The role of emotion regulation in the development, treatment, and prevention of youth psychopathology

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I, Bettina Moltrecht confirm that the work presented in this thesis is my own. Where

information has been derived from other sources, I confirm that this has been

indicated in the thesis.

Abstract

Past research has consistently highlighted the prominence of emotion regulation difficulties in the development, maintenance and treatment of psychopathology. However, especially for young people the evidence from longitudinal studies has been limited, partly due to a lack of appropriate measures and effective interventions. With respect to current prevalence rates of mental health problems in children and young people the present research aims to increase our understanding of the role of emotion regulation in the development, treatment and prevention of youth psychopathology.

The first part of the thesis consists of two main studies, which adopted two different statistical approaches to investigate the complex relationship between emotion regulation and psychopathology over time. Both studies utilized data from the UK's Millennium Cohort study, a national longitudinal study. Previous studies have not investigated the bi-directional effects between emotion dysregulation and psychopathology over childhood, as longitudinal studies were either under-powered or simply not available. Hence, the first study aimed to uncover the temporal dynamics between emotion regulation and psychopathology in childhood by conducting a developmental cascade model. The results of the cascade model demonstrated significant bidirectional effects between the two constructs over time. Subsequently, the second study investigated whether and how the two constructs overlap conceptually. A bi-factor analysis examined the level of distinctness and commonality between emotion regulation and psychopathology. The findings suggested a significant overlap between emotion dysregulation and psychopathological symptoms, thereby highlighting the potential of emotion regulation as a transdiagnostic intervention and prevention target.

The second part investigated the possibility of targeting emotion regulation difficulties in youth by developing and evaluating a newly mobile app intervention in the school context. An integrated design and development framework is presented that guided the development of the new intervention. In this part, the first study, a systematic review and meta-analysis summarised the effectiveness of existing interventions to improve emotion regulation in youth, and how these changes link to changes in psychopathological symptoms. Furthermore, a series of classroom observations, participatory co-design workshops and prototype testing sessions was conducted, of

which the results are presented and how they informed the design and development of the new mobile app intervention. The final study evaluated the usability and acceptability of the new digital intervention as part of an exploratory feasibility trail in primary schools. The results suggested adequate levels of acceptability and engagement from a user perspective. Areas for future improvements were identified. The findings of the school trial suggest that a digital intervention can be used to overcome common barriers that are associated with the implementation of more traditional school-based interventions, which have not been sufficiently adopted if they required too much teacher time or preparation. This is of significant importance, as schools are considered key players in providing mental health support for young people.

This research contributes to the current understanding of the complex relationship between emotion regulation and psychopathological symptoms in youth. The employed analytical approaches support the notion that emotion dysregulation processes are a central component in the development of youth psychopathology. The findings highlight new opportunities for the assessment of complex constructs as well as the treatment and prevention of mental health problems through technology-based interventions.

Impact Statement

It has been estimated that approximately 10-20% of children and young people children and young people worldwide experience mental health problems, making it one of the leading causes of disability for this population (Erskine et al., 2015; Kieling et al., 2011). Furthermore, prevalence rates of mental health problems in children and young people have been increasing in recent years (Patalay & Gage, 2019). Considering the significant impact of youth mental health difficulties on a wide range of other developmental outcomes (e.g., academic achievement, physical health; Catalino & Fredrickson, 2011; Izard et al., 2001), the human and economic costs of rising prevalence rates are substantial, calling for new, innovative approaches to tackle this problem.

The present research addresses these problems in two ways. First, a newly developed mobile app was developed and evaluated in the school context. In doing so, the present research provides an integrated framework that can be used by other mental health professionals and researchers as guidance to enhance the existing intervention further or to develop other useful digital interventions for children and young people. Furthermore, the present research shows that a digital intervention can be used to overcome common barriers frequently associated with the implementation of more traditional school-based interventions, which, if they require too much preparation or time from teachers, are not sufficiently adopted. These findings are of significant importance, as schools have been identified as an ideal setting to provide mental health support to children and young people (Caan et al., 2015; Stephan, Weist, Kataoka, Adelsheim, & Mills, 2007), as they help overcome social and environmental barriers to accessing community-based mental health services, such as family demographic factors, transport and social stigma around mental health (Memon et al., 2016; Weist & Evans, 2005).

Secondly, the present research adds to existing developmental psychopathology research by providing new evidence for the close relationship between emotion regulation and psychopathology in childhood and highlighting new directions for future research. Previous studies have not investigated the bi-directional effects between emotion dysregulation and psychopathology over childhood, as longitudinal studies were either under-powered or simply not available. By showing that emotion

dysregulation and psychopathology are closely connected not only over time, but also conceptually, the present research highlights the importance of addressing emotion regulation as a transdiagnostic factor in current youth mental health prevention and treatment programmes. This again supports the notion of transdiagnostic interventions representing promising opportunities to effectively support young people's mental health with a wider range and level of symptoms (Forbes, Rapee, & Krueger, 2019; Meier & Meier, 2018).

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List of Abbreviations

ART	Affect Regulation Training
BC	Bootstrap corrected
CBCL	Child-Behavior Checklist
CBT	Cognitive Behaviour Therapy
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CI	Confidence intervals
CSBQ	Child Social Behaviour Questionnaire
CO	Cooperative inquiry
DBT	Dialectic-behavioural therapy
DERS	Difficulties in Emotion Regulation Scale
DP	Dysregulation Profile
DSM 5	Diagnostic and Statistical Manual of Mental Disorders
ECV	Explained common variance
EFA	Exploratory Factor Analysis
ED	Emotion Dysregulation
EPHPP	Effective Public Health Practice Project Quality Assessment tool
ER	Emotion regulation
EXT	Externalizing Symptoms
HCI	Human Computer Interaction
HIFQ	How I feel - Questionnaire
ICD	International Classification of Diseases
INT	Internalizing Symptoms
K6	Kessler 6
MCS	Millennium Cohort Study
ML	Maximum likelihood estimation
MRC	Medical research council
NE	Negative Emotion
NVQ	National Vocational Qualifications
PCD	Patient-Clinician-Designer
PE	Positive Emotion

PI	Prediction Interval
PPI	Patient and public involvement
RCT	Randomized-control-trials
RMSEA	Root mean square error of approximation
SDQ	Strengths and Difficulties Questionnaire
SEL	Social emotional learning
SMFQ	Short Moods and Feelings Questionnaire
SR	Self-regulation
SWLS-C	Satisfaction with life scale for children
TLI	Tucker-Lewis index
UP	Unified Protocol for Transdiagnostic Treatment
WLSMV	Weighted least square means and variance estimator

Publications and conference presentations associated with this thesis

Journal articles

Moltrecht, B., Deighton, J., Patalay, P., & Edbrooke-Childs, J. (2020). Effectiveness of current psychological interventions to improve emotion regulation in youth – a meta-analysis. *European Child and Adolescent Psychiatry*, 1–20. https://doi.org/10.31234/osf.io/3yxcp

Conference presentations

"Eda: A new mobile app to improve emotion regulation in youth". Oral presentation 5th International Conference on Youth Mental Health. Brisbane, Australia, October 2019.

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Statement of Funding

Thesis structure and objectives

The present research involves a series of studies that aim to explore the relationship between emotion regulation and youth psychopathology within a developmental framework by employing a diverse set of methodological approaches.

Part I.

Chapter 1 summarises the existing literature on emotion regulation in relation to youth psychopathology and provides an overview of the relevant developmental theories, conceptual understandings and common methodological challenges in emotion regulation research.

The subsequent Chapters 2 - 4 explore potential temporal and conceptual relationships between emotion regulation and psychopathology, for which I utilised data from a national, longitudinal cohort, the Millennium Cohort Study (MCS).

Chapter 2 introduces the MCS dataset and provides relevant methodological information, including sample characteristics and measurements used. In relation to that it psychometrically validates the employed emotion regulation measure, which has not been previously validated nor extensively used in past studies.

Chapters 3 and 4 consist of two studies, for which I adopted two different statistical approaches in order to investigate the complex relationship between emotion regulation and psychopathology over time. The first study uncovers the temporal dynamics between emotion regulation and psychopathology in childhood by conducting a developmental cascade model and examining potential direct or bidirectional effects between the two constructs. Subsequently, the second study unpacks the conceptual relationship between emotion regulation and psychopathology, by putting a greater focus on the psychometric aspects of the two constructs and the way they are commonly assessed. A bi-factor analysis was performed to examine the level of shared variance between emotion regulation and psychopathology. In doing so I also explored the suitability of emotion regulation as a transdiagnostic factor.

Chapter 5 provides a summary of the findings of Part I and proposes relevant conclusions.

Part II.

The second part of the thesis investigates the relationship between emotion regulation and psychopathology in youth from a prevention and treatment perspective by examining potential changes in emotion regulation in response to psychological interventions that target emotion regulation or psychopathology, or both. The primary focus of this part is the development and pilot-testing of a new mobile app that aims to enhance emotion regulation abilities in children.

Chapter 6 summarises the relevant literature on youth mental ill-health, with a specific focus on digital mental health interventions and their potential to support young people's mental health. With respect to the primary focus of this part of the thesis - the development and design of a new emotion regulation app - I introduce the interdisciplinary design approach, which informed the sequence of the following studies.

Chapter 7 introduces the interdisciplinary framework that guided the development and design process of the mobile intervention and described the stage-wise development process including the employed methodology

Chapter 8 involves a systematic review and meta-analysis that summarise the effectiveness of existing psychological interventions to improve emotion regulation in youth and how potential changes in emotion regulation relate to changes in psychopathology. Implications for the app intervention content are presented.

Chapter 9 summarises the outcomes of my school and classroom observations, the participant involvement events as well as the co-design and prototype testing sessions. I show how these inform specific design features in the app intervention and describe the resulting intervention components in more detail.

Chapter 10 presents the results of a feasibility trial that was conducted with four primary schools in the UK to evaluate the usability and acceptability of the new app intervention and to inform a potential future randomised control trial

Part I: Emotion regulation in the development of psychopathology: unpacking a complex relationship

Chapter 1: Definition, models and challenges in emotion regulation research

1.1 Introduction

It is widely accepted that emotions facilitate adaptive functioning by activating a variety of response processes (physical as well as psychological) that help the individual to act effectively (Gross & Thompson, 2014). However, if emotional reactions are too intense, prolonged, or do not match a particular situation, their impact may be harmful (Cole, Hall, & Hajal, 2017). Thus, for emotional reactions to be adaptive, effective emotion regulation is necessary. Emotion regulation refers to a variety of processes that increase, decrease, or maintain an emotional reaction (Gross & Thompson, 2014). These processes consist of physiological, experiential, behavioural, and psychological components (Werner & Gross, 2010).

Research has shown that effective emotion regulation promotes adaptive functioning while deficient emotion regulation may lead to increased and/or prolonged physical as well as psychological distress (Beauchaine, 2015; Gross & Levenson, 1993), thereby heightening the risk of developing significant psychopathological symptoms (Aldao, Nolen-Hoeksema & Schweizer, 2010; Berking et al. 2008; Gross & Muñoz, 1995). With growing evidence highlighting the significance of emotion regulation in the diagnosis, development and treatment of psychopathologies, emotion regulation concepts have increasingly influenced a wide array of mental health research and practice. However, despite a vast number of publications reporting on the importance of emotion regulation in psychopathology each year, the field is still lacking consensus regarding the definition of emotion regulation (Gross, 2013; Thompson, 2011).

The present chapter aims to provide a comprehensive overview of existing emotion and emotion regulation concepts, their core features, and how emotion regulation research has shaped our understanding of the development and treatment of psychopathology.

1.1.1 Emotion

One of the most challenging endeavours in the field of emotion and emotion regulation research has been the definition of what an emotion is and what it entails. Historically, there have been two main perspectives regarding the theoretical definition of emotion. Structuralists have regarded emotions as discrete entities and suggested a set of basic, universal emotions. According to this approach each emotion is thought to consist of a coherent constellation of physiological, cognitive, subjective and behavioural

activities (Ekman, 1992). From a functionalist's perspective, however, emotions have been defined as human reactions to external stimuli that facilitate adaptive functioning by activating a variety of physical and psychological response processes, which in turn help the individual to adaptively react and achieve their goals (Gross, 1998).

