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Review

The emotion regulation process in somatic symptom disorders and related conditions - A systematic narrative review

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ABSTRACT

Somatic symptom disorders and related conditions (SSD-RC), along with depression and anxiety disorders, are among the most common mental disorders. Disturbances in emotion regulation (ER) are considered a key factor in the etiology and pathogenesis of SSD-RC. The present review aims to summarize relevant research on ER in SSD-RC and integrate results in the extended process model of ER. We conducted a systematic literature search in PubMed, PsycInfo, Psyndex, and Web of Science. After screening and systematic quality appraisal, 105 (n = 29332 participants) out of 2118 identified studies were included. Correlations with somatic symptoms in general and clinical populations as well as group comparisons with non-SSD-RC groups were included to summarize effects. We found evidence for deficits in the identification process of ER, especially reduced emotional clarity and ER self-efficacy, in patients with SSD-RC. SSD-RC were also significantly associated with a deviant pattern of habitual strategies (selection process) including a more frequent use of expressive suppression and a less frequent use of cognitive reappraisal. However, for both the identification and selection stages, there were many studies that did not find evidence for alterations in SSD-RC. Furthermore, self-report data suggests impairments in implementing ER. Experimental studies are scarce and have not found conclusive evidence for ER implementation deficits in SSD-RC. In addition to experimental studies, particularly ecological momentary assessments are needed to better understand potential alterations regarding ER in SSD-RC. Clinical interventions that target the identification of the need for ER, self-efficacy, and the repertoire of different strategies currently appear most promising.

1. Introduction

Persistent bodily symptoms are very common in the general population. In a representative study, over 81% of the general population reported at least one symptom with at least mild impairment during the last seven days and 22% even reported severe impairment caused by at least one unexplained symptom (Hiller, Rief, & Brähler, 2006). Research on this topic is challenging due to a great heterogeneity of symptoms and a substantial overlap between medical and psychological research areas. However, persistent bodily symptom experiences often cannot be explained by a monocausal underlying medical condition and frequently involve substantial psychological strain (e.g., high levels of negative affect) that might lead to mental disorders such as somatic symptom disorder (Van den Bergh, Witthöft, Petersen, & Brown, 2017). According to the DSM-5 (American Psychiatric Associaton, 2013), somatic symptom disorders (SSD) are characterized by at least one persistent bodily symptom and associated psychological impairment at an affective, cognitive, or behavioral level. SSD and related conditions (SSD-RC), such as health anxiety disorders, functional neurological disorders (formerly conversion disorder) and functional somatic syndromes (irritable bowel syndrome, psychogenic non-epileptic seizures, fibromyalgia etc.) share common features of bodily symptoms associated with pronounced distress and relevant impairment. There is an ongoing debate related to challenges in classifying SSD-RC. Besides the view that these diagnoses are distinct, other researchers argue that commonalities are greater than differences (e.g., Fink & Schröder, 2010; Petersen et al.,

Abbreviations: CFS, chronic fatigue syndrome; EPM, extended process model of emotion regulation; FNS, functional neurological disorders; FGID, functional gastrointestinal disorders; IBS, irritable bowel syndrome; ER, emotion regulation; PNES, psychogenic non-epileptic seizures; SSD, somatic symptom disorder; SSD-RC, somatic symptom disorders and related conditions.

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2020; Wessely, Nimnuan, & Sharpe, 1999).

As we know from extensive research in the last decades, emotion regulation (ER) represents an important transdiagnostic process in psychopathology: Deficits in regulating emotions are incorporated in numerous models of mental disorders and many important reviews and theoretical approaches focus on relationships between ER and psychopathology (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Hu et al., 2014; Sheppes, Suri, & Gross, 2015). Early theories as well as research on somatic symptoms and alexithymia (Kooiman, 1998; Kooiman, Bolk, Brand, Trijsburg, & Rooijmans, 2000; Mattila et al., 2008; Sifneos, 1973) or negative affect (Houtveen & van Doornen, 2007; van Diest et al., 2005; Watson & Pennebaker, 1989) suggest possible ER deficits in patients with SSD-RC. Although a large variety of mental disorders, ranging from depression over eating disorders to personality disorders is considered in emotion regulation research, SSD-RC appeared to be a blind spot in most important reviews for a long time.

Over the last years, two comprehensive reviews were published focusing on the role of emotion regulation in chronic pain and SSD-RC. Koechlin, Coakley, Schechter, Werner, and Kossowsky (2018) referred to the original process model of emotion regulation (Gross, 1998a) to identify patterns of ER strategies in patients with chronic pain. Central results indicate that response-focused ER strategies are more strongly associated with chronic pain than antecedent-focused strategies. Studies investigating ER in patients with other persistent bodily symptoms, SSD, and related conditions were not included in this review. Okur Güney, Sattel, Witthöft, and Henningsen (2019) conducted a review based on Koole's (2009) classification of ER to integrate studies with a broad range of SSD-RC. The authors found disturbances in ER regarding cognitive, bodily, and attentional components in these conditions.

Both reviews made an important contribution to the understanding of ER in SSD-RC. However, Okur Güney et al. (2019) focused on categorical (but not process-oriented) aspects of ER and Koechlin et al. (2018) followed Gross's original process model, which exclusively refers to ER strategies. The extended process model of ER (Sheppes et al., 2015) allows a more detailed view of the dynamic sequential regulatory process and includes several stages of ER and therefore offers a detailed differentiation of alterations in ER that might be characteristic of patients with SSD-RC. A deeper understanding of ER processes – in terms of differentiating emotional problems and potential corresponding failure points and relating them to different stages in the emotion generation and regulation process (Sheppes et al., 2015) – in SSD-RC is needed to improve therapeutic interventions adapted for these patients. The present review therefore aims to address these issues.

1.1. Emotion regulation processes

The process model of ER (Gross, 1998a) arguably represents the most influential model of emotion regulation. It postulates chronologically distinct strategies to regulate emotions. The original process model of ER suggests five sets of strategies, which take place at different points in the emotional process: *situation selection, situation modification, attentional deployment, cognitive change,* and *response modulation*. Gross (1998a) classifies the first four sets as antecedent-focused strategies, meaning they take place before the emotion is fully developed, while *response modulation* represents a set of response-focused strategies, which result in adjusting the emotional response – such as suppressing one's anger in public.

In the last decade, topics such as ER choice and flexibility, emotional goals, or contextual demands of ER have emerged within ER research. To meet these challenges, Sheppes et al. (2015) postulated the extended process model of emotion regulation (EPM) including three stages of ER. Thereby they offered explanations to how ER is initiated, how specific strategies are selected and implemented, and at what point the process of ER people fail when they do not succeed adaptive ER (McRae & Gross, 2020; Sheppes et al., 2015). These stages are *identification*, *selection,* and *implementation* and display the process of ER.

ER starts with an *identification* process. The emotional state is perceived. At this point (perception step), skills such as emotional awareness and clarity might be required. Then an evaluation takes place whether the emotion is sufficiently pronounced to be regulated and, based on prior experiences, whether regulation provides benefits, which might depend on self-efficacy beliefs about ER (valuation step). A positive evaluation results in activating the goal to regulate the emotion (action step). The activation of the ER goal provokes the *selection* stage in the process of ER. Available strategies are represented (perception) and evaluated regarding the available resources, the quality and quantity of the emotion, as well as costs and benefits of specific strategies. The activation of the selected general strategy leads to the *implementation* stage. In turn, successfully implementing the ER strategy influences the emotion itself (Gross, 2015; Sheppes et al., 2015).

Sheppes et al. (2015) describe different points of failure where deficits in ER can emerge. ER can be impaired in the *identification* stage (e.g., when emotional states are misrepresented or self-efficacy expectations about ER are low) which may result in not starting ER although it would be necessary. Deficits in the *selection* stage (e.g., underrepresentation of available strategies, overvaluation of maladaptive strategies) could result in choosing nonfunctional or non-promising strategies. Failures in the *implementation* stage (e.g., misrepresenting or misevaluating specific regulatory tactics, deficits in the applications) may lead to the experience that ER is not effective.

1.2. The present study

The present review aims to answer the following questions: (1) Are SSD-RC significantly associated with altered processes regarding the identification of emotions and the need and utility of ER?; (2) Are SSD-RC significantly associated with altered selection processes regarding ER strategies?; (3) Are SSD-RC significantly associated with altered implementation processes regarding the efficacy of ER?

To this end, we reviewed the existing literature on ER processes in SSD-RC, and assigned different scales of self-report questionnaires and experimental instructions to the three stages of the EPM.

2. Scope and methods of the review

The present literature review was carried out in alignment with the PRISMA guidelines for systematic reviews (Page et al., 2021) (see Supplements 1).

In order to ensure a comprehensive review, we included studies investigating bodily distress symptoms in the general population, SSD, health anxiety and former somatoform disorders (DSM IV) in clinical populations which would now result in the DSM-5 diagnosis of SSD and related disorders and studies investigating related functional syndromes (such as irritable bowel, fibromyalgia, psychogenic non-epileptic seizures, functional neurological disorders, chronic fatigue). Chronic pain and somatic complaints with a clear underlying medical condition (e.g., cancer) were excluded to prevent an expanded heterogeneous scope, although the new DSM-5 diagnosis SSD would cover many of these cases. For studies targeting ER in chronic pain see Koechlin et al. (2018).

Our definition of ER followed the EPM (Sheppes et al., 2015) including constructs such as emotional awareness and clarity, beliefs about emotions and ER (identification), the use of specific ER strategies (selection), and the effective implementation of ER. Following also Gross (1998b), we delimited ER from other related constructs such as general coping, mood regulation, global emotional intelligence, and unconscious defense mechanisms. Although theoretical considerations following the EPM (Sheppes et al., 2015) include alexithymia in the identification stage, we disregarded studies investigating alexithymia exclusively, because of the already existing number of reviews summarizing these findings (Aaron, Fisher, de La Vega, Lumley, & Palermo, 2019; De Gucht & Heiser, 2003; Di Tella & Castelli, 2016; Hadji-Michael, McAllister, Reilly, Heyman, & Bennett, 2019; Martino et al., 2020).

2.1. Literature search and inclusion criteria

The literature search was conducted using several databases including PsycInfo, Psyndex, Web of Science, and PubMed. The first systematic search with the final search string was conducted in August 2020. A second search took place at the end of November 2020 and was updated again in January 2022. Terms with different variations and truncations indicating ER and psychopathology were combined to search terms (full search terms see Supplements 2) in German and English. We searched for these terms in title, abstract, and MeSH terms or subject terms. Next to that, we screened reference lists for relevant studies. After removing duplicates, we identified $N = 2118$ studies and screened titles for relevant content. In a second and third step, abstracts and full texts were screened for inclusion criteria. Studies were examined for relevance, sample characteristics and ER measures meeting our definition of ER to evaluate eligibility. In case of uncertainty in the inclusion process, the studies were additionally evaluated by the third author and disagreement was discussed. For the selection process see Fig. 1.

We included studies which were (a) published in English or German until January 2022 (b) with a target sample of adults (c) either from the general population where bodily distress symptoms were inquired about, or patients with SSD-RC following the DSM-5. We included studies only if (d) empirical data (self-report questionnaires or experimental data) regarding psychopathology and ER were reported (correlations, mean differences, or experimental manipulation of ER), regardless of whether these analyses were the central target of this study.

We excluded brain-imaging studies, because they focused predominantly on the localization of emotional processes and therefore did not contribute significantly to answering our research question. We also excluded studies concerning acute pain, chronic somatic pain, body dysmorphic disorder, and studies concerning other diagnoses as the primary object of investigation. Furthermore, case studies, theoretical frameworks, study protocols, dissertations, master's or bachelor's theses, and conference posters were excluded. Reviews were excluded but screened for relevant primary literature.

The present review was not pre-registered. A formal protocol was not made publicly available before conducting the review.

2.2. Data collection and synthesis of findings

Based on these criteria, studies were reviewed for measures of ER (questionnaire scales and subscales, experimental instructions), which were categorized into the theoretical framework of the EPM (Sheppes et al., 2015). The taxonomy in Table 1 shows the results of a post-hoc classification to the three stages of emotion regulation following the EPM.

