each imputed data set and results were pooled afterwards incorporating the uncertainty about the missing data (van Ginkel, Linting, Rippe, & van der Voort, 2019).

1.5.2. Intervention effect

Between-group differences immediately post intervention (T2) and at 3-MFU were analysed using analyses of covariance (ANCOVA), with the respective baseline values of the particular outcome as covariates. Cohen's ds with 95% confidence intervals were calculated with *Meta-Essentials* (Suurmond, van Rhee, & Hak, 2017). Between-group Cohen's ds were calculated using pooled standard deviations. To learn more about the effectiveness of the gratitude training in clinical samples, exploratory subgroup analyses were performed for (a) those who reported clinical symptoms of depression at baseline (scoring > 22 on the CES-D); and (b) those who reported moderate or severe levels of generalized anxiety at baseline.

1.5.3. Long-term efficacy

Since only those in the IG were assessed at 6-MFU, long-term efficacy was examined employing within-subject comparisons. To do this, repeated-measures analyses of variance between T1 and 6-MFU were performed for each pertinent outcome variable. Within-group Cohen's ds were calculated by controlling for correlations within samples.

Table 1
Session content of the online and app-based gratitude intervention.

Session	Objectives	Exercises
1. Being aware of the positive	To get acquainted with the training and the app, as well as with the concept of gratitude and its interconnectedness with well-being.	• Analysis of the current state of gratitude. • Experiment on the selectivity of perception. • Perceiving the good in different areas of life. • Side effects of gratitude and your good reason for training.
Gratitude-App (daily usage from now on)	To use the app as a gratitude journal.	• Take pictures or notes of positive moments. • Recall positive moments and their sources in the evening within a gratitude meditation.
2. Experiencing gratitude	To learn to draw the attention to positive events and to intensify the experience of gratitude.	• Perceive and intensify feelings of gratitude through imagination exercises. • Gratitude throughout your life. • Experience gratitude with all senses. • How gratitude, rumination and worrying are connected.
3. Receiving and accepting the good	To develop positive attitudes to grateful events and to further perceive positive events in life.	• Hindering attitudes towards gratitude and modification of the users' dysfunctional cognitions concerning gratitude. • Gratitude within one's own biography.
4. Expressing gratitude	To encourage participants to actually express gratitude.	• Discover the sources of the good. • Catching someone doing good. • Expressing gratitude (e.g. gratitude letter, gratitude visit).
5. Consolidating gratitude in everyday life	To consolidate and to look back what has been learnt so far and to make a plan for future.	• Review of the sessions' personal summaries and integrating gratitude in future life.

1.5.4. Clinical response analyses

1.5.4.1. Reliable change, symptom-free status, and number needed to treat. For the primary outcome, reliable change, symptom-free status, and corresponding numbers needed to treat (NNT) were calculated at T2 and 3-MFU (Jacobson & Truax, 1991).To calculate reliable change, the standard deviation ($SD = 13.23$) and Cronbach's alpha ($\alpha = 0.95$) of the PTQ's non-clinical validation sample were used (Ehring et al., 2011). Hence, participants were categorized as having reliably improved if their PTQ score had decreased by more than 8.20 points from T1 to T2 or from T1 to 3-MFU, and as having reliably deteriorated if their PTQ score increased more than 8.20 points between either of these same two time intervals.

Symptom-free status was defined as scoring < 2 SD below the study sample's mean at T1 ($M = 39.42$; $SD = 7.24$); in this study, this meant having a score ≤ 24.95 on the PTQ scale at T2 or at the 3-MFU.

1.5.5. Sensitivity analyses

To assess the robustness of the results obtained via the ITT analyses we conducted two types of sensitivity analyses for the primary outcome at T2 and 3-MFU: Analysis of intervention completers and study completers. Analysis of intervention completers estimates an intervention's potential when the protocol is being followed. For our purposes, we considered participants who completed four or more of the five sessions as having followed the protocol; in this way, intervention completer analysis can be considered a "best-case-scenario" approach to analysis. In analysis of study completers, participants with missing data were excluded so that no kind of imputation had to be used.

1.5.6. Mediation analyses

To assess the mediating role of the transdiagnostic risk factor RNT and the transdiagnostic protective factor resilience, in the intervention's effects on (a) depression and (b) anxiety, parallel multiple mediation analyses were performed. To establish temporal precedence, the T2 scores of mediators and 3-MFU scores of outcomes were used. Following the recommendations of Hayes and Rockwood (2017), baseline scores for the mediating and outcome variables were included as covariates. An indirect effect is considered significant if its 95% confidence interval excludes zero. An additional sensitivity analysis with the study completers was conducted.

2. Results

2.1. Participants

The flow of participants through the study is depicted in Fig. 1. Of the 1905 individuals who were screened for eligibility, 611 were assessed at baseline. Of these, 262 were randomized to either the IG ($n = 132$) or WLG ($n = 130$). A majority of those interested and fulfilling inclusion criteria were allocated to a different study, which was set up ad-hoc, since the current study's required sample size had already been attained.