Acknowledging the difficulties of developing one concrete definition, Gross and Thompson (2007) proposed a set of core features of emotion. The first feature identifies when emotions occur: when an individual enters a situation and appraises it as being relevant to the achievement of a meaningful, personal goal. The second core feature relates to emotions being multi-faceted phenomena that involve experiential, behavioural and physiological response processes, which initiate certain action tendencies in an individual. Lastly, once an emotion is elicited it does not follow a fixed course, emotions are malleable, influenced by various internal and external factors. Based on these core features Gross and Thompson (2007) formulated the modal model of emotion (see Figure 1.1.). It presents the timely development of an emotion in four stages: 1) entering a situation, 2) paying attention to stimuli in the situation, 3) appraising the situation and 4) eliciting the emotional response.
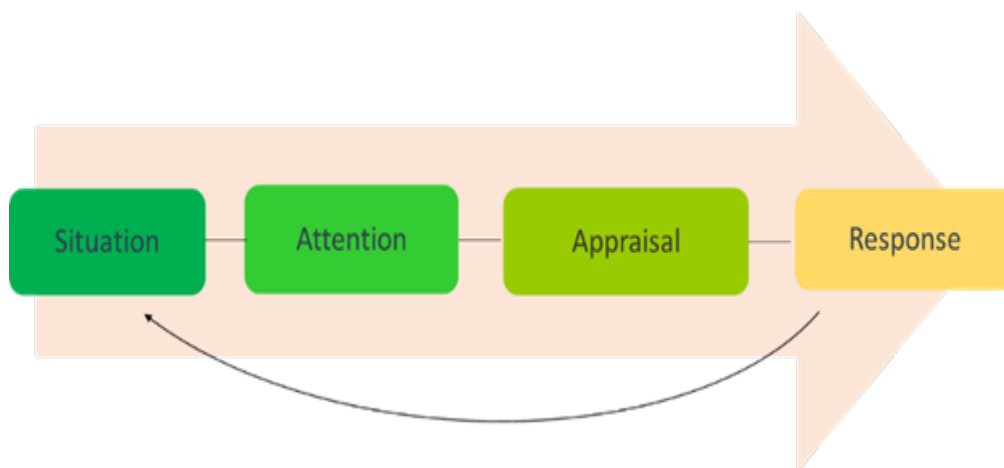
Figure 1.1 Modal model of emotion as proposed by Gross and Thompson

According to this model, an emotion begins with a personally relevant situation ("Stephen enters the playground"). Once in the situation we pay attention to certain aspects of it ("He looks out for his friends who wave at him"), which are then appraised for their relevance to goal attainment ("having fun with his friends"). This in turn elicits a range of response tendencies in us ("Stephen sees his friends, smiles and runs over to them"). Finally, the way in which we respond to a particular situation in the

first place ("Stephen approaches his friends" vs "Stephen runs away") can change certain aspects of that situation, which again has an influence on subsequent attention, appraisal and response processes.

1.1.2 Emotion regulation

Emotion research has been influenced by various, co-occurring approaches (e.g., structuralist and functionalist) and sub-approaches, which colour the definitional disparities in the field to date. As a result of the ambiguity around the definition of emotions, the concept of emotion regulation also faced significant definitional challenges (See Table 1.1 for an overview). It starts with the debate whether emotion and emotion regulation can be regarded as two distinct phenomena and continues with a list of internal and external processes by which emotional responses might be modified.

1.1.2.1 Emotion regulation as a function

Due to the definitional shift in the emotion literature from a structuralism to a functionalism perspective, emotion regulation started to gain popularity amongst developmental psychologists around 30 years ago. This group of researchers investigated which factors in child development determined adaptive and maladaptive outcomes (Campos, Campos, & Caplovitz Barrett, 1989; Thompson, 1994; Thompson & Calkins, 1996) and emotion regulation was assumed to be one of these determining factors.

An early definition by Cicchetti and colleagues regarded emotion regulation as "the intra- and extra-organismic factors by which emotional arousal is redirected, controlled, modulated, and modified to enable an individual to function adaptively in emotionally arousing situations" (Cicchetti, Ganiban, & Barnett, 1991, p.15). Later on, Thompson (1994) expanded this definition and described emotion regulation as "the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals "(pp.27-28). According to Thompson, for emotions to be adaptive, emotional responses need to be flexible and susceptible to fast changing needs in a situation, which could be achieved by emotion regulation processes. Furthermore, he emphasized that goal attainment is a central aspect of emotion regulation, as the presence of such goals is the motivating factor in any regulatory effort.

Exactly 10 years after Thompson had published his definition, Cole, Martin and Dennis (2004) reviewed the literature and showed that hundreds of papers had used the term emotion regulation in various direct and indirect ways. In most cases though a clear definition was not provided. Some researchers had referred to processes by which emotions had an impact on other psychological processes (e.g., cognition), while others treated it as a trait (e.g., temperament) or state and others again questioned whether emotion regulation refers to a process or an outcome (also see section 1.4). Cole and colleagues (2004) broadly defined emotion regulation as "the changes associated with activated emotions" and differentiated between "emotion as regulating", (changes as a result of activated emotion) and "emotion as regulated" (changes to the activated emotion). Their definition was challenged by Eisenberg and Spinrad (2004), who argued that it was too broad and did not sufficiently address the role of personal goals in the emotion regulation process. Eisenberg, Spinrad and colleagues (2004) introduced the term *emotion-related self-regulation,* with which they wanted to demonstrate that the regulation process incorporates multiple elements that facilitate effective functioning, including cognition, attention and behaviour. Furthermore, they emphasised the difference between internal and external regulation, whereby external regulation, which is particularly relevant during childhood, is primarily driven by external factors like parents, teachers and peers. Internal regulation on the other side entails a variety of cognitive and behavioural strategies that the person itself employs to modify an emotional response.

1.1.2.2 Emotion regulation strategies

Concurrent with the growing interest in emotion regulation in childhood development, an increasing number of researchers started to investigate emotion regulation processes in adults, which resulted in one of the most influential concepts of emotion regulation to date: *The Process Model of Emotion Regulation* by James Gross (Gross, 1998; Webb, Miles, & Sheeran, 2012). Gross (1998) described emotion regulation as the "processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (p.275). Gross' categorised these processes based on the modal model of emotion that was described earlier (See Figure 1.1). According to the process model of emotion regulation, as shown in Figure 1.2, an emotional experience can be modified at different time points throughout the emotion regulation process by implementing different strategies

(Gross, 1998, 2002; Werner & Gross, 2010). These strategies have been clustered into five families based on the point in time at which they are commonly applied.

The first four families have been classified as antecedent-focused emotion regulation strategies, which are applied before the emotional response has fully developed. During the early stages of the emotion regulation process (i.e., *situation selection*), an individual has the option to either enter or avoid a situation that is perceived as having the potential to elicit unpleasant emotions. In other words, by avoiding the emotion-eliciting stimuli (e.g. a particular person, object or activity), the individual averts the emotional response. If, however, a situation has already been entered, the individual can modify its emotional impact through *situation modification*. For instance, when facing a difficult situation one can change the situation by directly asking for help or by expressing one's fear to communicate the need for help to others. In the next stage, *attentional deployment*, the individual can determine its impact by focusing only on certain aspects of the situation. Attentional deployment includes strategies like distraction, rumination and concentration. By engaging in one of these strategies, certain aspects of the situation acquire greater significance than others. Subsequently, this has an impact on the evaluation process, in which the attended aspects guide the individual with the interpretation and evaluation of a situation's significance. At this stage (i.e., *cognitive change*), the individual can attempt to cognitively change the situation's meaning in order to reconfigure its emotional impact (e.g. amplifying or diminishing the personal significance). Strategies such as cognitive reappraisal or catastrophizing can lead to cognitive change. The fifth family, *response modulation*, belongs to the response-focused strategies. These strategies are used after the emotion has been generated and aim to modify the emotional response. This can include experiential, physiological or behavioural components, such as the suppression of emotion-expressive behaviours, crying and shouting, or maladaptive behaviours like self-harm.
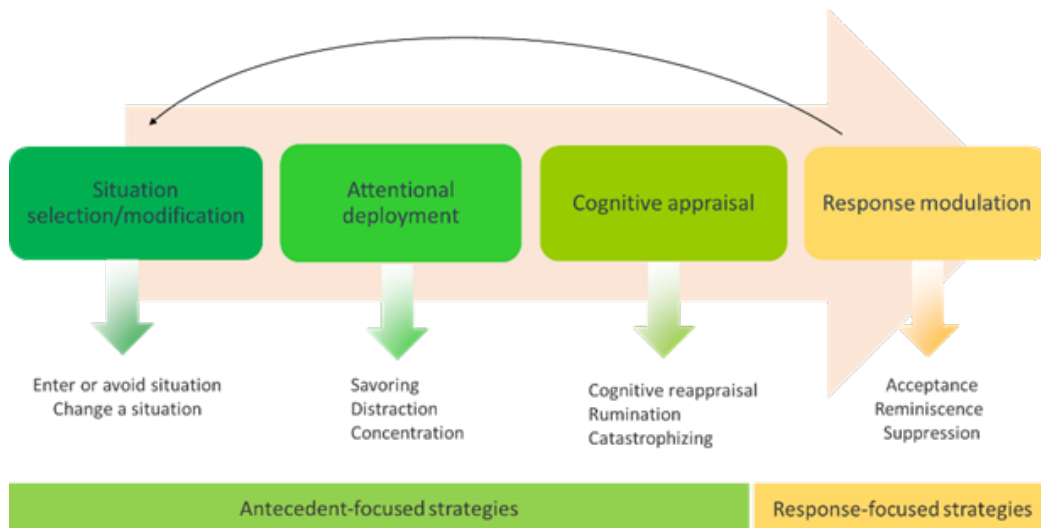
Figure 1.2 Process model of emotion regulation (adapted) by Gross and Thompson, (2007).

Gross, approached emotion regulation from a social psychology perspective. He conducted a series of studies to compare the effectiveness of different strategies, especially cognitive *reappraisal* and *suppression* (Gross, 1998, 2002). He instructed participants to either reappraise or suppress their emotional responses, while they were watching an emotion eliciting film-clip. The results indicated that participants in the suppression condition showed less emotional expression, but experienced as many negative emotions, as the control group. Reappraisers also showed less emotional expressive behaviours but reported less negative emotional experience. These results showed further support for psychophysiological studies demonstrating that the suppression of negative emotions resulted in increased physiological distress indicated by elevated cardiovascular and electrodermal measures (Gross & Levenson, 1993; Gross, 1998). Other researchers found that suppression was also more cognitively demanding. Richards and Gross (2000) presented participants with slides that elicited either strong or weak negative emotions. Participants were instructed to suppress, reappraise or simply observe the pictures. A subsequent memory test indicated that participants in the suppression condition had significantly greater decrements in their memory functioning than the control and reappraisal group. The results reported by Gross (1998, 2002) and others (Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Gross & Richards, 2000; Gross & Levenson, 1993) suggested that suppression could be categorised as a maladaptive strategy, while reappraisal was referred to as an adaptive strategy. Gross (1998, 2002) focused primarily on the suppression of

expressive emotional behaviours, while others concentrated on the effects of suppressing unwanted thoughts, emotions, sensations or memories (Salters-Pedneault, Steenkamp & Litz, 2009). The latter group also found that the suppression of thoughts and emotions was related to decreased positive emotional experiences, increased negative emotional experiences, and symptoms of psychological and physiological distress (Campbell-Sills et al., 2006a; Gross & Levenson, 1993; Wenzlaff & Wegner, 2000). Over the years, emotion regulation researchers have identified and investigated the effectiveness of various emotion regulation strategies and their impact on mental health outcomes. In doing so, the researchers also identified various sub-types of each strategy (see Webb et al., 2012). Section 1.2.3 discusses this research in more detail.

In 2007, Gross and Thompson attempted to combine their definitions of emotion regulation. The main differences were that Gross had put a greater focus on internal factors, while Thompson, due to his developmental background, highlighted the importance of external factors, like parents and peers, in the emotion regulation process (Gross & Thompson, 2007). Both authors agreed that emotion regulation processes are automatic, controlled, conscious, and unconscious. That they may interfere at multiple points, even simultaneously, and comprise the emotion generation and regulation process, to ultimately influence emotions in oneself, others or both.

Recently, Gross introduced the *Extended Process Model of Emotion Regulation* (Gross, 2015; Sheppes, Suri, & Gross, 2015). The new model was an extension of the original, for which the main focus was emotion regulation processes that occur after an emotion has been generated. The extended model also considered the emotion generation process. This involved a greater emphasis on *subjective valuation processes*, which give rise to subsequent *action* processes. Actions that are taken in order to overcome perceived discrepancies between a current and a desired state. By proposing this new model Gross aimed to overcome the persistent debate of whether emotion regulation and generation are two separate phenomena. Furthermore, it allows the incorporation of situational factors, which have the potential to influence the subsequent strategy selection process.