Scales measuring the ability to identify emotions, such as awareness and clarity of emotions, were subsumed under the identification stage. According to papers from Gross and colleagues (McRae & Gross, 2020; Sheppes et al., 2015), dysfunctional beliefs of emotions influence the

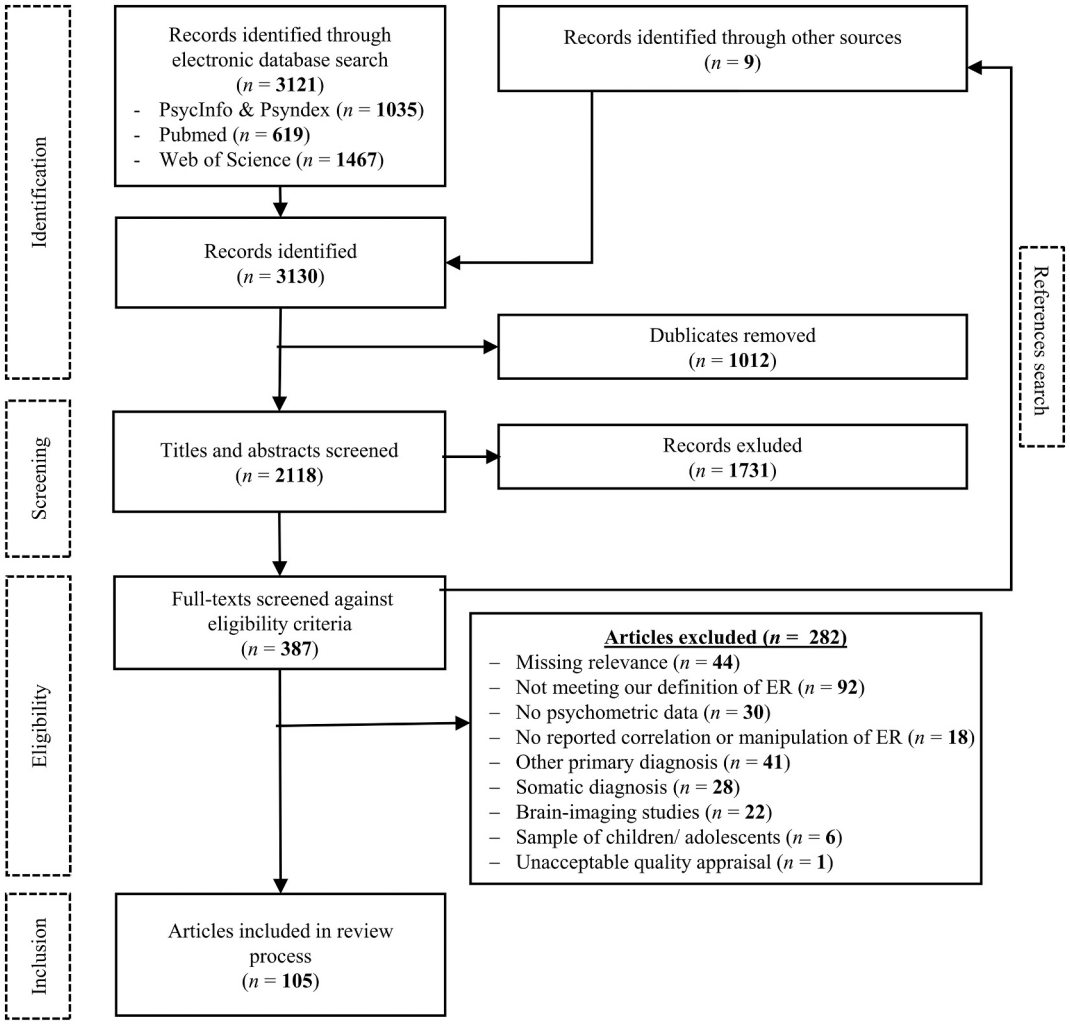

Fig. 1. Flowchart of the selection process.

Table 1
Taxonomy.

Regulatory Stages	Self-report Scales or Manipulation
Identification	Emotional awareness (DERS, EAQ, ERSQ, EPS-25, MZQ)/ attention (TMMS)
	Sensation (ERSQ) and perception (TEIQue)
	Emotional clarity (DERS, ERSQ, TMMS)
	Understanding (ECQ, ERSQ) and differentiating (OPD-SQ)
	Emotional processing (EACS)
	Beliefs about emotions (ACQ, BAEQ, BES)/ regulation expectancies (NMRS)
	Limited Access to ER strategies (DERS)
Selection	Attention Deployment
	Distraction (COPE, DTS, ERP-R, ERSQ-2, RSQ)
	Rumination (ECQ-2, ERP-R, RSQ)
	Cognitive Change
	Reappraisal (CERQ, COPE, ERP-R, ERQ)
	Acceptance (COPE, ERSQ) / non-acceptance of emotional Responses (DERS)
	Response Modulation
	Suppression (AES, ASQ, CECS, EAQ, ECQ-2, EPS-25, ERP-R, ERQ, MAI, SECS, STAXI-2)
	Expression (AES, BEQ, EACS, EEQ, ERP-R, MAI, SECS, STAXI-2)
Implementation	ER Efficacy (experimental tasks)
	Reappraisal
	Distraction
	Self-Support
	Emotion labeling
	Attention deployment (emotional Stroop task, emotional dot-probe task)
	Acceptance
	ER Self-Evaluation (self-reports)
	Readiness to confront (ERSQ)
	Emotion repair (TMMS)
	Difficulties in engaging goal-directed behavior (DERS)
	Impulse control difficulties (DERS)
	Unregulated/ unprocessed emotions (EPS-25; OPD-SQ; TEIQue)
	Modification (ERSQ)
	Adjusting (ASQ)
	Amplification and reduction (TEARS)
	Repair (TMMS)
	Tolerance (ASQ; ERSQ; OPD-SQ)

Notes. ACQ = Anxiety Control Questionnaire (Rapee, Craske, Brown, & Barlow, 1996); AES = Anger Expression Scale (Spielberg et al., 1985); ASQ = Affective Style Questionnaire (Hofmann & Kashdan, 2010), BAEQ = Beliefs about Emotions Questionnaire (Manser, Cooper, & Trefusis, 2012), BEQ = Berkeley Expressivity Questionnaire (Gross & John, 1995); BES = Beliefs about Emotions Scale (Rimes & Chalder, 2010), CATS = Comprehensive Affect-Testing System (Froming, Levy, & Ekman, 2004); CECS = Courtauld Emotional Control Scale (M. Watson & Greer, 1983), CERQ = Cognitive Emotion Regulation Questionnaire (Garnefski & Kraaij, 2007), COPE = Cope Scales (Carver, Scheier, & Weintraub, 1989); DERS = Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004), DTS = Distress Tolerance Scale (Corstorphine, Mountford, Tomlinson, Waller, & Meyer, 2007); EAQ = Emotional Awareness Questionnaire (Rieffe, Oosterveld, Miers, Meerum Terwogt, & Ly, 2008); ECQ = Emotional Competence Questionnaire (Rindermann, 2009), ECQ-2 = Emotion Control Questionnaire (Roger & Najarian, 1989); EEQ = Emotional Expressiveness Questionnaire (King & Emmons, 1990); ERSQ = Emotion Regulation Skills Questionnaire (Berking & Znoj, 2008); ERSQ-2 = Emotion Regulation Strategy Questionnaire (Lee & Kwon, 2007); EACS = Emotional Approach Coping Scale (Stanton, Kirk, Cameron, & Danoff-Burg, 2000); ERP-R = the emotion regulation profile-revised (Nelis, Quoidbach, Hansenne, & Mikolajczak, 2011); ERQ = Emotion Regulation Questionnaire (Gross & John, 2003), MAI = Multidimensional Anger Inventory (Siegel, 1986); MZQ = Mentalization Questionnaire (Hausberg et al., 2012); NMRS = Generalized Expectancies for Negative Mood Regulation (Catanzaro & Mearns, 1990); OPD-SQ = Operationalized Psychodynamic Diagnosis–Structure Questionnaire (Ehrenthal et al., 2012); RSQ = Response Style Questionnaire (Nolen-Hoeksema & Morrow, 1991), SECS = Self-Expression and Control Scale (van Elderen, Maes, Komproe, & van der Kamp, 1997); STAXI-2 = State-Trait Anger Expression Inventory-2 (Spielberger, 1999); TEARS = The Emotion Amplification and Reduction Scales (Hamilton et al., 2009), TEIQue = Trait Emotional Intelligence Questionnaire (Chirumbolo, Picconi, Morelli, & Petrides, 2018); TMMS = Trait-Meta-Mood Scale (Saloveym, Mayer, Goldman, Turvey, & Palfai, 1995).

initiation of ER as part of the identification valuation circle. Therefore, questionnaires and scales measuring beliefs about emotions were categorized into the identification stage. The DERS Subscale "Limited access to strategies" (Gratz & Roemer, 2004) was also assigned to this stage as its items mainly ask for beliefs about one's regulation skills ("I believe there is nothing I can do to make myself feel better."). Since the identification stage comprises a general decision whether to regulate (Sheppes et al., 2015), individuals might decide against initiating the regulation process at this point if they believe they have only fewer and poor ER strategies.

Akin to Cronbach's (1960) distinction between typical and maximum performance, McRae (2013) underlines the importance of distinguishing between emotion regulation frequency, which is often measured with self-report questionnaires, and ER success, which is usually measured with experimental manipulation. Following McRae and Gross (2020), strategies measured with questionnaires (frequency), for example, reappraisal ("When I want to feel less negative emotion, I change the way I'm thinking about the situation"), were categorized into the selection stage, whereas experimental data (success), in which tasks capture how well, for example, reappraisal works, were categorized into the implementation stage. Exceptions were made for questionnaire subscales asking for the ability to influence emotions in general (e.g., "I am able to let go off my feelings", ASQ-adjusting; Hofmann & Kashdan, 2010) or subscales measuring behavior which indicate a lack of successful ER (e.g., "When, I'm upset, I have difficulties getting work done" DERS- Difficulty engaging goal-directed behavior, "When I'm upset, I lose control over my behavior" DERS Impulse control difficulties; Gratz and Roemer, 2004). These subscales were also categorized into the implementation stage.

Global sum scores or subscales not distinguishing between different facets of ER (DERS sum score, ERSQ sum score) which do not allow specific categorization of ER processes were summarized separately (see Supplement 5).

The relevant data were extracted with respect to which analyses could most specifically answer the review's research questions. The strength of the effects was given as Cohen's *d*, correlation coefficient *r* or eta squared and presented as small, medium or large in the tabular presentation of results (see Table 2) according to the usual conventions (Cohen, 1988). In case of non-reported effect sizes, these were calculated by the authors if sufficient data were provided. In case of missing data, the corresponding authors of the respective studies were contacted. In addition to the effect sizes regarding the relevant ER constructs, we collected variables such as sample size, type of sample, study characteristics, method of analysis, name of the questionnaires used or experimental paradigms.

2.3. Quality appraisal

Relevant studies were then subjected to a quality appraisal following the formal criteria of Brown and Reuber (2016) including modifications from Okur Güney et al. (2019) and own supplements. The following features were rated: (1) sample size adequacy (following Cohen's considerations of effect size and power criteria (Cohen, 1988): very small <15 participants, small 16–25 participants, moderate 26–63 participants, large ≥64 participants, per group), (2) use of standardized ER measures (yes/no), (3) experimental methods (yes/no), (4) the use of established diagnostic criteria (yes/no/not applicable), (5) type of comparison groups (healthy controls, other controls, not applicable), (6) demographic matching or non-significant post-hoc analysis differences between groups regarding age, gender and education (yes/no/not applicable), (7) availability of sufficiently reported inclusion and exclusion criteria (yes/no), (8) the application of inferential statistics (yes/no). A total quality score defined as the proportion of criteria items

Table 2
Study Characteristics and Results.