2.2. Baseline characteristics

Table 2 shows the baseline characteristics of the sample. Participants were predominantly female (58.8%), Caucasian (91.6%), living in Germany (90.8%), and either married or cohabiting (54.2%). A majority reported either subclinical or clinical symptoms of depression (71.8%), while 41.2% reported moderate or severe symptoms of anxiety. Roughly half the sample had prior experience with psychotherapy (48.1%). The subjects' mean age was 42.2 ($SD = 10.9$) years.

2.3. Missing data

Baseline data were available for all participants. Overall, data were missing for the primary outcome for 19.8% of all participants at T2 (IG: 31.8%; WLG: 7.7%), 24.8% of all participants at 3-MFU (IG: 38.6%; WLG: 10.8%) and 45.5% of those in the IG at 6-MFU. The two subject groups (IG and WLG) differed with regard to missing data at T2 and 3-MFU (T2: $\chi^2 = 23.96$, $p < .001$; 3-MFU: $\chi^2 = 27.27$, $p < .001$). A MANOVA indicated that baseline scores among participants who failed to provide data were no different than among those who did.

Using valid data for all outcome measures at all assessment points, 100 single imputations were calculated. Group allocation also was included in the multiple imputation model as an auxiliary variable, as recommended by the National Research Council (National Research Council: U.S., 2010). See Table 3 for pooled means and standard deviations at all assessment points.

2.4. Primary outcome analysis – repetitive negative thinking

Individuals in the IG reported significantly less RNT than those in the WLG at T2, $F(1,204) = 32.8$, $p < .001$, $d = 0.61$; and at the 3-MFU, $F(1,190) = 47.6$, $p < .001$, $d = 0.75$. Effect sizes were ranging from medium to large at both assessment points (see Table 4).

2.4.1. Reliable change, symptom-free status, and number needed to treat

From T1 to T2, 47.2% ($n = 62.2$) of the participants in the IG reported reliable improvement, versus 13.8% ($n = 17.9$) in the WLG. Meanwhile, 48.7% ($n = 64.3$) in the IG failed to exhibit reliable improvement, versus 78.5% ($n = 102.1$) in the WLG. Reliable deterioration was reported by 4.2% ($n = 5.5$) versus 7.7% ($n = 10.0$) among individuals in the IG and WLG, respectively.

Between T1 and 3-MFU, 63.3% ($n = 83.5$) in the IG experienced reliable improvement, versus 18.9% ($n = 24.6$) with reliable improvement in the WLG. The difference in reliable improvement between groups was significant both at T2, pooled $\chi^2(1, 4632) = 27.8$, $p < .001$; and 3-MFU, $\chi^2(1, 2230) = 40.4$, $p < .001$. The NNT for one reliably-improved participant at T2 ranged between 2.5 and 4.2 across the 100 imputed data sets. The average NNT across multiply imputed data sets was 3.0, 95% CI [2.3, 4.4]. The NNT for one reliably-improved participant at 3-MFU ranged between 1.9 and 2.8 with a mean of 2.3, 95% CI [1.9, 3.0].

At T2 31.5% of the IG reported being symptom free ($n = 41.0$), versus 9.2% ($n = 12.0$) of the WLG. At 3-MFU, corresponding percentages were 41.7% ($n = 55.1$) and 11.3% ($n = 14.7$) of the IG and WLG, respectively. Inter-group differences in symptom-free status again were significant at both T2, $\chi^2(1, 5822) = 15.6$, $p < .001$; and 3-MFU, $\chi^2(1, 2865) = 23.9$, $p < .001$. The corresponding NNT ranged between 3.8 and 6.1, with a mean of 4.6, 95% CI [3.3, 8.3]. At 3-MFU the NNT ranged between 2.7 and 4.3, with a mean of 3.3, 95% CI [2.5, 5.0].

2.4.2. Sensitivity analyses

To assess the robustness of the results, sensitivity analyses were performed. Analyses of intervention completers (number of participants analysed: IG: $N = 77$; WLG: $N = 130$) supported the results obtained with ITT analyses, but generated slightly larger effect sizes at T2, $F(1,253) = 50.6$, $p < .001$, $d = 0.88$, 95% CI [0.58, 1.17]; and 3-MFU, $F(1,248) = 57.2$, $p < .001$, $d = 0.94$, [0.64, 1.23].

Sensitivity analyses including only study completers (number of participants analysed: IG: $N = 90$; WLG: $N = 120$) corroborated the results of ITT analysis and revealed a highly-significant difference between groups, again at both T2, $F(1,207) = 55.0$, $p < .001$, $d = 0.86$, 95% CI [0.57, 1.14]; and 3-MFU, $F(1,194) = 64.7$, $p < .001$, $d = 0.94$, [0.64, 1.24]. The effect sizes were larger than those observed with ITT analysis.

