

A Meta-Analytical Approach of the Relationships Between the Irrationality of Beliefs and the Functionality of Automatic Thoughts

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Abstract Although irrational beliefs (IBs) and automatic thoughts (ATs) have been proposed as mechanisms that contribute to psychopathology in the Cognitive Behavioral Therapy (CBT) model, surprisingly, no previous study systematically evaluated the magnitude and direction of the relationship between the two central constructs. Therefore, the present meta-analysis aimed to evaluate this association, considering its theoretical and clinical importance. We conducted a systematic search of the literature and included 34 experimental and correlational studies suited for the purpose of this meta-analysis, comprising 5086 participants. Results indicated a significant ($p < .001$) medium sized association ($r = .43$) for the relationship between the irrationality of beliefs and the functionality of ATs, higher levels of IBs being associated with more dysfunctional ATs. The magnitude of the relationship does not depend on the specific CBT theoretical model through which the two variables were approached and it is not influenced by the context, nor by the object of the beliefs. However, the content of beliefs appears to impact on this relationship, given that the results revealed a significant ($p < .001$) large effect size ($r = .58$) for the association of ATs with certainty beliefs, but no association was present

for control beliefs. Results also suggest that primary and secondary IBs equally impact on ATs' functionality and should be equally addressed in psychological interventions. Further theoretical and practical implications, and future directions are discussed.

Keywords Beliefs · Automatic thoughts · Dysfunctional · CBT · Meta-analysis

Introduction

Beliefs and Automatic Thoughts in CBT Approaches

One of the important theoretical aspects in CBT theory concerns the relationships between different types of cognitions involved in psychological problems, considering that CBT views client's cognitions as central to the emotional and behavioral problems (e.g., Beck and Dozois 2011). All CBT theories assume that while encountering an undesirable activating event, certain types of beliefs (i.e., rational, adaptive, functional, healthy) lead to functional consequences on cognitive (e.g., automatic thoughts—ATs), behavioral, and emotional levels, while other types of beliefs (i.e., irrational, maladaptive, dysfunctional, unhealthy) lead to dysfunctional consequences on the same variables (e.g., Beck 1976; Beck and Dozois 2011; Dryden and David 2008; Ellis 1962; Lazarus 1994). The functionality of a cognition/behavior/emotion is determined by the degree to which a certain thought/behavior/emotion is helpful (i.e., functional/adaptive) or unhelpful (i.e., dysfunctional/maladaptive) (Bond and Dryden 1997).

Rational Emotive Behavior Therapy (REBT), one of the first forms of CBT, generally focuses on rational (RBs) and irrational beliefs (IBs). Originally, Ellis (1962) delineated

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eleven IBs, but in the more recent developments REBT stresses the existence of four IBs (Ellis 1994): a primary belief—demandingness (DEM) and three secondary IBs—awfulizing (AWF), low frustration tolerance (LFT), and global evaluation of self (SD) and others (OD) (see Appendix). Their corresponding RBs alternatives are: preferences/acceptance (PRE), non-catastrophizing/badness (BAD), frustration tolerance (FT), and unconditional acceptance (UA)/non-global evaluation (non-GE) of self, others and life (see David et al. 2010). Both RBs and IBs can be general or situation-specific evaluations.

Similarly, Cognitive Therapy (CT), another central CBT approach, emphasizes the centrality of dysfunctional intermediary and core beliefs (Beck 2005). Core beliefs are conceptualized as absolute and generalized beliefs related to self, others, the world, and/or future (Beck, 1976, 2011). Intermediate beliefs are conditional rules, attitudes, and assumptions derived from the core beliefs (Beck 2011). These beliefs are seen as dysfunctional if they are inaccurate, unhelpful, judgmental, and/or unrealistic. Beck proposed a series of dysfunctional attitudes and beliefs that constitute a vulnerability for dysfunctional consequences (Beck, 1976, 2011). Additionally, the CT model places a greater emphasis on the role of ATs than the REBT model. Conceptualized as surface-level, non-volitional, stream-of-consciousness cognitions (Beck 1976), ATs can appear in the form of descriptions, inferences, or situation-specific evaluations. ATs were proposed in CBT as proximal causes for emotions (e.g., Beck 1976) and were shown to be related to emotions (e.g., Cristea et al. 2013; Lamberton and Oei 2008; Moldovan et al. 2013), as well as to mediate the relationship between IBs and dysfunctional emotions (e.g., Szentagotai and Freeman 2007; Vîsla et al. 2013). Moreover, dysfunctional ATs were revealed as a mediator of the effects of CBT interventions on dysfunctional emotions (e.g., Moldovan et al. 2013; Normann et al. 2015).

Comparing the two CBT models, it becomes apparent that the concepts of “irrational” and “dysfunctional” beliefs are both implying to some extent logical errors/distortions and are both referring to beliefs that are unhelpful for the individual, and/or lacking empirical support (see Beck and Dozois 2011; Ellis 2003). Oftentimes, the terms “irrational” and “dysfunctional” are used somewhat interchangeably in the literature while referring to beliefs (e.g., Ellis 2003; David et al. 2002; Ellis et al. 2010). In line with this practice, we will use these terms correspondingly in this article, unless otherwise specified.

Considering the detrimental effects that irrational/dysfunctional beliefs and ATs have on the emotional level (see Beck 2005; Browne et al. 2010; David et al. 2010), it is of both theoretical and practical importance to assess the relationship between the irrationality of beliefs and the

functionality of the ATs, and how other variables (e.g., content of IBs) might impact on the magnitude and/or direction of this relationship.

Current Status of the Literature on the Relationship Between Irrationality of Beliefs and Functionality of ATs

Although beliefs are assumed to have an impact on both the emotional and cognitive level, most studies are focused on testing the relationship between beliefs and emotions. The relationship between dysfunctional beliefs and emotions is already quite well established (see Beck 2005; Browne et al. 2010; David et al. 2002; Vîsla et al. 2016), but less is known about the relationship between dysfunctional beliefs and ATs.

Nevertheless, there are also some published experimental and correlational studies available, assessing this relationship. Most of the experimental studies are focused on inferences (e.g., Bond and Dryden 1997; Dryden et al. 1989a, c; McDuff and Dryden 1998), but some focus on combined ATs (i.e. descriptions, inferences, attributions, and evaluations taken together) as well (i.e., Pössel and Knopf 2008) (see Table 1). Studies generally reported significant effects, but it is unclear what the magnitude of these effects is, given that most studies failed to report effect sizes in the original articles and no meta-analytic synthesis is available on this topic.

Some of the correlational studies explicitly aim to test the relationships between beliefs’ irrationality and the functionality of ATs (e.g., Szentagotai and Freeman 2007). In addition, there are a series of studies developed within the CBT framework that report a measure of the relationships between the two variables, although that is not their main focus (e.g., David et al. 2013; Moldovan et al. 2013). Although the correlation coefficients seem to differ in magnitude between studies, variables that could explain the observed variance have not been systematically explored so far.

