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LITERATURE REVIEW

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# The effects of different types of treatment for anxiety on repetitive negative thinking: A meta-analysis

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**Abstract**

It is not clear if treatments for anxiety specifically targeting repetitive negative thinking (RNT: rumination, worry, and content-independent perseverative thinking) have a specific effect on RNT resulting in better outcomes than other psychological and nonpsychological treatments. We conducted a systematic search of randomized controlled trials comparing RNT-focused and non-RNT-focused psychological treatments, as well as nonpsychological treatments for anxiety with control groups and reporting outcomes on RNT. Inclusion criteria were met by 46 studies with a total of 3,194 participants. RNT-focused and non-RNT-focused psychological treatments had comparable effects on RNT, and level of anxiety and changes in RNT and anxiety were highly associated across treatments. Further mediation and mechanistic studies to test whether reductions in RNT during RNT-focused cognitive behavioral therapy predict subsequent reductions in anxiety are called for.

**KEYWORDS**

anxiety, cognitive behavior therapy, meta-analysis, randomized controlled trial, repetitive negative thinking, rumination, worry

## 1 | INTRODUCTION

Anxiety disorders are characterized by an overestimation of real or perceived threat and danger, heightened autonomic arousal, and maladaptive behavioral avoidance that is disabling to the individual (American Psychiatric Association, 2013). Treatment of anxiety disorders has traditionally involved devising effective strategies that target disorder-specific psychological processes and symptoms as described by conventional classification systems like the Diagnostic and Statistical Manual (DSM; Harvey, Watkins, Mansell, & Shafran, 2004). Psychological treatments using this approach have been shown to reduce anxiety disorder symptomology to a large effect, as demonstrated in a number of meta-analytic reviews (Bandelow et al., 2015; Cuijpers et al., 2016). More recently, however, this disorder-specific approach has been challenged. There is growing interest in identifying and understanding common psychological processes, referred to as transdiagnostic processes, that are relevant not only across the anxiety disorders, but also across multiple emotional disorders (Barlow, Allen, & Choate, 2004; Harvey et al., 2004).

One such transdiagnostic process proposed to be involved in the onset and persistence of emotional disorders is the repeated negative thinking about one's problems or experiences, which is perceived as uncontrollable and repetitive (Ehring & Watkins, 2008; Harvey et al., 2004). Research

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has typically defined the process of repetitive thinking into disorder-specific ways. For example, worry is defined as a sequential string of predominately verbal thoughts, as an individual contemplates and anticipates uncertain, negative outcomes of a problem (Harvey et al., 2004). Worry in itself does not have to be disturbing, as individuals may have positive metacognitive beliefs about worry (Wells, 2010). However, when worry becomes pathological, it is deemed excessive, difficult to control, and disturbing by the individual (Borkovec, Robinson, Pruzinsky, & DePree, 1983), and is the cardinal feature of generalized anxiety disorder (GAD; APA, 2013). However, worry is also present across other mental health disorders, such as panic disorder (PD; Casey, Oei, & Newcombe, 2004), obsessive–compulsive disorder (OCD, Abramowitz & Foa, 1998; Amir, Cashman, & Foa, 1997), and depression (Nolen-Hoeksema, 1991; Segerstrom, Tsao, Alden, & Craske, 2000). According to the DSM 5, difficulty sleeping is one of the physical symptoms that may be present in GAD, while in sleeping disorders, especially in insomnia, worry is a very common symptom (Harvey, 2002).

Conversely, rumination, defined as "repetitively focusing on the fact that one is depressed; on one's symptoms of depression; and on the causes, meanings, and consequences of depressive symptoms" (Nolen-Hoeksema, 1991, p. 569) is implicated in the onset and maintenance of depressive episodes (Moulds, Kandris, Starr, & Wong, 2007; Nolen-Hoeksema, 1991). While rumination has largely been studied in the context of depression, it is also associated with anxiety disorders (Olatunji, Naragon-Gainey, & Wolitzky-Taylor, 2013) and post-traumatic stress disorder (PTSD; Seligowski, Lee, Bardeen, & Orcutt, 2015). Moreover, studies have found that individuals with social anxiety disorder (SAD) repeatedly think about social situations, their performance in these situations, and how others perceive their behavior (Mellings & Alden, 2000). This form of repetitive thinking has been termed post-event rumination (Abbott & Rapee, 2004).

There are several reasons why worry and rumination may be important targets for treatment at a transdiagnostic level. Firstly, studies indicate that higher levels of worry and rumination confer greater risk of comorbidity between anxiety and depressive disorders (Hendriks et al., 2014; McEvoy, Watson, Watkins, & Nathan, 2013; Olatunji et al., 2013). Secondly, longitudinal studies show that worry and rumination predict the onset and maintenance of both anxiety and depressive disorders in clinical and healthy adults (Drost, Does, Hemert, Penninx, & Spinhoven, 2014; Spinhoven, Drost, Rooij, Hemert, & Penninx, 2016) and adolescents (Miers, Blöte, Heyne, & Westenberg, 2014). Moreover, worry and rumination prospectively predict anxiety and depressive symptoms in individuals with chronic physical conditions (Trick, Watkins, Windeatt, & Dickens, 2016). Thirdly, a systematic review and meta-analysis concluded that worry and rumination illicit biological responses in physiological stress systems that are comparable to acute stressors, and due to their persistent nature, the impact on psychosomatic illness vulnerability may be considerable (Ottaviani et al., 2016). Hence, developing treatments which aim to change underlying cognitive processes, such as worry, rumination, or RNT, may be effectively applied across a range of problems in which RNT is present (McHugh, Murray, & Barlow, 2009; McManus, Shafran, & Cooper, 2010).

**Public Health Significance**

Repetitive negative thinking (RNT) in the form of worry or rumination is involved in the onset and maintenance of various common mental health disorders (such as anxiety and depression) and may constitute an important target for treatment. We analyzed the effect of treatments for anxiety on RNT and found that RNT-focused and non-RNT-focused treatments had comparable effects on RNT and that anxiety reduction was highly associated with reduction in RNT. We recommend to examine whether RNT-focused treatments for anxiety help individuals to reduce their anxiety because they learn to accept or control their RNT.

Due to the involvement of worry in the maintenance of anxiety disorders, there has been a number of therapeutic approaches developed which specifically focus on disrupting the worry process, such as intolerance-of-uncertainty therapy (IUT), metacognitive therapy (MCT), and mindfulness-based therapy (MBT; Topper, Emmelkamp, & Ehring, 2010). IUT (Dugas, Gagnon, Ladouceur, & Freeston, 1998) and MCT (Wells, 2010) both focus on biases in the beliefs about the worry process, which are implicated to contribute to worry perseveration (Davey & Meeten, 2016). IUT, based on Dugas et al. (1998) conceptual model of GAD, aims to challenge the process of worry as a coping strategy for tolerating uncertainty. MCT, derived from Wells' (2010) metacognitive model of GAD, intends to modify the positive and negative metacognitive beliefs about worry that are proposed to cause and sustain pathological worrying. MBT has also been used to disengage from worry. Mindfulness techniques involve increasing metacognitive awareness in a nonjudgmental and accepting way, with the aim to recognize when maladaptive thinking processes like rumination are triggered and to decenter from these cognitive processes (Teasdale et al., 2002).

There is robust evidence that attentional bias to threatening information, associated with the onset and maintenance of anxiety disorders, also contributes to the generation of worry (see Davey & Meeten, 2016). Moreover, a high engagement in worry takes up working memory capacity, leading to inefficient and selective processing of information (Shipstead, Lindsey, Marshall, & Engle, 2014). As such, interventions

have been developed to engage working memory capacity to improve attentional control. Few studies have suggested the benefit of using working memory training in reducing worry for individuals with high worry (Course-Choi, Saville, & Derakshan, 2017; Hazen, Vasey, & Schmidt, 2009; Hotton, Derakshan, & Fox, 2018; Sass, Evans, Xiong, Mirghassemi, & Tran, 2017). However, the use of working memory training as a standalone treatment, or as an add-on to optimize current interventions in clinical settings, remains to be examined.

Finally, behavioral activation (BA) can be adapted to specifically target worry. Similar in its objectives when treating depression, BA for worry aims to increase goal-oriented activities, while reducing avoidance behaviors. Learning competing behaviors will attenuate worry through increased sources of positive reinforcement, reduced aversive experiences, and extinction of threat associations (Chen, Liu, Rapee, & Pillay, 2013; Chu, Colognori, Weissman, & Bannon, 2009).

Available evidence suggests that interventions targeting worry can reduce both worry and anxiety disorder symptomology. Still, it is unclear whether psychological interventions specifically targeting worry produce greater effects on worry compared with other psychotherapies, such as exposure-based CBT. In addition, it is unknown whether a greater effect on worry would also mediate treatment outcome and result in more anxiety reduction. In a recent meta-analysis of treatment for depression, RNT-focused treatments and traditional CBT demonstrated comparable effects for both reduction in depression and RNT (in the form of rumination, worry and content-independent perseverative thinking; Spinhoven, van Hemert, & Penninx, 2018). There was a strong association between post-treatment effects on depression and on RNT, but this association of RNT reduction with depression reduction following treatment was only significant for RNT-focused treatments. Although RNT-focused treatments overall did not demonstrate superior effects on RNT reduction compared with traditional CBT, the findings suggest that depression symptom improvement following RNT-focused treatments may be mediated by reducing RNT. Currently, there has been no meta-analysis that assesses whether treatments for anxiety disorders which target RNT (worry or otherwise) are more effective at reducing RNT and anxiety severity than non-RNT-focused psychological treatments or nonpsychological treatments.