2.5. Secondary outcome analyses

2.5.1. Mental health outcomes

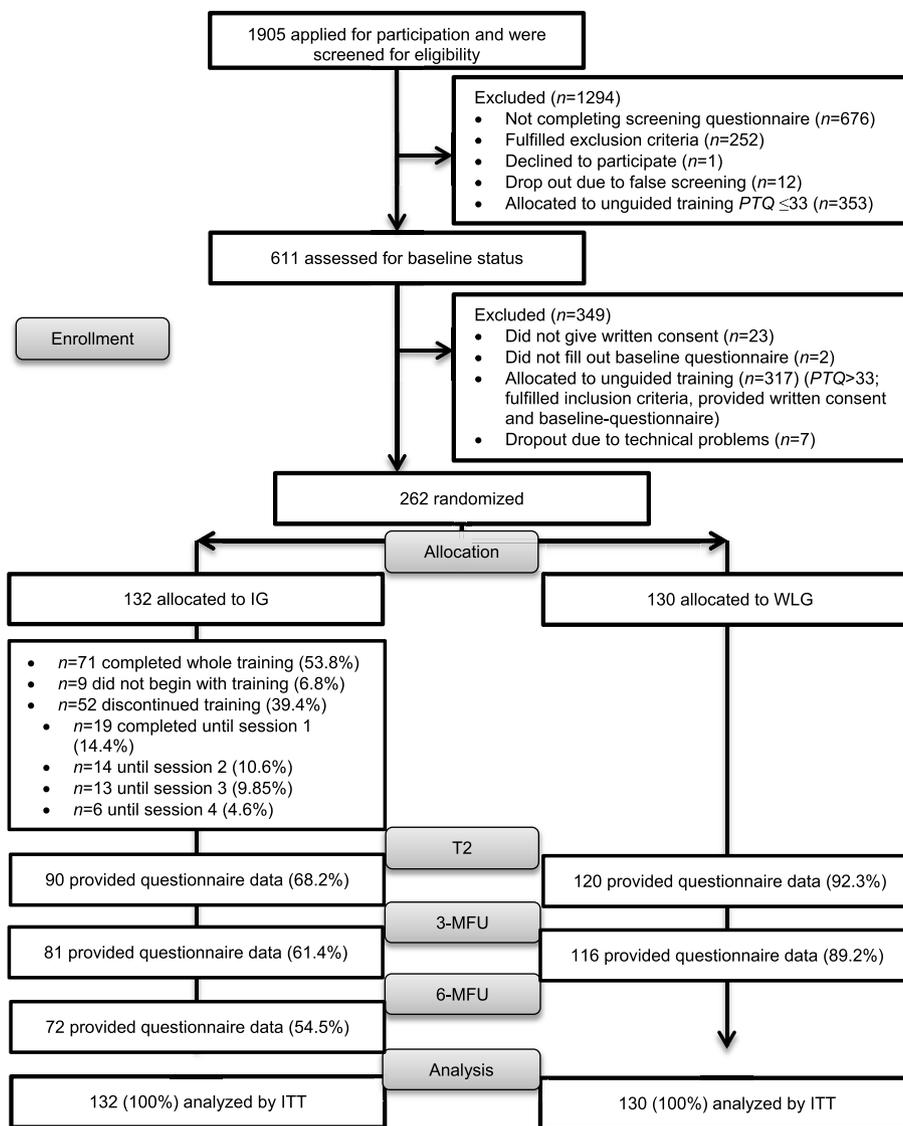Significant inter-group differences were identified for depressive

Fig. 1. Flow of participants. Post-intervention: 6 weeks after randomization; T2 = post-intervention; 3-MFU = 3-month follow-up; 6-MFU = 6-month follow-up (only in IG); IG = intervention group; WLG = wait list control group; PTQ = Perseverative Thinking Questionnaire; ITT = Intention to treat Analysis.

symptoms, anxiety, worrying and insomnia, at both T2 and 3-MFU (see Table 4). Differences on resilience were significant at T2, but not at 3-MFU. Effect sizes for those outcomes with significant effects were small to moderate, ranging from $d = 0.32$–0.41 and from $d = 0.33$–0.40 at the two data assessment points, respectively.

Subgroup analyses also were conducted. In the subsample with clinically-significant symptoms of depression at baseline (scoring > 22 on the CES-D), significant differences of small to moderate size were apparent for T2 depression scores, $F(1, 198) = 8.8$, $p = .003$, $d = 0.46$, 95% CI [0.09, 0.83].

In the subsample with at least moderate levels of anxiety at baseline (scoring > 9 on the GAD-7), significant, moderate differences were identified for T2 anxiety scores, $F(1, 213) = 7.0$, $p = .009$, $d = 0.62$, 95% CI [0.23, 1.01].

2.5.2. Resilience factors

For gratitude, there was a significant between-group effect at T2 ($d = 0.44$) and at 3-MFU ($d = 0.38$). For perceived available support there was no significant between-group difference at T2, but a small significant effect at 3-MFU ($d = 0.29$). There was no between-group difference for dispositional optimism.

2.5.3. Long-term effects

All of the significant effects detected on inter-group analyses, at both T2 and 3-MFU, remained significant on repeated-measures ANOVAs comparing baseline and 6-MFU. Overall, within-group effect sizes comparing baseline and 6-MFU tended to be larger than between-group effect sizes at T2 and 3-MFU. For RNT, a large within-group effect size was evident at the 6-MFU ($d = 1.66$). For secondary mental health outcomes, effect sizes ranged from small ($d = 0.40$ for insomnia) to large ($d = 1.00$ for worrying). For resilience factors, the effect sizes ranged from small ($d = 0.31$ for perceived social support) to moderate ($d = 0.73$ for gratitude).