There is a review published by MacInnes (2004) aiming to (a) assess the causal relationship between irrational beliefs and dysfunctional emotions and inferences, and (b) examine whether demand beliefs are the primary mechanism, as REBT claims. This study took into considerations only studies realized within the REBT paradigm, and concluded that although there is an association between IBs and dysfunctional inferences and emotions, the association is small. According to the author, there is also a small impact of the demand beliefs on the functionality of inferences. Given that this review failed to report an overall measure of these associations, the conclusions of the author are open to debate.

Despite the theoretical and practical importance, up to now no meta-analysis has been published on the

Table 1 Study characteristics and effect sizes (*r*)

Study	<i>N</i>	Mean age	% female participants	Design	Bs scale	ATs Scale	Bs approach	Type of ATs	Effect size (<i>r</i>)
Bond and Dryden (1996a, b) ^a	96	20.26	50	Experimental		Inference Scale	REBT	Inferences	.23
Bond and Dryden (1996a, b) ^b	96	21.3	50	Experimental		Inference Scale	REBT	Inferences	.28*
Bond and Dryden (1997) ^a	96	20.21	50	Experimental		Inference Scale	REBT	Inferences	.35**
Bond and Dryden (1997) ^b	96	20.26	50	Experimental		Inference Scale	REBT	Inferences	.33**
Bond et al. (1999)	48	22.19	50	Experimental		Inference Scale	REBT	Inferences	.65**
Bond and Dryden (2000)	96	21.17	50	Experimental		Inference Scale	REBT	Inferences	.67**
Carvalho and Nobre (2010)	211	35.3	100	Correlational	SDBQ	SMQ-AT	CT	ATs	.24**
Carvalho and Nobre (2011)	205	35.4	0	Correlational	SDBQ	SMQ-AT	CT	ATs	.14*
Chioqueta and Stiles (2007)	102	19.48	0	Correlational	DAS	ATQ-30	CT	ATs	.50**
Chioqueta and Stiles (2004)	344	19.61	0	Correlational	DAS	ATQ-30	CT	ATs	.47**
David et al. (2013)	591	27.17	92	Correlational	GABS-SF	ATQ-30	REBT	ATs	.65**
Dryden et al. (1989a)	96	21	50	Experimental		VAS-DI	REBT	Inferences	.31**
Dryden et al. (1989b)	96		50	Experimental		VAS-DI	REBT	Inferences	.62**
Dryden et al. (1989c)	96	20.5	50	Experimental		VAS-DI	REBT	Inferences	.31**
Furlong and Oei (2002)	30	41.8	30	Correlational	DAS	ATQ-30	CT	ATs	.61**
Hamamci and Büyükoztürk (2004)	80			Correlational	ICDS	ATQ-30	CT & REBT	ATs	.53**
Hollon et al. (1986)	136	35.44	28	Correlational	DAS	ATQ-30	CT	ATs	.53**
Kwon and Oei (1992) ^a	355	21.7	71	Correlational	DAS	ATQ-30	CT	ATs	.53**
Kwon and Oei (1992) ^b	200	21.3	56	Correlational	DAS	ATQ-30	CT	ATs	.46**
McDuff and Dryden (1998)	60	24.7	50	Experimental		Inference Scale	REBT	Inference	.77**
Moldovan et al. (2013)	84	23.04	88	Correlational	DAS; GABS-SF	ATQ-30	CT; REBT	ATs	.55**
Montgomery et al. (2007)	105	22	100	Correlational	ABS-II	VAS-RE	REBT	Inference	.37**
Nobre (2009)	310	29.65	100	Correlational	SDBQ	SMQ-AT	CT	ATs	.19**
Nobre (2010)	352	39.7	0	Correlational	SDBQ	SMQ-AT	CT	ATs	.26**
Ohue et al. (2011)	336		92	Correlational	IBQ	ATQ-R	REBT	ATs	.56**
Pössel and Knopf (2008) ^a	40	30.55	100	Experimental		Interview	CT	ATs	.21**
Pössel and Knopf (2008) ^b	48	25.5	100	Experimental		Interview	CT	ATs	.18*
Silverman and DiGiuseppe (2001)	126		49	Correlational	CASI	CNCEQ	REBT	ATs	.44**
Szentagotai and Freeman (2007)	170	37	68	Correlational	ABS-II	ATQ	REBT	ATs	.29**
Tiba et al. (2012)	27	37	81	Correlational	ABS-SF	ATQ	REBT	ATs	.33
Tiba and Szentagotai (2005)	29			Correlational	SDI	DPI	REBT	Inferences	.53**
Tobacyk and Milford (1982)	92	20.5	48	Correlational	IBQ	UIT	REBT	Inferences	.29**
Višla et al. (2013)	99	20.25	93	Correlational	GABS-SF	SSP-N; VAS-RE	REBT	ATs Inferences	.35**
Wong (2008)	138	24.76	71	Correlational	DAS; IVS	ATQ	CT; REBT	ATs	.45**

SDBQ Sexual Dysfunctional Beliefs Questionnaire, *DAS* Dysfunctional Attitudes Scale, *GABS-SF* General Attitude and Beliefs Scale-Short Form, *ICDS* Interpersonal Cognitive Distortions Scale, *IBQ* Irrational Belief Questionnaire, *CASI* The Child and Adolescent Scale of Irrationality, *ABS-II* Attitude Beliefs Scale-II, *ABS-SF* Attitude Beliefs Scale-Short form, *SDI* State Demandingness Items, *IVS* Irrational Values Scale, *SMQ-AT* Sexual Modes Questionnaire-Automatic Thoughts, *ATQ* Automatic Thoughts Questionnaire, *VAS-DI* Visual Analogue Scale-Dysfunctional Inferences, *VAS-RE* Visual Analogue Scale-Response Expectancy, *Interview* Downward arrow technique/State of Thoughts, *CNCEQ* The children's negative cognitive errors questionnaire, *DPI* Dysfunctional positive inferences, *UIT* Uncritical Inference Test; *SSP-N* Self-Statements During Public Speaking-Negative Self-Statements, *CT* Cognitive Therapy, *REBT* Rational Emotive Behavior Therapy, *AT* Automatic Thoughts

^a Study 1

^b Study 2

* $p < .05$; ** $p < .01$

relationship between beliefs' irrationality and AT's functionality. Therefore, although there are published data in the literature concerning this relationship, it is unclear what the mean magnitude of the effects is and whether or not the effect sizes are consistent across published studies.

Overview of the Present Research

The current study had two main goals. First, it aimed to systematically evaluate the literature on the relationship between the irrationality of beliefs and the functionality of ATs. The present investigation sought to establish the significance as well as the overall magnitude of this relationship. Second, this meta-analysis aimed to investigate potential moderators of the relationship between beliefs' irrationality and the functionality of ATs.