Additionally, there has been no examination of whether successful reduction in RNT in RNT-focused interventions mediates treatment outcomes in anxiety disorders. In accordance with the four criteria for a cognitive model of therapeutic change, as stipulated by Lorenzo-Luaces et al., (2015; see Figure 1), the current study had the following goals:

1. To determine the effect of any treatment on anxiety severity compared with a control condition, and to assess whether RNT-focused treatments result in greater symptom reduction than other psychological or nonpsychological treatments that are not focused on RNT (differential effect of intervention on outcome [path *c*]).
2. To determine the effect of any treatment on RNT compared with a control condition, and to assess whether RNT-focused treatments result in greater RNT reduction (differential effect of intervention on mediator [path *a*]).
3. To determine whether treatment effects on RNT are correlated with treatment effects on anxiety severity (effect of mediator on outcome [path *b*]).
4. To determine whether the association of the effect on RNT and on anxiety severity is stronger for RNT-focused interventions (cognitive specificity [path *d*]).

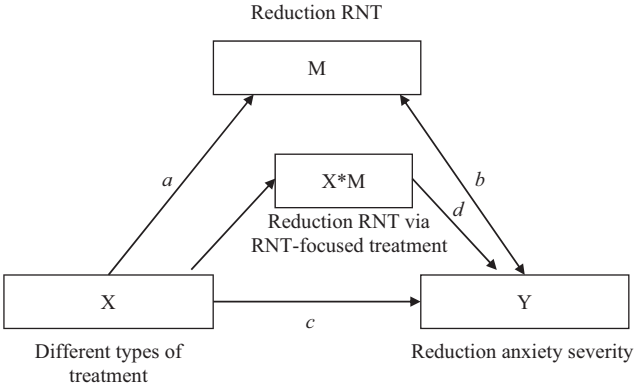


**FIGURE 1** Association between different types of treatment, reductions in RNT, and improvement in anxiety severity

However, if these criteria are met, this would be suggestive that RNT-focused interventions may produce their effect by specifically targeting RNT. In order to obtain causal instead of correlational evidence, mediation studies with more than two measurement points are necessary, showing that an intervention impacts upon a putative mediator preceding subsequent changes in outcome. Moreover, mediators may point to or stem from true working mechanisms, but may also act as a proxy for other variables (Kazdin, 2007). In order to address the above questions, a meta-analysis was conducted on studies investigating the effects of any treatment for anxiety versus a control condition (waitlist, care as usual, placebo) on RNT in (young and older) adults. The meta-analysis was restricted to randomized controlled trials (RCTs), which aim to reduce sources of bias, and thus allow more valid inferences in comparison with observational or naturalistic designs.

## 2 | MATERIALS AND METHODS

### 2.1 | Identification and selection of studies

The meta-analysis protocol can be accessed through the PROSPERO online registry for systematic reviews at https

://www.crd.york.ac.uk/prospero/display_record.php?RecordID=89213. Literature searches on the electronic bibliographic databases PubMed, EMBASE, PsycINFO, and the Cochrane Library were conducted in February and March 2018 to identify potential studies. Searches were executed by combining MeSH terms or subheadings and free-text words relating to anxiety or anxiety disorders, with treatment, and content-dependent (e.g., worry, rumination) or content-independent (e.g., perseverative thinking, intrusive thinking), RNT, with filters for RCTs. The exact search string for PubMed, adjusted accordingly for the remaining databases, is given in Appendix S1.

Studies were included if they met the following criteria: (a) an RCT in which (b) any active intervention for the treatment of anxiety was compared with (c) a control condition (waiting list, care as usual, other) in (d) adults (16 years or older) with (e) a current anxiety disorder diagnosis or exhibiting elevated (subclinical) anxiety symptoms (identified by clinical interview or cutoff on self-report scale), and whereby (f) the effects on content-dependent or content-independent RNT were measured. Studies published between the introduction of the DSM III in 1980 and the date the searches were performed were sought. Studies with mixed samples (i.e., those which include participants with other primary diagnoses than anxiety) and with fewer than 10 participants per condition were omitted. Additionally, articles not in the English language or not published in peer-reviewed journals were excluded.

All measures of RNT used in studies identified by the systematic search were allowed. This included, for worry, self-report measures such as the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990), the Thoughts Questionnaire (TQ; Edwards, Rapee, & Franklin, 2003), the Thought Control Questionnaire (TCQ; Wells & Davies, 1994) and the Worry Domains Questionnaire (WDQ; Tallis, Eysenck, & Mathews, 1992); and for rumination, self-report measures such as the Rumination Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991), the Rumination Reflection Questionnaire (RRQ; Trapnell & Cambell, 1999), the Rumination Questionnaire (RQ; Mellings & Alden, 2000), Postevent Processing questionnaire (PEP; Rachman, Gruter-Andrew, & Shafran, 2000), and the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski & Kraaij, 2007).

Titles and abstracts of the references identified by the literature search were screened independently against the inclusion criteria by two investigators and subsequently cross-checked. The full texts of selected references were obtained and reviewed independently for inclusion. The reference lists of identified studies and previous meta-analyses were also screened for additional studies. When necessary data were missing, the authors of the articles were contacted to request these data. Once included studies were identified, the two review investigators (AT and SM) also independently extracted the study data, including methodology and outcome measurements, into an Excel spreadsheet. If necessary, protocol papers and primary and secondary results papers were referred to in order to extract all the necessary data relevant to the meta-analysis. The study characteristics that were extracted followed the coding system as described by Cuijpers, Straten, Warmerdam, and Andersson (2008) based on previous meta-analyses of the psychological treatment of depression adjusted for use with anxiety. Any discrepancies between the two authors in the screening and selection of papers, as well as the extraction of data, were solved by means of discussion and consensus, with inclusion of a third investigator (PS) if necessary.

## 2.2 | Quality assessment

To assess the validity of the included studies, four criteria were used from the "risk of bias" assessment tool, developed by the Cochrane collaboration (Higgins et al., 2011) to identify possible sources of bias in RCTs. The current meta-analysis used the following four domains: random sequence generation for allocation to conditions; the concealment of condition allocation; blinding of outcome assessment by independent raters; and dealing with data incompletion (such as intention-to-treat analysis). The quality assessment was conducted by the two review investigators independently (AT and SM) and then cross-checked, with disagreements discussed along with the third investigator (PS).

## 2.3 | Meta-analyses

For each comparison of an active intervention with a control condition in the included studies, effect sizes were calculated primarily using the difference in group means at post-test. Hedges' $g$ was used as the measure of effect size as it addresses small samples (Hedges & Olkin, 1985). Precedence for outcome data from a total scale was taken over a subscale. Effect sizes from more than one outcome measure were pooled within the study prior to pooling effect sizes across studies so that each comparison yielded only one effect size.

The computer software Comprehensive Meta-Analysis (CMA) program was used to calculate the pooled mean effect. When means and standard deviations were not reported, any other precise statistic accommodated by CMA was used; otherwise, results were converted to an appropriate form; for example, standard errors were converted to standard deviations. A random-effects model was used in all analyses to address heterogeneity among the studies. To quantify heterogeneity of the effect sizes, $I^2$-statistic was used, which refers to "the percentage of total variation across studies that is due

to heterogeneity rather than chance" (Higgins, Thompson, Deeks, & Altman, 2003, p. 558). $I^2$ value of 0% indicates no observed heterogeneity between effect sizes, while values of 25%, 50%, and 75% correspond to low, moderate, and high heterogeneity, respectively (Higgins et al., 2003). We also calculated 95% confidence intervals around $I^2$ (Ioannidis, Patsopoulos, & Evangelou, 2007), using the noncentral chi-squared-based approach within the "heterogi" module for Stata. Publication bias was examined through inspection of the funnel plot on the primary outcome measures and by Duval and Tweedie's (2000) trim and fill procedure, which estimates the number of missing studies observed due to publication bias and then re-estimates the effect size to account for this bias. Egger's test for the asymmetry of the funnel test was also conducted.

In order to examine possible moderators of outcome and potential sources of heterogeneity, we examined the following variables: recruitment (community, clinical, combined), Phase II or Phase III study (RCT's to show sufficient preliminary efficacy of a new treatment vs. RCT's to demonstrate efficacy/effectiveness more definitively against a control treatment in a larger trial), treatment format (Grp, group; Ind, individual; Gsh, guided self-help; Ugsh, unguided self-help), class of disorder (GAD, high worriers, other), number of sessions (<8 vs. 8 or more), target group (students/adults vs. older adults), type of control group (waiting list, care as usual, other [e.g., attention/placebo, pill placebo]), measurement of RNT (rumination vs. worry and type of worry instrument [PSWQ vs. other]), and study quality (3–4 criteria vs. 0–2 criteria).

To assess whether the effect sizes of included studies were in line with the mediation model as presented in Figure 1, also subgroup analyses and meta-regressions were performed. Firstly, interventions were coded into overall class of treatment. Besides RNT-focused interventions (e.g., MCT, MBT, IUT, attentional control, behavioral activation for worry [BAW]) that are psychological by the nature of focusing on RNT, we coded non-RNT-focused psychological treatments (e.g., problem-solving CBT, psychodynamic treatment), and nonpsychological treatments (e.g., pharmacological treatment, therapeutic massage, thermotherapy, repetitive transcranial magnetic stimulation). Then, subgroup analyses were performed to test whether the effect sizes of different classes of treatment on RNT differed significantly from each other. Next, meta-regression analyses were conducted to assess the relationship between the effect sizes of different classes of treatment on RNT and the effect sizes of different classes of treatment on anxiety severity, indicated by a regression slope coefficient and corresponding 95% confidence intervals (CIs). To calculate this, the post-test effects on RNT were used as a predictor variable and the post-test effects on anxiety severity were used as the dependent variable.