2.6. Intervention usage and client satisfaction

2.6.1. Intervention usage

Of the 132 participants allocated to the IG, 6.8% did not begin the intervention ($n = 9$), while 93.2% completed session one ($n = 123$), 78.8% session two ($n = 104$), 68.2% session three ($n = 90$), 58.8% session four ($n = 77$), and 53.8% the entire program ($n = 71$). On average, participants in the IG completed 3.5 of the five sessions ($SD = 1.8$), which corresponds to 70.5% of the intervention, and used the intervention for an average of 4.0 weeks ($SD = 3.3$, range 0–15).

Table 2
Demographic characteristics of the sample.

	Total (N = 262)		IG (n = 132)		WLG (n = 130)	
	N	%	n	%	n	%
Age (M/SD)	42.4	10.9	42.3	10.6	42.6	11.2
Sex						
Men	108	41.2	60	45.5	48	36.9
Women	154	58.8	72	54.5	82	63.1
Relationship						
Single	93	35.5	46	34.8	47	36.2
Married or cohabiting	142	54.2	73	55.3	69	53.1
Divorced or separated	27	10.3	13	9.8	14	10.8
Widowed	0	0	0	0	0	0
Education						
No university degree	63	24	30	23	33	25
University degree	199	76	102	77	97	75
Employment status						
Full-time working	163	62.2	86	65.2	77	59.2
Part-time working	63	24.0	28	21.2	35	26.9
Nonworking	30	11.5	15	11.4	15	11.5
Unemployed/seeking work	5	1.9	3	2.3	2	1.5
On sick leave	1	0.4	0	0	1	0.8
Experience with health training						
Yes	36	13.7	16	12.1	20	15.4
No	226	86.3	116	87.9	110	84.6
Experience with psychotherapy						
No, never	136	51.9	73	55.3	63	48.5
Yes, in the past	126	48.1	59	44.7	67	51.5
Symptoms of depression						
No elevated symptoms	74	28.2	41	31.1	33	25.4
Subclinical symptoms	72	27.5	37	28.0	35	26.9
Clinical symptoms	116	44.3	54	40.9	62	47.7
Symptoms of anxiety						
Minimal level of anxiety	29	11.1	15	11.4	14	10.8
Mild level of anxiety	125	47.7	60	45.5	65	50.0
Moderate level of anxiety	77	29.4	47	35.6	30	23.1
Severe level of anxiety	31	11.8	10	7.6	21	16.2

Note. IG = intervention group; WLG = wait list control group. Symptoms of depression based on CES-D scores: No elevated symptoms = 0–15, subclinical symptoms = 16–22, clinical symptoms = 23–60. Levels of anxiety symptom based on GAD-7 scores: Minimal level = 0–4, mild level = 5–9, moderate level = 10–14, severe level = 15–21.

Among those who discontinued the intervention, $n = 9$ provided their reasons for dropout: $n = 3$ dropped out because of a perceived incongruence between training content and their needs; $n = 1$ because of technical problems; $n = 1$ because of the lack of motivation; $n = 1$ because of a lack of time; and $n = 3$ for other reasons (e.g., comprehension difficulties, unwillingness to use a smartphone).

The eCoaches received a total of 78 messages via the training platform. Of these, the majority ($n = 67$) were about how the study was being conducted or for technical difficulties. In 11 messages, participants asked for support processing the training; as such, these can be classified as requests for feedback on demand. Requests for feedback on demand included questions such as the following: "(…) I find it difficult to detect an experience that evokes the feeling of gratitude. How should I continue with the exercise?" or "Is it [the collection of grateful moments within the Gratitude App] about moments where I am grateful to other people (…) or also about moments that simply give me joy (…)?". A total of $n = 10$ individuals (7.6%) took advantage of the feedback on demand offer.

2.6.2. App usage

A subgroup of $n = 114$ individuals in the IG also consented to the collection of app-usage data. Within the first six weeks after randomization, individuals in the IG averagely collected 51.89 gratitude notes ($SD = 52.49$, range: 0–306), 22.12 gratitude photos ($SD = 32.74$; range: 0–192) and 15.67 gratitude reviews ($SD = 11.67$; range: 0–42). This sums to 89.68 ($SD = 81.40$; range: 1–413) gratitude activities as a whole, and an average of 14.95 gratitude activities per week over the course of the five-week intervention. The number of gratitude activities recorded with the app declined between T2 and 3-MFU, to an average of 20.23 ($SD = 60.02$) activities over that 6-week time frame. The number of gratitude activities recorded at T2 and 3-MFU were highly correlated ($r = 0.69$, $p < .001$).