For the second goal, we aimed to analyze potential moderators derived from the common CBT theoretical corpus, and from the specific conceptual differences implied by the two main approaches within CBT theory (i.e., REBT and CT).

Therefore, we tested whether the relationship was moderated by the theoretical perspective in which the beliefs were approached (i.e., REBT beliefs vs. CT beliefs), the context (i.e., academic, social, personal, spider exposure) and the object (i.e., self vs. others) to which the beliefs referred to, the type (i.e., primary, secondary, evaluative) and content/theme (i.e., certainty, control) of the beliefs, the type of ATs assessed (i.e., inferences vs. combined ATs), and/or by the manner in which the two theoretical approaches to beliefs were combined with the type of ATs (i.e., CT beliefs & ATs, REBT beliefs & ATs, REBT beliefs & inferences). Subsequently, other categorical (i.e., type of scale for assessing beliefs and ATs, type of population, gender, reward, design type) and continuous (i.e., sample size, mean age, year of publication, percentage of married people, internal consistency of the measurements) variables that could potentially explain the variance in the magnitude of the effect sizes were also explored.

Results of this meta-analysis may have both theoretical and practical implications. From a theoretical point of view, the results synthesize and add to the basic understanding of the relationships between beliefs' irrationality and the functionality of ATs, by summarizing the existing data and emphasizing potential relevant variables that may impact on these relationships. From a practical point of view, this study may provide important information relevant for both practitioners (e.g., what type of IBs or beliefs' contents (if any) might be more problematic in relation to dysfunctional ATs and needs to be addressed in the interventions first) and further development of CBT interventions.

Methods

Literature Search

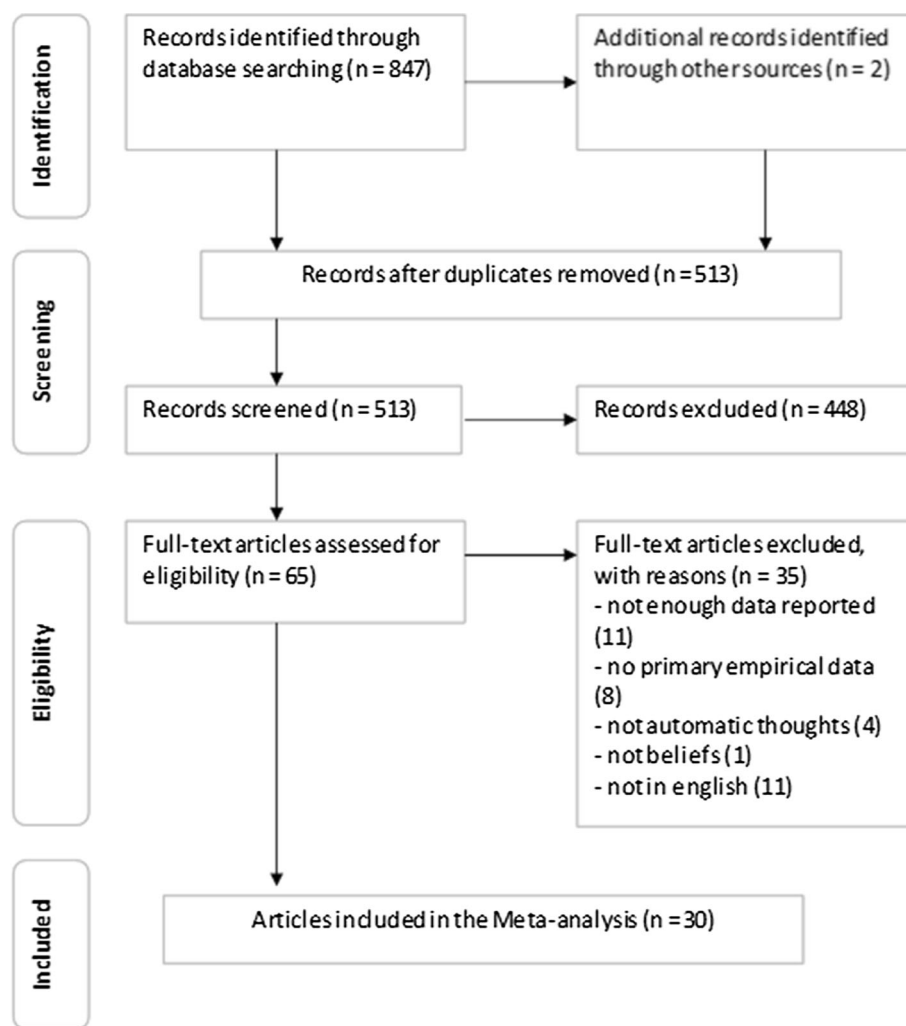
For the present meta-analysis we searched for experimental studies in which beliefs were manipulated to assess the impact on the functionality of ATs, and studies in which both functional/dysfunctional beliefs and ATs were evaluated and a measure of their relationship was provided. Potentially relevant studies were identified through a systematic search of the PsychInfo, PubMed, Scopus and Web of Science databases. The search has been conducted through February 2015, using the following keywords: (belief* AND (inference* OR "automatic thought*")) AND (functional OR dysfunctional OR rational OR irrational). Additionally, we searched for potentially relevant articles within the references of recent articles and reviews relevant for the topic.

Study Selection

A number of 847 records were identified through database search and 2 additional records were identified within the references of the articles (see Fig. 1). After duplicates removal, 513 records were screened for relevance. The remaining 65 potentially relevant articles were further analyzed for relevance based on the full-text. In order to be included in the meta-analysis, studies had to pass the following criteria: (a) assessed both the irrationality of beliefs (as defined in CBT approaches) and the functionality of ATs; *OR* manipulated the irrationality of beliefs and assessed the impact on the ATs; (b) reported original empirical findings; (c) were written in English; (d) provided enough data to calculate the effect sizes; (e) were not case studies. Thirty articles comprising 34 studies conducted on independent samples ($N = 5086$) were included in the meta-analysis.

Twenty two of the included studies were correlational and twelve were experimental. Most of the experimental studies ($n = 10$) were conducted within the REBT approach, and two (i.e., in Pössel and Knopf 2008) used a CT approach. The REBT experimental studies used a role-play paradigm, asking people to imagine themselves on a specific context (e.g., being at a party) while holding certain RBs or IBs. Identical situations and beliefs were presented to participants randomized to the same experimental condition. Only participants scoring above a predetermined threshold (i.e., at least 7 on a scale from 0 to 10) on the manipulation check, enquiring about the extent to which they managed to imagine the prescribed scenario and holding the thoughts they received, were included in the analyses. In the other two experimental studies, participants were first asked to imagine a personal stressful event (i.e., baseline), and in the next

Fig. 1 Flow diagram of the study selection process



phases were required to additionally focus on personalized functional beliefs, ATs or emotions. A within subject design with counterbalanced order of the three conditions between participants was implemented, and no manipulation check was used in the two studies. Most of the studies included in the present meta-analysis ($n = 24$) were conducted on students or samples from the general population. These studies were carried on by research groups from UK ($n = 10$), Romania ($n = 6$) and other European countries ($n = 7$), USA ($n = 7$), Australia ($n = 3$), and Japan ($n = 1$). The list of the instruments used in the included studies to assess beliefs and ATs, as well as other characteristics of these primary studies can be seen in Table 1.