1.1.2.3 Emotion regulation as skills and deficits

With the increasing evidence demonstrating the effects of emotion regulation on cognitive and behavioural outcomes, a new line of research aimed to approach emotion

regulation from a clinical perspective. Gratz and colleagues argued that existing emotion regulation definitions had limited utility for the clinical context (Gratz & Roemer, 2004; Gratz, Weiss, & Tull, 2015). They reviewed past emotion regulation concepts and developed a new Difficulties with Emotion Regulation Scale (DERS; Gratz & Roemer, 2004), which was assumed to assess the more clinically relevant aspects of emotion regulation. Similar to developmental researchers, Gratz and Roemer put the focus on the functional aspects of emotion regulation and how these facilitate adaptive functioning. According to their new conceptualization for an individual to be able to effectively regulate an emotion certain abilities are needed, of which one or more seem to be lacking in individuals with mental health difficulties: (a) awareness and understanding of emotions, (b) acceptance of emotions, (c) ability to control impulsive behaviours and to behave in accordance with desired goals when experiencing negative emotions, and (d) ability to use situationally appropriate emotion regulation strategies in a flexible manner to modulate emotional responses as desired in order to meet individual goals/situational demands. Gratz and Roemer further explained that their definition was influenced by Saarni's work on *emotional competence* (Saarni, 1999), which described a set of emotional competence skills including: a) the ability to be aware and understand one's own and other people's emotions, b) being empathically involved and able to engage in emotional communication with others, c) being able to differentiate between internal emotional experiences and external emotional expression, and d) the capacity to adaptively cope with negative or stressful experiences.

Similarly, Berking (2007), who had worked with clinical adult populations, proposed a model of nine emotion regulation skills that promote adaptive emotion regulation: a) being aware of emotions, b) ability to identify and label emotions, c) correct interpretation of emotion-related bodily sensations, d) understanding the prompts of emotions, e) self-compassion in distressing situations, f) active modification of emotions to feel better, g) emotional acceptance, h) tolerating negative emotions, and lastly i) to encounter emotionally distressing situations to reach important goals. According to Berking not all of the nine skills are equally important, only the abilities to modify emotions and/or accept and tolerate them are essential to maintaining good mental health, whereas the other six help promote successful emotion regulation. Berking and colleagues (2008) tested the relationship between the nine emotion

regulation skills, mental health and treatment outcomes and found that modification, acceptance and tolerance of negative emotional experiences were especially important for mental health and treatment outcomes. They even found that replacing some parts of a standardized cognitive-behaviour therapy (CBT), with emotion regulation training led to better treatment and mental health outcomes. Based on these findings Berking and Lukas developed the *Affect regulation training* (Berking & Lukas, 2015), which targets emotion regulation deficits as they are frequently seen across various mental disorders. Berking and others have repeatedly highlighted the role of emotion regulation as a transdiagnostic (i.e., cutting-across multiple diagnostic categories) mechanism in psychopathology. This approach seems highly compatible with the clinical picture that is often seen in youth populations, which is marked by high comorbidity rates and frequent transitions from one disorder to another.

Table 1.1 Emotion regulation definitions found in the current literature

Author	Emotion regulation definitions
Cicchetti, Ganiban and Barnett, 1991, p. 15	The intra- and extra-organismic factors by which emotional arousal is redirected, controlled, modulated, and modified to enable an individual to function adaptively in emotionally arousing situations.
Thompson, 1994, pp.27 - 28.	Emotion regulation consists of the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals.
Gross, 1998, p.275	The process by which individuals influence which emotions they have, when they have them and how they experience and express these emotions
Eisenberg and Morris, 2002, pp. 190	Emotion regulation in defined as the process of initiating, maintaining, modulating, or changing the occurrence, intensity, or duration on internal feeling states and emotion-related motivations and physiological processes, often in the service of accomplishing one's goals.
Cole, Martin and Dennis, 2004, p 320.	Emotion regulation refers to changes associated with activated emotions. These include changes in the emotion itself (e.g., changes in intensity, duration) or in other psychological processes (e.g., memory, social interaction).The term emotion regulation can denote two types of regulatory phenomena: emotion as regulating and emotion as regulated. Emotion as regulating refers to changes that appear to result from the activated emotion. Emotion as regulated refers to changes in the activated emotion. These include changes in emotion valence, intensity, or time course and may occur within the individual or between individuals.
Eisenberg and Spinrad, 2004, p.338.	Emotion-related self-regulation: the process of initiating, avoiding, inhibiting, maintaining, or modulating the occurrence, form, intensity, or duration of internal feeling states, emotion-related physiological, attentional processes, motivational states, and/or the behavioural concomitants of emotion in the service of accomplishing affect-related biological or social adaptation or achieving individual goals.

Campos, Frankel and Camras, 2004, p. 380.	Emotion regulation is the modification of any process in the system that generates emotion or its manifestation in behaviour. The processes that modify emotions come from the same set of processes as those that are involved in emotion in the first place. An exception is when a social agent, often mobilized by his or her own emotions, intervenes to address one's problem. Regulation takes place at all levels of the emotion process, at all times the emotion is activated, and is evident even before an emotion is manifested.
Gratz and Roemer, 2004, p.42.	Emotion regulation may be conceptualized as involving the (a) awareness and understanding of emotions, (b) acceptance of emotions, (c) ability to control impulsive behaviours and behave in accordance with desired goals when experiencing negative emotions, and (d) ability to use situationally appropriate emotion regulation strategies flexibly to modulate emotional responses as desired in order to meet individual goals situational demands.
Aldao, 2013, p.155.	Emotion regulation has been conceptualized as a process by which individuals modify their emotional experiences, expressions, and physiology and the situations eliciting such emotions in order to produce appropriate responses to the ever-changing demands posed by the environment.
Beauchaine 2015, p. 876.	Emotion *dysregulation* can be described as a pattern of emotional experience and/or expression that interferes with appropriate goal-directed behaviour

1.2 Evidence for the links between emotion regulation and psychopathology

Research has provided consistent evidence for the link between emotion regulation and psychopathology. This relationship has been investigated in many ways, partly as a result of the various conceptualizations and partly due to different methodological approaches that were typical for the field. However, the following two conceptual frameworks have convened the largest amount of evidence to date (Bardeen & Fergus, 2014):

1.2.1 Framework one: Emotion regulation strategies

As described earlier, Gross' process model of emotion regulation proposes a set of strategies, which are employed to modify emotional experiences. Over the past years, a growing body of research has suggested that certain emotion regulation strategies are associated with psychopathological symptoms. Most of the evidence on emotion regulation strategies stems from research that has been conducted with adult populations. Recently however, there has been an increase in studies involving youth populations.

1.2.2 Framework two: Emotion regulation skills and deficits

The second framework focuses on research studies with a more clinical outlook. It is based on Gratz and Roemer's conceptualisation of emotion regulation difficulties and related research (e.g., Berking & Wupperman, 2012; Berking et al., 2008; Mennin, Holaway, Fresco, Moore, & Heimberg, 2007; Saarni, 1999) on emotion understanding, awareness and acceptance, as well as the access to and flexible use of effective strategies. Conceptually, Berking's definition of emotion regulation skills (Berking & Wupperman, 2012) also falls into this framework; however, existing studies have only been conducted with adult samples and are therefore not discussed in this chapter. Chapter 4 in this thesis provides further insights to their work when existing interventions to enhance emotion regulation skills are reviewed.

There is empirical and conceptual evidence that the two frameworks tap into different aspects of emotion regulation research. Hence, I decided to use these two frameworks as guidance to review the literature, in order to provide a comprehensive picture of the current evidence (Bardeen & Fergus, 2014).

1.2.3 Emotion regulation strategies and psychopathology

A range of emotion regulation strategies and processes have been identified thus far (Table 1.1), each of them having the potential to benefit the individual if applied in the right way and context (Augustine & Hemenover, 2009; Coifman & Bonanno, 2010). Researchers have commonly tried to categorise emotion regulation strategies into adaptive or maladaptive strategies based on their effectiveness to reduce negative emotional experiences, which was long presumed to be a primary goal of emotion regulation (Aldao, Nolen-Hoeksema, & Schweizer, 2010).

One of the most comprehensive systematic reviews by Aldao et al. (2010) looked at the relationship between six emotion regulation strategies and four different psychopathologies: depression, anxiety, eating disorders, and substance abuse (See Table 2 for definition of emotion regulation strategies). The authors found that the six strategies - avoidance, problem-solving, reappraisal, suppression, rumination and acceptance - were all associated with the four different types of psychopathology. More specifically though, they found that avoidance and suppression were positively associated with anxiety, depression and eating disorders, while rumination was positively associated with anxiety, depression, eating, and substance-abuse disorders. Problem-solving and reappraisal correlated negatively with all four psychopathologies (i.e., anxiety, depression, eating, and substance abuse), while acceptance showed no significant association with depressive or anxiety symptoms (insufficient data was available for substance-abuse or eating disorder symptoms). Further moderator analyses demonstrated that age (child vs. adult) significantly moderated the association between suppression, problem-solving, and depression, but not for rumination and depression. Their systematic review was primarily based on data from adult studies (12 studies included children, while more than 100 involved adults). However, similar patterns have been reported for studies investigating younger populations (Rood, Roelofs, Bögels, Nolen-Hoeksema, & Schouten, 2009; Schäfer, Naumann, Holmes, Tuschen-Caffier, & Samson, 2017). Schäfer and colleagues (2017) summarized the evidence for different ER strategies in relation to sub-clinical symptoms of anxiety and depression in youth. They found that depression and anxiety had the strongest positive association with avoidance and rumination and the strongest negative association with acceptance. Since their review focused on adolescents in the ages of 13 to 18 years

with sub-clinical symptoms, no conclusions could be made regarding younger groups or those displaying severe clinical symptoms.

Rumination has been extensively studied in relation to the development and maintenance of anxiety and depression (Campbell-Sills, Barlow, Brown, & Hofmann, 2006b; Kirkegaard Thomsen, 2006; Nolen-hoeksema, Wisco, & Lyubomirsky, 2008). It has been criticised that in comparison to the adult literature, research on rumination with youth has been limited (Baiocco et al., 2017) due to a lack of appropriate measures for this age group. A meta-analysis by Rood et al. (2009) reviewed the evidence for studies involving non-clinical child and adolescent samples and concluded that rumination was significantly associated with concurrent and future levels of depression. Further studies have highlighted rumination as a significant risk factor for the development of substance abuse (Nolen-Hoeksema, Stice, Wade, & Bohon, 2007), eating disorders (Smith, Mason, & Lavender, 2018) and self-harming behaviour in adolescents (Nolen-Hoeksema et al., 2007).

Suppression of emotional expression, feelings, or thoughts has also been emphasised to play a key role in anxiety, depression, and eating disorders (Magee, Harden, & Teachman, 2012). It has long been suggested that in clinical samples suppression of thoughts or feelings is followed by a rebound effect, leading to an even greater occurrence of these thoughts or feelings, than in non-clinical samples. A recent meta-analysis by Magee and colleagues (2012), however, found that suppression and subsequent effects were of similar magnitude amongst both healthy and clinical groups. The authors suggested that the positive or negative interpretation of recurring thoughts (e.g., "I shouldn't be having these thoughts") determines the ultimate negative impact of suppression on an individual's mental health.

Another strategy, very similar to suppression, is experiential avoidance, which has been described as the tendency to avoid certain psychological experiences (e.g., thoughts, emotions, sensations, memories) as an attempt to modify their impact (Hayes, Wilson, Gifford, Follette, & Strosahl, 1996). Similar to suppression, it has been stated that avoidance strategies seem to work well in the short-term, but have disadvantageous long-term effects by exacerbating the initial experience that an individual is trying to avoid (Hayes et al., 1996). Studies investigating the effects of experiential avoidance on child and adolescence mental health have been neglected so far. A few however have reported that experiential avoidance mediated the relationship

between childhood maltreatment and post-traumatic stress disorder (Shenk, Putnam, & Noll, 2012) and borderline personality disorder (Armey & Crowther, 2008). Numerous clinical investigations with adults have reported that experiential avoidance is a major underlying factor of various psychopathologies (e.g., depression, anxiety and substance abuse see Chawla & Ostafin, 2007 for a review), thereby making it a promising target component in newer psychological interventions, such as Acceptance and Commitment therapy (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). Acceptance, frequently thought of as a counter strategy of avoidance, is assumed to be an adaptive strategy, due to its proposed positive effects on mental health (Swain, Hancock, Hainsworth, & Bowman, 2015a).

Within the range of adaptive emotion regulation strategies, research has focused primarily on acceptance, problem-solving, and cognitive reappraisal. Evidence from adult studies has shown that adaptive strategies reduced the subjective experience of negative emotions (Goldin, McRae, Ramel, & Gross, 2008) and that problem-solving and cognitive reappraisal were negatively associated with psychopathological symptoms (Aldao & Nolen-Hoeksema, 2012b; Aldao et al., 2010). However, it was also pointed out that the association between adaptive strategies and psychopathological symptoms was weaker than for maladaptive strategies (Aldao et al., 2010) and that the use of adaptive strategies did not predict future levels of psychopathological symptoms (Aldao & Nolen-Hoeksema, 2012b).