Subgroup analyses were conducted with a mixed-effects model (Borenstein, Hedges, Higgins, & Rothstein, 2009), in which studies within subgroups are pooled by means of random effects, while tests for significant differences between subgroups are conducted by means of fixed effects. Meta-regression analyses were performed to test for significant relationships between predictor variable(s) and effect size, as indicated by a *Z*-value and an associated *p*-value.

# 3 | RESULTS

## 3.1 | Selection and inclusion of studies

The literature search yielded a total of 5,812 references from PubMed ($n$ = 1,271), EMBASE ($n$ = 1,647), PsycINFO ($n$ = 1,144), and The Cochrane Library ($n$ = 1,750). One additional reference was identified through reviewing reference lists of previous meta-analyses. After the removal of 1,796 duplicates, 4,017 abstracts were independently screened by two investigators. Agreement on exclusion of PubMed references based on titles and abstracts was directly reached in 87.4% of cases. Next full-text versions of 188 articles were retrieved for further consideration, of which 142 were excluded for the following reasons: study protocol ($n$ = 3), not an RCT ($n$ = 6), no measure of worry/rumination/RNT ($n$ = 17), participants inappropriate (no anxiety disorder or elevated anxiety severity; $n$ = 40), no control condition ($n$ = 37), dissertation not published in a peer-reviewed journal ($n$ = 11), sample overlapping with another study ($n$ = 21), authors did not send the data despite repeated requests ($n$ = 2), and not in English language ($n$ = 5). The remaining 46 studies were included in the meta-analysis. Figure 2 presents the flowchart showing the process of identification, screening, and inclusion of studies.

## 3.2 | Characteristics of included studies

Table 1 displays the selected characteristics of the included studies (see Appendix S2 for the references of the selected studies). There were 3,194 participants in the 46 included studies (1,953 participants in the active treatment conditions and 1,241 in the control conditions). Mean age across all the participants was 40.93 years, and the mean proportions of females across the studies were 70.6%. Participants were recruited from the community in 30 studies, from clinical populations in eight studies, and from a combination of community and clinical populations in eight studies. Adults were the targeted population in 31 studies, seven studies specifically aimed at older adults, six studies at university students, and two studies at a mix of adults and students. There were 16 studies conducted in the USA, six in Canada, five in the

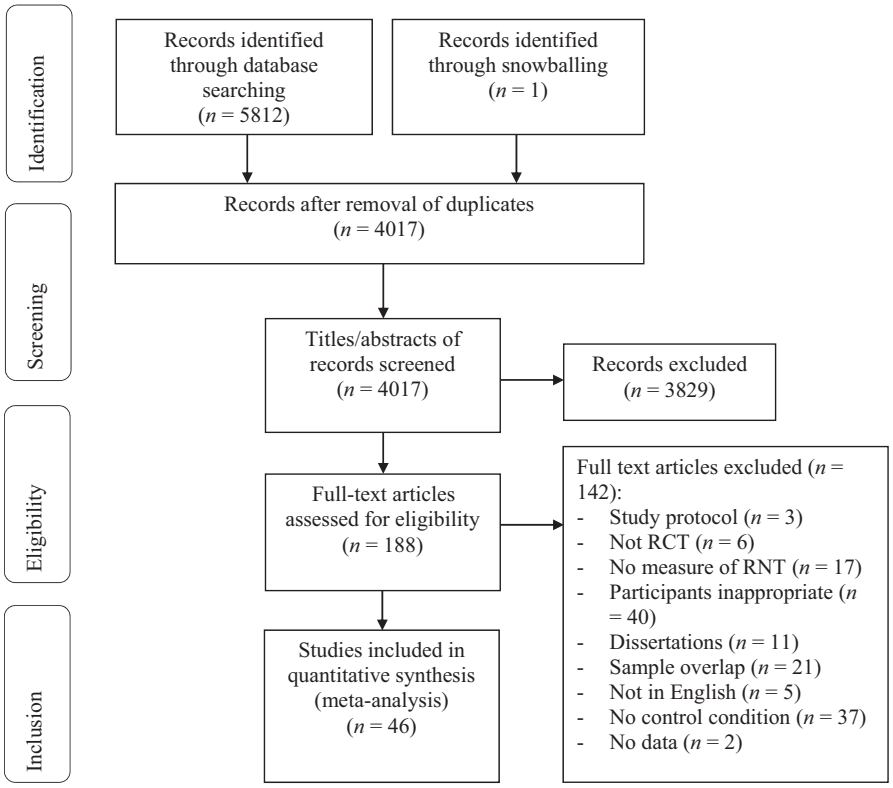


**FIGURE 2** Flowchart for identification, screening, and inclusion of eligible studies

UK, eight in Europe (excluding the UK), five in Australia, and six in other countries.

Almost half of the included studies focused on GAD ($n$ = 22), six studies on SAD, two studies on PTSD, and nine studies on participants exhibiting elevated worry. The remaining seven studies were comprised of mixed anxiety disorder samples: one study with GAD and anxiety disorders not otherwise specified (ADNOS), one study with GAD, PD, and ADNOS, and four studies with GAD, SAD, and PD (with or without agoraphobia). In 31 studies, the presence of anxiety disorders was established using a standardized diagnostic interview, one study used a nonstandardized diagnostic interview, nine studies used a cutoff score on a self-report questionnaire to establish the presence of clinically relevant anxiety symptoms, and five studies used a combination of diagnostic interviews and self-report measures. Of the 39 studies that measured worry as an outcome, 34 used the PSWQ, one used the TCQ worry subscale, one used the WDQ, and three studies used the PSWQ in combination with another measure: WDQ, RRS-brooding subscale (Treynor, Gonzalez, & Nolen-Hoeksema, 2003), and percentage of day spent worrying. Six studies measured postevent rumination as an outcome with the following measures: TQ-negative rumination subscale, modified version of TQ-negative rumination subscale, RRS-brooding subscale, RRQ, PEP questionnaire, and RQ. Finally, one study measured rumination with the CERQ rumination subscale (Garnefski & Kraaij, 2006).

Sixty-three treatment conditions were examined in the 46 studies. There were 26 RNT-focused psychological treatments, which used cognitive behavioral techniques (e.g., BA, IUT, MCT) or process-focused techniques (e.g., MBT, attention control) specifically targeting RNT (worry or rumination). This included four IUTs, two MCTs, one mindfulness and acceptance-based therapy, one acceptance-based behavioral therapy (ABBT), one emotion regulation therapy (ERT), one extinction therapy for worry, one BAW, one worry journal, two positive alternatives to worry, six MBTs, four working memory or attentional bias training, one combining working memory training and MBT, and one combining cognitive, metacognitive, and behavioral techniques. There were 29 non-RNT-focused psychological treatments largely comprised of full or partial CBT manuals, which did not specifically focus on RNT but incorporated a number of techniques, such as applied relaxation, cognitive restructuring, anxiety exposure, problem-solving, BA problem-solving, assertiveness training, thought stopping, and sleep management. Within the non-RNT-focused treatment conditions, there was also one psychodynamic therapy (DYN), and two combining different treatment approaches (one CBT plus interpersonal therapy and one spiritually integrated CBT). There were a remaining 8 nonpsychological treatments (i.e., anti-anxiety medications, alternative medicine, therapeutic massage, thermotherapy, spiritually integrated treatment, repetitive transcranial magnetic stimulation, flotation restrictive environmental stimulation technique, discussion group). Of the 46 control conditions, 26 were waiting list, five received no intervention, two were information only, three were enhanced usual care (EUC), eight were attention control, and two were

pill placebo. In 32 of the 63 treatment conditions, an individual format was used, 13 used a group format, and 18 used (guided) self-help. Number of sessions ranged from one to thirty sessions, with 21 studies with eight or less sessions.

### 3.3 | Quality assessment

The quality of the included studies, assessed using the risk of bias tool, was varied (see Table 1). Only nine studies reported an adequate sequence generation by an independent person, while 37 studies did not. Similarly, 11 studies sufficiently described the method used to conceal the randomization, but 35 studies did not. Blinding of outcome assessors or the use of only self-report outcome measures was seen in all but one study ($n = 45$). Thirty-six of the studies used an intention-to-treat analysis to deal with missing data or did not have any attrition from the study. Twelve studies met three or four of the quality criteria, 25 studies met two of the criteria; the remaining nine studies met one of the criteria.

### 3.4 | The effects of active treatments versus control groups on RNT (path *a*)

#### 3.4.1 | Overall effect of active treatments versus control groups

In the random-effects model, in 63 comparisons the overall effect of any active treatment compared with control conditions on post-test RNT was moderate and in favor of the active treatments, $g = 0.68$ (95% CI [0.53, 0.83]) and heterogeneity across the studies was high, $I^2 = 78$, 95% CI [0.72, 0.82]. Examination of the funnel plot showed an asymmetric shape with three Iranian studies reporting extremely high Hedges' $g$ values of 9.4 (Shahbazirad, Ghadampour, Ghazabfari, & Momen, 2016), 5.3 (Asmaee Majid, Seghatoleslam, Homan, Akhvast, & Habil, 2012), and 3.1 (Rezvan, Baghban, Bahrami, & Abedi, 2008) suggesting almost complete nonoverlap of post-treatment scores in the interventions and control condition. Further, a test for asymmetry of the funnel plot using Egger's test was significant, $t(44) = 2.92$, $p < .01$. Using Duval and Tweedie's trim and fill procedure, no correction for these extreme effect sizes proved to be possible. However, after excluding these three studies, Egger's test was no longer significant, $t(41) = 0.05$, $p = .96$ and the funnel plot became more symmetrical (see Figure 3). Although this is not generally recommended, these three studies were excluded from further analyses because the results were not credible. The forest and funnel plot of the analyses including the three Iranian studies can be found in Appendices S3 and S4.