Procedure

For each study the following variables were coded, if available: study identification data (names of the authors, year of publication), mean age of the participants, number of subjects, clinical status (i.e., clinical, nonclinical, mixt), population type (i.e., general, clinical (MDD or

dysthymia), clinical + general, preselected), percentage of married participants per study, country of data collection, design (i.e., correlational, experimental) beliefs approach (i.e., CT, REBT) beliefs type (i.e., primary, secondary, evaluative), contents of beliefs (i.e., certainty, control), object of the beliefs (i.e., self, others), beliefs scale, ATs scale, context (i.e., personal, social, academic, exposure to spiders), internal consistency of the used scales, outcome (i.e., combined ATs, inferences).

Two coders developed a coding schema, which was independently used to systematically capture data for coding the aforementioned variables for each primary study. An inter-rater agreement of 95.11 % was obtained. All disagreements were solved through discussions.

We chose the r correlation coefficient for effect size estimates (Borenstein et al. 2009). According to common conventions, a value between 0.1 and 0.3 indicates a small effect size, a value between 0.3 and 0.5 indicates a medium effect size, and a value of 0.5 or higher indicates a large effect size (Cohen 1988). All effect sizes, but two, were computed based on correlation coefficients and number of

subjects or based on means and SD. The other two effect sizes were computed based on pre-post means, sample size and paired groups *t* value.

For studies reporting multiple outcomes or multiple subgroups, a combined effect size was computed within each study (i.e., across multiple outcomes/subgroups). Thus, each study contributed with a single mean effect size in the overall analyses, in order to avoid overrepresentation of studies reporting multiple analyses and dependence among effects. Given that we were interested in the relationship between irrationality of beliefs and functionality of ATs and most of the experimental studies compared the ATs' functionality in the irrational vs. rational beliefs conditions, we chose to include in this meta-analysis only the comparisons between IBs and RBs. Therefore, we did not include the comparisons between RBs/IBs and indifference, reported by McDuff and Dryden (1998).

For the experimental studies the effect sizes were coded so that a positive value indicates higher levels of dysfunctional ATs in the irrational beliefs condition, while for the correlational studies a positive value indicates a direct association between the irrational beliefs and the dysfunctional ATs.

To compute effect sizes for all studies, we used the random effects model under the assumption that the effect sizes differ in the population. In order to assess whether effect sizes from the studies included in the meta-analysis are heterogeneous, we used the *Q* statistic (i.e., a standardized measure of weighted square deviations) and *I*² statistic (i.e., a proportion of true heterogeneity, from the total observed variance) (Borenstein et al. 2009).

For moderators with more than two categories, we first conducted an omnibus analysis, and further used simple comparison between sub-groups only if omnibus analyses were significant (Borenstein et al. 2009).

To assess for potential publication bias, we visually inspected the symmetry of the data represented in the funnel plot. Additionally, we used Rosenthal's Fail-safe *N* (Rosenthal 1979) to compute the number of non-significant studies that would be required to nullify the effect. We also used the Trim and Fill method (Duval and Tweedie 2000) to estimate the unbiased effect size.

All analyses were conducted using Comprehensive Meta-Analyses 2.2.046 (Borenstein et al. 2005).

Results

Main Effect of B's Irrationality on ATs' Functionality

There was a significant medium overall effect size for the relationship between the irrationality of beliefs and the

functionality of ATs, $r = .428$, 95 % CI [0.364; 0.488], $p < 0.001$. The effect was pooled from 34 studies, with a total of 5086 participants.

Also, there was evidence of heterogeneity in results, $Q(33) = 237.686$, $p < 0.001$; $I^2 = 86.116$, (see Higgins et al. 2003). Given that around 86 % of the observed variance comes from real differences between studies, the between study variability could be explained by study-level variables. Therefore, we tested potential moderators.

Theoretically Derived Moderators

The first variable related to beliefs we took into account was the type of theoretical approach in which the beliefs were conceptualized (i.e., CT vs. REBT). For this analysis we excluded one study (i.e., Hamamci and Büyükoztürk 2004) because the measure used for assessing beliefs was designed by the authors to cover both the REBT and CT approaches to beliefs. Results revealed that although there appears to be a somewhat higher effect size for the REBT approach (i.e., large effect size for REBT, and medium effect size for CT), Bs' theoretical approach did not significantly moderate the relation between Bs' irrationality and the functionality of ATs ($Q_{between} = 1.496$, $p = .221$; see Table 2).

The second tested variable, the context of the beliefs (i.e., academic, personal, social, spider exposure) did not significantly moderate the magnitude of the relationship, although the effect size is high for spider exposure, medium for social and academic contexts, and low for the personal context ($Q_{between} = 1.313$, $p = .726$; see Table 2). In this analysis we only included studies that reported beliefs that specifically made references to a certain context. Studies that reported a general measure of beliefs' irrationality in a certain context (e.g., Montgomery et al. 2007) were not included in this analysis.

For the next three variables we found the necessary data reported only in experimental studies conducted within the REBT approach. The first two of these potential moderators, object of the beliefs (i.e., self vs. others) and type of the beliefs (i.e., primary, secondary, evaluative), did not moderate the relationship between beliefs' irrationality and ATs' functionality ($Q_{between} = 0.194$, $p = .660$; see Table 2). To further explore the type of beliefs as a potential moderator, we tested the differential relationship of specific REBT beliefs or their combination (the categories extracted from the available studies were: DEM + AWF, DEM + SD, DEM + SD/AWF, DEM, SD) with ATs' functionality. The type of specific beliefs' also did not moderate the relationship between the two cognitive variables ($Q_{between} = 9.493$, $p = .174$; see Table 2). Yet, the theme/content of the beliefs (i.e., certainty, control), significantly moderated the effect size of