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
Akbari, Spada, Nikčević, & Zamani 2(021)	health anxiety symptoms	$N = 541$ family members of COVID-19 patients	self-report	correlations	SHAI	ERQ		↓ reappraisal ↑↑ suppression	
Bacon, White, & Norman (2021)	fibromyalgia	$N = 390$ patients $N = 151$ persons without fibromyalgia, IBS, CFS	self-report	rmANOVA		CERQ	*Note:* three measure points	↓/○/○ reappraisal ○/↑/↑ acceptance ○/↑/↑ rumination	
Badenes, Prado-Gascó, & Barrón (2016)	somatic symptoms	$N = 479$ persons from general population	self-report	regression (age, gender, mood, personality)	SCL	EAQ	↓ awareness differentiating ↓ emotions analyzing own ○ emotions	↓ expression (not hiding emotions)	
Bailer, Witthöft, Erkic, & Mier (2017)	health anxiety	$N = 19$ patients with health anxiety $N = 33$ patients with depression $N = 52$ healthy controls	self-report	ANOVA (additional correlation & regression in the total sample)	SHAI SOMS SAIB	RSQ-D		↑↑↑ symptom-related rumination ○ self-related rumination ↓↓↓ distraction *Note*: Compared to depressive patients, patients with hypo-chondriasis reported less rumination.	
Bardeen & Fergus (2014)	health anxiety symptoms	$N = 482$ persons from general population	self-report	correlations hierarchical regression analyses with all ER variables and negative affect	WI	DERS ERQ	**zero- order corr.:** ○ awareness ↓ clarity limited ER ↑↑ strategies **regression:** ○ awareness ○ clarity limited ER ↑ strategies	**zero- order correlations:** ↑↑ non-acceptance ↓ reappraisal ↑ suppression **regression:** ○ non-acceptance ↓ reappraisal ↑ suppression	**ER self-evaluation:** **zero- order correlations:** ↑↑ impulse control difficulties ↑↑ difficulties in goal-directed behavior **regression:** ○ impulse control difficulties ○ difficulties in goal-directed behavior
Beath, McDonald, Osborn, & Jones (2019)	Somatic (gastro-intestinal) symptoms	$N = 276$ persons from general population (female)	self-report	correlations	GSRS	ERQ RRS		○ reappraisal ↑ suppression ↑/↑↑ rumination	
Berens et al. (2021)	IBS	$N = 127$ patients $N = 127$ healthy controls	self-report	MANOVA		OPD-SQ MZQ	↓ awareness ↓↓ differentiation		**ER self-evaluation:** ↓↓↓ tolerance ↓↓ regulation
Bowers and Wroe (2016)	IBS	$N = 87$ patients $N = 37$ healthy controls	self-report	*t*-tests		BES CECS	↑↑ dysfunctional beliefs about emotions	○ suppression	
Bowers, Wroe, & Pincus (2017)	fibromyalgia	$N = 174$ female patients	self-report	mediation model correlations	FIQr PHQ-15	BES CECS TEIQue	dysfunctional beliefs about emotions lead to higher use of emotional suppression, which in turn leads to affective distress which then result in higher impact of fibromyalgia ↓↓		**ER self-evaluation:**
Brambila-Tapia et al. (2021)	somatic symptoms	$N = 164$ persons from general population	self-report				emotion perception		emotion ○ regulation

(*continued on next page*)

Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results				
					Psycho-pathology	ER	Identification		Selection		Implementation
Brooks, Chalder, & Rimes (2017)	CFS	$N = 67$ patients $N = 73$ healthy controls	self-report	*t*-tests		BES	↑	dysfunctional beliefs about emotions			
Brown et al. (2013)	PNES	$N = 43$ PNES patients $N = 24$ epilepsy patients	self-report	Mann–Whitney *U* tests		DERS	○ ○ ○	awareness clarity limited ER strategies	○	non-acceptance	**ER self-evaluation** ↑ impulse control difficulties ↑ difficulties in goal-directed behavior
		$N = 58$ students		correlation							**ER efficacy (behavioral)** ER ("control and relax"-instruction)
Camodeca and Nava (2020)	somatic symptoms		experi-mental		SCL-90-R	ER task					○
Canlı and Karaşar (2020)	health anxiety symptoms	$N = 874$ persons from general population	self-report	correlations	SHAI	ERQ			↓ ○	reappraisal suppression	
	fibromyalgia	$N = 15$ patients		ANOVA							**ER efficacy (behavioral)**
Cardoso et al. (2021)		$N = 15$ healthy controls	experi-mental			emotional dot probe task					attention ○ deployment
Catanzaro and Greenwood (1994)	somatic symptoms	$N = 222$ students	self-report	correlation	HDL- somatic scale	NMR Scale	↓↓	negative mood regulation expectancies			
Chutko et al. (2020)	SSD	$N = 46$ patients $N = 30$ healthy controls	self-report	*t*-tests		CERQ			↓↓↓ ↓↓↓ ↑↑↑	reappraisal acceptance rumination	
	IBS	$N = 29$ patients		ANOVA							**ER efficacy (behavioral)**
Constantinou et al. (2015)		$N = 26$ healthy controls	experi-mental			affect labeling task					**emotion labeling vs. non-emotional labeling vs. merely viewing instructions** → neither of the strategies reduced symptoms or arousal *Note:* no group-task-interaction reported
Davoodi et al. (2019)	SSD	$N = 30$ patients with SSD $N = 29$ patients with depression	self-report	MANOVA		CERQ			↑↑ ○ ○ *Note*: compared to depressive patients	reappraisal acceptance rumination	
Del Río-Casanova et al. (2018)	conversion disorder	$N = 43$ patients $N = 42$ healthy controls	self-report	*t*-tests		DERS	↓ ↓ *Note:* no data for effect sizes calculation available	awareness clarity	↑	non-acceptance	**ER self-evaluation** impulse control ↑ difficulties difficulties in goal-directed ↑ behavior
Duschek et al. (2014)	fibromyalgia somatic symptoms	$N = 27$ female patients $N = 34$ female healthy controls	experi-mental self-report	MANOVA correlations	PHQ-15	emotional Stroop task DERS					**ER efficacy (behavioral)** attention ↓↓ deployment **ER self-evaluation**

(*continued on next page*)

Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results			
					Psycho-pathology	ER	Identification	Selection		Implementation
Dworsky et al. (2016)		$N = 307$ persons from general population (with spiritual struggle)					↑↑ limited ER strategies			↑ impulse control difficulties ↑ difficulties in goal-directed behavior
		$N = 64$ high symptom reporters	experi-mental	rmANOVA	PHQ-15 SOMS-7	ER task	○			**ER efficacy (behavioral)** ↓↓↓ suppression *Note:* high symptom reporters showed stronger emotions when suppressing (=less effective), but lower emotions when instructed not to regulate
Eger Aydogmus and Hamilton (2019)	somatic symptoms	$N = 81$ low symptom reporters (psychology students)					emotional awareness			
Elhamiasl, Dehghani, Heidari, & Khatibi (2020)	health anxiety	$N = 30$ patients $N = 30$ healthy controls	self-report	MANOVA (additional correlations in the total sample)	SHAI WI	CERQ ERQ		↓/↓↓ ○ ↑↑ ↑↑↑	reappraisal suppression acceptance rumination	
	SSD	$N = 35$ patients		MANOVA (additional correlations in the total sample)	PHQ-15 SOMS-7	ERQ		↓↓↓ ○	reappraisal suppression	
Erkic et al. (2018)		$N = 35$ healthy controls	self-report							
)Fedorenko, Kibbey, Contrada, & Farris (2021)	health anxiety symptoms	$N = 608$ students $N = 231$ patients	self-report	correlations correlations	SHAI FIQR	DERS total score CERQ	general difficulties in ER (↑↑)	↓ ↑ ↑↑	reappraisal acceptance rumination	
Feliu-Soler et al. (2017)	fibromyalgia		self-report							
Fergus & Valentiner (2010)	health anxiety symptoms	$N = 503$ students	self-report	correlations (additional regressions)	IAS WI	ERQ		○ ↑	reappraisal suppression	
	SSD	$N = 149$ patients with SSD		correlations	GBB	VCQ-36	general ER skills (↓)			
Forstmeier and Rüddel (2008)		$N = 565$ patients with depression	self-report	*t*-tests			*Note:* correlated with physical symptoms in the total sample			
		$N = 1018$ total sample of psychosomatic inpatients					general ER skills (○) *Note:* compared to depressive patients			
Garnefski, van Rood, de Roos, & Kraaij (2017)	somatic symptoms	$N = 465$ persons from general population	self-report	hierarchical regression (age, gender, life & traumatic events)	SCL-90	CERQ		○ ○ ↑	reappraisal acceptance rumination	
Gärtner, Behnke, Conrad, Kolassa, & Rojas (2019)	somatic symptoms	$N = 102$ persons from general population	self-report	correlations	PHQ-15	ERQ RSQ COPE		○ ↑ ↑↑ ↓	reappraisal suppression rumination acceptance	
Geenen, van Ooijen-van der Linden, Lumley, Bijlsma, & van Middendorp (2012)[1]	fibromyalgia	$N = 403$ female patients	self-report	hierarchical regression (age, education, emotion processing)	FIQ	ERQ EACS		○ ↓	reappraisal emotional expression	
Gerolimatos & Edelstein (2012a, 2012b)	health anxiety symptoms	$N = 86$ elderly $N = 117$ young persons from general population	self-report	correlations	SHAI (SF-12)	ERQ ACQ	↓↓ perceived anxiety control	↓ ○	reappraisal suppression	

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Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
								Note: Splitting the sample (2012b), this effect was only found in younger adults.	
Görgen et al. (2014) - Study 1	health anxiety symptoms	*N* = 172 persons from general population	self-report	structural equation modeling	MIHT	ERQ CERQ		○ - ↑↑ reappraisal ↑ - ↑↑ rumination ○ acceptance ↓↓ - ↑ suppression*	
							Note: Ranges of effect sizes are displayed because four different health anxiety dimensions were measured. Positive corr. wWere found for both maladaptive AND adaptive strategies, but were less and weaker for adaptive strategies. *suppression was associated with lower values of the behavioral and higher values of the cognitive dimension		
Görgen et al. (2014) - Study 2	health anxiety symptoms	*N* = 242 persons from general population	self-report	structural equation modeling (controlling for depressive-ness)	MIHT	ERQ CERQ		○ - ↑ reappraisal ○ - ↑↑ rumination ↓↓ -↑ suppression*	
							Note: Ranges of effect sizes are displayed because four different healthy anxiety dimensions were measured. *suppression was associated with lower values of the behavioral and higher values of the cognitive dimension		
Görgen, Loch, Hiller, & Witthöft (2015)	SSD	*N* = 21 patients with SSD *N* = 57 patients with depression *N* = 26 patients with anxiety control sample from Loch et al. (2011): *N* = 414 general population	self-report	MANCOVA		CERQ		↓ acceptance ↓↓ reappraisal ○ rumination *Note:* results for MANCOVA, clinical groups did not differ significantly from each other	
Gross and John (1995)	somatic symptoms	*N* = 1392 persons from general population	self-report	correlations	self-created items	BEQ		↑ expression	
Gul and Ahmad (2014)	PNES	*N* = 72 patients *N* = 72 healthy controls	self-report	*t*-tests		ERQ		↓↓↓ reappraisal ↑↑↑ suppression	
Gürdal, Sevi Tok, & Sorias (2018)	SSD	*N* = 72 patients with SSD *N* = 78 patients with depression *N* = 74 patients with anxiety disorder *N* = 61 healthy control group	self-report	ANOVA		DERS CERQ	○ awareness ↓↓↓ clarity ↑↑↑ limited ER strategies	↑↑↑ non-acceptance ○ acceptance ↓↓↓ reappraisal ○ rumination	**ER self-evaluation** ↑↑↑ impulse control difficulties ↑↑↑ difficulties in goal-directed behavior
							Note: results show differences between all four groups, no post-hoc differences between SSD and other clinical groups		
Hamamura and Mearns (2019)	somatic symptoms	*N* = 334 college students	self-report	correlations	HSCL	NMR Scale	↓↓ negative mood regulation expectancies *Note:* splitting the sample by gender, this effect was found only in women		
Hambrook et al. (2011)	CFS	*N* = 45 patients with CFS *N* = 40 patients with anorexia *N* = 48 healthy controls	self-report	ANOVA		BES DTS	○ dysfunctional beliefs about emotions *Note:* anorexia > CFS = healthy controls	○ distraction *Note:* anorexia = CFS = healthy controls	
	fibromyalgia	*N* = 35 female patients	self-report	correlations	FHAQ	TEARS			**ER self-evaluation**