Exploratory analyses revealed that the number of activities performed with the app also correlated significantly with the number of completed sessions ($r = .33$, $p < .001$). The number of activities with the app correlated marginally with change in RNT scores between T1 and T2 ($r = 0.17$, $p = .098$), indicating a dose-response relationship with app usage. The number of gratitude activities between T2 and to 3-MFU also significantly predicted change in RNT between T1 and 3-MFU ($r = 0.25$, $p = .01$).

2.6.3. Client satisfaction

The client satisfaction questionnaire was answered by 68.2% of those allocated to the IG ($n = 90$). Overall satisfaction with the training was comparable to other, previously-studied interventions ($M = 25.67$, $SD = 5.6$, range = 8–32) (e.g., Boβ et al., 2016). In an "overall, general sense", 46.7% ($n = 42$) were very and 40.0% ($n = 36$) mostly satisfied with the training they received, while 8.9% ($n = 8$) were mildly and

Table 3
Means and standard deviations of the outcomes.

Outcome	T1				T2[a]				3-MFU[a]				6-MFU[a]	
	IG		WLG		IG		WLG		IG		WLG		IG	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Primary outcome														
Repetitive negative thinking	39.8	7.2	39.1	7.3	30.6	12.7	37.2	8.7	27.6	13.4	36.4	9.7	27.3	7.7
Secondary outcomes														
Mental health														
Depression	21.8	9.3	22.3	9.4	16.7	11.5	20.8	10.0	16.2	11.8	20.7	11.0	15.3	7.6
Anxiety	9.1	3.8	9.3	4.1	6.4	4.6	8.2	4.0	6.5	4.9	8.0	4.2	6.3	3.4
Resilience	30.3	6.1	29.6	5.4	32.7	8.3	30.3	6.3	32.0	9.0	30.3	6.6	33.4	6.3
Worrying	8.6	3.8	8.4	3.8	5.8	4.6	7.6	4.1	5.7	5.5	7.3	4.4	5.2	3.2
Insomnia	10.7	5.6	12.0	6.0	9.3	6.8	11.5	6.5	8.4	6.8	11.1	6.7	8.7	4.5
Resilience factors														
Social Support	26.0	4.8	25.5	5.5	26.4	5.5	25.2	5.5	26.9	5.8	25.3	5.6	27.4	4.2
Gratitude	20.5	4.6	20.3	4.9	23.5	5.7	21.2	5.1	23.5	5.7	21.4	5.0	23.7	4.4
Optimism	11.7	2.2	11.5	2.4	11.9	3.9	11.6	2.4	11.9	4.4	11.9	2.9	12.1	2.1

Note. IG = intervention group; WLG = wait list control group; T1 = Baseline; T2 = post-intervention; 3-MFU = 3-month follow-up, 6-MFU = 6-month follow-up.
[a] Missing data were imputed by multiple imputations. Pooled results are reported.

Table 4

Results of AN(C)OVAs and Cohen's *d*s for primary and secondary outcomes.

Outcome	Differences between study conditions				Differences within intervention condition	
	T2		3-MFU		6-MFU	
	F_{df}	Cohen's *d* [95% CI][a]	F_{df}	Cohen's *d* [95% CI][a]	F_{df}	Cohen's *d* [95% CI][b]
Primary outcome						
Repetitive negative thinking	$32.8_{1,204}$***	0.61 [0.36,0.86]	$47.6_{1,190}$***	0.75 [0.50,1.00]	$230.1_{1,127}$***	1.66 [1.32,1.98]
Secondary outcomes						
Mental health						
Depression	$10.6_{1,200}$***	0.38 [0.13,0.62]	$11.9_{1,203}$***	0.40 [0.15,0.64]	$58.3_{1,127}$***	0.75 [0.53,0.97]
Anxiety	$12.9_{1,208}$***	0.40 [0.15,0.64]	$8.6_{1,209}$**	0.34 [0.09,0.58]	$57.0_{1,125}$***	0.80 [0.56,1.03]
Resilience	$6.4_{1,196}$*	0.32 [0.08,0.57]	$1.6_{1,198}$n.s.	0.20 [-0.04, 0.45]	$37.8_{1,125}$***	0.50 [0.33,0.66]
Worrying	$16.4_{1,212}$***	0.41 [0.17,0.66]	$9.9_{1,213}$**	0.33 [0.09,0.58]	$74.4_{1,127}$***	1.00 [0.71, 1.26]
Insomnia	$4.6_{1,217}$*	0.34 [0.10,0.58]	$7.2_{1,207}$**	0.39 [0.15,0.64]	$14.9_{1,127}$***	0.40 [0.19,0.61]
Resilience factors						
Social Support	$2.6_{1,213}$n.s.	0.20 [-0.04,0.45]	$5.7_{1,215}$*	0.29 [0.05,0.54]	$10.1_{1,125}$**	0.31 [0.12,0.50]
Gratitude	$18.1_{1,207}$***	0.44 [0.19,0.69]	$12.3_{1,194}$***	0.38 [0.14,0.63]	$57.4_{1,125}$***	0.73 [0.52,0.93]
Optimism	$0.5_{1,192}$n.s.	0.10 [-0.14,0.34]	$0.0_{1,188}$n.s.	0.00 [-0.24,0.24]	$2.5_{1,125}$n.s.	0.18 [-0.05, 0.40]

Note. T2 = post-intervention; 3-MFU = 3-month follow-up, 6-MFU = 6-month follow-up; CI = Confidence Interval.

n.s. non-significant; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

[a] Cohen's *d*s were calculated by using pooled standard deviation.