Table 2 Categorical moderators

Moderator	Categories	<i>k</i>	<i>r</i>	<i>CI</i>	<i>Q_w</i>	<i>p</i>	<i>Q_b</i>	<i>p</i>
Bs' approach	CT	14	.37	[.335; .399]	91.131	0.000	1.496	.221
	REBT	21	.52	[.487; .543]	142.087	0.000		
Context	Academic	3	.49	[.189; .711]	21.767	0.002	1.313	.726
	Personal	1	.23	[−.361; .689]	0.000	0.453		
	Social	5	.48	[.244; .659]	19.482	0.000		
	Spider exposure	1	.62	[.136; .864]	0.000	0.864		
Object of beliefs	Others	3	.43	[.127; .656]	5.764	0.056	0.194	.660
	Self	7	.50	[.326; .635]	43.173	0.000		
Type of beliefs	Evaluative	10	.47	[.329; .594]	49.60	0.00	3.493	.174
	Primary	2	.46	[.088; .724]	0.64	0.42		
	Secondary	1	.78	[.468; .919]	0.00	1.00		
Specific beliefs	DEM + AWF	4	.53	[.330; .682]	27.042	0.000	8.598	.072
	DEM + SD	2	.65	[.376; .818]	7.260	0.007		
	DEM + SD&AWF	4	.30	[.056; .512]	0.671	0.880		
	DEM	2	.46	[.111; .713]	0.643	0.423		
	SD	1	.78	[.494; .913]	0.000	1.000		
Content of beliefs	Certainty	6	.58	[.499; .647]	8.608	0.126	40.992	.000
	Control	4	.05	[−.104; .196]	0.758	0.860		
AT type	Combined ATs	21	.43	[.405; .455]	178.074	0.000	0.242	.623
	Inferences	14	.45	[.397; .491]	60.833	0.000		
Combination beliefs—ATs	CT beliefs—ATs	14	.39	[.294; .476]	91.131	0.000	1.298	.523
	REBT beliefs—ATs	8	.47	[.344; .572]	49.022	0.000		
	REBT beliefs—Is	14	.45	[.348; .533]	60.833	0.000		
Bs Scale	ABS	3	.33	[.180; .458]	5.708	0.000	36.247	.000
	CASI	1	.44	[.222; .616]	5.020	0.000		
	DAS	6	.50	[.431; .571]	18.661	0.000		
	GABS-SF	2	.57	[.454; .658]	18.780	0.000		
	ICDS	1	.53	[.303; .700]	5.179	0.000		
	IBQ	2	.48	[.345; .587]	12.050	0.000		
	SDBQ	4	.21	[.109; .304]	7.024	0.000		
	SDI	1	.53	[.259; .723]	4.125	0.000		
ATs Scale	ATQ	13	.51	[.439; .569]	42.433	0.000	23.828	.000
	Inference Scale	7	.50	[.392; .596]	37.438	0.000		
	Interview	2	.20	[−.015; .390]	0.067	0.796		
	SMQ-AT	4	.21	[.066; .341]	2.200	0.532		
	VAS	4	.42	[.274; .541]	12.473	0.006		
Population	Clinical + general	3	.32	[.148; .478]	15.393	0.000	14.532	.002
	General	4	.19	[.032; .345]	1.123	0.772		
	MDD or Dysthymia	2	.49	[.186; .705]	1.712	0.191		
	Preselected	22	.48	[.420; .537]	94.786	0.000		
Gender	F	5	.24	[.089; .371]	3.536	0.472	12.376	.002
	M	4	.35	[.192; .482]	23.989	0.000		
	Mixed	24	.48	[.421; .535]	106.887	0.000		
Reward	Yes	7	.44	[.289; .577]	73.854	0.000	0.321	.571
	No	11	.39	[.254; .507]	79.561	0.000		

Table 2 continued

Moderator	Categories	<i>k</i>	<i>r</i>	<i>CI</i>	<i>Q_w</i>	<i>p</i>	<i>Q_b</i>	<i>p</i>
Design	Correlational	22	.43	[.348; .502]	158.892	0.000	0.001	.980
	Experimental	12	.43	[.316; .531]	76.335	0.000		

CT Cognitive Therapy, *REBT* Rational Emotive Behavior Therapy, *ATs* Automatic Thoughts, *Bs* Beliefs, *DEM* Demandingness, *AWF* Awfulizing, *SD* Self Downing, *ABS* Attitude Beliefs Scale, *CASI* The Child and Adolescent Scale of Irrationality, *DAS* Dysfunctional Attitudes Scale, *GABS-SF* General Attitude and Beliefs Scale-Short Form, *ICDS* Interpersonal Cognitive Distortions Scale, *IBQ* Irrational Belief Questionnaire, *SDBQ* Sexual Dysfunctional Beliefs Questionnaire, *SDI* State Demandingness Items, *ATQ* Automatic Thoughts Questionnaire, *Interview* Downward arrow technique/State of Thoughts, *SMQ-AT* Sexual Modes Questionnaire-Automatic Thoughts, *VAS* Visual Analogue Scale, *MDD* Major Depression Disorder, *F* Female, *M* Male, *I* Inference

the relationship between B's irrationality and ATs' functionality ($Q_{between} = 40.992$, $p < .001$; see Table 2).

We further tested whether the type of ATs assessed (i.e., combined ATs vs. inferences) moderated the effect size of the relationship. No moderation effect was found ($Q_{between} = 0.242$; $p = .623$; see Table 2).

The combination between the approach to beliefs (CT vs. REBT) and the type of ATs (i.e. general ATs vs. inferences) was also analyzed as a potential moderator. The way in which the modalities of the two variables were combined did not moderate the effect size ($Q_{between} = 1.298$, $p = .523$; see Table 2). The study of Hamamci and Büyükoztürk (2004) was excluded for reporting a mixed measure for beliefs (i.e., combined CT & REBT beliefs).

The last two theoretically derived moderators were the type of measurements used for beliefs and ATs. Both variables significantly moderated the effect size of the relationship between beliefs' irrationality and the functionality of ATs.

For the type of scale used for assessing dysfunctional beliefs, only correlational studies were included, given that in all the experimental studies beliefs' irrationality was the independent variable. Two by two comparisons revealed that studies measuring dysfunctional beliefs with SDBQ reported significantly smaller effect sizes than studies measuring beliefs with GABS-SF ($Q_{between} = 12.911$; $p < .001$), SDI ($Q_{between} = 6.556$; $p = .010$), ICDS ($Q_{between} = 10.099$; $p = .001$), IBQ ($Q_{between} = 10.619$; $p = .001$), and CASI ($Q_{between} = 6.753$; $p = .009$). Similarly, results indicated smaller effect sizes for studies assessing dysfunctional beliefs with ABS, as compared with studies using ICDS ($Q_{between} = 4.017$; $p = .045$), and DAS ($Q_{between} = 10.953$; $p = .001$). In other words, the association between the irrationality of beliefs and the functionality of ATs was smaller in studies reporting SDBQ and ABS as instruments for assessing beliefs than in studies reporting the other aforementioned measurements for beliefs. No other significant difference was found.