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Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
Hamilton et al. (2012)					MPQ-S				○ amplify emotions ○ reduce emotions
				correlations	SHAI	DERS			**ER self-evaluation**
							↑ awareness	↑↑ non-acceptance	difficulties in goal-directed
Hong, Zhu, & Yu (2022)	health anxiety symptoms		self-report				↓↓ clarity		↑↑ behavior
		$N = 1546$ persons from general population					limited ER		impulse control
							↑↑ strategies		↑↑ difficulties
Huang et al. (2021)	SSD	$N = 104$ patients with SSD		ANOVA					**ER efficacy (behavioral)**
									Women
						Emotional Stroop Task			attention
		$N = 100$ healthy controls	experimental						↓ deployment
									Men
									attention
									○ deployment
Ifeagwazi, Nwokpoku, Chukwuorji, Eze, & Abiama (2020)						ERQ		↑ reappraisal	
	somatic symptoms	$N = 209$ prison inmates	self-report					○ suppression	
								Note:	
					SCL-90 somati-zation subscale			reappraisal for participants >30	
								↑↑ years	
				hierarchical regression (age, mindfulness, length of stay in prison)				reappraisal for participants <30	
								○ years	
		$N = 104$ students		correlations		ERQ		○ reappraisal	
Jasper and Witthöft (2013)	health anxiety symptoms		self-report (experim.)			CERQ		○ acceptance	
								○ suppression	
								↑ rumination	
			Note: exp. measures of implicit health anxiety (AMP), self-reports for ER	hierarchical regression (positive and negative affect, health anxiety)	Affective misattri-bution task (AMP)			*Note:* bivariate correlations between AMP and rumination were small, hierarchical regression coefficients small to medium	
	SSD	$N = 32$ patients		*t*-tests		CERQ		○ reappraisal	
Ji et al. (2021)			self-reports					○ acceptance	
		$N = 29$ healthy controls						○ rumination	
Jungilligens et al. (2021)	PNES	$N = 20$ patients				ERQ		○ reappraisal	
		$N = 20$ healthy controls	self-reports	*t*-tests				○ suppression	
Jungilligens et al. (2019)	PNES	$N = 20$ patients				ERQ		↓ reappraisal	
		$N = 20$ healthy controls	self-reports	Mann–Whitney *U* test				○ suppression	
			self-report	correlations	SHAI	CERQ		↓ adaptive strategies	
Jungmann and Witthöft (2020)	health anxiety symptoms	$N = 1615$ persons from general population						maladaptive ↑↑ strategies	
Kalibatseva and Leong (2018)	somatic symptoms	$N = 519$ college students	self-report	correlations	PHQ-15	ERQ		○ reappraisal	
								○ suppression	
	FNS			*t*-tests		DERS			**ER self-evaluation**
		$N = 41$ patients with FNS	self-report				○ awareness	↑↑ non-acceptance	difficulties in goal-directed
Karatzias et al. (2017)	(fibro-myalgia, PNES, functional movement disorder)	$N = 41$ patients with organic neurological disorders					↓↓↓ clarity		○ behavior
							limited ER		impulse control
							↑↑ strategies		↑↑ difficulties

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Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
Kidd and Sheffield (2005)	somatic symptoms	$N = 191$ persons from general population	self-report	correlations	GHQ-28	STAXI-2		↑ suppression of anger ○ expression of anger	
Kienle et al. (2018)	FNS	$N = 19$ patients $N = 19$ healthy controls	self-report	Mann–Whitney *U* tests		ERQ		↓↓↓ reappraisal ○ suppression	
Kim (2020)	somatic symptoms	$N = 318$ persons from general population	self-report	correlations	SCL-90	ERSQ-2		↑↑ maladaptive strategies ↓↓ distraction	
Kirsch, Mearns, & Catanzaro (1990)	somatic symptoms	$N = 472$ students	self-report	correlations	HDL- somatic scale	NMR Scale	↓ negative mood regulation expectancies		
Kleinstäuber et al. (2018)[2]	SSD	$N = 48$ patients $N = 48$ healthy controls	experi-mental	hierarchical linear modeling		ER tasks		no significant group differences in preference of regulation strategies	**ER efficacy (behavioral)** Both groups showed small effects in reappraisal, acceptance & distraction. No direct group comparison reported. Follow-up questions: Patients reported higher distress and lower compliance during ER task compared to controls
Koh and Park (2008)	SSD	$N = 47$ patients with SSD $N = 73$ patients with depression	self-report	*t*-tests regression (age, gender, marital status)	SSRS	AES		**group differences (SSD compared to depression)** ○ internalization of anger ↓↓ externalization of anger **regression on somatic symptoms in SSD group** ○ internalization of anger externalization of ○ anger	
Kornadt et al. (2009)	health anxiety symptoms	$N = 27$ elevated healthy anxiety $N = 29$ elevated depression $N = 28$ healthy controls	experi-mental	ANOVA		emotional Stroop task			**ER efficacy (behavioral)** attention ↓↓ deployment *Note:* group difference disappeared during high working memory load
Kramska et al. (2020)	PNES	$N = 64$ patients $N = 64$ healthy controls	self-report	*t*-tests		DERS ASQ	○ awareness ↓↓ clarity limited ER ↑↑ strategies	↑↑ suppression ↑↑ non-acceptance	**ER self-evaluation** ○ tolerance ○ adjusting impulse control ↑ difficulties difficulties in goal-directed ↑↑↑ behavior
Lee et al. (2018)	SSD	$N = 23$ patients $N = 20$ healthy controls	experi-mental	*t*-tests		emotional face dot-probe task			**ER efficacy (behavioral)** attention ○ deployment

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Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
Lim and Kim (2005)	SSD	$N = 25$ patients with SSD $N = 30$ patients with depression $N = 33$ patients with panic disorder $N = 33$ healthy controls	experi-mental	ANOVA		emotional Stroop task	*Note:* displayed results show results compared to healthy controls		**ER efficacy (behavioral)** ↓↓↓ attention deployment
Liu, Cohen, Schulz, & Waldinge (2011)	somatic symptoms	$N = 218$ persons from general population (109 couples)	self-report	correlations	SSI	MAI		**female subsample** ↑↑↑ suppression of anger ○ overtly anger expression **male subsample** ↑ suppression of anger ○ overtly anger expression	
Love, Sharman, & Kannis-Dymand (2018)	health anxiety symptoms	$N = 21$ health anxious $N = 74$ non-health anxious individuals of general population	self-report	MANOVA		ERP-R		○ reappraisal ○ suppression ↑ expression ○ rumination ○ distraction (attention reorientation)	
Macatee and Cougle (2013)	health anxiety symptoms	$N = 122$ college students	experi-mental	correlations	SHAI	ER task			**ER efficacy (behavioral)** ○ emotional tolerance
Marcus, Hughes, & Arnau (2008)	health anxiety symptoms	$N = 198$ college students	self-report	correlations (additional structural equation modeling)	IAS			↑↑ rumination *Note:* ↑↑↑ indirect effect on healthy anxiety via negative affect ↑ direct effect on health anxiety	
Matud (2004)	somatic symptoms	$N = 2816$ persons from general population	self-report	correlations	GHC	ECQ-2		○ suppression ↑ rumination	
Mazaheri (2015)	FGID	$N = 167$ patients	self-report	correlations	GSRS	DERS	○ awareness ○ clarity ↑ limited ER strategies	↑↑ non-acceptance	**ER self-evaluation** ↑↑ impulse control difficulties difficulties in goal-directed ↑↑ behavior
Mazaheri, Afshar, Nikneshan, & Adibi (2016)	functional dyspepsia	$N = 43$ patients $N = 43$ healthy controls	self-report	Wilcoxon test		CERQ		↓ acceptance ↓↓↓ reappraisal ↑↑↑ rumination	
Mazaheri, Roohafza, Mohammadi, & Afshar (2016)	FGID	$N = 176$ inpatients	self-report	structural equation modeling	MPI pain intensity subscale	CERQ		↑↑ maladaptive strategies ○ adaptive strategies	
Mograbi et al. (2018)	CFS	$N = 283$ high vs. low fatigue	self-report	*t* test		BES	↑↑ dysfunctional beliefs about emotions		
Molero-Jurado, Pérez-Fuentes, Gázquez-Linares,	somatic symptoms	$N = 351$ nurses during COVID-19	self-report	correlations	GHQ-28	CERQ		○ acceptance ↓ reappraisal ↑↑ rumination	

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Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
& Santillán García (2021)									
Monfort and Afzali (2017)	somatic symptoms	*N* = 451 persons from general population	self-report	regression (childhood and present trauma, media use)	BSI-18	ERQ		○ reappraisal ↑↑ suppression	
Niles, Haltom, Mulvenna, Lieberman, & Stanton (2014)	somatic symptoms	*N* = 116 persons from general population	self-report	correlations	PILL	EAC EEQ	○ emotional processing	○ expression (in both scales EAC and EEQ)	
Phillips et al. (2013)	IBS	*N* = 82 patients *N* = 67 healthy controls	self-report	*t*-tests		EPS-25 COPE		↑↑ acceptance ○ reappraisal ○ distraction	
Preis, Golm, Kroener-Herwig, & Barke (2017)	somatic symptoms	*N* = 29 high symptom reporters *N* = 21 low symptom reporters	self-report	ANCOVA		ECQ	↓↓ deficient general emotional processing (↑) awareness and understanding		
Rector and Roger (1996)	somatic symptoms	*N* = 121 first year students	self-report	correlations	GHC	ECQ-2		○/ ○ suppression ↑↑/ ○ rumination *Note:* 2 measuring points with two-weeks-interval	
Rimes et al. (2016)	CFS	*N* = 80 patients *N* = 80 healthy controls	experi-mental	ANOVA		FACES (observer rating) VAS self-rating		↑↑↑ suppression (observer ratings) ○ suppression (self-ratings)	
Rimes and Chalder (2010)	CFS	*N* = 121 patients *N* = 73 healthy controls	self-report	*t* test		BES	↑↑ dysfunctional beliefs about emotions		
Roberts et al. (2012)	PNES	*N* = 18 patients *N* = 36 seizure free controls (18 with high and 18 with low PTS symptoms)	self-report	ANOVA		DERS total score	**Compared to seizure free controls with low posttraumatic stress symptoms:** general difficulties in ER (↑↑) **Compared to seizure free controls with high posttraumatic stress symptoms:** general difficulties in ER (○)		
Rogier et al. (2017)	somatic symptoms	*N* = 379 persons from general population	self-report	partial correlations (controlling for age)	SCL-90-R somati-zation subscale	ERQ		**female subsample** ↓ reappraisal ↑ suppression **male subsample** ↓ reappraisal ○ suppression	
Rosales, Dworetzky, & Baslet (2020)	PNES	*N* = 143 patients compared to normative data	self-report	*t*-tests		ASQ TMMS	↓↓ attention ↓↓ clarity	○ suppression	**ER self-evaluation** ○ tolerance ↓↓ adjusting
Schmitz et al. (2021)	fibromyalgia	*N* = 55 patients *N* = 55 healthy controls	self-report	MANOVA		ERSQ total score	general difficulties in ER (↑↑)		
	SSD	*N* = 62 patients	self-report	*t*-tests ANOVA		DERS ERQ ER-task	↓ awareness ↓↓↓ clarity ↑↑↑ limited ER strategies	**Trait (self-reports)** ↓↓ reappraisal ○ suppression	**ER self-evaluation** ↑↑↑ impulse control difficulties difficulties in goal-directed
		N = 61 healthy controls	experi-mental			RC- task		↑↑↑ non-acceptance	↑↑↑ behavior
Schnabel, Schulz and Witthöft (2022)								**State (behavioral)** ○ reappraisal ○ suppression	**ER efficacy (behavioral)** ○ reappraisal ○ suppression