Interestingly, research conducted with school-aged children has provided opposite results in that adaptive strategies, including problem-solving and acceptance, were significantly associated with both internalizing and externalising symptoms, while none of the maladaptive strategies (i.e., giving up, withdrawal preservation) showed this association (Braet et al., 2014). Besides looking at the relationship within the broad domains of internalizing and externalizing symptoms, Braet and colleagues (2014) also investigated emotion regulation patterns in relation to specific symptoms clusters (i.e., affective problems, anxiety problems, somatic problems, attention-deficit (hyperactivity) disorder, conduct problems, and oppositional-defiant problems). They found that attention-deficit (hyperactivity) disorder and conduct symptoms were characterised primarily by "giving up", while affective problems were characterised by maladaptive "self-devaluation" and somatic problems by adaptively approaching situations with "good humour". The researchers also found that depressive symptoms

correlated positively with maladaptive strategies (e.g., giving up, withdrawal, and perseveration) and negatively with adaptive strategies (i.e., problem-solving, distraction, humour, acceptance, and revaluation). In line with these results, another study compared the use of emotion regulation strategies in children with and without attention-deficit (hyperactivity) disorder symptoms, and found that adaptive strategies explained more of the differences between the two groups than the maladaptive emotion regulation strategies (Schmitt, Gold, & Rauch, 2012).

Although emotion regulation research with youth populations is still in its infancy, the evidence summarized above highlights the significant differences in the "emotion-regulation-and-psychopathology" relationship between children and adults. Both lines of research have contributed to the consistent evidence base demonstrating that specific emotion regulation strategies are more commonly applied by individuals with certain mental health disorders.

The continuing attempt by researchers to categorise emotion regulation strategies into "good" or "bad" has been highly criticised, initiating a debate as to what "good" and "bad" even means. Is acceptance a "good" or "adaptive" strategy as long as it down-regulates a negative emotion? What about the few incidences where it merely maintains the emotional experience or benefits only those who are healthy (Aldao & Mennin, 2012)? In an attempt to answer some of these questions Webb and colleagues (2012) conducted a meta-analysis to summarise the effectiveness of different strategies to change an emotional outcome. They identified nuanced differences (e.g., suppressing an emotional expression versus suppressing the experience of an emotion) within each strategy that determined whether a strategy was effective or not. The tendency to not differentiate between these subtypes might explain some of the mixed findings across studies, with some of them finding that a putatively adaptive strategy like reappraisal can have detrimental effects as well (Webb et al., 2012).

Others have emphasized the importance of contextual aspects, which can determine whether a strategy is adaptive or not. For instance, a study by Troy, Shallcross and Mauss (2013) found that cognitive reappraisal was associated with lower levels of depression in adults reporting uncontrollable levels of stress, whereas for participants with controllable stress levels, cognitive reappraisal was linked to greater depression. The authors concluded that in situations with possibly controllable stressors (e.g., new child rearing responsibilities), it might be more effective to change the situation than

the emotion itself, while in the context of uncontrollable stress (e.g., illness), it might not be possible to change the situation easily, so it might be more beneficial to change the emotion that is associated with the stressor. Another study reported different effects of experiential avoidance on subsequent social anxiety levels, which depended on the type of social interaction that participants were exposed to prior to a lab task (Kashdan et al., 2014). In their study, Kashdan and colleagues (2014) showed that participants exposed to a more intimate self-disclosure condition showed greater social anxiety in the subsequent lab task, compared to participants who had been assigned to a small-talk condition, which was less socially intimate.

These and other studies have demonstrated that the putative adaptive or maladaptive effects of emotion regulation strategies are highly dependent on the context in which they are applied (Aldao, 2013; Aldao & Nolen-Hoeksema, 2012a; Dixon-Gordon, Aldao, & De Los Reyes, 2015a). Following this, it was soon pointed out that the ability to flexibly employ different strategies in response to changing situational demands might be more relevant than the mere frequency with which adaptive or maladaptive strategies are applied (Aldao, Sheppes, & Gross, 2015; Bonanno & Burton, 2013). A cross-sectional study by Zimmermann and Iwanski (2014) investigated the use of seven emotion regulation strategies in nine different age groups, ranging from 11 to 50 years. The results demonstrated differences in the use of emotion regulation strategies over time and depending on the emotion for which the strategies were applied for. More specifically, they found that during middle adolescence (age 15) participants reported the least use of emotion regulation strategies, compared to early (age 11), and late adolescents (age 17) when experiencing sadness or anger. For fear, middle adolescents only used fewer emotion regulation strategies compared to the older age groups. Their study however, was not able to link any of these patterns to existing mental health measures. To my knowledge, there has been no study thus far that investigated the flexible use of certain emotion regulation strategies in (clinical) youth samples. However, developmental and clinical researchers, like Thompson in 1994 and ten years later Gratz and Roemer (2004), have covered related concepts, as discussed below.

1.2.4 Emotion regulation skills and deficits in psychopathology

When Gratz and Roemer (2004) reviewed the existing emotion regulation concepts to develop a new and more clinically relevant emotion regulation measure (i.e., DERS), they concluded that adaptive emotion regulation must involve:

> a) awareness and understanding of emotions, b) acceptance of emotions, c) ability to control impulsive behaviours and behave in accordance with desired goals, and d) the ability to use situationally appropriate emotion regulation strategies flexibly to modulate emotional responses in order to meet goals and demands (pp.42-43).

In studies with adult samples higher scores (indicating more difficulties) on the DERS have been linked to anxiety disorder symptoms (e.g., Helbig-Lang, Rusch, & Lincoln, 2015; Yap et al., 2018), depression (Abravanel & Sinha, 2015), eating disorders (e.g., Cooper, O'Shea, Atkinson, & Wade, 2014), and self-harming behaviour (Nadja Slee, Garnefski, Spinhoven, & Arensman, 2008). Furthermore, problems with emotion regulation have been shown to fully mediate the relationship between child maltreatment or experiences of early adversity with adult psychopathology symptoms (e.g., Abravanel & Sinha, 2015; Heleniak, Jenness, Vander Stoep, McCauley, & McLaughlin, 2016; Jennissen, Holl, Mai, Wolff, & Barnow, 2016).

Due to a lack of appropriate measures to assess emotion regulation difficulties in youth, the DERS was recently validated with adolescent samples (Neumann, van Lier, Gratz, & Koot, 2010; Weinberg & Klonsky, 2009). The study by Weinberg and Klonsky (2009) employed the DERS with more than 400 adolescents and found that it correlated significantly with a wide range of disorders, including depression, anxiety, suicidal ideation, eating disorders, alcohol, and drug use. Similarly, another study with 870 adolescents found that greater emotion regulation difficulties significantly correlated with enhanced internalizing and externalizing problems. This study also showed that certain subscales of the DERS were linked to different types of psychopathology: "Difficulties controlling impulsive behaviours" and "Engaging in goal-directed behaviours" were related to aggressive behaviour, while "Lack of emotional clarity", "Non-acceptance of negative emotional responses", and "Limited access to strategies" were associated with anxiety and depression (Neumann et al., 2010). Mathews and colleagues (2014) went further into detail with a sample of adolescents exhibiting social or general anxiety symptoms. They found that both

groups were generally less accepting of their negative emotions, had difficulties identifying which emotions they were experiencing, and believed less in their abilities to regulate their emotional experiences. When the researchers controlled the analyses for the other anxiety type, they found that social anxiety was uniquely related to emotional understanding and acceptance, while generalized anxiety had no significant relationship left with any of the DERS subscales. This demonstrated that emotion regulation processes, as underlying mechanisms, could only partly explain the large comorbidity rates among disorders and the frequent transitions from one disorder to another, especially in youth populations (Seymour et al., 2012). It also highlights that more nuanced research is necessary to identify small, but relevant differences in emotion regulation processes across different disorders.

Gratz and Roemer had stated that their conceptual definition of emotion regulation was primarily influenced by developmental researchers such as Thompsons, Saarni and Cole (Gratz & Roemer, 2004; Neumann et al., 2010). As stated above, developmental researchers emphasized the functional aspects of emotion regulation and aimed to identify characteristics that differentiated typical from atypical developing children. In line with the identified milestones of emotion regulation development, research with very young children focused on behavioural aspects, like emotional expression (e.g., facial or vocal). While studies with older children looked at the more complex cognitive processes, including emotion recognition, awareness, and understanding, as well as knowledge, access, and flexible use of emotion regulation strategies.

The years between the ages of 2 and 5 are marked by considerable changes in children's emotion regulation abilities. These are hugely influenced by maturing cognitive functions and the acquisition of language, which enables children to label, express and learn about emotional states (Thompson & Meyer, 2007). Theory and evidence has suggested that by the age of 5 children are able to self-regulate their emotions (Von Salisch, 2009). In line with that Cole and colleagues (1996) investigated the links between e*motional expression,* the ability to externally express one's inner emotional experience, and behaviour problems in pre-school children (age 5). They found that overly expressive and inexpressive children displayed more externalizing symptoms than modulated expressive children, concurrently and a year later. Furthermore, inexpressive children exhibited more internalizing symptoms when they were older. Subsequent studies emphasized that *emotional awareness*, so the

ability to recognise and identify one's own internal emotional experiences, is another key-component of effective emotion regulation, which should be assessed alongside emotional expression (Zeman, Shipman, & Suveg, 2002). Zeman and colleagues (2002) investigated both, emotional expression and awareness of anger and sadness in 10 year old children exhibiting internalizing or externalizing symptoms. According to their findings, excessive emotional expression of sadness and anger was related to internalising problems, but not to externalizing symptoms. Interestingly, the results also indicated that poor emotional awareness of negative emotional states was only associated with internalizing problems. A recent meta-analysis provided further support for this connection. Evidence from 21 studies suggested that youth with either anxiety or depressive symptoms had significant difficulties with being emotionally aware (Sendzik, Schäfer, Samson, Naumann, & Tuschen-Caffier, 2017).

Factor and colleagues (2016) provided evidence that impaired emotional awareness was related to externalizing problems, but only for a specific type. The authors distinguished between a "reactivity-driven" and "proactive" type of externalizing disorder, whereby the pro-active type is described as being instrumental and organized, and the reactive type is characterised by uncontrolled, automated, and reactive behaviours. Children of the latter type are assumed to suffer from information-processing deficits, which again have been related to their poor emotional awareness (Factor et al., 2016).

The growing research body of the past years has highlighted repeatedly that more nuanced studies are necessary to disentangle the complex links between emotion regulation and psychopathology (Aldao, Gee, De Los Reyes, & Seager, 2016). Unsurprisingly, there are contradicting findings, as provided in a recent study, which demonstrated that there was no direct relationship between emotional awareness and depressive symptoms, but that this association was mediated by the use of maladaptive strategies (Van Beveren et al., 2019). This study's approach was quite unique as they employed emotion regulation instruments from a different framework, one measuring emotion regulation competences and the other emotion regulation strategies.

In order to function adaptively, children also need to be able to recognise emotions in others and understand why someone might feel a certain way by taking into account relevant contextual information (Saarni, 1999). Children who struggle with emotion recognition and understanding often experience difficulties when they interact with

others, which again puts them at risk of not improving their emotion regulation skills further, as they are frequently avoided by their peers (Boyatzis & Satyaprasad, 1994; Halberstadt, Denham, & Dunsmore, 2001). A meta-analysis by Trentacosta and Fine (2010) summarized the existing evidence for the links between emotion understanding and internalizing and externalizing problems in children and adolescents. They found that emotion understanding had small to medium relations with internalizing problems (based on 19 studies) and externalizing problems (34 studies). While their results were in line with previous studies indicating that internalizing and externalizing problems correlated with poor emotional understanding (Chronaki et al., 2015; Göbel, Henning, Möller, & Aschersleben, 2016; Heinze, Miller, Seifer, Dickstein, & Locke, 2015), most of the studies reviewed were cross-sectional, thereby making it difficult to conclude whether poor emotion understanding is a risk factor for the development of mental health problems in youth. The current absence of longitudinal studies has been frequently pointed out by many researchers in the field (e.g., Mathews et al., 2014; Sloan et al., 2017; Trentacosta & Fine, 2010). Mathews and colleagues (2016) had conducted a comprehensive systematic review on emotion regulation competences in youth experiencing anxiety. While they found medium to large effect sizes for anxious youth being generally less effective at expressing, understanding and accepting negative emotions and more likely to use maladaptive strategies, the authors could not derive any definite conclusion whether these difficulties are symptomatic or predictive of mental health difficulties. The distinction between emotion regulation difficulties being a risk factor or symptom of psychopathology is highly relevant for the development of treatment or preventative interventions. If emotion regulation difficulties were a risk factor, it should be targeted in both treatment and prevention interventions. If, however, it is a transdiagnostic factor merely underlying multiple mental health disorders, it should be primarily addressed in treatment programmes. In order to increase our understanding about the nature of this relationship, insights from longitudinal studies are necessary.