[b] Cohen's *d*s for within-subject effects were calculated by controlling for dependence within samples.

4.4% ($n = 4$) quite dissatisfied. Almost half (47.8%, $n = 43$) stated that they would definitely recommend the training to a friend in need, while 35.7% ($n = 33$) were somewhat willing to recommend it. Ten percent ($n = 9$) indicated that they would rather not, and 5.6% ($n = 5$) that they would definitely not recommend the program to a friend.

2.6.4. Usage of care as usual

All individuals in both groups had full access to care as usual, as offered through routine healthcare services. Usage was comparable in the two groups. At T2, 91.5% ($n = 119$) of the WLG and 68.2% ($n = 90$) in the IG provided data on care as usual. 6.7% ($n = 8$) of the WLG reported having received psychotherapeutic support over the past three months (7.6%, $n = 7$ in the IG), while 4.2% ($n = 5$) of participants in the WLG participated in some other health-oriented training, like yoga or meditation (7.6%, $n = 7$ in the IG). A further 30% ($n = 36$) of the WLG indicated that they had read a self-help book, versus 25% ($n = 23$) in the IG. Also among participants in the WLG, 5.8% ($n = 7$) reported having spoken with a mental health expert, counselor or pastor (5.4%, $n = 5$, in the IG), while 5.0% ($n = 6$) claimed to have attended a course or workshop (7.6%, $n = 7$, in the IG), and 10% ($n = 12$) indicated that they had made use of other things that they perceived to be similar to gratitude training, in terms of effectiveness (8.7%, $n = 8$, in the IG). In summary, 53,3% of the participants ($n = 64$) in the WLG reported having used some care as usual or self-help approaches, versus 52.2% of the participants in the IG ($n = 47$).

2.7. Mediation analyses

2.7.1. Depression

As shown in Fig. 2, RNT, $a_1b_1 = -1.25$, 95% CI [-2.42, -0.07] at T2 significantly mediated the effect of the intervention on depression at 3-MFU. The indirect effect through resilience was marginally significant, $a_2b_2 = -0.56$ [-1.14, 0.02]. The direct effect of the intervention reducing depression did not remain significant, after the mediators were incorporated into the model, c' = -2.36 [-4.92, 0.19]. In a sensitivity analysis with the completer sample both RNT, $a_1b_1 = -1.84$ [-2.85, -0.83], and resilience, $a_2b_2 = -0.58$ [-1.05, -0.11], at T2 significantly mediated the effect of the intervention on depression at 3-MFU.

2.7.2. Anxiety

As shown in Fig. 3, the intervention's effect on anxiety at 3-MFU was also significantly mediated by T2 scores of RNT, path $a_1b_1 = -0.64$, 95% CI [-1.14, -0.13]. The indirect effect through resilience was not significant, $a_2b_2 = -0.15$ [-0.33, 0.03]. The direct effect of the intervention on anxiety did not remain significant, c' = -0.67 [-1.72, 0.37]. In a sensitivity analysis with the completer sample both RNT, $a_1b_1 = -0.92$ [-1.37, -0.48], and resilience, $a_2b_2 = -0.15$ [-0.30, 0.00], at T2 significantly mediated the effect of the intervention on anxiety at 3-MFU.

3. Discussion

The current study had two main aims. The first was to assess the efficacy of a newly-developed internet and app-based gratitude intervention, delivered with adherence-focused guidance, at reducing repetitive negative thinking (RNT). The second was to investigate the interplay of two transdiagnostic factors—RNT and resilience—as underlying mechanisms in the intervention's effect on levels of depression and anxiety.

With regard to the first aim, the present RCT demonstrates the efficacy of the gratitude intervention with adherence-focused guidance at reducing RNT. As hypothesized, participants in the intervention group reported significantly lower RNT immediately after the intervention and at 3-MFU compared to a wait list control group. Effects were of moderate to large size and sustained until the 6-MFU.

Sensitivity analyses corroborated the results from ITT analyses. To estimate the potential of the intervention on a best-case-scenario basis further analyses were conducted. These included only those participants who had completed four or five sessions of training. And, in this group of more adherent subjects, effect sizes were greater than across the ITT sample as a whole. Additionally, we conducted analyses including only study completers and these analyses also corroborated the results from ITT analyses. Effect sizes were larger than those of ITT analysis and comparable to those from the intervention completer analysis.

Reliable change analysis suggested that three individuals need to be given access to the intervention, compared to a wait list control group, for one to experience a reliable improvement immediately upon completion of the program. Significant differences, both short- and long-term, of small to moderate size also were detected for other mental

Fig. 2. Parallel multiple mediation model with 3-MFU depression scores as the outcome variable, post-treatment repetitive negative thinking and resilience scores as mediators and baseline values of mediators and outcome as covariates. Treatment is coded 0 = wait list control group, 1 = intervention group. Path diagrams representing statistically significant mediated effects. Unstandardized beta coefficients are shown, with 95% confidence intervals in brackets. IG = intervention group; WLG = wait list control group; RNT = Repetitive negative thinking.