The instrument used for assessing ATs significantly moderated the effect size ($Q_{between} = 23.828$, $p < 0.001$;

see Table 2). Results of the two by two comparisons showed differences between studies evaluating ATs with SMQ-AT and some form of interview, and studies measuring ATs with others instruments. In the studies assessing ATs with SMQ-AT the effect sizes obtained were smaller than those obtained in studies assessing ATs with Inference Scale ($Q_b = 8.465$; $p = .004$), single items scales (i.e., VAS) ($Q_b = 7.524$; $p = .006$), and ATQ ($Q_b = 25.997$; $p = .000$). In studies that evaluated ATs using Interview procedure, effect sizes were also smaller than in studies evaluating ATs with ATQ ($Q_b = 12.428$; $p = .000$). Therefore, there was a less powerful relationship between beliefs' irrationality and ATs' functionality in studies assessing ATs with an interview procedure and SMQ-AT relative to studies using the measurements specified above.

Procedure Related Moderators

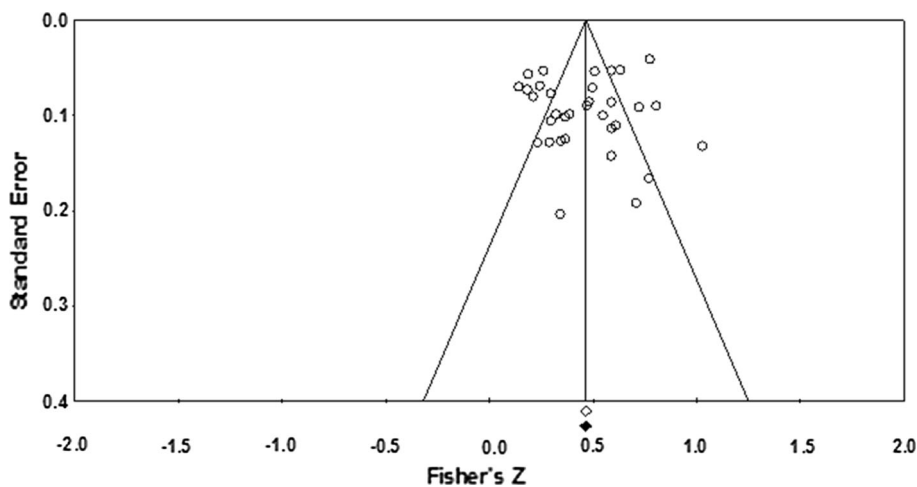
From the procedure related moderators, only population (i.e., general, clinical, clinical + general, preselected) and gender of the sample (i.e., female, male, mixed) (see Table 2) significantly moderated the effect size of the relationship between the irrationality of beliefs and the functionality of ATs.

The two by two comparisons between the modalities of the population variable revealed a significant difference only between general ($r = .194$; CI [0.034, 0.343]) and preselected ($r = .481$; CI [0.421, 0.536]) populations ($Q_b = 12.973$, $p < .001$), and between general population samples ($r = .193$; CI [0.124; 0.261]) and populations with major depression disorder or dysthymia (MDD) ($r = .491$; CI [0.257; 0.670]) ($Q_b = 5.559$; $p = .018$), higher effect sizes for the association between beliefs and ATs being reported on preselected and MDD & dysthymia samples.

Given that the omnibus moderation analysis for gender revealed a significant result ($Q_{between} = 12.376$, $p = .002$), two by two comparisons were also conducted between the modalities of this variable. Result showed significantly higher effect sizes for mixed samples ($r = .480$; CI [0.442; 0.535]), as compared to female samples ($r = .235$; CI [0.092; 0.368]) ($Q_b = 11.482$; $p = .001$). No other

Table 3 Continuous moderators

Variables	<i>k</i>	<i>B</i>	<i>z</i>	<i>Q_{Model}</i>	<i>P</i>	<i>Q_{Residual}</i>	<i>P</i>
α Cronbach for beliefs	6	−0.318	−0.547	0.300	.584	4.264	.371
α Cronbach for ATs	13	−1.038	−1.314	1.726	.189	14.097	.228
Sample size	34	0.000	0.550	0.303	.582	31.709	.481
Mean age	29	−0.006	−1.053	1.109	.292	25.622	.540
% married subjects	9	−0.006	−2.297	5.275	.022	9.241	.236
Publication year	34	−0.003	−0.682	0.465	.495	27.614	.688

Fig. 2 Funnel Plot

differences between the categories of this variable were statistically significant.

The regression coefficient for the proportion of married people included in the sample indicates that every increase with one unit of married people corresponds to a decrease of 0.006 units in effect size (see Table 3).

The effect size of the relationship was not moderated by reward (i.e., received reward vs. no reward for participation) (see Table 2), internal consistency of the scales used for assessing beliefs and ATs, sample size, mean age of the sample, or publication year (see Table 3).

Publication Bias

In order to investigate the presence of publication bias a Funnel Plot was generated (see Fig. 2), and Rosenthal's Fail-safe *N* (Rosenthal 1979) and Trim and Fill method (Duval and Tweedie 2000) were computed using a random effects model.

For the overall analysis of the meta-analysis, we obtained a Fail-safe *N* = 8420. Therefore, it would be needed to locate and include 8420 studies (i.e., 247.6 studies for each observed study) with no effect (i.e., “null” studies) for the effect to be nullified (i.e., $p > .050$). The computed value of Fail-safe *N* is greater than the critical Fail-safe *N* value for this meta-analysis ($5 \times 34 + 10 = 180$). Trim and Fill method estimated no

study with effects lower or higher than the mean that could modify the results for the combined studies. Trim and Fill imputed point estimate and 95 % confidence interval are identical to those already reported ($r = .428$; *CI* [0.364; 0.488]).

Conclusions

This meta-analysis examined the mean magnitude of the relationship between irrationality of beliefs and functionality of ATs, and tested theoretical derived moderators, as well as explored additional potential moderators of this relationship.

The results of this study confirmed the CBT hypothesis concerning the relationship between IBs and ATs, revealing a medium to high effect size that somewhat contradict the conclusions of MacInnes (2004) who claimed that the association between IBs and dysfunctional inferences is small. Therefore, as expected, higher levels of Bs' irrationality are associated with increased levels of dysfunctional ATs. These findings have important implications, considering the relationships that both IBs and ATs have been hypothesized and found to have with distress and negative dysfunctional emotions (see Beck 2005; Browne et al. 2010; David et al. 2010). However, the interrelationships between these two constructs in generating

distress are still less clear in the literature and need to be approached. Szentagotai and Freeman (2007) showed that both IBs and ATs predict distress and that ATs partially mediate the relationship between IBs and distress. Other studies (Kwon and Oei 1992; Vîsla et al. 2013) reported similar results, showing that ATs mediated the effects of dysfunctional beliefs on depressive symptoms. Yet, future studies are needed to examine the stability of these results and explore the causal sequence between dysfunctional beliefs, ATs and emotions/behaviors.