1.2.5 Longitudinal studies in infants and children

Eisenberg and colleagues (1995, 2000) were one of the first to look at the relationship between emotion regulation and externalizing problems in children from a longitudinal perspective. In line with their emotion regulation definition, they differentiated between attentional and behavioural emotion regulation. Their first study included

children at the age of 6, 7, and 8, and showed that emotion regulation and negative emotionality at age 6 and 7 predicted behaviour problems at age 8. The second study investigated whether emotion regulation abilities could mitigate the adverse effects of negative emotionality, a temperamental feature, on future behaviour problems (see following section regarding conceptual differences between temperament and emotion regulation). The results supported this assumption in that the relationship between attentional control and problem behaviour was significant, and even more so in children with greater negative emotionality.

The potential of emotion regulation to act as both a protective and a risk factor in risk populations has been supported in further studies, showing that emotion regulation was a mediator and moderator between early adversity (e.g., child maltreatment, negative life events, peer victimization) and later internalizing or externalizing symptoms (Abela & Hankin, 2011; Heleniak et al., 2016; Herts, McLaughlin, & Hatzenbuehler, 2012; Kim & Cicchetti, 2010).

Evidence for the importance of emotion regulation abilities in early life has been provided by Halligan and colleagues (Halligan et al., 2013). They conducted a five-year longitudinal study, where they assessed the development of emotion regulation capacities (observation by researcher) at 12 and 18 months and again at age five to investigate whether any emotion regulation difficulties would precede or predict externalizing problems at age 5. The results demonstrated that emotion regulation capacities at 12 months correlated significantly with concurrent and future externalizing symptoms. Furthermore, they found that emotion regulation stabilised around the age of 2, and that neonatal regulation abilities (around 3 month of age) were neither stable nor predicted later behaviour problems.

Studies with slightly older children have demonstrated similar results. Rydell, Berlin and Bohlin (2003) found that low emotion regulation of positive emotions at age 5 predicted externalizing problems at age 8, while low regulation of fear was associated with greater internalizing symptoms. Similarly, Castro and colleagues (2018) conducted cross-lagged path models to investigate whether emotion regulation deficits predicts the onset of psychopathological symptoms or vice versa. They found that difficulties in emotion recognition at age 6 predicted greater internalizing behaviours at age 8, but not externalizing or hyperactivity symptoms. Furthermore, only hyperactivity, not internalizing or externalizing behaviours, predicted later emotion

recognition abilities. I discuss the relevance of potentially existing bi-directional effects between emotion dysregulation and psychopathology over childhood development in more depth in Chapter 3.

1.2.6   Longitudinal studies with adolescents

Adolescence represents a highly interesting period for researching the relationship between emotion regulation and psychopathology. First, adolescents have been reported to show an increased vulnerability to experience affect related difficulties (Cracco, Goossens, & Braet, 2017; Zimmermann & Iwanski, 2014) in comparison to younger and older age groups. Furthermore, it has been argued that an observed peak in psychopathological symptoms at this age results from unique environmental and biological changes, which hamper adequate emotion regulation (Dahl, 2004).

Nolen-Hoeksema and colleagues (2007) were one of the first to examine reciprocal effects between rumination and psychopathological symptoms in adolescents at the age of 14, 15, 16, and 17. They provided evidence that rumination predicted future eating disorder, substance abuse, and depression symptoms. However, all of the symptoms, apart from substance abuse, also predicted future levels of rumination, thereby also hinting at possible bidirectional effects (see Chapter 3 on this topic). Furthermore, the study found that rumination did not predict future increases in externalizing problems, however externalizing symptoms predicted future increases in rumination. In a series of studies McLaughlin and colleagues extended this line of research with adolescents and investigated further emotion regulation factors, including emotional understanding, expression, and rumination in relation to depression, anxiety, aggression, and eating pathology (McLaughlin, Aldao, Wisco, & Hilt, 2014; McLaughlin, Hatzenbuehler, Mennin, & Nolen-Hoeksema, 2011; McLaughlin & Hatzenbuehler, 2009). Their research took a prospective approach and followed 1065 adolescents (ages 11-14) over a 7-month period. All analyses demonstrated that emotion dysregulation (here entered as a latent variable) played a significant role in the development of later mental health difficulties. Their first study (McLaughlin & Hatzenbuehler, 2009) examined emotion dysregulation as a linking mechanism between stress and young people's internalizing problems and found that stressful life-events inhibited adaptive emotion regulation, which in turn lead to poor mental health outcomes. The second study (McLaughlin et al., 2011) suggested that emotion dysregulation predicted later increases in anxiety, aggression, and eating

pathology, but not depression. They also tested whether any of the psychopathological symptoms predicted increases in emotion dysregulation, but none of the associations were significant. Their final study (McLaughlin et al., 2014) demonstrated that rumination explained longitudinal transitions in boys, moving from externalizing behaviour (aggression) to later anxiety and depressive symptoms. This finding is in line with Nolen-Hoeksema's results and previous research, suggesting that childhood is dominated by externalizing symptoms, while adolescents exhibit more internalizing symptoms (Martel, 2013; Nolen-Hoeksema et al., 2007).

McLaughlin and colleagues' studies (2009, 2011, 2014) contributed significantly to our understanding of the relationship between emotion regulation and youth psychopathology, highlighting the role of emotion dysregulation being a predictor, mediator, and trans-diagnostic mechanism. However, their study only covered a 7-month period, which may not be sufficient to detect important developmental changes in this age group. A recent study assessed emotion regulation difficulties (using DERS) in relation to adolescents' depressive symptoms over a 2 year period (Gonçalves et al., 2019). Based on adolescents' self-report data they found that all emotion regulation difficulties subscales were associated with concurrent depressive symptoms, while only "limited access to strategies" predicted depressive symptoms two years later. This finding is in line with previous research suggesting that young people seem to have limited access to their emotion regulation strategy repertoire during mid-adolescence (Zimmermann & Iwanski, 2014). Furthermore, it has been suggested that "limited access to strategies" (one example item: "When I am upset, I believe that there is nothing I can do…"), may have been related to adolescents' negative beliefs about their emotion regulation abilities. Beliefs about one's emotion regulation efficacy have been shown to significantly influence people's effectiveness in regulating their emotions (Bigman, Mauss, Gross, & Tamir, 2016). The study also reported significant gender differences, with lack of emotional awareness and clarity, being more strongly associated with depression in girls cross-sectionally, but not longitudinally. The authors suggest that gender differences might be more pronounced in early adolescents, due to girls facing more negative life events (e.g., sexual harassment and body-dissatisfaction) and hormonal changes, compared to boys. More research is needed to explain the mechanisms by which emotional clarity links with depressive symptoms in girls at different developmental stages.

The consistent evidence from adult studies demonstrating the strong links between emotion regulation and psychopathology cannot be directly transferred to youth populations without further investigation. The research reviewed above primarily involved child and adolescent studies, for which the general picture seems to be in line with that found in the adult literature. However, the mixed findings (e.g., different results for subtypes of strategies, age, or gender) also highlight that more nuanced, longitudinal research needs to be conducted. Each developmental stage is characterised by certain neurobiological and social changes (e.g., parent-child dyads, joining kindergarten) that pose different challenges and opportunities to the emotion regulation process in a child. Furthermore, it has been suggested that emotion regulation processes become increasingly complex and differentiated as children mature (McLaughlin et al., 2011). With respect to this, there is currently a lack of longitudinal studies that span across multiple developmental stages (i.e., early, middle, late childhood to early, middle, and late adolescence), which would allow us to capture developmental patterns in the emotion regulation and psychopathology relationship (Zimmermann & Iwanski, 2014). Thus, evidence from more extensive longitudinal studies is needed so that a more detailed picture of the developmental processes involved can be drawn.

Currently, there is a dearth of studies that has investigated specific and sufficient aspects of the emotion regulation process in relation to the developmental changes that children experience. Moreover, it should be emphasized that emotion regulation and youth psychopathology are two highly dynamic constructs, which require researchers to employ more complex and extensive longitudinal designs as well as statistical approaches, which will allow us to enhance our present understanding regarding the nature of this relationship.

1.3   Challenges in emotion regulation research

1.3.1   Emotion regulation assessment

As seen above, some researchers have assessed a full range of emotion regulation strategies, others only a few, some measured emotion regulation difficulties as they have been defined by Gratz and Roemer (2004), and again others derived new latent variables based on physiological or observational methods. Additionally, it has been observed that in studies where multiple measures were used, the different modalities

(e.g., skin conductance, heart-rate, self-report) often did not converge well, with the different instruments (e.g., physiological and self-report) portraying a different picture of the emotion regulation process (Mauss, McCarter, Levenson, Wilhelm, & Gross, 2005). In 2011, Adrian, Zeman, and Veits reviewed methodological approaches in emotion regulation research with children and adolescents of the past 35 years (Adrian, Zeman, & Veits, 2011). According to their review emotion regulation was primarily assessed in four ways: self-report, parent/teacher report, observational methods, or through bio-physiological measures. Their findings revealed that the majority of studies (61.1%) had used only one measure and that there was no increase in multimodal assessments over time (1989-2010). Most strikingly, the authors reported the use of 13 different self-report measures across 38 studies that had relied on self-report instruments. It should be noted that these studies did not significantly differ with respect to the age group nor were any of the self-report measures valid for a particular age group. The results exemplified the great diversity and inconsistency in the field when it comes to emotion regulation assessment.

As touched upon earlier, the methodological challenges that the field has been facing are closely linked to the definitional challenges and the nature of the construct itself. Emotion regulation is assumed to comprise multiple processes ranging from cognitive and behavioural to biological and physiological, which, to complicate the situation further, are known to influence with each other. With respect to developmental studies, it also needs to be taken into account that many of the systems involved in the emotion regulation develop over time. Hence, the picture might change significantly when we assess emotion regulation in a 3 year old child in comparison to a 13 year old adolescent (Ahmed, Bittencourt-Hewitt, & Sebastian, 2015). Moreover, developmental researchers have often drawn on constructs that are related to emotion regulation, such as temperament or negative emotionality, while others have derived conclusions based on certain behaviour patterns or social competences that they assumed were a manifestation of adaptive or maladaptive emotion regulation. As a consequence, the literature has been scattered with confusing terminology for which it is often not entirely clear whether these phenomena are a part of or distinct from the emotion regulation construct.

1.3.2 Emotion regulation terminology

Thus, I would like to clarify some of the terminology found in the literature and how it can be differentiated from the emotion regulation and emotion dysregulation concepts used in the present thesis.

Starting with the word *affect,* which forms an umbrella term to describe any type of valence state, including emotions and moods. Furthermore, it is important to differentiate between emotions and moods: "*emotion*" refers to positive and negative affect states of short duration in response to a specific object or situation, while *moods* also refer to affective states but that typically last longer and are more diffuse (not situation specific).

Especially in developmental research, a variety of concepts have been studied that are closely related to emotion regulation, but differences between the concepts have often not been explicit. For instance, many studies have focused on emotion regulation and *temperament* as vulnerability factors to child psychopathology. Although researchers suggested that temperament and emotion regulation are two separate constructs (Southam-Gerow & Kendall, 2002), the boundaries are not clearly set.

Temperament has been described as "individual differences in reactivity and self-regulation (Denham, Wyatt, Bassett, Echeverria, & Knox, 2009, p. 45) and has frequently been defined by three underlying dimensions: positive emotionality, negative emotionality, and effortful control (Rothbart, 2007; Rothbart & Bates, 1998).

Evidence has supported the important role of temperament in the development of emotion regulation and psychopathology in children (Eisenberg et al., 1995). Furthermore, a vast amount of research has demonstrated that high levels of negative emotionality in children was predictive of later behavioural and emotional problems (Seifer, 2000). However, further research showed that emotion regulation was a better predictor of problem behaviour in children with high levels of negative emotionality and that emotion regulation was not a good predictor in children with low levels of negative emotions (Eisenberg, Cumberland, Spinrad, Fabes, Shepard, Reiser, Murphy, Losoya, & Guthrie, 2001; N. Eisenberg et al., 1997, 2000). These findings suggest that the interaction effects between the two constructs provide a much better picture of their long-term impact on mental health than any direct effects of one or the other. To make the difference between the two constructs clearer, Southam-Gerow and Kendall (2002)

compared the interaction effects between temperament and emotion regulation with the process of building a house in a certain neighbourhood. According to their analogy, temperament provides the foundation of the house, while emotion regulation abilities represent the "brick and mortar" in order to build the house. Environmental factors, like parents, teachers, and peers, on the other hand influenced the shape and the design of the house.