In the subsequent random-effects model, in 59 comparisons the overall effect of any active treatment compared with control conditions on post-test RNT remained moderately large, $g = 0.57$ (95% CI [0.45, 0.69]). Table 2 and the forest plot in Figure 4 display the results of this analysis. Moreover, heterogeneity across the studies became moderate, $I^2 = 64$.

In this analysis, 16 studies contained more than one effect size for RNT. In 12 studies, this was due to there being two or more active treatment conditions, in two studies more than one instrument was used to measure RNT, and in the final two studies there were multiple active treatment conditions as well as multiple RNT instruments. This indicates there are multiple comparisons of the same participants, and thus, outcome data on which the effect was calculated were not independent from each other. This may have led to an inaccurate estimate of the variance for the overall effect. Therefore, a sensitivity analysis was conducted which included only one effect size per study. First, the highest effect size was selected for each study to calculate the overall effect, and then, the lowest effect size was selected. As can be seen in Table 2, the effect sizes and their associated heterogeneity from the sensitivity analysis were comparable to the overall main analysis.

When the effects were limited to the 52 comparisons that used worry measurements ($g = 0.57$, 95% CI [0.43, 0.70], $I^2 = 67$), the effects were comparable to the overall effect. More specifically, in 49 of the 52 comparisons the PSWQ was used to measure worry ($g = 0.57$, 95% CI [0.43, 0.72], $I^2 = 69$), which again resulted in a similar effect. In the eight comparisons that used rumination measurements, large effect sizes were also observed ($g = 0.69$, 95% CI [0.41, 0.97], $I^2 = 61$).

In order to examine possible moderators of outcome and potential sources of heterogeneity, a series of subgroup analyses was performed. There was a significant difference for number of sessions, $Q(1) = 6.387$, $p = .01$, with interventions with eight or more sessions ($g = 0.68$; 95% CI [0.59, 0.77]; $I^2 = 66$) showing a significantly larger effect size than interventions with less than eight sessions ($g = 0.42$; 95% CI [0.30, 0.54]; $I^2 = 50$). Moreover, effect sizes differed depending on the type of control group, $Q(2) = 26.89$, $p < .001$, with waiting list conditions ($g = 0.73$; 95% CI [0.64, 0.82]; $I^2 = 69$, $p < .001$) but not care as usual ($g = 0.64$; 95% CI [0.40, 0.88]; $I^2 = 0.00$, $p = .08$) showing a significantly larger effect size than other active control conditions ($g = 0.24$; 95% CI [0.11, 0.36]; $I^2 = 0.00$). In addition, there was a difference between Phase II versus III studies $Q(2) = 7.818$, $p < .01$, with Phase III studies ($g = 0.68$; 95% CI [0.59, 0.76]; $I^2 = 60$) showing a larger effect size than Phase II studies ($g = 0.34$; 95% CI [0.22, 0.47]; $I^2 = 60$). There were no significant differences in effect sizes among the following subgroups of studies: recruitment, treatment format, target group, class of disorder, and study quality (see Table 2).

**TABLE 1** Selected characteristics of randomized controlled trials examining the effects of different types of treatment for anxiety disorders on repetitive negative thinking

| Authors | Recr | Diagnosis | Definition of anxiety | Target group | % Female | Mean age | Conditions | *N* baseline | *N* analyzed | Format | *N* sess | Quality[a] | Measure of RNT | Country |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Andersson et al. (2012) | Comm | GAD | SCID-I | Adults | 76.5 | 40.1 | 1. iDYN<br>2. iCBT<br>3. WLC | 81 | 75 | Gsh | 8 | ++++ | PSWQ | EUR |
| Andersson et al. (2017) | Comm | High worriers | PSWQ > 56, MINI | Adults | 84.5 | 32.5 | 1. iET<br>2. WLC | 140 | 140 | Gsh | 8 | ++++ | PSWQ | EUR |
| Asmaee Majid Seghatoleslam Homan Akhvast and Habil (2012) | Clin | GAD | SCID-I | Adults | 0 | 32.2 | 1. MBSR<br>2. Non-int control | 33 | 31 | Grp | 8 | − − −+ | PSWQ | OTH |
| Bell, Colhoun, Carter and Frampton (2012) | Clin | GAD, SAD, PD +/− A | SCID-I | Adults | 68.0 | 35.3 | 1. iCBT<br>2. WLC | 83 | 68 | Gsh | 4–6 | −+++ | PSWQ | OTH |
| Brenes et al. (2012) | Comm + Clin | GAD, PD, ADNOS | SCID-I | Older adults | 69.2 | 83.3 | 1. CBT: tel<br>2. Information-only comparison | 60 | 54 | Gsh | 8 | +− −+ | PSWQ | USA |
| Brown et al. (2015) | Comm | GAD | MINI | Adults | 64.6 | 37.5 | 1. Alprazolam<br>2. Pill placebo | 30 | 30 | Ind | 28 (days) | − −++ | PSWQ | USA |
| Brozovich et al. (2015) | Comm | SAD | ADIS-IV | Adults | 47.95 | 33.51 | 1. CBT<br>2. WLC | 75 | 60 | Ind | 16 | +− −+ | RRS-brooding subscale | USA |
| Chen et al. (2013) | Comm | High worriers | PSWQ ≥ 55 | Adults | 78.0 | 39.3 | 1. BAW<br>2. WLC | 49 | 49 | Grp | 8 | ++−+ | PSWQ | AUS |
| Course-Choi et al. (2017) | Comm | High worriers | PSWQ ≥ 45 | Adults | 75.0 | 28.7 | 1. Adaptive WMT<br>2. MMP<br>3. WMT + MMP<br>4. Nonadaptive WMT | 60 | 60 | Gsh | 7 | +− −+ | PSWQ | UK |
| Delgado-Pastor et al. (2015) | Comm | High worriers | PSWQ > 80th percentile ($M = 67.46 \pm 4.3$) | Students | 100 | 21.5 | 1. MBCT<br>2. MBIT<br>3. Non-int control | 45 | 41 | Grp | 6 | − − −+ | PSWQ | EUR |
| Diefenbach et al. (2016) | Comm + Clin | GAD | MINI | Adults | 75.7 | 44.3 | 1. rTMS<br>2. Sham rTMS | 26 | 25 | Ind | 30 | ++++ | PSWQ | USA |
| Dugas et al. (2003) | Comm | GAD | ADIS-IV | Adults | 71.2 | 41.2 | 1. CBT-IU<br>2. WLC | 52 | 52 | Grp | 14 | +− −+ | PSWQ | CAN |
| Eagleson, Hayes, Mathews, Perman and Hirsch (2016) | Comm | GAD | SCID-I | Adults | Not reported | 30.3 | 1. PIW<br>2. PVW<br>3. PIN | 102 | 102 | Ind | 1 | − − −+ | PSWQ | UK |
| Fracalanza, Koerner and Antony (2014) | Comm | GAD | MINI | Adults + students | 79.0 | 33.7 | 1. IWT: CE<br>2. IWT: VE<br>3. IWT: NC | 57 | 57 | Ind | 3 | +− −+ | PSWQ | CAN |

(Continues)