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Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results					
					Psycho-pathology	ER	Identification		Selection		Implementation	
											○	observation
	SSD	*N* = 48 patients		ANOVA		DERS	↓↓↓	clarity	○	reappraisal		
Schwarz et al. (2016)[2]		*N* = 48 healthy controls	self-report			ERQ	↑↑↑	limited ER strategies				
Schwarz, Rief, Radkovsky, Berking, & Kleinstäuber (2017)	SSD	*N* = 138 SSD patients *N* = 106 patients with depression *N* = 114 patients with SSD and depression *N* = 100 healthy controls	self-report	MANCOVA		ERSQ	○ ↓ ↓↓↓	awareness clarity understanding	↓↓	acceptance	**ER self-evaluation** ↓↓ ↓↓ ○	modification tolerance readiness to confront
							Note: displayed results show results compared to healthy controls					
Serrano-Sevillano, Gonzalez-Ordi, Corbi-Gran, & Angel Vallejo-Pareja (2017)	somatoform dissociation	*N* = 177 low somatoform dissociators *N* = 16 high somatoform dissociators	self-report	Mann-Whitney *U* Test		DERS	↓↓↓ ↓↓	awareness clarity	↓↓↓	acceptance	**ER self-evaluation** ↑↑↑ ↑↑↑	impulse control difficulties difficulties in goal-directed behavior
Sibelli, Chalder, Everitt, Chilcot, & Moss-Morris (2018)	IBS	*N* = 558 patients	self-report	correlations mediation analyses	IBS-SSS	BES	↑ *Note:* in mediation analyses no sign. direct but small sign. indirect effect via distress & positive affect	dysfunctional beliefs about emotions				
Sitges, González-Roldán, Duschek, & Montoya 2018)	fibromyalgia	*N* = 17 FM patients with high depression *N* = 18 FM patients with low depression *N* = 18 healthy controls	self-report	ANOVA		ERQ			**FM patients with low depression:** ○ ○ **FM patients with high depression:** ○ ↑↑↑	reappraisal suppression reappraisal Suppression		
Sojka et al. (2019)	FNS (functional movement disorder)	*N* = 15 patients *N* = 15 healthy controls	experi-mental	ANOVA		ER-task			**State (behavioral)** ○ ○ ○	attention deployment reappraisal emotional response modulation	**ER efficacy (behavioral)** ○	emotion regulation ("decrease"-instruction)
Steffen, Fiess, Schmidt, & Rockstroh (2015)	FNS	*N* = 45 patients *N* = 45 healthy controls *N* = 183 students	self-report	*t*-tests (additional correlations) correlations	(SDQ-20) PMDQ	ERQ COPE			↑ ○	suppression acceptance		
Teixeira, Brandão, & Dores (2021)	somatic symptoms		self-report			DERS total score		general difficulties in ER (↑↑)	↓ ○	reappraisal distraction		
Trucharte et al. (2020)	fibromyalgia	*N* = 47 patients *N* = 47 healthy controls	self-report	*t*-tests		DERS STAXI-2	○ ↓↓↓	awareness clarity	↑↑↑ ↑↑↑	non-acceptance suppression of anger	**ER self-evaluation** ↑↑↑	

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Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
									difficulties in goal-directed behavior
								↑↑ expression of anger	↑↑↑ lack of emotional control
Uliaszek, Prensky, & Baslet (2012)	PNES	$N = 55$ patients				DERS			**ER self-evaluation**
							Cluster 1 ($n = 14$)	**Cluster 1 ($n = 14$)**	**Cluster 1 ($n = 14$)**
			self-report				↓↓ awareness	↑↑↑ non-acceptance	↑↑↑ difficulties in goal-directed behavior
		compared to normative data ($N = 357$ persons from general population)		cluster analyes based on DERS scores			↓↓↓ clarity limited ER		impulse control
				t-tests			↑↑↑ strategies		↑↑↑ difficulties
							Cluster 2 ($n = 41$)	**Cluster 2 ($n = 41$)**	**Cluster 2 ($n = 41$)**
							↑ awareness	○ non-acceptance	↓↓ difficulties in goal-directed behavior
							○ clarity		
							○ limited ER strategies		○ impulse control difficulties
							Note. Clusters compared to normative data. Both clusters differed sign. in all scales from each other		
Urbanek, Harvey, McGowan, & Agrawal (2014)	PNES	$N = 56$ patients				BAEQ	↑↑↑ dysfunctional beliefs about emotions	↑ suppression	
		$N = 88$ healthy controls	self-report	*t* test/ Mann– Whitney *U* test		CECS			
	fibromyalgia			*t*-tests	FIQ	ERQ	○	○ reappraisal	
		$N = 403$ female patients			MPI	SECS		↓	
van Middendorp et al. (2008)[1]		$N = 196$ female healthy controls	self-report			EACS	emotional processing	emotional expression ↑ suppression	
				(additional correlations in clinical subsample)				↑ internalizing of anger externalization of anger	
	fibromyalgia			regression				**Trait**	
								↑ internalizing of anger externalization of anger	
					pain level			↓	
								State	
						SECS (trait and state version)		○ internalizing of anger externalization of anger	
van Middendorp et al. (2010)[1]		$N = 333$ female patients	self-report (diary assessment)					↓ anger	
		$N = 881$ persons from general population			GHQ-28	TMMS	↑↑↑ attention		**ER self-evaluation**
Vicente-Galindo et al. (2017)	somatic symptoms	(catholic priests)	self-report	canonical correspondence analysis			↓ clarity		↓ emotional repair
White & Schweitzer (2000)	CFS	$N = 44$ patients		ANOVA		CECS		○ suppression	
		$N = 44$ healthy controls	self-report						
	FNS	$N = 26$ patients		*t*-tests		EPS-25	↓↓↓ awareness	↑↑↑ suppression	**ER self-evaluation**
Williams, Reuber, & Levita (2021)		$N = 27$ healthy controls	self-report						unregulated ↑↑↑ emotions unprocessed ↑↑↑ emotions
	SSD			*t*-tests	FBL	ERQ		○ suppression	**ER efficacy (behavioral)**
		$N = 30$ patients with SSD	self-report	correlations				*Note:* group comparison	
Wingenfeld et al. (2011)		$N = 52$ patients with depression	experi-mental	regression (body symptoms, anxiety, depression, trauma,		emotional Stroop Task		between SSD vs. non-SSD and controls vs. all patients	○ attention deployment

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Table 2 (*continued*)

Study	Symptoms	Sample Details	c Study Charac-teristics	Analysis	Relevant Measures		Main Results		
					Psycho-pathology	ER	Identification	Selection	Implementation
		N = 45 patients with anxiety		dissociation on Stroop performance				↑ suppression *Note:* correlation with body symptoms	
		N = 42 healthy controls							
	SSD								**ER efficacy (behavioral)**
		N = 44 patients with SSD	experi-mental			emotional Stroop Task			↓ attention deployment *Note:* for Stroop task; effect found in both clinical groups
		N = 54 patients with idiopathic environ-mental intolerance							attention ○ deployment *Note:* for dot probe task
Witthöft et al. (2006)		*N* = 54 healthy controls		ANCOVA (age as covariate)		emotional dot probe task			
					PHQ-15	ERQ RSQ		↓↓ reappraisal ○ suppression* ↓ distraction	
Witthöft, Loch, & Jasper (2013)	somatic symptoms	*N* = 414 persons from general population	self-report	structural equation modeling				symptom-related ↑↑↑ rumination self-related ○ rumination *Note:* Displayed results are associations with general somatization. Controlled for depressive symptoms, associations disappeared. *suppression revealed sign. Positive associations with subfacets (cardio-pulmonary, fatigue)	
Yang (2020)	somatic symptoms	*N* = 186 college students	self-report	correlations	BSI Soma-tization	DERS sum score	general difficulties in ER (↑↑) *Note*: displayed effect was found in both analyses		
Zautra, Smith, Affleck, & Tennen (2001)	fibromyalgia	*N* = 89 patients	self-report	correlations	pain ratings for FMS-areas	TMMS	○ clarity		

Note.[1]same sample; [2]same sample; ↓ = significant negative association, ↑ = significant positive association, ○ = no significant group differences or associations, ↓/↑ = small effect size, ↓↓/↑↑ = medium effect size, ↓↓↓/↑↑↑ = large effect size; in case of non-reported effect sizes, these were calculated by the authors if sufficient data were provided. **Psychopathology measures:** BSI = Brief Symptom Inventory, FBL = Freiburger Beschwerdeliste-Revised, FHAQ = Fibromyalgia Health Assessment Questionnaire, FIQr = Revised Fibromyalgia Impact Questionnaire, GBB = Giessen Subjective Complaints List (Giessener Beschwerdebogen), GHC = General Health Checklist, GHQ-28 = General Health Questionnaire-28, GSRS = Gastrointestinal Symptom Rating Scale, HDL = Health and Daily Living Form, HSCL = Hopkins Symptom Checklist, IAS = Illness Attitudes Scale, IBS-SSS = IBS Symptom Severity Score, MIHT = Multidimensional Inventory of Hypochondriacal Traits, MPI = Multidimensional Pain Inventory, MPQ-S = McGill Pain Questionnaire (short form), PHQ-15 = Patient Health Questionnaire (somatic scale), PILL = Pennebaker Inventory of Limbic Languidness, PMDQ = Physical Manifestations of Discomfort Questionnaire, SAIB = Scale for the Assessment of Illness Behavior, SHAI = Short Health Anxiety Inventory, SCL = Somatic Complaint List, SCL-90-R = Symptom Checklist-90-R, SDQ-20 = Somatoform Dissociation Questionnaire, SF-12 = Short Form Health Survey SOMS = Screening for Somatoform Symptoms, SSI = Somatic Symptom Inventory, SSRS = Somatic Stress Response Scale, WI = Whiteley-Index; **ER measures:** ACQ = Anxiety Control Questionnaire, AES = Anger Expression Scale, ASQ = Affective Style Questionnaire, BAEQ = Beliefs about Emotions Questionnaire, BEQ = Berkeley Expressivity Questionnaire, BES = Beliefs about Emotions Scale, CATS = Comprehensive Affect Testing System, CECS = Courtauld Emotional Control Scale, CERQ = Cognitive Emotion Regulation Questionnaire, COPE = Cope Scales, DERS = Difficulties in Emotion Regulation Scale, DTS = Distress Tolerance Scale, EACS = Emotional Approach Coping Scale, EAQ = Emotional Awareness Questionnaire, ECQ = Emotional Competence Questionnaire, ECQ-2 = Emotion Control Questionnaire, EEQ = Emotional Expressiveness Questionnaire, ERP-R = the Emotion Regulation Profile-revised, ERQ = Emotion Regulation Questionnaire, ERSQ = Emotion Regulation Skills Questionnaire, ERSQ-2 = Emotion Regulation Strategy Questionnaire, ER-task = emotion regulation task, MAI = Multi-dimensional Anger Inventory, MZQ = Mentalization Questionnaire, NMRS = Generalized Expectancies for Negative Mood Regulation, OPD-SQ = Operationalized Psychodynamic Diagnosis–Structure Questionnaire, RC-task = regulatory choice task, RSQ = Response Style Questionnaire, SECS = Self-Expression and Control Scale, STAXI-2 = State-Trait Anger Expression Inventory-2, TEARS = The Emotion Amplification and Reduction Scales, TEIQue = Trait Emotional Intelligence Questionnaire, TMMS = Trait-Meta-Mood Scale.

rated as "yes" (items 2, 3, 4, 6, 7, 8) was calculated for each study. This score comprises a total of 4 to 6 items (depending on whether the study investigated clinical groups or correlations in a general population sample). Quality of the studies was rated with high (≥ 80% & good sample size), medium (50–79% & at least moderate sample size or 80% & moderate sample size), low (20–49% or poor sample size), or unacceptable (<20% or very poor sample size), following the suggestion of Brown and Reuber (2016). After meticulously defining the criteria, the first and the second author independently rated all relevant studies (see Supplement 3). Interrater reliability was almost perfect (Cohen's Kappa = 0.83). We excluded studies with an unacceptable quality rating (n = 1; Kotwas et al., 2019), in this case due to a very small sample size of the relevant patient group in the study. All other studies were included but quality ratings were taken into account when drawing conclusions, by placing greater emphasis on higher-quality studies.

3. Results

We included 105 studies (see Supplement 4 for references) in the review with a total of 29332 participants. The studies include samples from the general population assessing levels of bodily distress symptoms or elevated health anxiety (n = 43) and clinical samples with patients with SSD (n = 17), health anxiety (n = 2), psychogenic non-epileptic seizures (PNES; n = 9), the irritable bowel syndrome (IBS) or other functional gastrointestinal disorders (FGID) (n = 7), fibromyalgia (n = 13), conversion disorders, somatoform dissociation or other functional neurological disorders (FNS) (n = 7), functional dyspepsia (n = 1) or chronic fatigue syndrome (CFS; n = 6).

N = 89 (84.8%) studies were exclusively based on self-reports, n = 14 (13.3%) studies implemented an experimental design, and n = 2 (1.9%) studies used self-reports and experimental measures.

Of the 105 included studies, 1–3% studies (depending on Rater 1 vs. Rater 2) received high quality ratings, 84–86% medium and 14% low quality ratings. If not explicitly mentioned, the quality of studies showing effects in one vs. the other direction vs. no effects were approximately equally distributed.

Main findings of our review are displayed in the EPM in Fig. 2. An overview of the included studies and their key finding is presented in Table 2. A more detailed summary of results regarding the different stages of the ER process can be found in Supplements 5.