Fig. 3. Parallel multiple mediation model with 3-MFU anxiety scores as the outcome variable, post-treatment repetitive negative thinking and resilience scores as mediators and baseline values of mediators and outcome as covariates. Treatment is coded 0 = wait list control group, 1 = intervention group. Path diagrams representing statistically significant mediated effects. Unstandardized beta coefficients are shown, with 95% confidence intervals in brackets. IG = intervention group; WLG = wait list control group; RNT = Repetitive negative thinking.

health-related outcomes—like anxiety, depression and insomnia—and for gratitude at T2 and 3-MFU and for perceived social support at 3-MFU. On resilience, effects were significant at T2 and 6-MFU, but failed to reach statistical significance at 3-MFU.

In the following paragraphs, the study's results will be discussed in light of previous intervention studies that (a) examined a gratitude intervention; (b) focused on RNT as an outcome; (c) were internet-based and focused on depression and anxiety; and (d) targeted resilience.

This study is among the first to demonstrate that a gratitude intervention can also be effective at reducing transdiagnostic RNT. Results of the current study are consistent with prior evidence on gratitude interventions that indicate their ability to reduce content-dependent forms of RNT, such as rumination and worry, that were partly obtained from very specific subject samples, like cancer survivors (Otto et al., 2016; Shao et al., 2016) or the completer sample (Geraghty et al., 2010b). The effect sizes detected by the current RCT lie between the moderate effects reported for two studies that employed ITT analyses (Otto et al., 2016; Shao et al., 2016) and the very large (Geraghty et al., 2010b) effect sizes found in a study in which only those who completed the intervention were analysed.

With regard to meta-analyses on gratitude interventions, this RCT's results are slightly larger than the effects identified for different indicators of mental health and responds to the call for future research with more effective interventions (Davis et al., 2016). There may be several explanations for finding slightly stronger effects as compared to previously-reported gratitude interventions. First, previously-reported interventions were mostly provided as pure self-help. In contrast, participants in the current study had the opportunity to receive support from eCoaches. On the one hand, when taking the amount of requests for support into account, the current intervention could also be regarded as a pure self-help intervention. On the other hand, simply by knowing that someone would care if necessary could enfold a positive effect as predicted by the supportive accountability theory (Mohr, Cuijpers, & Lehman, 2011). Second, the intervention examined here was probably more intense than those used in previous RCTs, which mostly evaluated single exercises, like the count-your-blessings approach. The gratitude intervention evaluated here sprang from a working model of gratitude, and incorporates multiple different exercises that target various aspects of gratitude. Third, the intervention was offered as a computer and app-based hybrid. By offering more than one medium for use, its efficacy might have been augmented. Fourth, due to the inclusion criteria the sample of the current study had an elevated RNT pattern; and approximately half reported either sub-clinical or clinical symptoms of depression and/or anxiety. Thus, the sample might have had more room to improve.

In terms of reducing RNT, the current study's results are slightly larger than the medium-sized effects generally identified in a meta-analysis that has assessed mostly face-to-face CBT and MBCT interventions for depression (Spinhoven et al., 2018). They also are comparable to the medium to large effects found in the few studies that have specifically targeted RNT (Spinhoven et al., 2018).

Comparing the results and those of studies with the same mode of intervention delivery, the effect sizes we detected for depression were comparable to those of diagnosis-specific, internet-based CBT offering a similar level of support (Karyotaki et al., 2017). Compared to the average effect sizes identified in a meta-analysis assessing internet-based CBT for anxiety (Richards, Richardson, Timulak, & McElvaney, 2015) effects of the current study were smaller. However, almost all of the studies included in that meta-analysis entailed intense therapist support, likely leading to increased efficacy. Furthermore, 58.8% of the currently-studied sample reported minimal to mild levels of anxiety and, as such, had less room to improve than the samples studied in trials explicitly designed for individuals with anxiety.

The effect on resilience that was found in the current study lies between effects meta-analytically found for interventions targeting resilience (Joyce et al., 2018; Vanhove, Herian, Perez, Harms, & Lester, 2016). However, at 3-MFU the effect on resilience did not reach statistical significance.

The effect sizes discovered in this study are comparable to those reported for a previously-conducted RCT that evaluated the same gratitude intervention, but offered more intensive guidance (Lehr et al., submitted).