**TABLE 1** (Continued)

| Authors | Recr | Diagnosis | Definition of anxiety | Target group | % Female | Mean age | Conditions | *N* baseline | *N* analyzed | Format | *N* sess | Quality[a] | Measure of RNT | Country |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goldman, Dugas, Sexton and Gervais (2007) | Comm | High worriers | PSWQ ≥ 54 | Adults + students | 66.7 | 26.0 | 1. Written exposure task<br>2. Non-int control | 30 | 30 | Gsh | 5 | +− −+ | PSWQ | CAN |
| Hazen et al. (2009) | Comm | High worriers | PSWQ ≥ 60 | Students | 65.0 | 19.3 | 1. ARTS<br>2. Sham ARTS | 24 | 23 | Ind | 5 | − − −+ | PSWQ | USA |
| Hotton et al. (2018) | Comm | High worriers | PSWQ ≥ 60<br>MINI | Adults | 78.1 | 29.6 | 1. Adaptive WMT<br>2. Nonadaptive WMT | 47 | 41 | Ind | 15 | − − −+ | 1. PSWQ<br>2. WDQ | UK |
| Hui and Zhihui (2017) | Comm | GAD | Meet DSM−5 diagnosis | Older adults | 42.8 | 65.7 | 1. CBT-IU<br>2. WLC | 63 | 63 | Grp | 12 | +− −+ | PSWQ | OTH |
| Jonsson and Kjellgren (2016) | Comm + Clin | GAD | PSWQ ≥ 45 and/or GAD-Q-IV ≥ 5.7 | Adults | 70.0 | 43.1 | 1. flotation-REST<br>2. WLC | 50 | 46 | Ind | 12 | − − −+ | PSWQ | EUR |
| Kocovski Fleming Hawley Ho and Antony (2015) | Comm | SAD | SCID-I | Adults | 55.47 | 34.72 | 1. MAGT<br>2. CBGT<br>3. WLC | 137 | 137 | Grp | 12 | +− −+ | RRQ | CAN |
| Ladouceur et al. (2000) | Comm | GAD | ADIS-IV | Adults | 76.9 | 39.7 | 1. CBT-IU<br>2. WLC | 26 | 26 | Ind | 16 | +− −+ | PSWQ | CAN |
| LaFreniere and Newman (2016) | Comm | GAD | GAD-Q-IV | Students | 84.3 | >18 years | 1. WOJ<br>2. TL | 51 | 51 | Gsh | 10 | +− −+ | PSWQ | USA |
| Mennin, Fresco, O'Toole and Heimberg (2018) | Comm + Clin | GAD | ADIS-IV or SCID-IV | Adults | 75.0 | 39.0 | 1. ERT<br>2. WLC | 53 | 53 | Ind | 20 | +− −+ | 1. PSWQ<br>2. RRS-brooding subscale | USA |
| Modini & Abbott (2017) | Comm | SAD | SIAS ≥ 36<br>ADIS-IV | Students | 74.5 | 19.9 | 1. Cognitive restructuring<br>2. Non-int control | 47 | 47 | Ind | 1 | +− −+ | TQ-negative rumination subscale | AUS |
| Park et al. (2014) | Comm + Clin | GAD | SCID-I | Adults | 76.2 | 39.2 | 1. GSS-I<br>2. GSS-M<br>3. Pill placebo | 147 | 147 | Ind | 8 (weeks) | ++++ | PSWQ | OTH |
| Paxling et al. (2011) | Comm | GAD | SCID-I | Adults | 79.8 | 39.3 | 1. iCBT<br>2. WLC | 89 | 89 | Gsh | 8 | ++−+ | PSWQ | EUR |
| Price and Anderson (2011) | Comm | SAD | SCID-I | Adults | 61 | 39.1 | 1. VRET<br>2. EGT<br>3. WLC | 98 | 98 | 1. Ind<br>2. Grp | 8 | +−++ | RQ | USA |
| Rezvan et al. (2008) | Clin | GAD | GAD-Q-IV ≥ 5.7<br>Diagnostic interview for DSM-IV | Students | 100 | 20.3 | 1. CBT<br>2. CBT + IPT<br>3. WLC | 36 | 36 | Ind | 8 | +− −+ | PSWQ | OTH |

(Continues)

**TABLE 1** (Continued)

| Authors | Recr | Diagnosis | Definition of anxiety | Target group | % Female | Mean age | Conditions | *N* baseline | *N* analyzed | Format | *N* sess | Quality[a] | Measure of RNT | Country |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Robinson et al. (2010) | Comm | GAD | MINI | Adults | 68.4 | 47.0 | 1. iCBT: TA<br>2. iCBT: CA<br>3. WLC | 150 | 150 | Gsh | 6 | +− −+ | PSWQ | AUS |
| Roemer, Osillo and Salters-Pedneault (2008) | Clin | GAD | ADIS-IV | Adults | 73.3 | 32.8 | 1. ABBT<br>2. WLC | 31 | 31 | Ind | 16 | +− −+ | PSWQ | UK |
| Rosmarin, Pargament, Pirutinsky and Mahoney (2010) | Comm | High worriers | PSS ≥ 27<br>PSWQ ≥ 54 | Adults | 76.1 | 41.6 | 1. iSIT video<br>2. iPMR audio<br>3. WLC | 261 | 125 | Ugsh | 14 | − − −+ | PSWQ | USA |
| Sass et al. (2017) | Comm | High worriers | MASQ ≥ 28 and/or PSWQ ≥ 62 | Students | 70.6 | 19.9 | 1. ATP stimuli<br>2. Placebo control | 41 | 40 | Ind | 1 | − − −+ | PSWQ | USA |
| Schuurmans et al. (2006) | Comm + Clin | GAD, SAD, PD +/− A, Ag | SCID-I | Older adults | 73.0 | 69.1 | 1. CBT<br>2. Sertraline<br>3. WLC | 84 | 56 | Ind | 15 | − − − − | WDQ | EUR |
| Shahbazirad Ghadampour Ghazabfari and Momen (2016) | Clin | SAD | SCID-I | Adults | Not reported | 29.38 | 1. Cognitive, metacognitive, and behavioral model<br>2. WLC | 30 | 30 | Grp | 16 | +− −+ | PEP | OTH |
| Sherman et al. (2010) | Clin | GAD | SCID-I | Adults | 76.3 | 43.0 | 1. Therapeutic massage<br>2. Thermotherapy<br>3. Relaxing room control | 68 | 68 | Ind | 12 | ++++ | PSWQ | USA |
| Shikatani, Antony, Kuo and Cassin (2014) | Comm | SAD | SCID-I | Adults | 69.6 | 24.5 | 1. Control<br>2. Cognitive restructuring<br>3. Mindfulness | 56 | 56 | Ind | 1 | +− −+ | TQ-negative rumination subscale (modified)<br>1. PEP-degree<br>2. PEP-distress | CAN |
| Stanley et al. (2009) | Comm + Clin | GAD | MINI<br>SCID-I | Older adults | 78.3 | 67.0 | 1. CBT<br>2. EUC | 134 | 134 | Ind | 10 | ++++ | PSWQ-A | USA |
| Stanley et al. (2016) | Comm | GAD, ADNOS | SCID-I<br>PSWQ-A ≥ 23 | Older adults | 95 | 62.6 | 1. CBT + optional SIT<br>2. EUC | 40 | 40 | Ind | 12 | +−++ | PSWQ-A | USA |

(Continues)

**TABLE 1** (Continued)

| Authors | Recr | Diagnosis | Definition of anxiety | Target group | % Female | Mean age | Conditions | *N* baseline | *N* analyzed | Format | *N* sess | Quality[a] | Measure of RNT | Country |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Titov et al. (2009) | Comm | GAD | MINI | Adults | 76.0 | 44.0 | 1. iCBT 'Worry program'<br>2. WLC | 48 | 45 | Gsh | 6 | +− −+ | PSWQ | AUS |
| Titov, Andrews, Johnston, Robinson and Spence (2010) | Comm | GAD, SAD, PD | MINI | Adults | 67.9 | 39.6 | 1. iCBT<br>2. WLC | 86 | 78 | Gsh | 6 | +− −+ | PSWQ | AUS |
| van der Heiden et al. (2012) | Clin | GAD | SCID-I | Adults | 36.0 | 76.3 | 1. MCT<br>2. IUT<br>3. DT | 126 | 126 | Ind | 14 | +− −+ | PSWQ | EUR |
| Vøllestad, Sivertsen and Nielsen (2011) | Comm | GAD, SAD, PD +/− A | MINI | Adults | 67.2 | 42.5 | 1. MBSR<br>2. WLC | 76 | 76 | Grp | 8 | +− −+ | PSWQ | EUR |
| Wells and Colbear (2012) | Clin | PTSD | SCID-I | Adults | 55.0 | 37.4 | 1. MCT<br>2. WLC | 20 | 20 | Ind | 8 | +− −+ | TCQ- worry subscales | UK |
| Wetherell, Gatz and Craske (2003) | Comm | GAD | ADIS-IV MINI | Older adults | 80.0 | 67.1 | 1. CBT<br>2. Discussion group<br>3. WLC | 75 | 57 | Grp | 12 | − − −+ | 1. PSWQ<br>2. % day spent worrying | USA |
| Wetherell et al. (2009) | Comm + Clin | GAD, ADNOS | ADIS-IV | Older adults | 84.0 | 72.2 | 1. Modular psychotherapy<br>2. EUC | 31 | 31 | Ind | 12 | +− −+ | PSWQ | USA |
| Wisco, Sloan and Marx (2013) | Comm | PTSD | CAPS SCID-IV | Adults | 65.0 | 40.7 | 1. WET<br>2. WLC | 46 | 46 | Ind | 5 | +−++ | CERQ-short rumination subscale | USA |