3.1. Identification stage

Thirty-eight studies provide findings concerning the identification stage investigating emotional awareness, emotional clarity and understanding, and dysfunctional beliefs about emotions and ER.

In terms of emotional awareness, nine studies (45%) indicate deficits in individuals with SSD-RC, although due to nine other studies (45%) with nullfindings current evidence is inconclusive: Seven self-report studies found significantly lower emotional awareness in patients with SSD-RC compared to different comparison groups (e.g., healthy controls, individuals with low somatoform dissociation, normative data) and two studies revealed significant negative correlations with somatic symptoms in the general population. However, seven studies, of which one study investigated emotional awareness using an experimental design, could not detect deficits in patients with SSD-RC compared to different comparison groups (e.g., healthy controls, low symptom reporters, patients with organic neurological disorders, patients with depression, anxiety and epilepsy) and two studies revealed non-significant correlations. Note that four of the studies that found no effects used comparison groups of other mental disorders or physical illnesses, which could explain the lack of effects. Only two studies found a positive association between somatic or health anxiety symptoms and emotional awareness.

Relatively clear evidence was found for a self-reported lack of emotional clarity and understanding associated with SSD-RC. Seventeen (77%) out of 22 studies measuring emotional clarity, analyzing, or understanding of one's own emotions found significant negative associations with bodily distress symptoms in the general population (four studies) or significantly greater deficits in patients with SSD-RC. These patients were mainly compared to healthy participants (12 studies), while only one study used a clinical comparison groups (organic neurological disorders). Clinical studies in particular predominantly found medium to large effect sizes. The remaining studies (correlational analyses and group comparisons with healthy controls) found no significant effects. All included studies measuring emotional clarity and understanding were based on self-reports.

With regard to dysfunctional beliefs about emotions and emotion regulation strategies, fairly clear conclusions can be drawn from the included studies. Twenty-one (91%) out of 23 studies found evidence for greater dysfunctional basic assumptions regarding emotions or negative self-efficacy expectation regarding the regulation of emotions in the SSD-RC population (10 group comparisions between SSD-RC and healthy controls and one between SSD-RC and organic neurological disorders; 10 correlational analyses with somatic or health anxiety symptoms in general population). A broad range of different somatic symptoms seems to be significantly related to negative beliefs about emotions, such as expecting emotions to be overwhelming and uncontrollable, self-perceived limited access to emotion regulation strategies, or negative mood regulation expectancies. Two studies (9%) did not find significant associations with SSD-RC.

3.2. Selection stage

Seventy-five of the included studies investigated the selection and use of different ER strategies, of which four studies used experimental designs and one study diary assessments.

3.2.1. Experimental studies

Five studies were included: four with experimental designs and one with diary assessments measuring the choice of ER strategies. Three studies (two of which were rated of medium quality and one of low quality) comparing patients with SSD (Kleinstäuber, Gottschalk, Ruckmann, Probst, & Rief, 2018; Schnabel, Schulz, & Witthöft, 2022) and functional movement disorder (Sojka et al., 2019) to healthy control participants revealed no significant group differences regarding state choice or preference of regulation strategies such as expressive suppression, cognitive reappraisal, acceptance, or distraction. In contrast, one medium quality study (Rimes, Ashcroft, Bryan, & Chalder, 2016) found higher use of suppression in patients with chronic fatigue compared to healthy participants. Furthermore, in patients with fibromyalgia, state anger-expression was significantly negatively associated with end-of-day pain ratings but state anger-inhibition did not show significant correlations (medium quality; van Middendorp et al., 2010).

3.2.2. Self-report studies

In contrast to only few experimental studies, 72 studies used self-reports to investigate the use of different emotion regulation strategies in daily life associated with SSD-RC. The following strategies were investigated in the field of SSD-RC: distraction and rumination (attention deployment), reappraisal and acceptance (cognitive change), and expressive suppression or (overtly) emotional expression (response modulation).

Regarding attention deployment strategies, 16 (76%) out of 21 studies found significantly elevated levels of rumination in patients with SSD-RC compared to healthy controls (four studies) or significant positive correlations in the general population (12 studies). Studies differentiating between symptom-related and self-related rumination found this effect only for symptom-related rumination. One additional study showed similar levels of rumination in patients with SSD as in patients with depression (Davoodi et al., 2019). The remaining studies found no significant effects. Regarding the strategy of distraction, which is also less investigated, four studies (57%; with medium quality ratings) did

not find significant correlations in the general population or group differences between SSD-RC and healthy controls, while three studies (43%), one of which was of low quality, found lower use of distraction to be associated with higher symptoms or lower use in SSD-RC compared to healthy controls. Taken together, patients with SSD-RC tend to stick more to negative thoughts and may habitually use attention shifting or disengagement less frequently to regulate emotions, but there is no clear evidence for the lower use of the distraction strategy.

Regarding cognitive change strategies, reappraisal and acceptance are relatively well investigated. Eighteen (47%) of the 38 studies that examined cognitive reappraisal found evidence for less reappraisal use in SSD-RC compared to healthy people (nine studies) or significant negative associations with symptoms in the general or clinical population (nine studies), although one study found this effect only in the first assessment, but not during follow ups. Additionally, two studies (5%) comparing clinical conditions (anxiety, depression, SSD) with healthy controls found significantly less reappraisal use in patients, but no significant differences between clinical groups. However, 15 studies (39%) did not find significant correlations or group differences between SSD-RC and healthy controls. Only three studies (8%) found significant positive associations with reappraisal, and this was true for only part of the sample or subscales of the symptomatology, while others were nonsignificant. Regarding acceptance strategies, 16 (57%) out of 28 studies found evidence of a significantly lower use of acceptance strategies and more non-acceptance in patients with SSD-RC compared to healthy controls (or in one study organic neurological patients), and significant associations with somatic symptoms (two studies with low and 14 studies with medium quality). Eight medium-quality studies (29%) did not find significant associations or group differences between SSD-RC and healthy controls and four medium-quality studies (14%) found significantly higher acceptance strategies use in patients with SSD-RC compared to healthy controls. Taken together, many findings indicate that patients with SSD-RC tend to use less cognitive change strategies compared to healthy people, although no clear conclusions can be drawn currently considering the many null findings regarding reappraisal.

Expressive suppression or emotional inhibition on the one hand and (overtly) emotional expressiveness on the other hand were categorized as response modulation strategies and are relatively well investigated regarding their association with SSD-RC. 18 of 40 studies (45%) found evidence for higher use of expressive suppression (eight significant group comparisons, 10 significant correlations). However, of these, one study found this significant positive correlation only in the female subsample (Rogier, Garofalo, & Velotti, 2017), and in further regression analyses of two studies no significant predictive effects of expressive suppression (beside demographic variables, life events or other emotional processing variables) on somatic symptoms could be detected. Two additional studies (5%) found both positive and negative associations between suppression and various facets of health anxiety symptoms (Görgen, Hiller, & Witthöft, 2014). Another study found significant positive correlations with somatic complaints but no significant group differences (Wingenfeld et al., 2011). In contrast, 19 studies (48%) did not find significant associations with expressive suppression or group differences between SSD-RC and healthy controls. At this point, it should be noted that four of these studies received a low-quality rating. Focusing on emotional expression, of a total of 10 studies, four studies (40%) found significant negative correlations with somatic symptoms or significant group differences between SSD-RC and healthy controls. In contrast, three studies (30%) did not find significant associations or group differences and three other studies (30%) found significant positive associations and group differences between SSD-RC and healthy controls, indicating that individuals with higher somatic symptoms tend to express emotions more intensely. Taking all results together, the evidence suggests a reduced use of expressive suppression. However, this relationship must be viewed with caution in light of the considerable number of null results.

3.3. Implementation stage

Thirty-four studies with results regarding the implementation of ER were found. Fourteen studies used experimental designs to investigate state ER efficacy and 21 studies used self-reports (additionally) which measure deficits in ER implementation in daily life (trait).

3.3.1. Self-report studies

Eighteen (90%) of the 21 self-report studies contained at least indirect evidence for lacking ER implementation skills: Patients reported significantly higher difficulties in impulse control and in engaging goal-directed behavior compared to healthy or clinical controls (organic neurological disorders) when experiencing negative emotions and deficits in the modification of negative feelings. These scales are also significantly positively correlated with somatic symptoms in the general and in clinical populations with SSD-RC. Few studies showed no significant associations between SSD-RC and the ability to amplify and reduce emotions and readiness to confront negative emotions or showed contradicting results regarding emotional tolerance and adjusting.

3.3.2. Experimental studies

Experimental research is essential for concluding whether patients with SSD-RC are less able to implement ER strategies effectively. We included seven studies investigating efficacy of different regulation strategies and eight studies investigating attentional bias, which could be considered as an implicit indicator for deficits in attention deployment.

Six out of seven studies could not find evidence for deficits in implementing ER in patients with SSD-RC, when participants were instructed to apply a specific strategy. Of these seven studies, five were rated with medium quality, one with low and one with low to medium quality, showing the lack of well-powered experimental studies. Four experimental studies did not find deficits in the efficacy of ER in individuals with SSD-RC compared to healthy controls, specifically reappraisal and suppression (Schnabel et al., 2022), and free regulation instructions (Sojka et al., 2019) nor significant correlations between emotional tolerance (Macatee & Cougle, 2013) or control emotional control (Camodeca & Nava, 2020) and somatic symptoms in a students sample. In one study (Kleinstäuber et al., 2018) both patients and healthy controls showed mainly similar (small) effect sizes in implementing reappraisal, acceptance, and compassionate self-support to down-regulate their negative mood (within-group-effects). With regard to the down-regulation with distraction, the healthy sample showed an effect size of $d = 0.4$ and the clinical sample of $d = 0.1$. Unfortunately, no between-group differences were reported. Another study did not find the strategies emotion labeling or non-emotion labeling to be effective in regulating pain or arousal – neither for patients with IBS nor for healthy controls (Constantinou et al., 2015). In contrast, only one study (Eger Aydogmus & Hamilton, 2019) found that patients with SSD-RC were less effective in suppressing the experience and expression of emotions when instructed to do so, but experienced fewer negative emotions when they were asked not to regulate. The authors of this experiment suggest that high symptom reporters usually might tend to suppress their emotions, but when asked to do so, the forced attention on emotions might impede successful suppression.

Furthermore, five studies including one with low-quality rating (Duschek, Werner, Limbert, Winkelmann, & Montoya, 2014; Huang, Liao, & Gau, 2021; Kornadt, Witthöft, Rist, & Bailer, 2009; Lim & Kim, 2005; Witthöft, Gerlach, & Bailer, 2006) found some evidence of attentional bias in patients with SSD-RC compared to healthy controls indicating reduced skills in attention deployment strategies, one of them only in women (Huang et al., 2021). Three studies (two low-quality ratings) could not show this effect (Cardoso, Fernandes, & Barbosa, 2021; D. Lee et al., 2018; Wingenfeld et al., 2011).