While there seems to be some theoretical agreement that temperament and emotion regulation are two separate phenomena, it has also been pointed out that various emotion dysregulation measures often assess behavioural difficulties in children, which could represent temperamental as well as emotion dysregulation features (Adrian et al., 2011; Beauchaine, 2015).

Similar lines of research have frequently used the term s*elf-regulation*, which refers to a set of processes that have been directly linked to behavioural difficulties (Calkins & Keane, 2009). With self-regulation, conceptual boundaries to emotion regulation seem even less clear. Calkins, has argued that emotion regulation is a sub-component of self-regulation, as self-regulation comprises cognitive, emotional, biological, and behavioural processes (Calkins, 2009). Diamond and Aspinwall (2003) assumed a similar structure but pointed out that many self-regulation models often neglected the role of emotions. Hence, the authors asked for a greater integration of the two constructs, as this could help to draw a more comprehensive picture of the underlying mechanisms. Others have regarded self-regulation as part of an individual's temperament, which would suggest a greater biological component (Denham et al., 2009; Derryberry & Rothbart, 1984). A recent paper, by Eisenberg and colleagues (Eisenberg et al., 2018), who defined self-regulation as "the ability to modulate behaviour in service of long-term goals", employed a data-driven methodology to demonstrate how poorly the concept of self-regulation has been defined and understood to this day. With respect to their research, it can be argued that more research is needed to clarify the underlying structure and boundaries of and between complex constructs like self-regulation and emotion regulation (I discuss this further in Chapter 3 and 4).

Another construct that is often regarded as highly similar to emotion regulation is *coping*. The term stems from research looking at stress and coping mechanisms in individuals, whereby the organism reacts to challenges in the environment by eliciting

a range of psychophysiological responses (Lazarus & Folkman, 1987). Researchers often distinguish between problem-focused and emotion-focused coping, which aim to decrease negative emotional experiences in relation to stress (Baker & Berenbaum, 2007; Schoenmakers, van Tilburg, & Fokkema, 2015). While research on coping has been an important predecessor of emotion regulation research, coping differs from emotion regulation research in two ways. First, coping can include a range of non-emotional actions that are activated in response to demands that are perceived as exceeding a person's resources. Secondly, in comparison to coping, emotion regulation concerns the regulation of both negative and positive emotional experiences (Gross, 1998).

1.3.3 Emotion regulation, competence and dysregulation

There have been ongoing discussions around what constitutes emotion dysregulation. Many have criticized the general tendency in the field to refer to emotion dysregulation as exhibiting either high levels of negative emotions or diminished levels of positive emotions. Emotion dysregulation, however, is not a matter of sheer emotional valence or frequency, nor does it equate to 'un-regulation' (Cole et al., 2017; Gross & Thompson, 2007). Emotion regulation serves to initiate, enhance, maintain, and reduce both positive and negative emotions, including the accompanying experiential, behavioural, and physiological aspects (Mauss et al., 2005; Werner & Gross, 2010). Furthermore, emotion dysregulation does not refer to single instances, as experienced by everyone, when we feel out of control. Emotions are dysregulated when they hamper long-term functioning by threatening social relationships and personal achievements, as well physical and psychological wellbeing (P. M. Cole et al., 2017). Recently, it has been suggested that emotion dysregulation differs from emotion regulation competences in the following four areas: a) emotions endure due to ineffective regulatory attempts (Beauchaine, Gatzke-Kopp, & Mead, 2007), b) emotions interfere with appropriate behaviour and goal-attainment (Beauchaine & Gatzke-Kopp, 2012), c) emotions are context inappropriate, and d) emotions either change too quickly or too slowly (Cole et al., 2017).

1.4 Emotion dysregulation and psychopathology

Many have asked whether and how we can differentiate emotion dysregulation from psychopathology. As a matter of fact, emotion dysregulation is central to many

different mental disorders, and is mentioned as an identifying feature for several disorders in the Diagnostics and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013). Furthermore, the National Institute of Mental Health has adopted the new research domain criteria framework, which emphasises the role of underlying regulatory systems in the development of psychopathology. Emotion regulation represents one of these systems, besides other behavioural and biological systems (Fernandez, Jazaieri, & Gross, 2016; Insel et al., 2010). While these developments support the general notion that emotion dysregulation is integral to psychopathology, it is not clear yet where emotion dysregulation ends and psychopathology begins. Closely related to this research gap, are the aforementioned methodological challenges. Most of the time emotion dysregulation has been assessed through observable features, although much of the emotion regulation process is unobservable under most circumstances (Beauchaine, 2015). In other words, emotion dysregulation has often been inferred from the presence or absence of problematic behaviour. While this approach seems sensible, it can be problematic when the presence of psychopathological symptoms is inferred from the same type of problematic behaviour. Hence, it has been emphasized that future studies would benefit from a combination of measures, including self-report, behavioural and biological (Beauchaine, 2015).

1.5 Implications for the present research

The literature review above sets the scene for the present research by providing an overview of the relevant theories and models relating to emotion regulation and psychopathology. The following chapters draw on this literature and discuss certain aspects in more detail as relevant for the respective studies. Moreover, by summarising the existing evidence above, I demonstrate the strong links between emotion dysregulation and psychopathology, and highlight the considerable research gaps and challenges. More specifically, my research aims to address the following gaps:

a) As mentioned above, the mixed evidence that has been derived from the limited research involving child and adolescent populations, highlights the need for more nuanced research with this age group. The present research aims to extend the existing evidence base by examining emotion regulation processes in child populations.

b) The existing literature shows that there is a significant lack of longitudinal studies that can shed a light on the dynamic relationship between emotion regulation and psychopathology within a developmental framework. Therefore, the current evidence does not allow to draw any concrete conclusions about the temporal precedence of the two constructs and how they affect each other over the course of childhood development. Following this, my research aims to answer whether emotion dysregulation leads to increased psychopathology or vice versa, by estimating a developmental cascade model with a large, longitudinal dataset. This analysis allows to uncover temporal dynamics between emotion regulation and psychopathology, and to identify potential bidirectional effects between the two constructs.

c) I suggest that emotion regulation and youth psychopathology are two highly dynamic and closely linked constructs. Thus, any attempt to enhance our understanding for the nature of this relationship, requires more complex, longitudinal designs as well as statistical approaches. In light of the existing conceptual and methodological challenges that I have outlined above, the present research employs more complex data-driven methods, including confirmatory factor analyses and bi-factor modelling, to identify how emotion regulation and psychopathology relate to each other conceptually.

Chapter 2: Introduction to the Millennium Cohort Study and validation of an emotion regulation measure

2.1   Introduction

As outlined in Chapter 1, there has been a growing acknowledgement for the key role of emotion regulation difficulties in the development and maintenance of youth psychopathology (see Chapter 1 for a review). Research based on cross-sectional data has repeatedly shown that deficits in emotion regulation, including emotional awareness and understanding, acceptance of emotions, impulse control, and the use of certain emotion regulation strategies, is linked to internalizing as well as externalizing symptoms in youth (Mathews et al., 2016; Trentacosta & Fine, 2010).

While this evidence, primarily derived from adult studies, consistently demonstrated the strong links between emotion regulation difficulties and psychopathology, the evidence based on child and adolescent populations is still scarce (Aldao et al., 2010; Baiocco et al., 2017). Of the few studies that have explored the relationship between emotion regulation and psychopathology in youth, most studies reported similar findings to those in the adult literature. In contrast to the adult literature however, a few suggested slightly different links between emotion regulation and psychopathology in youth, whereby the lack of adaptive strategies seemed to show a stronger association with psychopathology than the use of maladaptive strategies (e.g., Braet et al., 2014). Additionally, there has been a lack of longitudinal studies, which makes it difficult to conclude whether emotion regulation difficulties is a risk factor or a result of mental health difficulties (McLaughlin et al., 2011; Sloan et al., 2017). The distinction, between emotion dysregulation being a risk factor or a consequence of mental ill-health, is highly relevant for the development of treatment and prevention interventions. If emotion dysregulation was a risk factor, it should be targeted in both treatment and prevention interventions, if it was an outcome or a symptom it would be primarily addressed in treatment interventions. In order to increase our understanding of this relationship, insights from longitudinal studies are necessary. Chapter 3 provides a summary of the existing longitudinal evidence relevant for this research.

It has been suggested that a potential reason for the missing research with younger populations has been the lack of adequate emotion regulation measures (Baiocco et al., 2017; Cracco, Van Durme, & Braet, 2015; Rood et al., 2009). With young children, researchers have mostly employed parental or teacher reports to assess visible emotion

dysregulation patterns and for older children self-report measures have been deemed suitable as well (Adrian et al., 2011).

In order to fill the gap of missing longitudinal evidence, I am utilizing data from the UK Millennium Cohort Study (MCS). The MCS is a UK-based longitudinal study that has assessed more than 18,000 families and their children born in early the 2000s (Connelly & Platt, 2014). The data collected at the ages 3, 5, and 7 includes relevant measures to assess internalizing, externalizing symptoms, and emotion regulation levels. Therefore, these data allow me to explore the complex, longitudinal relationship between emotion regulation and internalizing and externalizing symptoms in children (see Chapter 3 and 4).

The employed Child Social Behaviour Questionnaire (CSBQ) which assesses both emotion dysregulation and self-regulation, has primarily been used in MCS related studies (e.g., Flouri, Midouhas, & Joshi, 2014) but has not been psychometrically validated to-date. Thus, I am also addressing one of the methodological barriers to emotion regulation research in children, the lack of appropriate measures for children, by validating the psychometric properties of the CSBQ.

The primary purpose of the present chapter is to introduce the reader to the MCS data and provide them with the relevant background information about the sample and the included measures, as these build the basis for the subsequent studies. In line with this, I also validate the CSBQ at the end of this chapter before utilising it in the more complex analyses in Chapter 3 and 4.

2.2 The Millennium Cohort Study

The MCS is an ongoing longitudinal study, which has continuously assessed families whose children were born in the four countries of the UK between September 2000 and January 2002 (Connelly & Platt, 2014; Plewis, Calderwoood, Hawkes, Hughes, & Joshi, 2007). Children and their families were aimed to be selected if they were born within the eligible dates, living in the UK at the age of 9 month and eligible to receive Child Benefits at that age.

With respect to the sampling procedure, certain areas of residence were identified with the aim to recruit 100 per cent of the children who were born within the defined 17 months for recruitment. The total population was stratified by the four UK countries.

The geographical areas were clustered based on electoral wards as they had been defined before the 2001 census. The number of wards required for each stratum were calculated based on expected birth rates and expected response rates (Plewis et al., 2007). Relevant data on socio-economic and demographic variables were sought for the included electoral wards. This data was used, so that groups from "hard to reach populations", such as children from disadvantaged areas and ethnic minorities could be oversampled in order to enable meaningful analyses for minority groups. Furthermore, children from the smaller nations of Wales, Scotland and Northern Ireland were oversampled so that the sample size allows for useful analyses and is large enough to combat expected attrition over time. Thus, the selection method was not based on random sampling, but rather systematic, which resulted in a disproportionately stratified clustered sample. While the final sample size of children included in the cohort was random, one needs to keep in mind that the included observations are not independent (i.e. they are clustered) and sample-weights need to be applied when analysing the data in order to account for potential sampling effects (Plewis et al., 2007).

The chosen sampling method ensured that the 19,244 families that have been part of the study, are representative of the UK's population, while also providing sufficient data for smaller subgroups. The first wave (when children where 9 month old) collected data of 18,818 children, of which 512 were twins (256 sets) and 30 children were part of triplets. Up to this date, data for the MCS was collected when cohort members were 9 month old, 3, 5, 7, 11, and 14 years old, with the most recent data collection taking place at age 17. The MCS data is managed by the Centre for Longitudinal Studies at the Institute of Education, at the University of London. Access can be requested for free through the UK data service (https://ukdataservice.ac.uk/).

The MCS collects data on several physical (e.g., illness, weight, height, vaccination) and psychological components (e.g., cognitive abilities, developmental mile stones, temperament), but also covers important social demographic data including ethnicity, parental education, income, housing situation, parenting practices. (See https://cls.ucl.ac.uk/cls-studies/millennium-cohort-study/ for a full list). For the studies in Part I of the thesis, I only included data of children at the age of 3, 5 and 7 (Sweep 2-4). This decision was primarily based on the availability of the measures of interests at each wave: the Strength and Difficulties Questionnaire (SDQ) and CSBQ.

2.2.1 MCS – Sample Characteristics

Each wave has had a slightly different number of respondents, due to non-response, emigration, or death of a child (See Table 2.1). I only included one cohort member per family in the following analyses and excluded the remaining sibling(s) from twins and triplets, as these would otherwise add an additional level of data-dependency to the analysis. Table 2.2 provides an overview of the socio-demographic distribution in the sample per wave.