Abbreviations: ABBT, acceptance-based behavioral therapy; ADIS-IV, Anxiety Disorders Interview Schedule for DSM-IV; ADNOS, anxiety disorder not otherwise specified; Ag, agoraphobia; ARTS, Attentional retraining for threat stimuli; ATP stimuli, attention training to pleasant stimuli; AUS, Australia; BAW, behavioral activation for worry; CA, clinician assisted; CAN, Canada; CAPS, Clinician-Administered PTSD Scale; CBGT, cognitive behavioral group therapy; CBT, cognitive behavioral therapy; CBT-IU, CBT targeting intolerance of uncertainty; CE, consistent exposure; CERQ-short, shortened Cognitive Emotion Regulation Questionnaire; Clin, recruitment from a clinical population; Comm, community recruitment; DT, delayed treatment; EGT, exposure group treatment; ERT, emotion regulation therapy; EUC, enhanced usual care; EUR, European country; flotation-REST, flotation restrictive environmental stimulation technique; GAD, generalized anxiety disorder; GAD-Q-IV, Generalized Anxiety Disorder Questionnaire fourth edition; Grp, group; Gsh, guided self-help; GSS-I, Gamisoyo-San individual extract mixture; GSS-M, Gamisoyo-San multi-compound extract; iCBT, Internet-based CBT; iDYN, Internet-based psychodynamic therapy; iET, Internet-based extinction therapy; Ind, individual; iPMR, Internet-based progressive muscle relaxation; IPT, interpersonal therapy; iSIT, Internet-based spiritually integrated treatment; IUT, intolerance-of-uncertainty therapy; IWT, imaginal writing task; MAGT, mindfulness and acceptance-based group cognitive therapy; MASQ, Mood and Anxiety Symptom Questionnaire; MBCT, mindfulness-based cognitive training; MBIT, mindfulness-based interoceptive training; MBSR, mindfulness-based stress reduction; MCT, metacognitive therapy; MINI, Mini-International Neuropsychiatric Interview; MMP, mindfulness meditation practice; *N* sess, number of sessions; NC, neutral control; Non-int, nonintervention; OTH, other country not otherwise listed; PD +/− A, panic disorder with or without agoraphobia; PD, panic disorder; PEP, Postevent Processing questionnaire; PEP-degree, postevent processing-degree to which participants currently agree with these thoughts; PEP-distress, postevent processing- distress currently caused by these thoughts; PIN, positive imagery nonworry; PIW, positive imagery of worry; PSS, Perceived Stress Scale; PSWQ, Penn State Worry Questionnaire; PSWQ-A, Penn State Worry Questionnaire Abbreviated; PTSD, post-traumatic stress disorder; PVW, positive verbal worry; Recr, recruitment; RQ, Rumination Questionnaire; RRQ, Rumination Reflection Questionnaire; RRS, Rumination Response Scale; rTMS, repetitive transcranial magnetic stimulation; SAD, social anxiety disorder; SCID-I, Structured Clinical Interview for DSM III/IV; SIAS, Social Interaction Anxiety Scale; SIT, spiritually integrated treatment; TA, technician assisted; TCQ, Thought Control Questionnaire; tel, by telephone; TL, thought log; Ugsh, unguided self-help; UK, United Kingdom; USA, United States of America; VE, varied exposure; VRET, virtual reality exposure treatment; WDQ, The Worry Domains Questionnaire; WET, written exposure therapy; WLC, waiting list control; WMT, working memory training; WOJ, worry outcome journal.

[a]In this column, a positive (+) or negative (−) sign is given to indicate that there is agreement or disagreement, respectively, of four quality criteria of the study, in the following order: dealing with incomplete outcome data; adequate generation of allocation sequence; concealment of allocation to conditions; and masking of outcome assessments by independent raters.

### 3.4.2 | Effects of different classes of treatments versus control groups on RNT

The effects of RNT-focused psychological treatments, non-RNT-focused psychological treatments, and nonpsychological treatments on RNT were compared using a subgroup analysis. As shown in Table 2, the subgroup analysis demonstrated a significant effect for class of treatment on RNT, $Q(2) = 10.386$, $p < .01$, with RNT-focused ($g = 0.69$), non-RNT-focused ($g = 0.58$), and nonpsychological treatments ($g = 0.26$) all having an effect significantly different from zero (see Appendix S5 for the forest plot). A subsequent meta-regression, using nonpsychological treatments as the reference category, showed that only RNT-focused psychological treatments had a significantly larger effect than nonpsychological treatments on post-treatment RNT, $Z = 2.27$, $p = .02$, while the difference between nonpsychological and non-RNT-focused treatments was not significant, $Z = 1.37$, $p = .17$. This effect remained significant also after controlling for significant moderators (i.e., Phase II/III study, number of sessions, and type of control group): $Z = 2.54$, $p = .01$.

As the difference in effect on RNT between RNT-focused and non-RNT-focused psychological treatments is crucial for our research question, we calculated a post hoc power analysis for this comparison. As we posit a medium-sized difference in effect sizes ($\Delta(d) = 0.32$ according to Lipsey & Wilson, 1993), and the minimum difference in effect on RNT is what we are concerned about, using the formulas as described by Hedges and Pigott (2001, 2004), the power to detect such a difference in post-test RNT with the number of studies included in the present meta-analysis between RNT- ($d = 0.69$; lower limit 95% CI [0.55]) and non-RNT-focused treatments ($d = 0.58$; lower limit 95% CI [0.28]) is 0.60 (one-sided) and 0.47 (two-sided).

## 3.5 | The effects of active treatments versus control groups on anxiety severity (path *c*)

In the random-effects model based on 52 comparisons, the overall effect of any active treatment compared with control conditions on post-test anxiety severity was of medium magnitude and in favor of the active treatments, $g = 0.63$ (95% CI [0.48, 0.78]), with a moderate heterogeneity, $I^2 = 74$, 95% CI [0.66, 0.80]. The forest plot of effect sizes is displayed in Appendix S6. A subsequent subgroup analysis revealed that there were significant differences between RNT-focused psychological treatments ($g = 0.66$), non-RNT-focused psychological treatments ($g = 0.70$), and nonpsychological treatments ($g = 0.22$), $Q(2) = 6.10$, $p = .047$. A subsequent meta-regression, however, showed that the effect size for RNT-focused ($p = .12$) and non-RNT-focused psychological treatments ($p = .10$) did not significantly differ from the effect size for nonpsychological treatments.

## 3.6 | Association between effects on RNT and effects on anxiety severity (path *b*)

To assess the relationship between treatment effects on RNT and treatment effects of anxiety severity, a meta-regression analysis was conducted with post-test effects on RNT as a predictor of post-test effects on anxiety severity as the dependent variable. The association between the effects on RNT and the effects on anxiety severity was significant (slope coefficient: 0.67, 95% CI [0.45, 0.90], $Z = 5.89$, $p < .001$). This indicates that in any treatment for anxiety, reduction in RNT post-treatment was concurrently associated with reduction in anxiety severity. Figure 5 displays the regression plot for the association.

## 3.7 | Moderation of the association between effects on RNT and effects on anxiety severity by class of treatment (path *d*)

To assess whether the association between post-treatment effects on RNT and anxiety severity was stronger in RNT-focused psychological treatments compared with non-RNT-focused psychological therapies and nonpsychological treatments, separate meta-regression analyses were conducted for each class of treatment. The associations for RNT-focused psychological treatments (slope coefficient: 0.65, 95% CI [0.39, 0.92], $Z = 4.90$, $p < .001$), non-RNT-focused psychological therapies (slope coefficient: 0.63, 95% CI [0.13, 1.30], $Z = 2.47$, $p = .013$), and nonpsychological treatments (slope coefficient: 1.06, 95% CI [0.24, 1.87], $Z = 2.55$, $p = .011$) were all significant. Next, separate meta-regressions including two interaction terms for post-treatment effect on RNT and condition (with RNT-focused psychological treatments as reference category) showed that the slope of RNT-focused psychological treatments did not differ from the slope of non-RNT-focused psychological therapies ($Z = 0.61$, $p = .54$) nor from the slope of nonpsychological treatments ($Z = -0.67$, $p = .50$).

# 4 | DISCUSSION

The present meta-analysis examined if treatments for anxiety specifically targeting RNT (rumination, worry, and content-independent perseverative thinking) have a specific effect on RNT resulting in better outcomes than other psychological and nonpsychological treatments that do not specifically target RNT in comparison with control conditions. Independent of the type of treatment, treatment had a medium-sized effect

on anxiety severity and RNT at post-test in comparison with control groups. RNT-focused psychological treatments had a medium-sized and significantly larger effect size than nonpsychological treatments, but the effect sizes were comparable to those of non-RNT-focused psychological treatments. Effects on RNT at post-test were strongly associated with effects on anxiety severity, and this association was significant across the different types of treatment. No indications were found that the effect sizes were associated with recruitment, treatment format, target group, class of disorder, or study quality.

In the included studies, there was a moderate effect on reducing anxiety severity, which was comparable across different types of treatment (path *c* in Figure 1). As all types of treatment were equally effective in reducing anxiety severity, the first criterion for a cognitive model of therapeutic change as specified by Lorenzo-Luaces, German, and DeRubeis (2015; differential effects of interventions on symptoms) was not met. The effect on anxiety was somewhat smaller than the effect of psychological treatments reported in previous meta-analyses for individual anxiety disorders (i.e., $d = 0.77$ or more), such as SAD (Acarturk, Cuijpers, Van Straten, & De Graaf, 2009), GAD (Cuijpers et al., 2014), PTSD (Cusack et al., 2016), PD (Sánchez-Meca, Rosa-Alcázar, Marín-Martínez, & Gómez-Conesa, 2010), and specific phobias (Wolitzky-Taylor, Horowitz, Powers, & Telch, 2008). However, the estimated effect on anxiety symptoms in this study is well within the range of effect sizes reported in meta-analyses of multiple anxiety disorders (e.g., Cohen's $d = 0.12$–$1.33$ [Bandelow et al., 2015]); $g = 0.30$–$1.48$ [Cuijpers et al., 2016]).

Unique to the current meta-analysis, we also examined the (differential) effects of treatments on RNT (path *a* in Figure 1). The results demonstrated that any active intervention compared with a control condition had a moderate effect on reducing RNT at post-treatment. There was moderate heterogeneity among studies, and a sensitivity analysis revealed that the effect of interventions on RNT was not likely due to multiple comparisons within studies or the instrument used to assess RNT. The PSWQ was by far the most common measure used across the studies and none of the studies in the meta-analysis used content-independent measures of RNT, such as the Repetitive Thinking Questionnaire (McEvoy, Mahoney, & Moulds, 2010) or Perseverative Thinking Questionnaire (Ehring et al., 2011). Given the predominant content-specific approach of measuring RNT in the included studies, the current meta-analysis cannot conclude on the premise that the commonalities between different forms of RNT could be more important than their distinctions (see Ehring & Watkins, 2008 for detailed discussion).