Taken together, most studies investigating efficacy in ER could not find evidence of deficits in the implementation of emotion regulation

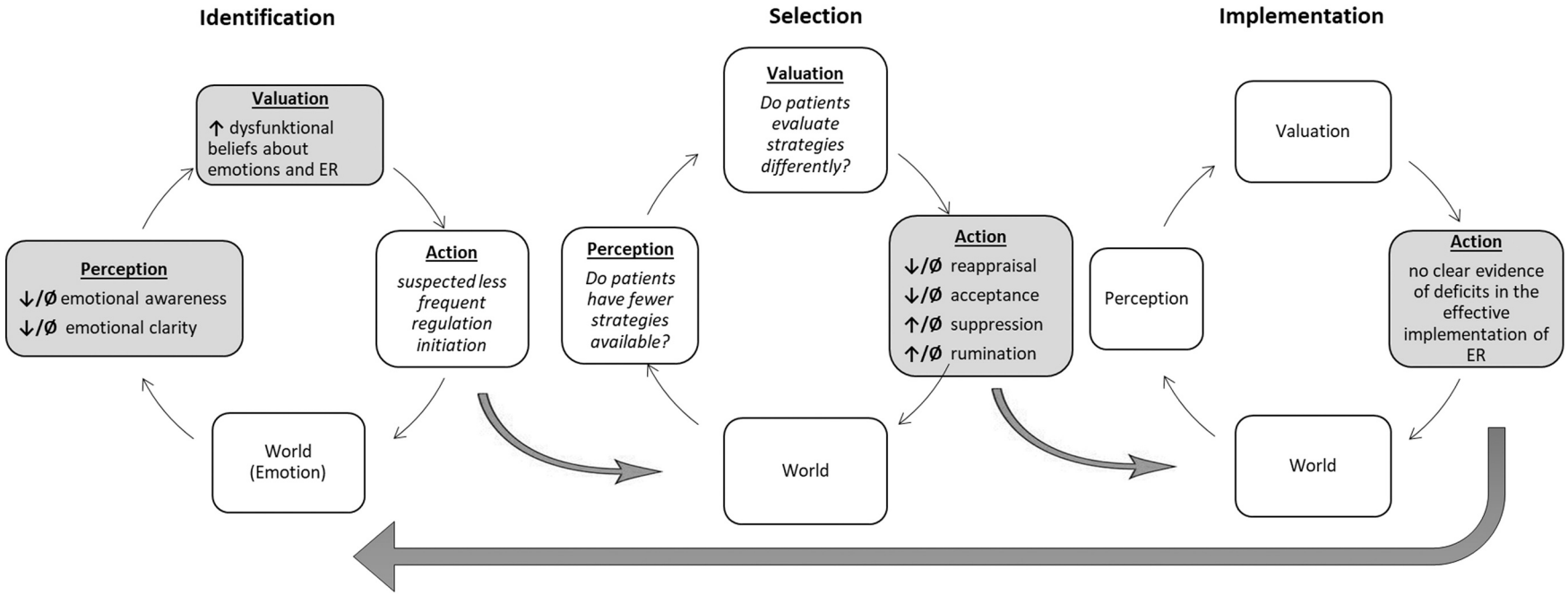

Fig. 2. Main findings, hypotheses and future research questions integrated in the EPM (Sheppes et al., 2015).
Note.↓ = significant negative association, ↑ = significant positive association, Ø no significant association, fields with gray background display central findings of the review, fields with white background and italic letters display hypothesis and possible future research questions.

strategies associated with SSD-RC when participants received instructions in a laboratory setting.

4. Discussion

Various theories incorporate emotional problems as key pathogenetic factors in SSD-RC (De Gucht & Heiser, 2003; Houtveen & van Doornen, 2007; Kooiman, 1998; Sifneos, 1973; van Diest et al., 2005). In the development of the Hierarchical Taxonomy of Psychopathology (HiTOP) evidence was found that the somatoform spectrum shares substantial variables with other conditions of a emotion dysregulation superspectrum (D. Watson et al., 2022). Studies reporting global scores of questionnaires measuring ER difficulties support the hypothesis of habitual ER dysfunctions in the daily life of patients with SSD-RC (Dworsky, Pargament, Wong, & Exline, 2016; Phillips, Wright, & Kent, 2013; Yang, 2020). However, the exact role and particular type of crucial emotion regulation alterations and difficulties remain unclear.

Psychotherapy studies show that patients with SSD-RC might benefit from interventions targeting ER skills. Two randomized controlled studies found that patients with IBS and fibromyalgia receiving a specific emotional awareness and expression training reported significantly reduced IBS symptom severity compared to patients receiving relaxation training and waiting list (Thakur et al., 2017) and significantly lower fibromyalgia symptoms and widespread pain compared to patients receiving CBT (Lumley et al., 2017). Kleinstäuber et al. (2019) compared treatment outcomes for a group that received CBT and a group that received CBT enriched with emotion regulation training (ENCERT). Both groups improved significantly but did not differ in symptom severity. However, group differences were found for secondary outcomes such as psychological features of SSD, health anxiety, general psychopathology, symptom distress, and emotion regulation skills in favor of the ENCERT condition. These results suggest that patients with SSD-RC might benefit from addressing deficits in ER processes.

A differentiated analysis is necessary to better understand at which point ER processes might be disturbed, and to tailor therapeutic interventions to the corresponding ER deficits. This review aimed to summarize the existing research categorizing results in the framework of Gross' widely cited process model of ER (Sheppes et al., 2015) to differentiate ER deficits in patients with SSD-RC. To this end, 105 studies were included and analyzed for relevant findings concerning whether patients with SSD-RC show deficits regarding the identification of emotions, alterations regarding the selection of ER strategies, and deficits in the successful implementation of ER strategies.

Results show that patients with SSD-RC report alterations or deficits of ER processes in the identification phase, the selection of ER strategies, and the implementation of ER strategies, but experimental studies are scarce and have not been able to confirm a clear picture of pronounced ER deficits. Eighty-five percent of the included studies used exclusively self-reports, which entails that a great part of our knowledge about ER in SSD-RC refers to subjective emotional traits and habitual use of regulation strategies. Most studies investigate the selection process of ER, but differences found in strategy selection do not allow any conclusion about the success of ER.

Although we investigate the association between ER and clinical symptoms of SSD-RC, we do not refer exclusively to clinical samples. Regarding the interpretation of our results, it should be noted that a large proportion of the included studies investigated somatic symptoms in the general population. However, in light of the dimensional nature of the SSD-RC spectrum as demonstrated in taxometric studies (Jasper, Hiller, Rist, Bailer, & Witthöft, 2012; Kliem et al., 2014; Sellbom et al., 2021) and implicated in novel taxonomies (D. Watson et al., 2022), we consider such a general population approach as justified and informative. Furthermore, we summarize studies of different symptom clusters regarding potential failure points in the identification stage, the selection stage and the implementation of ER. When descriptively contrasting studies investigating SSD and studies investigating functional somatic syndromes or health anxiety, no clear differences are apparent with regard to abnormalities in the ER process. This offers at least indirect evidence that commonalities in the broad field of SSD-RC might be greater than potential differences between specific syndromes and single diagnoses – also regarding ER processes.

4.1. Deficits in identification stage

Regarding the identification stage of the ER process, we included studies investigating emotional awareness, clarity, and understanding. These are basic processes to initiate ER. Results of the present review regarding emotional awareness deficits showed partly deficits in patients with SSD-RC (total 45%: 35% significant group differences, 10% significant correlations) but were inconsistent (35% nonsignificant group differences, 10% nonsignificant correlations, 10% significant positive correlations). In contrast, emotional clarity and understanding showed clearer associations with SSD-RC (59% significant group differences, 18% significant correlations, 9% nonsignificant group differences, 14% nonsignificant correlations). Our results are in line with previous reviews targeting alexithymia (Bankier, Aigner, & Bach, 2001; De Gucht & Heiser, 2003; Di Tella & Castelli, 2016; Hadji-Michael et al., 2019). The widely used TAS-20 (Bagby, Taylor, Parker, & D.A., 1994) as a self-report measure of alexithymia showed the strongest and most consistent associations between the subscale “difficulties in identifying feelings” and somatic symptoms – with a medium effect size.

Furthermore, we considered studies assessing beliefs both about emotions and ER strategies, which might influence the initiation of ER in the identification process as well. We found evidence for dysfunctional beliefs about emotions in patients with SSD-RC (48% significant group differences, 43% significant correlations, 9% nonsignificant correlations), which is crucial for the valuation in the question of whether to regulate or not. In addition to self-reports about emotional beliefs, research on implicit attitudes towards emotions and ER, for example, measured with the Emotion Regulation-Implicit Association Task (ER-IAT; Mauss, Evers, Wilhelm, & Gross, 2006), could be interesting to substantiate these findings.

Both lacking emotional awareness or clarity and dysfunctional beliefs about emotions or one's own regulation skills might result in less initiation of ER (see Fig. 2): If patients are not aware or able to clarify emotions, they might not be aware of the need to regulate or able to select an appropriate strategy to regulate intense emotions. According to the predictive coding approach of symptom experience (Van den Bergh et al., 2017), the generation of a symptom experience arises as a result of cognitive processes in which peripheral somatic input is interpreted in the light of predictions. Additionally, deficits in emotional awareness could lead to physiological sensations not being recognized as evidence of emotional activation and thus patients with SSD excessively focus on somatic symptoms instead of applying ER strategies. This in turn might lead to the development or amplification of the symptom experience (see Fig. 3). Furthermore, if emotions are considered uncontrollable and efforts to regulate them not promising, this affects the prior on the one hand, and on the other hand initiation of ER becomes less likely (see Fig. 2), which in turn leads to higher negative affect (see Fig. 3). Experimental research should investigate the influence of lacking emotional awareness and clarity, as well as dysfunctional beliefs on the initiation of ER.

Psychoeducation about emotions and mindfulness training on the one hand and cognitive restructuring and behavioral experiments regarding dysfunctional beliefs about emotions on the other hand should be considered as helpful therapeutic interventions. These could positively influence emotional awareness and clarity and dysfunctional beliefs in order to improve ER initiation when necessary.

4.2. Alterations in the selection stage

To identify alterations in the selection process of ER strategies, we

found studies investigating the use of attention deployment, cognitive change, and response modulation strategies. Existing research gives indications that patients with SSD-RC might differ in their choice of ER strategies in daily life: A large part of the reviewed studies using self-reports found a negative association with cognitive change strategies (total 53%: 33% significant group comparisons, 20% significant correlations) and attention deployment (total 69%: 19% significant group comparisons, 50% significant correlations) and a positive association with response modulation (total 44%: 18% significant group comparisons, 26% significant correlations). Although a non-negligible proportion of the studies included in our review could not confirm these effects, all significant results point in the same direction and indicate that at least some of the patients with SSD-RC habitually use certain strategies (e.g., reappraisal and acceptance) less often and other strategies (e.g., suppression and rumination) more frequently than healthy controls. This is in line with previous reviews targeting ER strategies and other psychopathology (Aldao et al., 2010). However, three out of four experimental studies included in the review did not find significant differences in selection or preference of the presented ER strategies. One explanation for the partially found differences between experimental and self-report results might be that individuals with SSD-RC report a limited access to ER strategies (Karatzias et al., 2017; Kramska, Hreskova, Vojtech, Kramsky, & Myers, 2020; Schnabel et al., 2022; Schwarz, Gottschalk, Ruckmann, Rief, & Kleinstäuber, 2016) and thus some strategies (e.g., reappraisal) are less available in daily life than others (see Fig. 2). However, when all strategies are presented in a highly-standardized laboratory setting (including practice trials of different strategies), these differences disappear. Alternatively, patients might evaluate the adaptivity of strategies differently than healthy individuals (see Fig. 2). Reporting biases in self-reports could also be an explanation for different findings in questionnaire and experimental studies. A negative self-perception or continuous stress due to chronic symptom experience could have led to a (negative) bias in the questionnaires on the part of the patient group.

Note that results of altered regulatory choice do not allow any statement regarding the functionality or the effective implementation of the strategies. McRae (2013) emphasizes that ER frequency – measured by questionnaires – does not necessarily indicate successful ER: Individuals may often use a particular strategy without being able to downregulate emotions and thus suffer from inefficient ER. Flexible use of many different strategies might be functional (Kashdan & Rottenberg, 2010; Rogier et al., 2017). Further research is needed on possible reasons why patients with SSD-RC use these strategies less or more often than healthy people – be it because of the lack of availability of other strategies, because of different emotional goals, or because this strategy is actually the most promising for patients – and if they are successful (implementation stage). Taken together, altered habitual strategies might have an influence on the B-criteria of SSD such as the amplification of excessive symptom-related negative affect, disproportionate and persistent thoughts about symptoms, and excessive dysfunctional behavioral strategies associated with symptoms (see Fig. 3), but future studies should test this hypothesis. Therapeutic interventions at this ER stage could be an expansion of the ER repertoire or support in finding the most promising strategy.

4.3. Deficits in the implementation stage

What becomes apparent from this review is the immense lack of studies, especially experimental designs, regarding the effective implementation of ER strategies. Contrary to the evidence for alteration in the identification and selection stage of the ER process in patients with SSD-RC, we know little about whether these patients also have problems in implementing strategies effectively.