Table 2.1 Sample Size Millennium Cohort Study

Sweep	N total cohort	Cohort siblings per wave	N used in analysis
1 (9 month)	18,552	246 twin, 10 third	N/A
2 (3 years)	15,590	208 twin, 10 third	15,512
3 (5 years)	15,246	204 twin, 10 third	15,032
4 (7 years)	13,857	165 twin, 10 third	13,447
5 (9 years)	13,287	168 twin, 7 third	N/A

Table 2.2 Demographic overview

Ethnicity	N wave 2	N wave 3	N wave 4
White	12,893	12,705	11,597
Mixed	449	437	378
Hindi	1,417	1,369	1,231
Black	509	514	459
Other	219	214	191
Gender			
Male	7,957	7,798	7,029
Female	7,633	7,448	6,828

2.2.2　MCS measures relevant for the present research

2.2.2.1 Child Social Behavioural Questionnaire

The CSBQ is a revised 10-item questionnaire which was developed as part of the Effective Provision of Pre-school Education project in England (Sylva, Melhuish, Sammons, Siraj-blatchford, & Taggart, 2004) and Northern Ireland (Melhuish et al., 2006). The developed and revised items were based on the original Adaptive Social Behaviour Inventory (Hogan, Scott, & Bauer, 1992). The CSBQ contains two subscales, one for emotion dysregulation (ED) and one for self-regulation (SR). Higher scores on the emotion dysregulation subscale indicate greater problems with emotion regulation, while a higher score on the self-regulation scale refers to better self-regulation abilities. Parents were presented with 10 statements about their child's behaviour and had to rate whether each statement was "not true" (1), "somewhat true" (2), "certainly true" (3) or "can't say" (4). All "can't say" responses were again recoded into missing. The emotion dysregulation subscale (e.g. "shows mood swings") and the self-regulation subscale (e.g." persists in the face of difficult tasks") both consist of five items each. The emotion dysregulation subscale has one item "gets over being upset quickly" that was reversely coded. The CSBQ has been used in previous studies, but has not been extensively validated. Cronbach's alpha values between 0.57 and 0.66 have been reported (Flouri et al., 2014).

2.2.2.2 Strengths and Difficulties Questionnaire

Symptoms of internalizing and externalizing problems were assessed with the SDQ (Goodman, 1997). The SDQ consists of 25 statements describing a child's emotional and behavioural symptoms for which a parent or caregiver (95% mother, 4% father, 1% other) has to indicate whether a statement is "not true" (1), "somewhat true" (2), "certainly true" (3), or "can't say" (4). All "can't say" responses were recoded into missing, as this response option is not part of the original SDQ. The SDQ measures five different domains: hyperactivity, emotional symptoms, conduct problems, and peer problems and prosocial behaviour. Past studies have supported a five and a three-factor model. The latter has been recommended for epidemiologic studies and low-risk populations, and consists of an externalizing, internalizing, and prosocial behaviour scale (Goodman, Lamping, & Ploubidis, 2010). For the present research I used the five items of the emotional symptoms subscale (e.g. "often seems worried")

to represent internalizing problems and five items of the conduct subscale (e.g. "often argumentative with adults") to represent externalizing symptoms. For both scales a higher score indicates greater emotional or behavioural problems, respectively. Psychometric analyses have indicated that the SDQ has good psychometric properties and is suitable for longitudinal studies (Sosu & Schmidt, 2017). In the present sample Cronbach's α values ranged between .68 (age 3) and .60 (age 7) for externalizing symptoms and between .52 (age 3) and .65 (age 7) for internalizing symptoms.

2.3   Validation of the CSBQ

As mentioned before, the CSBQ has not been psychometrically validated yet. In order to do that I performed the subsequent analyses to identify and validate the factor structure, and test the reliability of the CSBQ. First, an exploratory factor analysis (EFA) with the CSBQ was performed with a randomly selected sub-sample (n = 7000 so almost half of the MCS sample) for each wave. This was followed by confirmatory factor analyses (CFA) to confirm the model fit with the remaining observations of the sample. Lastly, Cronbach's alpha and McDonald's omega were calculated to assess the reliability of the measure (Cronbach, 1951; McDonald, 1999). The use of Cronbach's α has sometimes been criticised as it assumes that all items have the same, equal item-construct relations and that the covariances would be the same. Therefore, it has been recommended to also calculate congeneric reliability indices, such as McDonald's ω, which has been suggested to be a more consistent estimator of reliability, as it takes into account the contribution of each latent factor to each item, as well as the items' error. Thus, McDonald's ω and an estimated 95% confidence interval (CI) were calculated in Mplus. With a bootstrap command (here of 1000 random samples) the confidence interval for the reliability coefficient were estimated as well (Padilla & Divers, 2013).

Where necessary items were reverse coded prior to the analyses. Random samples creation and internal consistency analysis was done in STATA. The CFA and EFA were conducted in MPlus

2.4 Results

2.4.1 Factor structure

Exploratory factor analyses for all three waves suggested a good model fit for both a two- and a three-factor solution (See Table 2.3). However, a comparison of the item loadings with respect to the different factor structures (2 versus 3 factor structure) suggested that the two-factor solution was more suitable (See Table 2.4), because in the 3-factor solution, one of the factors consistently showed small to moderate factor loadings below .05. For both subscales, factor loadings increased over time, with average factor loadings of .55 (ED and SR) at age 3, .59 at age 5, and .60 (ED) and .61 (SR) at age 7. The correlations between the factors were negative and increased over time but overall they stayed small (r_2=-.05, r_3=-.32, r_4=-.41). This suggests that the two constructs are related, but conceptually distinct.

Table 2.3 Model Fit Indices for EFAs per wave

		1- factor	2 -factors	3- factors
		EFA for different factor solutions		
Wave 2	RMSEA	.14	.05	.03
	CFI/TLI	.56/.43	.95/.92	.98/.97
Wave 3	RMSEA	.133	.05	.04
	CFI/TLI	.73/.65	.97/.94	.98/.96
Wave 4	RMSEA	.13	.05	.04
	CFI/TLI	.78/.71	.97/.95	.98/.96

Table 2.4 Comparison of item loadings for EFA with a 2- and 3-factor structure

Wave 2		2 - factors		3 - factors		
Subscale	**Item**	**1**	**2**	**1**	**2**	**3**
Emotion dysregulation	Shows mood swings	.69	.00	.25	.66	-.00
	Gets over excited	.65	.02	-.05	.66	.02
	Easily frustrated	.73	-.11	.01	.71	.12
	Gets over being upset quickly*	.12	-.31	.17	.05	-.34
	Acts impulsively	.57	-.00	-.13	.61	.00
Self-regulation	Works things out for self	.05	.52	.47	.00	.55
	No need for much help with tasks	.02	.50	.31	-.00	.51
	Chooses activities on their own	.05	.52	-.00	.11	.54
	Persists with difficult tasks	-.01	.59	.13	.00	.59
	Moves to new activity after finishing	-.09	.61	-.13	.00	.66
Wave 3						
Emotion dysregulation	Shows mood swings	.75	.00	.00	.66	.38
	Gets over excited	.68	.04	.05	.70	-.01
	Easily frustrated	.76	-.04	-.05	.69	.15
	Gets over being upset quickly*	.11	.29	-.33	.00	.24
	Acts impulsively	.63	-.00	.01	.70	-.11
Self-regulation	Works things out for self	.08	.61	.63	.01	.34
	No need for much help with tasks	-.01	.65	.67	-.05	.24
	Chooses activities on their own	.07	.52	.55	.12	-.01
	Persists with difficult tasks	.00	.61	.63	.00	.13
	Moves to new activity after finishing	-.18	.60	.63	-.12	-.02
Wave 4						
Emotion	Shows mood swings	.75	.00	-.00	.69	.36
	Gets over excited	.68	.04	.08	.74	-.00

dysregulation	Easily frustrated	.76	-.04	-.05	.73	.14
	Gets over being upset quickly*	.11	.29	-.31	-.00	.25
	Acts impulsively	.63	-.00	.01	.72	-.08
Self-regulation	Works things out for self	.08	.61	.71	.02	.35
	No need for much help with tasks	-.01	.65	.67	-.08	.27
	Chooses activities on their own	.07	.52	.55	.12	-.02
	Persists with difficult tasks	.00	.61	.66	-.01	.15
	Moves to new activity after finishing	-.18	.60	.61	.15	-.01

*reverse coded item

The CFA, was performed on the second half of the sample for each wave to confirm the fit of the suggested 2-factor solution based on the EFA. The results of the CFAs support a good model fit for the 2-factor solution at each wave (See Table 2.5). Factor loadings on both scales increased in later waves, with average factor loadings of .56 (ED) and .54 (SR) at age 3, .61 (ED) and .59 (SR) at age 5, and .63 (ED) and .62 (SR) at age 7 (See Table 2.6). The correlations between the factors were negative and increased over time but overall they were small to moderate ($r2 = -.12$, $r3 = -.39$, $r4 =-.46$). This also confirms that the two constructs are related, but conceptually distinct.

Table 2.5 Model Fit Indices for CFA with 2 factors per wave

Model fit			
	Wave 2	**Wave 3**	**Wave 4**
RMSEA	.06	.07	.06
CFI/TLI	.90/.87	.92/.90	.94/.92

Table 2.6 CFA factor loadings per wave

Wave		Wave 2 CFA		Wave 3 CFA		Wave 4 CFA	
Factor structure		**I**	**II**	**I**	**II**	**I**	**II**
Subscale	**Item**						
Emotion dysregulation	Shows mood swings	.68		.74		.76	
	Gets over excited	.63		.65		.66	
	Easily frustrated	.75		.78		.81	
	Gets over being upset quickly*	.17		.27		.27	
	Acts impulsively	.57		.63		.67	
Self-regulation	Likes to work things out for self		.53		.54		.61
	Does not need much help		.51		.66		.69
	Chooses activities on own		.50		.46		.44
	Persists in the face of difficult tasks		.59		.59		.64
	Moves to new activity after finishing task		.61		.73		.73

*reverse coded item

2.4.2 Internal consistency

Cronbach's α for the emotion dysregulation subscale ranged from α= .63 to .69 and for the self-regulation subscale from α= .57 to .65 (See Table 2.7). In the social sciences it is common practice to assume that any Cronbach's alpha value of .7 and greater is good. However, this tradition has been greatly criticised recently, with the argument that "no universal minimally acceptable reliability value" has been established yet (Bonett & Wright, 2015), as very high alphas might be suggestive of too much homogeneity between items and not capture sufficient variation in behaviours and outcomes related to any construct.

The McDonald's ω values for the emotion dysregulation scale ranged from ω=.73 with a bootstrap corrected [BC] 95% CI [.72, .74] at age 3, ω= .78 [BC] 95% CI [.77, .79] at age 5, and ω= .80 [BC] 95% CI [.79, .80] at age 7. For the self-regulation scale ω

ranged from ω=.68 with a bootstrap corrected [BC] 95% CI [.67, .70] at age 3, ω= .74 [BC] 95% CI [.73, .75] at age 5, and ω= .76 [BC] 95% CI [.75, .77] at age 7. These values suggest that both subscales of the CSBQ have good composite reliability.

The reverse coded item "gets over being upset quickly" was only weakly correlated with the other items on the scale (item-rest correlation: 0.09). However, results did not significantly change after this item was removed.

Table 2.7 Cronbach's alpha for each subscale per sweep

Cronbach's α per wave	Emotion Dysregulation	Self-regulation	Reduced emotion dysregulation scale
Wave 2	.63	.57	.69
Wave 3	.67	.62	.73
Wave 4	.69	.65	.75

2.4.3 External validity

2.4.3.1 Externalizing problems

The emotion dysregulation subscale correlated positively with the externalizing symptoms across all time points. ($r = .58$, $p < .001$ at age 3, $r = .61$, $p < .001$ at age 5, and $r = .63$, $p < .001$ at age 7). The self-regulation subscale correlated negatively with externalizing symptoms at every age ($r = -.12$, $p < .001$ at age 3, $r = -.27$ $p < .001$ at age 5, and $r = -.31$, $p < .001$ at age 7). With respect to the existing literature, it was expected that externalizing symptoms would correlate positively with emotion dysregulation, but negatively with self-regulation (Rydell et al., 2003; Wills, Simons, Sussman, & Knight, 2016). Thus, the results further support the use of CSBQ in children.