Examining possible differential treatment effects on RNT, results indicated that the effects on RNT were significantly larger in RNT-focused treatments compared with nonpsychological treatments. However, this category of other treatments comprises a very heterogeneous group of interventions (e.g., pharmacological and alternative therapies such as therapeutic massage, thermotherapy, repetitive transcranial magnetic stimulation, and flotation restrictive environmental stimulation technique) precluding a clear interpretation of these differences in effect size. Importantly, the effects on RNT of RNT-focused treatments ($g = 0.69$) and non-RNT-focused psychological treatments ($g = 0.58$) both had a moderate and comparable effect size. Thus, the findings partially support the second criterion (differential effects of interventions on mediator, i.e., RNT; Lorenzo-Luaces et al., 2015), although interestingly as discussed above there were no significant differences in effect on anxiety between RNT and non-RNT-focused treatments. One explanation for the comparable effect on RNT of RNT-focused and non-RNT-focused psychological treatments could be that both classes of treatment are predominantly CBT-based and show a large degree of overlap. RNT-focused treatments such as IUT (Dugas et al., 1998) and BAW (Chu et al., 2009) stem from cognitive and behavioral models of anxiety and utilize similar techniques to non-RNT-focused CBT manuals. On the other hand, techniques in CBT that do not necessary aim to change RNT may nonetheless indirectly affect the occurrence of RNT. Moreover, similar outcomes across the different treatment types do not imply that the same mediating pathways are responsible for this change. Comparative and mediation research of different types of psychological treatments indicates that both related and distinct mechanisms underlie symptom change in CBT and interventions targeting worry (Arch & Craske, 2008; Donegan & Dugas, 2012). For example, in an RCT for SAD comparing CBT and mindfulness- and acceptance-based treatments (MABT), cognitive reappraisal was identified as an important mediator of symptom change in the CBT group, but not in MCBT, whereas mindfulness was important for both groups (Kocovski, Fleming, Hawley, Ho, & Antony, 2015).

Examination of the associations between the effects on RNT and the effects on anxiety severity (path *b* in Figure 1) showed a significant and moderate association of RNT with anxiety outcomes post-treatment, which is in line with the third criterion of the cognitive mediation model (the effects of mediator on symptoms; Lorenzo-Luaces et al., 2015). This result is consistent with the hypothesis that the reduction in RNT may play a mediating role in anxiety symptom reduction, although it is impossible to make valid inferences about mediation on the basis of concurrent associations and to rule out reverse causality. In order to demonstrate mediation between an intervention and subsequent symptom change, temporal ordering of the intervention, mediator, and outcome variables must be demonstrated (Kazdin, 2007). Of note, only one study included in the analysis (Price & Anderson, 2011) investigated the effect of RNT on post-treatment anxiety

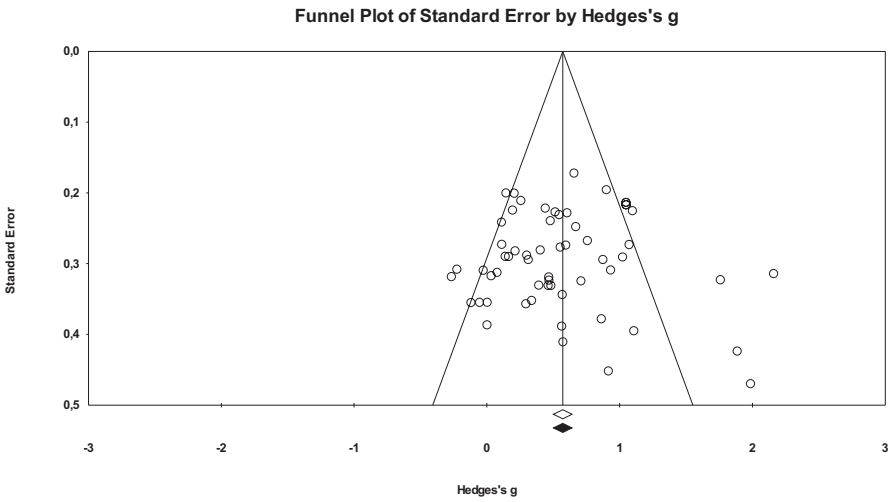


**FIGURE 3** Funnel plot of standard error by Hedges' *g* in observed and imputed studies examining the effect of active treatment compared with control conditions on RNT at post-test

severity over three time points, and evidently more studies of the mediating effect of RNT in anxiety treatments are needed.

Lastly, we examined the cognitive specificity criterion severity (path *d* in Figure 1) of the cognitive mediation model (Lorenzo-Luaces et al., 2015), whereby the associations between the effects on RNT and the effects on anxiety severity for each class of treatment were tested. For each class of treatment, we found a significant and moderate association between effects on RNT and those on anxiety severity. These results differ from those concerning similar associations in the meta-analysis on treatments for depression (Spinhoven, Klein, et al., 2018), which found an association between RNT and depressive symptoms unique to RNT-focused treatments. These results suggest that the covariation of changes in RNT and anxiety is not unique for RNT-focused treatments, and that future, more fine-grained analyses are necessary to disentangle to what extent these changes are dependent on the measurement instrument for RNT, constitute a corollary of therapeutic improvement irrespective of treatment condition, and to what extent the direction of causality may depend on treatment context. In almost all studies included in this meta-analysis, the PSWQ was used to measure RNT in the form of worry and this measure includes content-specific or disorder-specific items (McEvoy et al., 2013). Future studies have to assess RNT in a disorder-independent way, as RNT may be a similar underlying process present across depressive and anxiety disorders, and the representation of this process in disorder-specific cognitive content such as rumination in depression and worry in anxiety may be secondary (Spinhoven, Hemert, et al., 2018; Spinhoven, Klein, et al., 2018). Moreover, it is conceivable that change in anxiety and RNT (and the covariance in this change) may be primarily due to the effects of treatment on general distress/negative affectivity as an underlying variable. In order to avoid model misspecification even in studies with repeated measurements, relevant predictors and covariates have to be included. Finally, the direction of causality may depend on treatment context and RNT may be a mediating mechanism in RNT-focused treatment, while it may primarily represent an epiphenomenon of therapeutic improvement with less prognostic significance in other treatments such as pharmacotherapy.

There are a number of limitations that need to be considered when interpreting the results of this meta-analysis. Critically, only one study included in the meta-analysis employed a formal mediation analysis with more than two time points. Consequently, integrating meta-analytic techniques with SEM to statistically evaluate and synthesize evidence for mediation across multiple studies was not possible (Cheung & Chan, 2005). The results of this review foremost emphasize the need to conduct RCTs with repeated measurements of anxiety and RNT to formally test RNT as a putative mediator. As noted above, the association of changes in anxiety with RNT precludes conclusions about the direction of causality. In addition, the statistical power of the moderator analyses to detect significant differences in between-group effect sizes for RNT for various study designs and sample characteristics was low (Hedges & Pigott, 2001, 2004). For example, the power to detect a medium-sized difference in effect on RNT between RNT-focused and non-RNT-focused psychological treatments was relatively low in the current meta-analysis, 0.60 (one-sided). Consequently, it is not warranted to interpret such findings of no differences between types of treatment, as more studies are needed to substantiate this conclusion.

The limited number of studies also meant that in particular the subgroup and meta-regression analyses were prone to bias from outliers. Measures of RNT in the included studies were exclusively self-report and content-specific, and almost entirely concerning worry. Furthermore, self-report assessments may be more prone to conflate distinct dimensions underlying RNT (Samtani & Moulds, 2017), such as valence and purpose (Segerstrom et al., 2016), which may be associated with differential outcomes. Moreover, the classification of RNT-focused treatments did not distinguish

**TABLE 2** The effects of treatment for anxiety on repetitive negative thinking compared with control groups, post-test, and follow-up: Hedges' *g*

| Variable | Categories | *c* | *g* | 95% CI | $I^2$ | 95% CI | *p*[a] |
|---|---|---|---|---|---|---|---|
| Post-test | | | | | | | |
| Hedges' *g* | | 59 | 0.57 | 51–72 | 64 | 161.36 | |
| One effect size per study (highest *g*) | | 43 | 0.67 | 51–74 | 64 | 121.476 | |
| One effect size per study (lowest *g*) | | 43 | 0.56 | 55–76 | 68 | 131.653 | |
| Specific measures | | | | | | | |
| Worry only | | 52 | 0.57 | 55–75 | 67 | 155.47 | |
| Worry (PSWQ only) | | 49 | 0.57 | 58–76 | 69 | 156.38 | |
| Rumination | | 8 | 0.69 | 0–80 | 61 | 17.98 | |
| Subgroup analyses | | | | | | | |
| Recruitment | Community | 41 | 0.55 | 52–75 | 67 | 120.03 | .620 |
| | Clinical | 9 | 0.68 | 0–75 | 51 | 16.37 | |
| | Combined | 8 | 0.61 | 20–84 | 70 | 23.33 | |
| Format | Individual | 30 | 0.48 | 47–76 | 66 | 84.415 | .083 |
| | Group | 11 | 0.82 | 6–78 | 61 | 25.648 | |
| | Self-help | 18 | 0.56 | 15–73 | 56 | 38.97 | |
| Target group | Adults | 49 | 0.55 | 48–72 | 63 | 129.11 | .473 |
| | Older adults | 10 | 0.71 | 30–83 | 70 | 29.70 | |
| Number sessions | 8− | 21 | 0.42 | 6–69 | 50 | 50.19 | .011 |
| | 8+ | 35 | 0.68 | 49–75 | 66 | 65.94 | |
| Control group | Waiting list | 32 | 0.73 | 53–77 | 69 | 68.65 | <.001 |
| | Other | 21 | 0.24 | 0–41 | 0 | 0.00 | |
| | CAU | 6 | 0.64 | 0–61 | 0 | 0.00 | |
| Class of treatment | >RNT-focused | 24 | 0.69 | 55–80 | 72 | 80.72 | <.01 |
| | Other psychological therapies | 27 | 0.58 | 28–71 | 57 | 60.28 | RNT-focused > Other |
| | Other | 8 | 0.26 | 0–56 | 0.00 | 6.71 | |
| Class of disorder | GAD | 30 | 0.64 | 64–82 | 75 | 117.21 | .107 |
| | High worriers | 16 | 0.57 | 0–60 | 28 | 20.96 | |
| | Other | 13 | 0.40 | 0–61 | 27 | 16.39 | |
| Phase II/III | Phase II | 25 | 0.34 | 33–73 | 60 | 60.088 | <.01 |
| | Phase III | 34 | 0.68 | 38–72 | 60 | 82.561 | |
| Study quality | 1–2 | 43 | 0.57 | 50–74 | 65 | 120.66 | .636 |
| | 3–4 | 16 | 0.57 | 28–77 | 63 | 40.70 | |

c = Number of comparisons.