Four studies (Camodeca & Nava, 2020; Macatee & Cougle, 2013; Sojka et al., 2019; SSD; Schnabel et al., 2022) showed that patients with SSD-RC were equally able to successfully tolerate and regulate emotions when instructed to do so. Two other studies were mainly in line with these results although they did not directly compare both groups. Only one study (out of seven) (Eger Aydogmus & Hamilton, 2019) found some evidence for reduced efficacy in implementing suppression on part of patients with SSD, but when patients were instructed to perceive emotions they seemed to suppress them. The conflicting results between Schnabel et al. (2022) and Eger Aydogmus and Hamilton (2019) could have resulted from the different instructions of suppression (expressive suppression vs. suppression of experience and expression). Five studies found an attentional bias in patients with SSD-RC indicating reduced skills in attentional deployment and disengagement from negative content, whereas three study did not find this bias. Taken together, the results from experimental studies might lead to the assumption that is not the general implementation skills that are impaired, but the ability to apply the strategy consciously and purposefully.

Several self-reports subscales give indirect indications for the lack of implementing skills, for example that patients score lower in subscales measuring *modification* ("I was able to influence my negative emotions.") or *adjusting* ("I am able to let go off my feelings."). Nevertheless, findings from self-reports investigating implementation skills should be treated carefully, because patients might not distinguish between whether they really cannot influence their emotions or whether they identified emotions and the need to regulate too late (e.g., emotional clarity in the identification stage) or selected a non-promising strategy (selection stage). Therefore, the self-perceived deficits in effective ER can also be due to deficits that would have to be located earlier in the ER process. Experimental studies and ambulatory assessments in patients' daily life are needed to answer this question. This is crucial so that therapeutic interventions (e.g., the training of emotion regulation strategies) target the right issue.

The patterns of ER deficits measured by self-report and equal regulation abilities in a laboratory setting are also found in other psychopathologies (e.g., Goldin, Manber, Hakimi, Canli, & Gross, 2009; Opoka, Sundag, Riehle, & Lincoln, 2021). McRae and Gross (2020) assume that individuals with mental disorders are capable to apply ER strategies effectively when guided to do so, but have deficits in the identification stage for example, do not realize the need for ER in everyday life. This hypothesis fits to our results regarding the identification deficits.

4.4. Strengths and limitations

The major strength of the current review is the summary and classification of existing findings into the entire process of ER following the extended process model of emotion regulation (Gross, 1998b; Sheppes et al., 2015). This sheds light on the question where exactly deficits are presumably to be located when patients with SSD-RC report that they suffer from ER difficulties. This knowledge represents a prerequisite for developing and tailoring concrete therapeutic interventions to improve ER skills in SSD-RC. To ensure a high level of heterogeneity and comprehensiveness, we searched for different variations of terms of emotion regulation, specific facets of the ER process, and different somatic symptoms and syndromes.

Nevertheless, this review has some limitations. First, included studies are mainly cross-sectional and based on self-reports. This is more a general limitation of ER research in this field rather than a specific limitation of our review. Self-reports give us information on subjective beliefs about emotions and the habitual use of ER strategies, but also bring some drawbacks. On the one hand, assessing implicit ER processes, such as emotional awareness and implicit automatic strategies, with self-reports involves an inherent problem because participants have to evaluate a deficit they might not even be aware of, meaning this either requires high self-reflection or comes at the expense of validity. On the other hand, since experimental designs, longitudinal studies, or ambulatory assessments are scarce, there is a lack of knowledge about the ability to regulate emotions in an effective way as well as about causal relationships between ER and bodily distress symptoms.

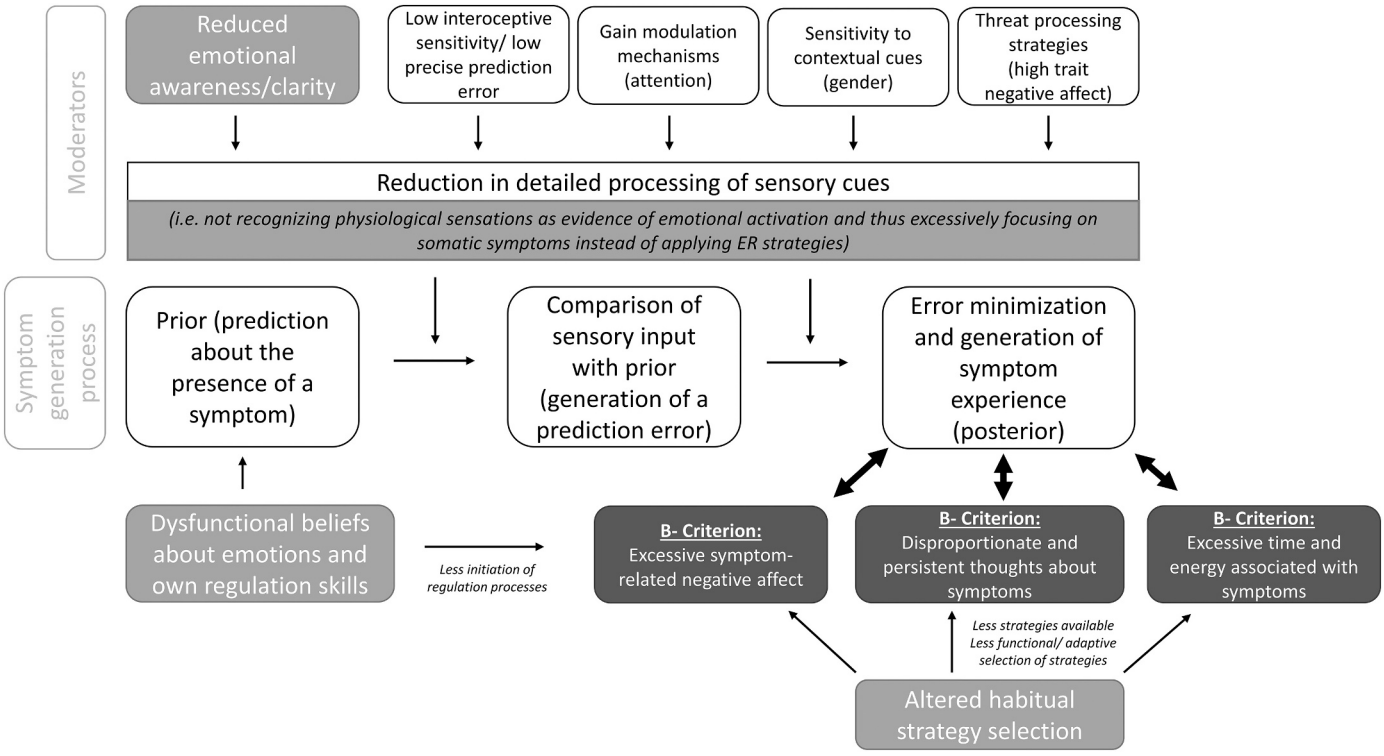

Fig. 3. Integration of the main deficits in a hypothetical model of SSD.
Note. Fields with white background are part of the predictive coding approach of symptom experience (Van den Bergh et al., 2017), fields with black background are criteria of the SSD according to the DSM-5 (American Psychiatric Associaton, 2013), fields with gray background and white font are main deficits found in the present review, hypothesis are written in italics.

Furthermore, both ER and SSD-RC involve a broad spectrum of definitions and symptoms. Definitions of ER processes are not consistent across studies. Behind specific terms regarding ER (e.g., emotional tolerance) might be several different instruments which do not measure the same construct. Thus, the validity of self-reports, especially of subscales measuring a common construct, needs to be viewed critically in general. Our search terms include variations both of emotion and affect regulation, as well as relevant constructs of all three ER stages. However, following the definition of Gross (1998b) we excluded terms that might be used as synonyms for ER in some studies, such as coping. Although studies targeting alexithymia were excluded due to already existing reviews on the one hand (De Gucht & Heiser, 2003; Kooiman, 1998) and criticism of alexithymia measures on the other (Rief, Heuser, & Fichter, 1996), there is a substantial overlap between emotional awareness and alexithymic characteristics. In the same vein, the strength of our study to cover the wide range of different symptom clusters of SSD-RC, is also a limitation. Different symptom clusters might have different associations with ER processes and thus findings might be difficult to summarize. Although there were no grossly apparent differences in terms of salience in the ER process between studies with SSD and studies with functional somatic syndromes and health anxiety, we did not examine this specifically and statistically in subgroup analyses. Therefore, grouping such different symptom patterns may have led to masking of specific abnormalities.

We excluded studies and results focusing on biological factors and correlates of ER in SSD-RC that could have additionally corroborated the questionnaire data and experimental studies. Studies with neuropsychological and psychophysiological measurements give clues to the biological basis of ER processes in the general population. Focusing on the identification stage, the anterior insular cortex appears to be a relevant correlate for emotional awareness (Gu, Hof, Friston, & Fan, 2013). Regarding the selection stage, neural bases of reappraisal and suppression are early and late prefrontal cortex responses, respectively, and decreased and increased amygdala and insula responses, respectively (Goldin, McRae, Ramel, & Gross, 2008). For the identification stage, HRV is often used as a relevant psychophysiological indicator of functional ER, as highly flexible autonomic nervous system is considered functional, because it can adapt rapidly to situational demands (Appelhans & Luecken, 2006). Greater success in ER is associated with greater amygdala inhibition and stronger inverse connectivity between the amygdala and several areas of the prefrontal cortex (H. Lee, Heller, van Reekum, Nelson, & Davidson, 2012). Future reviews should investigate these biological indicators of ER processes in SSD-RC and relate them to questionnaire and experimental data.

Our review also has some methodological limitations. First, it is limited to a narrative summary of the existing literature since the research so far is too heterogeneous and there are too few findings on the same paradigms and measures to be able to aggregate these meta-analytically in a meaningful way. Second, our taxonomy is a bottom-up classification of existing instruments measuring ER processes. We meticulously referred to theoretical categorizations and descriptions of the authors of the EPM, but future studies should go further and examine the factor structure of our taxonomy using a confirmatory approach.

5. Conclusion

The present review indicates that patients with SSD-RC show alterations in the process of ER. Existing literature shows deficits in the identification of emotional states and negative beliefs about emotions which indicate reduced self-efficacy expectations regarding ER. Both deficits in turn might impede the initiation of regulation or influence the evaluation when patients have to select the most promising regulation strategy and thus result in regulation difficulties. Furthermore, patients with SSD-RC seem to use ER strategies differently in daily life compared to control participants. Regarding the successful implementation of ER strategies, we found that self-report trait data provide indirect evidence

that patients are less effective in regulating negative emotions. However, studies comparing the state efficacy or success of ER between patients with SSD-RC and healthy participants in a laboratory setting are scarce. Therefore, we know little about the ability of patients to successfully implement ER strategies and it would be premature to assume clear deficits at this stage of ER. As for the selection and implementation stage, most of the ER alterations found were measured with questionnaires that mainly capture habitual tendencies. Thus, ER alterations in SDD-RC might affect typical performance more strongly (what individuals "will do") than maximum performance (what individuals "can do") (Cronbach, 1960; DuBois, Sackett, Zedeck, & Fogli, 1993). Experimental studies and particularly ecological momentary assessments are needed to better understand potential ER alterations and deficits in patients with SSD-RC. Since a non-negligible proportion of the included studies found no significant effects (in terms of group differences or associations), it cannot be assumed at this stage that the deficits found can be used as valid diagnostic markers. However, the deficits found could be relevant indicators of severity, as some included correlative studies in clinical populations showed, or prognosis, a topic on which future psychotherapy research should focus.

Following our results, clinical interventions should not only focus on ER training but also on mindfulness to successfully perceive the regulation needs and on psychoeducational elements to support patients in gaining more clarity and understanding about their own affective states and emotions. Additionally, these interventions should concentrate on dysfunctional cognitions regarding ER to improve self-efficacy and encourage a positive cost-benefit ratio in patients with SSD-RC to increase ER frequency in daily life (see also McRae & Gross, 2020). In terms of Gross' framework of the ER process (Sheppes et al., 2015), these skills are required in the identification stage. Furthermore, patients might benefit from improvements in the selection stage, since research shows positive effects of high regulation flexibility on psychological health (Kato, 2012). Supporting them to have sufficient ER strategies available in everyday life could improve ER success, as patients seem to be able to implement the strategies effectively when they are presented and explained. In conclusion, this review identifies ER difficulties in patients with SSD-RC and highlights new avenues for clinical applications of ER interventions.

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CRediT author statement

Katharina Schnabel: Conceptualization; Investigation; Formal Analysis; Methodology; Data Curation; Validation; Visualization; Writing - original draft; Project Administration; **Tara Petzke:** Formal Analysis; Writing - review & editing; **Michael Witthöft:** Supervision; Conceptualisation; Formal Analysis; Methodology; Visualization; Resources; Writing - review & editing. All authors have approved this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cpr.2022.102196.

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