On subgroup analyses of those reporting clinically-relevant symptoms of depression and anxiety, the gratitude intervention also appeared to be effective, suggesting that it may be useful for highly-distressed individuals as well. The effect sizes on depression and anxiety in this subsample were moderate and larger than those found in the ITT sample. The effect sizes were slightly stronger than those found meta-analytically for self-help interventions on depression (Karyotaki et al., 2017). With regard to anxiety the effect was comparable to a self-help study for individuals with a diagnosed anxiety disorder (Boettcher et al., 2014), but slightly smaller than those found meta-analytically for fully-supported diagnosis-specific internet-based CBT for anxiety (Richards et al., 2015). Even though we did not directly compare diagnosis-specific and gratitude interventions, these results are noteworthy and consistent with results of previously-published gratitude interventions (Geraghty et al., 2010a; 2010b) that found a gratitude intervention to be equally effective as a diagnosis-specific treatment commonly used in psychotherapy. They show that positive psychological interventions might not only be helpful for health promotion and illness-prevention purposes, but also for those who are clinically distressed. In line with Wood and Tarrier's (2010) proposal of a 'positive clinical psychology' these results encourage to incorporate positive psychological interventions in clinical psychology and to conduct future studies with clinical samples recruited from primary and secondary care.

Besides efficacy, we investigated the underlying mechanisms behind this gratitude intervention's effects on depression and anxiety. To date, it remains unknown whether so-called positive interventions enact their effect via some resource-building pathway, a risk-reduction pathway, or a pathway that combines both. Consequently, we investigated both RNT—as a transdiagnostic risk factor—and resilience—as a transdiagnostic protective factor—as underlying mechanisms behind the intervention's effect on anxiety and depression. In line with the conceptualisation of RNT as a transdiagnostic risk factor, on mediational analyses, immediate post-intervention scores for RNT were found to significantly mediate the intervention's effect on both depression and anxiety at 3-MFU. Results on resilience as a mediator were marginally or non-significant in the ITT sample. In sensitivity analyses with the completer sample both mediators were significant, supporting a dual pathway hypothesis. Results for RNT as a mediator are consistent with

prior research, which suggests that reductions in RNT are linked to and mediate reductions in levels of depression and anxiety (Kertz et al., 2015; Newby et al., 2014). They also agree with results reported by Petrocchi and Couyoumdjian (2016), who found that specific forms of RNT about self, mediate the impact of gratitude on depression and anxiety. The current study extends this finding by showing for the first time that content-independent/transdiagnostic RNT also functions as a mediator.

Pertaining to resilience as a mediator, prior research has identified a range of resilience factors (e.g., positive emotions) as mediators of gratitude intervention's effects on well-being (Emmons & McCullough, 2003; Lambert et al., 2012; O'Connell et al., 2017; Wood et al., 2007). The results of the current study also reveal significant differences for specific resilience factors, like gratitude and perceived social support. Analyses are inconclusive but suggest that resilience as a whole—and not just single resilience factors—might also function as a mediator. Being more aware of the mechanisms of change, therapists and eCoaches might be able to become better at monitoring and optimizing therapeutic change (Kazdin, 2007).

3.1. Limitations and future directions

The overall encouraging findings of the current study should be interpreted in light of several methodological limitations. First, due to the study's inclusion criteria, the sample studied consisted of individuals with high-level RNT. On one hand, this shows that positive psychological interventions also work in distressed individuals. On the other hand, future research must determine the generalizability of the results in a less distressed sample recruited from a universal preventive setting. Second, the gratitude intervention was offered in a hybrid fashion, combining online with app-based exercises. Thus, no statements can be made with regard to the efficacy of the individual elements. Future research could investigate the efficacy of the gratitude app as a standalone intervention. Third, due to missing data, multiple imputations had to be used. Even though multiple imputations are a state of the art method for dealing with missing data (Schafer & Graham, 2002), biased estimates cannot be ruled out. Nevertheless, sensitivity analyses clearly underlined the robustness of the results found.

On mediation analysis, using RNT and resilience at T2 as mediators and anxiety and depression symptoms at 3-MFU as outcomes, we tried to establish the temporal precedence of mediators. Although this approach provides a stronger test of causality (Kazdin, 2007), we cannot rule out that changes in the outcomes occurred prior to changes in the mediators. To establish a timeline with greater confidence, future research should assess mediators and outcomes at multiple time points during treatment, and/or at times when changes in the mediators are deemed more likely to occur (Kazdin, 2007; Laurenceau, Hayes, & Feldman, 2007).

We investigated RNT and resilience as mediators of the gratitude intervention's effect on symptoms of depression and anxiety. We did not assess more proximal mediators explaining the gratitude intervention's effect on these mediators. Even if it seems plausible that the gratitude intervention exerts its effect by increasing the emotion of gratitude, this may not be the case and the effect of the gratitude intervention might also be explained by other mechanisms such as more general positive affect (Wood et al., 2010). Future research should assess and test even more proximal mediators to further understand how the gratitude intervention works.

4. Conclusions

Notwithstanding the above-listed limitations, the present study is among the first to show that an internet- and app-based gratitude intervention can reduce transdiagnostic RNT. It also reduces other mental health outcomes, like anxiety, depression and insomnia, both short- and

long-term. Subgroup analyses of clinically distressed individuals suggest that the gratitude intervention might also be helpful for clinical samples. Furthermore, mediational analyses suggest that the gratitude intervention works by reducing RNT, as a transdiagnostic risk factor. Analyses regarding the mediating role of resilience, as a transdiagnostic protection factor, were inconsistent and require future research.

Conflicts of interest

Acknowledgements

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