[a]The p-value in this column indicates whether the effect sizes in the subgroup analysis differed significantly from each other.

between techniques that target the content of worries compared with those that target the process of worry, and it is noted that techniques that target content or process may constitute different mediating mechanisms and outcomes. Publication bias was detected, and thus, caution must be taken when interpreting the size of effect of treatment on RNT after excluding three studies with improbably high effect sizes to reduce this bias. Additionally, the risk of bias in the included RCTs was generally high, with less than a third of studies evaluated as having a low risk of bias. Possible sources of heterogeneity were assessed through subgroup and mega-regression analyses, but in general, heterogeneity remained moderate in subgroups or after accounting for the effects of moderators. Also, long-term effects of treatments on outcomes, which arguably are more clinically relevant, were not assessed. Moreover, we note there is a

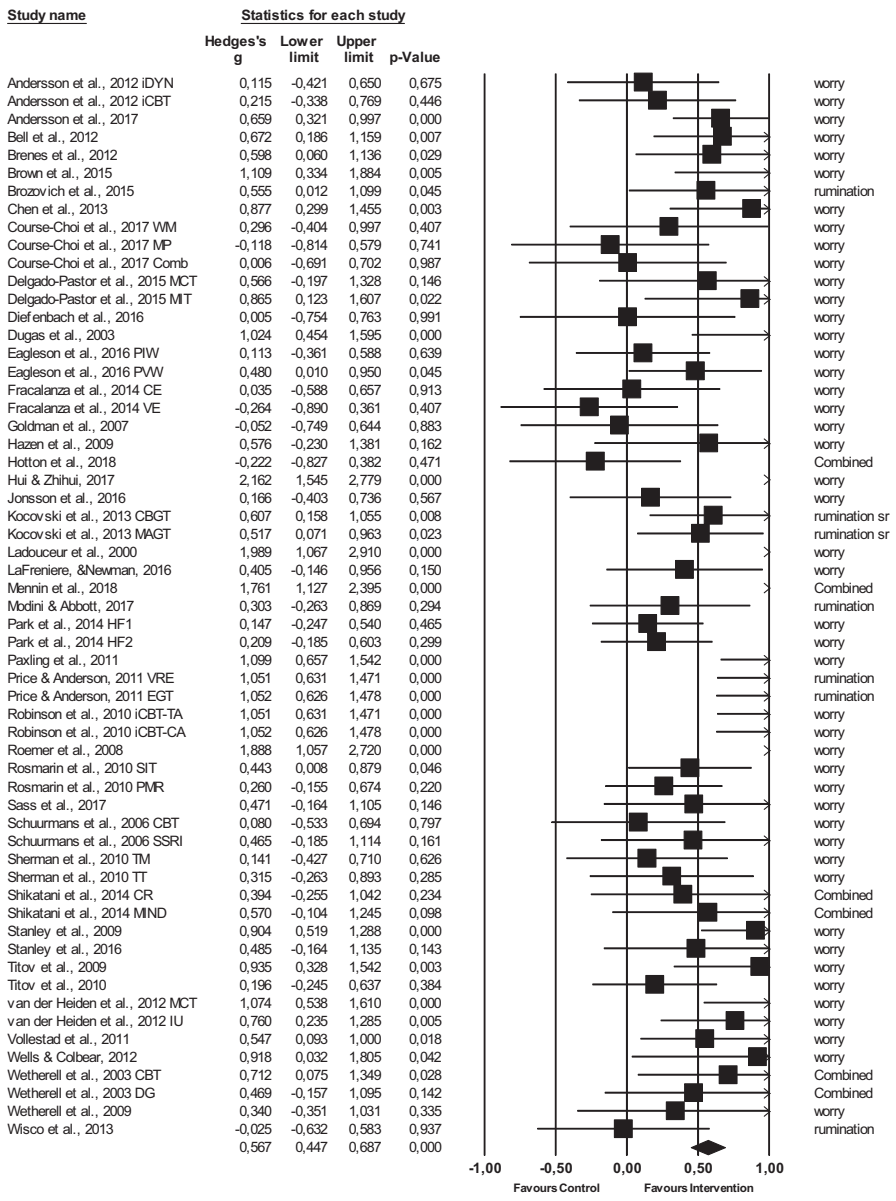


**FIGURE 4** Forest plot of Hedges' *g* effect sizes of active treatment compared with control conditions on RNT at post-test

small chance that some studies were missed from the meta-analysis. As RNT is often not a primary outcome within RCTs of treatment effects, relevant studies that did not adequately describe secondary measures in the abstract could have been overlooked by the literature search or in the initial phase of screening. Additionally, the literature search was limited to four databases (PubMed, EMBASE, PsycINFO, and The Cochrane Library), and, for practical reasons, only studies in English and published in scientific journals were included in the meta-analysis. Finally, the large majority of studies included in the meta-analysis examined the treatment of GAD. Far fewer studies investigated treatments for other anxiety disorders (e.g., SAD, PD, PTSD), and because of this, the generalizability of the current findings to these disorders may be limited.

Future research needs to verify whether the correlational associations found in the current meta-analysis are prospectively supported using high-quality RCTs with multiple assessments appropriate for mediation analyses that can determine temporal precedence. Proposed mediating mechanisms must also be isolated in dismantling studies to determine whether indeed, interventions targeting RNT produce their effect through RNT reduction. If RNT is identified as an essential element in treatment, this can lead to the enhancement of therapeutic interventions for anxiety as well as other psychological problems, such as depression. Research into transdiagnostic approaches is gaining increasing momentum, and recent evidence suggests that transdiagnostic treatments are as effective as disorder-specific approaches (Pearl & Norton, 2017). Thus, efficacy studies of treatments for anxiety should

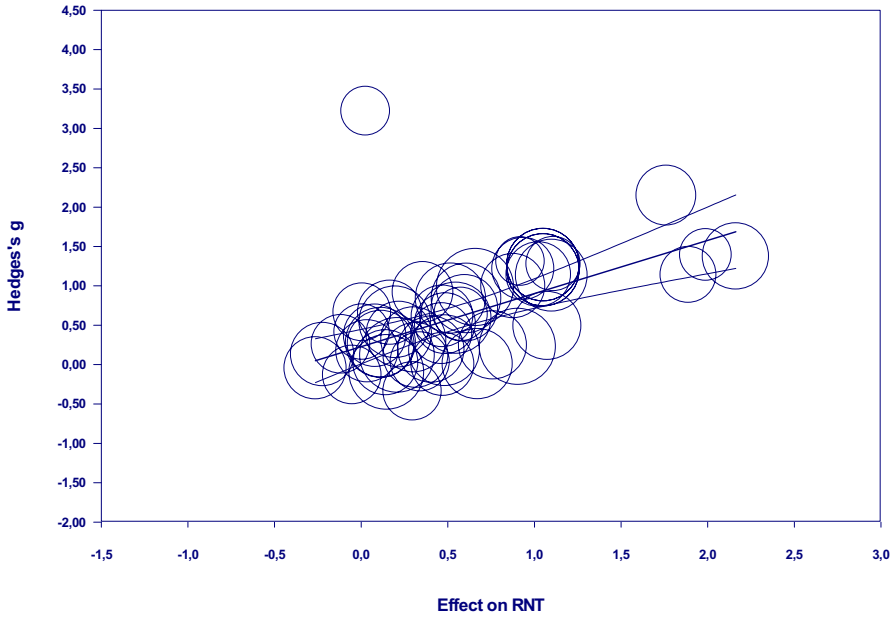


**FIGURE 5** Regression of the association between the effect of treatment on RNT and the effect of treatment on anxiety severity (Hedges' *g*)

incorporate content-independent RNT outcomes so that findings can be interpreted from a transdiagnostic perspective.

This was the first meta-analysis to investigate the differential effects of treatments for anxiety on RNT and the concurrent associations with anxiety outcomes, across a broad array of treatment approaches (RNT-focused and non-RNT-focused as well as nonpsychological treatment approaches) and delivery formats (face-to-face individual and group and technology-assisted treatment) in a diverse population group (students, adults, older adults). The findings from the meta-analyses indicate that psychological treatments have comparable effects on RNT and level of anxiety and show that changes in RNT and anxiety are highly associated across treatments. However, more studies are needed to detect even medium-sized differences in effect between study designs or sample characteristics with enough statistical power. Further, mediation and mechanistic studies to test the possible predictive value of reductions in RNT following RNT-focused psychological treatment for subsequent anxiety outcomes are called for.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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