It should be noted that IBs and ATs are somewhat overlapping concepts in the literature. IBs can be viewed both as core beliefs (e.g., evaluative beliefs about self) or ATs, while ATs can comprise both evaluations and inferences/descriptions. An investigation of the affirmations used to assess/manipulate each of the two variables reveals that there is a superposition between some of the contents used to operationalize ATs and IBs. Thus, the relationship between IBs and ATs, as well as the associations that each variable was found to have with emotional distress in primary studies could be influenced by the shared contents of the two variable. Making a distinction between evaluative cognitions and descriptions/inferences could contribute to a more clear definition that could facilitate the exploration of the relationships between the cognitive concepts. In this context, of interest is one moderation analysis from this meta-analysis that revealed no differences in the magnitude of the relationship between IBs and ATs while comparing studies that evaluated combined ATs (i.e., that also comprise situation-specific evaluations) with studies that focused on inferences exclusively (i.e., not contaminated by evaluative contents). This analysis is of importance for this discussion given that all studies that evaluated inferences exclusively, also manipulated/assessed only evaluative beliefs (i.e., with no inferential contents), clearly separating the two concepts. Thus, the results of the present meta-analysis are unlikely to be explained by these conceptual confusions, since studies that clearly separate the two variables reveal the same effect size as those somewhat overlapping the two concepts. Nevertheless, this overlap still needs further attention and the results and conclusions of this meta-analysis need to be analyzed with caution.

Considering that the two major theoretical CBT approaches (i.e., CT vs. REBT) emphasize somewhat different cognitive distortions at the beliefs level, we tested whether there is a difference in the magnitude of the relationships depending on the theoretical perspective in which the beliefs were approached. No significant difference was found, although point estimates appear to indicate a medium mean effect size for CT and a large effect size for REBT. This result could be explained by the similarities shared by the conceptualizations of beliefs in the two theoretical approaches. As other authors previously noted (e.g., Wong 2008), both

REBT's beliefs and CT's intermediate beliefs are conditional beliefs, sharing a similar "if—then" structure. Moreover, the measures of beliefs developed in REBT and CT approaches are tapping item contents that share certain similarities (e.g., some cognitive distortions proposed in CT and some REBT IBs are equally absolutistic or all-or-nothing thoughts). Indeed, in line with these observations, different published studies revealed a positive significant relationship between different measures of REBT beliefs and CT intermediate beliefs or dysfunctional attitudes (e.g., Moldovan et al. 2013; Wong 2008). It has been argued (Wong 2008) that given the similarities and high correlations between the two constructs, these constructs may be measuring the same latent variable. Considering this perspective and the supposition of Ellis that REBT's IBs and CT's main categories of dysfunctional beliefs all seem to include explicit or implicit DEM (see Ellis 2003), it could be hypothesized that absolutistic "musts" and demands could be the underlying shared factor. However, future studies are needed to test these hypotheses.

The relationship between irrationality of beliefs and functionality of ATs was not moderated by the context nor by the object of the beliefs. These results suggest that this relationship has the same magnitude when beliefs refer to different context, and irrespective of whether beliefs refer to self or others.

Results showed no difference between primary, secondary and evaluative (primary + secondary) beliefs. Therefore, secondary beliefs alone (i.e. not in combination with DEM) are equally related to the functionality of ATs, compared to other types of beliefs (primary and primary + secondary). These results confirm common therapeutic practice in which secondary beliefs are also targeted in the interventions to promote healthier inferences. In line with these findings, it has been previously proposed in the literature that this might be the case when the secondary beliefs are functionally autonomous from DEM and/or are very vivid clinically (DiGiuseppe et al. 2013). Given that the results of these moderation analyses from our meta-analysis are mainly based on role-play experiments, it is unclear whether this autonomy could occur in ecological settings or is an artificially experimentally induced separation. As in the role-play studies the level of irrationality prior to experimental manipulation was not assessed, it is not clear if the level of irrationality on both primary and secondary beliefs were equal between groups after the gender matched randomization. Therefore, a possible interaction between prior beliefs and manipulated beliefs could not be assessed. Moreover, the results should be interpreted with caution, given that there was only one study assessing the relationship between secondary beliefs and ATs, and two studies in the "primary beliefs" modality. Future studies are needed for firmer conclusions.

Our results suggest an interaction effect between the dysfunctionality of beliefs and the type of theme (i.e., contents) in affecting ATs. These results are in line with the CBT assumptions, as both CT (e.g., Beck 1976; Barlow 1988) and REBT, in its more recent developments (see David 2015), stress the importance of belief contents. The certainty theme at the levels of beliefs appears to be more closely related to the functionality of ATs than the control theme. In fact, according to the results of this meta-analysis, there is no relationship between beliefs' irrationality and ATs' functionality when beliefs refer to control. These findings are somewhat in contrast with the results from the animal-learning and human-subjects experiments that showed that control has a greater impact on anxiety/fear, behavior and negative emotions in comparison with certainty (e.g., Geer and Maisel 1972; Maier and Warren 1988; Mineka et al. 1984). The somewhat contradictory findings could be explained by the fact that the aforementioned studies focused on controllability/certainty of the situation while the studies included in our analysis examined the controllability/certainty expressed in beliefs' contents (see Bond and Dryden 1996a, b for a more detailed discussion).

Like in the case of beliefs' approach, nor the type of ATs, neither the combination between beliefs' theoretical approach and type of ATs significantly moderated the relationship between the irrationality of beliefs and the functionality of ATs. Once again, these results could be explained by the similarities shared by CT and REBT concerning the conceptualization and assessment of beliefs' and ATs/inferences.

Although results showed differences in the magnitude of the relationship between the irrationality of beliefs and the functionality of ATs based on the type of assessment tool that was used for assessing the two variables, it is unlikely for the differences to reflect different patterns between the two theoretical approaches. Differences in the magnitude of the effect sizes are revealed between assessment tools developed in different approaches (i.e., REBT vs. CT), as well as within the same theoretical approach (e.g., REBT).

According to CBT approaches, irrational beliefs are vulnerability factors that generate dysfunctional consequences only activated by stressful life events (e.g., Dryden and David 2008). Therefore, one can hold IBs without experiencing maladaptive consequences. In most of the correlational studies included in this meta-analysis it is unclear whether the relationship between B's irrationality and the functionality of ATs is assessed in the presence of specific stressful activating events. Thus, we were unable to test the presence of a negative event as a moderator. Therefore future studies are needed in order to further establish whether the magnitude and/or significance of the relationship differs depending on the presence/absence of activators.

This study shares the limits of any quantitative meta-analysis. Some limitations of this study are derived from the characteristics of the included studies. Most studies failed to report some important aspects for assessing the internal validity (e.g., internal consistency of the scales for the study sample). Moreover, as noted before, most of the experimental studies included in this meta-analysis are using a role-play paradigm. It is unclear whether their results are generalizable to real life situation. Additionally, all of the role-play experiments are conducted by the same research group (i.e., Bond & Dryden). Replications of their findings by different research groups and in more ecological designs are needed.

Although some moderation analysis showed significant differences between different modalities within the moderators, the results must be interpreted with caution. Given that the studies included in moderation analysis were not a priori randomized to the moderators' modalities (i.e., the differences between subgroups are observational) and studies differed in other respects than the one captured by subgroup membership, a causal interpretation might be challenged even for moderators tested exclusively on experimental data. Even if it is possible that the differences are due to the moderator's modality, it is also possible that the studies included in a certain modality systematically differ in some other ways from other studies. Also, there might be some other confounders for which we did not find enough reported data (e.g., internal validity of the primary studies).

Specific to this meta-analysis, an additional limit is the small number of studies per subgroup in some of the moderation analysis conducted. This raises the questions of statistical power and stability of the results. Therefore, for some analysis, the failure to find a significant difference when comparing subgroups (e.g. type of beliefs) could reflect either a nonexistent or small effect, or a poor statistical power to detect relevant effects. On the other hand, some significant differences (e.g. beliefs Scale) are based on a reduced number of studies per subgroups and the results must be interpreted with cautious. Additional studies are needed for more firm conclusions concerning these differences.

It is worth nothing that most studies are related to anxiety and depression. Studies relating irrationality/dysfunctionality of beliefs with the functionality of the ATs in the context of other psychological problems need to be conducted in order to generalize the results of this meta-analysis.

It should also be noted that the studies published on this topic and included in this meta-analysis are mainly focused on evaluating dysfunctional ATs. Even some experimental studies comparing the impact of RBs versus IBs on the functionality of ATs (e.g., Bond and Dryden 1996a, b)

assessed the dependent variable using items phrased exclusively in the dysfunctional (but not functional) form. Therefore, as previous authors noted (Dryden and David 2008), it is unknown whether RBs lead to functional ATs or just to less dysfunctional ATs. Future studies are needed to address this question.

Given the post hoc nature of some of the moderation analysis we conducted, our findings are probably not definitive, but these results suggest future directions for additional research.

In summary, the dysfunctionality of beliefs was significantly associated with the functionality of ATs, with a medium effect size. The findings of the present meta-analysis also suggest that the magnitude of this relationship does not depend on the theoretical perspective (i.e., CT, REBT) on which the two variables are approached. As for the theme/content of beliefs, based on a somewhat limited number of studies reporting necessary data, we conclude that IBs with a “certainty” theme are more closely related to dysfunctional ATs than “control” related IBs, while the type of beliefs (i.e., primary, secondary, evaluative) does not impact on this relationship. From a theoretical point of view, this meta-analysis is of importance, given that it is the first study to systematically review and summarize the available published data on the relationship between two central concepts from the CBT theory, as well as to assess variables that could influence this relationship. From a clinical perspective, the results of this meta-analysis suggest that both primary and secondary IBs should be addressed in interventions, and that IBs related to certainty

might be more problematic than control related beliefs. Future studies are still needed to further clarify how the magnitude of the relationships between different types of beliefs and the functionality of ATs could impact on the emotional level. Finally, it is worth noting that addressing some important limitations (e.g., aforementioned conceptual confusions, methodological limitations) of the literature synthesized here concerning the two variables might be a necessary first step, in order to increase both the internal and external validity of future studies approaching these relationships.

Compliance with Ethical Standards

Conflict of Interest Radu Șoflău and Daniel David declare that they have no conflict of interest.

Informed Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (national and institutional). Informed consent was obtained from all individual participants included in the study.

Animal Rights No animal studies were carried out by the authors for this article.

Appendix

See Table 4.

Table 4 Glossary of terms

Terms	Definitions	Examples
ATs' functionality ^a	The degree to which a certain automatic thought is helpful/adaptive (i.e., functional) or unhelpful/maladaptive (i.e., dysfunctional)	
Rationality of belief ^b	Is determined by the extent to which a belief is logical, helpful, and/or consistent with one's goals or with reality (i.e., rational/irrational)	
Demandingness (DEM) ^c	An irrational belief that refers to absolutistic requirements/demands expressed in terms of “must”, “should”, “ought”, and “have to”	“Life should always be fair”
Awfulizing (AWF) ^c	An irrational belief that refers to evaluating an event as being the worst case scenario (i.e., a catastrophe)	“It's awful to be criticized”
Global evaluation ^c	Global negative ratings (i.e., labels) of oneself (i.e., self downing; SD), others (i.e., other downing; OD), and/or the world	“I am worthless”
Low frustration tolerance ^c	Represents the belief that certain circumstances are unbearable/cannot be tolerated	“I cannot bear to lose someone dear”
Descriptions ^d	Cognitive structures that merely present (i.e., representations of) an observed fact	“He didn't answer the phone”
Inferences ^e	Interpretations about activating events (A)/representations of A that go beyond the available data	“He does not want to be my friend anymore”
Evaluations ^{d, f}	Cognitions that refer to how the cognitive representations of reality are appraised in terms of personal significance	“It would be awful to lose him”
Combined ATs		Automatic Thoughts Questionnaire (ATQ—Hollon and Kendall 1980)

Table 4 continued

Terms	Definitions	Examples
	An expression used in this paper to refer to assessment tools for ATs that comprise descriptions, inferences, as well as evaluations within the same measurement;	
Primary beliefs ^c	Segments of the rational or irrational beliefs that convey the preference/acceptance (i.e., primary rational beliefs; PRE) or the demand (i.e., primary irrational beliefs; DEM)	PRE: “I would prefer to be respected” DEM: “I must be respected”
Secondary beliefs ^d	Beliefs that are derived from the primary beliefs, whose functionality/rationality depend on the rationality of the primary beliefs. Thus, holding rational primary beliefs (PRE) will result in rational secondary beliefs (i.e., BAD, non-GE, and/or FT), while maintaining irrational primary beliefs (DEM) is associated with irrational secondary beliefs (i.e., AWF, GE, and/or LFT)	
Evaluative beliefs ^e	Type of beliefs that contain both primary and secondary beliefs (e.g., DEM and LFT)	“I must be respected and it would be unbearable not to be treated with respect”
Certainty beliefs ^a	Type of beliefs that have contents pertaining to certainty themes	“I must be absolutely certain of others’ opinions of me”
Controllability beliefs ^a	Type of beliefs that have contents related to the theme of control	“I must control what other people think of me”

Letters are used to indicate papers in which the terms are defined

^a Bond and Dryden (1997)

^b Beck and Dozois (2011), Ellis (2003), Still (2010)

^c Ellis (1994)

^d Vřsla et al.(2015)

^e Bond et al. (1999)

^f Lazarus (1994)

^g Ellis (1977)

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