2.4.3.2 Internalizing problems

The emotion dysregulation subscale correlated positively with the internalizing symptoms across all time points. ($r = .29$, $p < .001$ at age 3, $r = .35$, $p < .001$ at age 5, and r = 0.39, $p < .001$ at age 7). As expected the self-regulation subscale correlated negatively with internalizing symptoms at all ages ($r = -.14$, $p < .001$ at age 3, $r = -.18$, $p < .001$ at age5, and $r = -.25$, $p < .001$ at age 7). The associations between internalizing

symptoms and the emotion dysregulation and self-regulation subscale are also in line with the existing evidence, thereby supporting the usability of the CSBQ for child populations (Rydell et al., 2003).

2.5   Discussion

The aim of the present research was to psychometrically validate the CSBQ, before employing it in subsequent analyses. The investigation of the internal structure of the CSBQ through confirmatory factor analysis supported previous suggestions of a two-factor structure, with a self-regulation and an emotion dysregulation subscale. The factor loadings increased with the increase in age of the sample.

Internal consistency of the CSBQ was acceptable with most values being greater than 0.60. This is comparable to previous studies using other emotion (dys-) regulation instruments (e.g., Abela, Brozina, & Haigh, 2002; Garnefski, Kraaij, & Spinhoven, 2001).

As expected emotion dysregulation was positively associated with psychopathological symptoms, while self-regulation was negatively associated. The emotion dysregulation scale showed strong associations with externalizing symptoms, but only small to medium links with internalizing problems. A possible explanation could be that the emotion dysregulation scale primarily taps into difficulties related to externalizing behaviours ("over excited" and "acts impulsive"). Future studies should re-evaluate this measure by adding emotion dysregulation items that have been found to be more characteristic of internalizing problems, such as "giving up" or "withdrawal" (Cracco et al., 2015). The self-regulation subscale only showed small links with both externalizing and internalizing symptoms, which reflects results from previous studies that have correlated emotion regulation measures with psychopathological symptoms in youth (Cracco et al., 2015).

Factor loadings and model fit indices increased over time, which could suggest that the CSBQ becomes a better instrument for older children. Similar concerns have been raised with other behaviour rating measures, which are expected to be highly subjective and may therefore not always be suitable for longitudinal studies. Many inter and intra- individual factors, like age, parent-child interactions, or social context change over time and can have an impact on how, in this case, parents might rate their child's behaviour (Little, 2013). Therefore, it has been emphasized that longitudinal studies may not always detect "true change" but rather change that is caused by the measurement instrument itself (Oort, 2005). Future studies should therefore investigate whether the CSBQ actually assesses the same construct over time.

Furthermore, it was not possible to test the construct validity of the CSBQ in the present study due to the absence of comparable emotion regulation measure in the data set. Future studies should conduct further analyses regarding the construct of the CSBQ compared to other measures of emotional regulation in this age group.

To my knowledge this is the first study that has validated the factor structure of the CSBQ which has been frequently used in various studies utilizing MCS data. While the CSBQ seems to be a reliable and brief measure to assess emotion dysregulation patterns in young children, it might be further improved by adding items that also capture regulation difficulties associated with internalizing symptoms. I discuss the implications of this limitation further in the following chapters.

Chapter 3: Developmental cascades of externalizing and internalizing problems and emotion regulation

3.1 Introduction

The acquisition of emotion regulation abilities during childhood and adolescence is considered a major developmental milestone, which has significant implications for a wide range of developmental outcomes, including a child's mental health, social competences, and academic achievements (e.g., Blair et al., 2015; Eisenberg et al., 1997). The concept of emotion regulation has been of high interest to developmental psychopathology researchers, who try to understand how essential developmental processes, like emotion regulation, can lead to adaptive outcomes in some individuals, but maladaptive ones in others (Aldao, Gee, De Los Reyes, & Seager, 2016; Cole, Dennis, Martin, & Hall, 2008). The idea that the same construct is deeply integrated in multiple mental health disorders, while also being a central component to the development of a wide range of competencies, has left scholars in the field wondering what factors make a difference in the end and how typical developing children differ from atypical developing children. In line with this, researchers have increasingly focused on the role of emotion regulation processes and how they relate to the development of psychopathology: are they a predictor or a result of psychopathology?

3.1.1 Emotion regulation development and psychopathology

Children show the greatest progressions in their emotion regulation abilities during the first few years of life, with a multitude of internal (e.g., motor and cognitive abilities) and external factors (e.g., family and peers) influencing its development (Kopp, 1989).

In the first days of life, infants respond to unpleasant situations with reflexes such as hand-to-mouth movements and sucking (Kopp, 1989). These reflexes are often insufficient when it comes to the regulation of high arousal states, for which infants are highly dependent on their caregivers (Kopp, 1989). Through crying and cooing sounds, an infant indicates their emotional state to the caregiver, who then helps to regulate it by altering or maintaining the situation. Infants are normally able to exhibit different facial expressions for anger, fear, and joy at around 3 months (Zeman, Cassano, Perry-Parrish, & Stegall, 2006). With the development of more advanced motor abilities, infants start to engage in basic regulatory abilities such as attentional deployment (e.g., turning one's head away). In a series of lab experiments with infants of 6 month, it has been shown that in order to lower their emotion arousal (i.e., fear and anger), infants distracted themselves from an emotion eliciting stimuli by turning

away from it. At 12 months, infants were able to employ basic problem-solving strategies (i.e., reach out to the barrier that was between them and their favourite toy) or sought for support from a nearby adult (i.e., looking at them; Buss & Goldsmith, 1998). These early changes in emotion regulation are closely tied to children's cognitive development. Throughout the first year, children experience and learn to differentiate between emotional states, associate them with specific events, and grow in their arousal tolerance (Kopp, 1989; Zeman et al., 2006).

During the second and third year, a child's sense of self-awareness develops, which coincides with the development of new facial expressions for shame and embarrassment. Research has shown that deficits in emotion expression are highly apparent in atypical developing children from an early age on (Curtis & Cicchetti, 2013). Compared to typical developing children, children at risk (e.g., maltreated, parental mental illness) had the tendency to inhibit their emotional expressions (Camras et al., 1988; Lundy, Field, & Pickens, 1996) and demonstrated more difficulties recognizing emotional expressions in others (Camras et al., 1988). Furthermore, significant long-term associations with psychopathological symptoms have been reported, with overly-expressive children being more likely to develop externalizing problems, while children who inhibited their emotional expressions tended to develop internalizing symptoms as they got older (Cole, Fox, Zahn-Waxler, Usher, & Welsh, 1996).

Between the ages of two and five neurobiological maturation allows for the greater use of executive functions, a key component of emotion regulation, which enables children to exert better affect and behaviour control. Children begin to understand that situational factors can cause their emotional distress and that they as an agent, can initiate actions (e.g., by removing the stressor) to alleviate the distress (Kopp, 1989; Janice Zeman et al., 2006). During the same period, children's language skills start to develop another important milestone. The acquisition of language contributes significantly to the growth of a child's emotion regulation competencies, as it learns to label, express, and communicate emotional states in an increasingly verbal manner. As a consequence, children increasingly talk with their mothers and siblings about the causes and consequences of their feelings, which further enhances the understanding for their own and other's emotional responses (Dunn, Bretherton, & Munn, 1987).

Unsurprisingly, research has consistently demonstrated that children's verbal abilities correlated (between .24 and .61) with their emotion regulation abilities (Flouri et al., 2014; Izard et al., 2001). Increased verbal interactions with parents and siblings play a crucial role in the socialization of emotion regulation (Thompson, 1990). Various family factors, including parenting practices, attachment style, emotional climate, and expressiveness or engagement in "emotion talk" contribute to the development of a child's emotion regulation abilities (Morris, Silk, Steinberg, & Robinson, 2007; Stansbury & Sigman, 2000). Especially throughout the early years parents serve as role models, who provide support and feedback on their child's emotion regulation attempts. Over time, young children develop their emotion understanding further by observing and interacting with parents and siblings (Morris et al., 2007; Von Salisch, 2009). Deficits in emotion understanding during the pre-school years have been associated with greater levels of externalizing and internalizing symptoms (Heinze et al., 2015; Trentacosta & Fine, 2010). Limited evidence from longitudinal studies supports these associations and has indicated that emotion understanding at age five significantly predicted later hyperactivity and internalizing problems at age nine (Izard et al., 2001). Additionally, it has been reported that both emotion understanding and recognition, also referred to as emotion knowledge, contribute significantly to a child's social competences and academic achievements (Garner & Waajid, 2012; Halberstadt et al., 2001; Izard et al., 2001).

Regular attendance of a child at kindergarten and later school give rise to more social interactions with peers. These experiences contribute hugely to the growth of a child's emotion regulation repertoire. Peer interactions provide ideal opportunities to practice new emotion regulation approaches and to receive feedback on their social appropriateness (Thompson & Meyer, 2007). It is when children start to engage more with their peers that the impact of emotion regulation difficulties become increasingly evident. Emotion dysregulation can lead to social interactions with peers being more difficult and the resulting frustration can foster the development of problem behaviour. This has been suggested to result in limited opportunities for a child to practice and develop their emotion regulation abilities further, as children who show difficult behaviour are more likely to be avoided by their peers (Hubbard, 2001). A recent study by Blair and colleagues (2015) investigated the relationship between emotion regulation and social competence over a 6 year period during middle childhood. Their

findings indicated not only that early emotion regulation was associated with later social skills and peer acceptance, but also that there were significant indirect effects. More developed emotion regulation at age 5 led to greater social skills at age 7 and in turn resulted in better emotion regulation at age 10. Blair et al.'s study (2015) has highlighted the complex longitudinal relationship between the two constructs and how changes in one construct can shape changes in the other over the developmental course.

By the time children approach the end of primary school, they have learned that emotional arousal gradually fades over time and that multiple emotions can be experienced at the same time in response to a single situation (Thompson, 1990; Thompson & Goodman, 2010). Furthermore, children experience a shift in their emotion regulation patterns. They start to rely less on external factors (e.g., asking for help, turning away from sources of distress) and increasingly employ internal strategies, such as restructuring of thoughts or goals that are associated with the emotion (e.g., think of something that makes you happy or changing a goal that is currently not obtainable). Moreover, children at this age show an increased understanding of both the physiological aspects relating to an emotional reaction and that altering them (e.g., by taking a deep breath) can impact the emotional reaction itself. The continuous maturation of the prefrontal cortex, and thus executive functioning, enables the use of more planned and increasingly complex emotion regulation strategies (e.g., problem-solving, cognitive reappraisal; Kopp, 1989; Thompson & Meyer, 2007). Research has repeatedly demonstrated that the use of certain emotion regulation strategies has been linked to adaptive functioning and positive mental health, while the use of maladaptive strategies has been associated with the development and maintenance of psychopathology (see Chapter 1 for a detailed review).

Interestingly, a recent study by Cracco and colleagues (2017) examined the use of certain emotion regulation strategies over time in children (8 years) and adolescents (18 years). They found that in comparison to younger and older age groups, adolescents between the ages of 12 and 15 tended to use fewer adaptive emotion regulation strategies and more maladaptive strategies. In contrast to past assumptions that emotion regulation abilities gradually improve over time, due to neuro-biological changes and increased experience (Blandon, Calkins, Keane, & Brien, 2008; John & Gross, 2004), this observation suggested that it seems to follow a U-shaped pattern

instead, with significant declines during adolescence (e.g., Cracco et al., 2017; Zimmermann & Iwanski, 2014). This finding was also supported by Zimmerman and Iwanski (2014), who found that during middle adolescence (age 15) participants reported the least use of emotion regulation strategies, compared to early (age 11), and late adolescents (age 17). Together, these findings supported suggestions that the decline in emotion regulation is related to the observed peak of psychopathological symptoms in adolescents (Twenge & Nolen-Hoeksema, 2002).

As seen above, emotion regulation is a highly dynamic, fast developing, multi-process phenomena, which impacts and is impacted by various, continuously changing internal and external factors that ultimately define a whole set of developmental outcomes, including a child's mental health. Similarly, the relationship between emotion regulation and psychopathology across childhood development can be assumed to be equally dynamic due to neurobiological changes and age-specific tasks and challenges (e.g., different social expectations for younger and older children). Additionally, it has become evident that the general developmental trajectory of emotion regulation does not seem to follow a simple, linear pattern with gradual improvements. Hence, in order to increase our understanding for the dynamic relationship between the development of emotion regulation and psychopathology, more complex longitudinal studies are required to provide insight on the potential bidirectional effects within and across time.

3.1.2 Emotion dysregulation or psychopathology, what comes first?

While existing research sufficiently demonstrated the strong links between emotion dysregulation and child psychopathology, it has so far failed to provide a clear direction for the effects involved. Based on the theoretical framework of developmental cascades (Masten et al., 2005), it can be suggested that there are three ways by which psychopathology and emotion regulation may interact with each other over time:

a) Externalizing or internalizing symptoms interfere with the acquisition of emotion regulation abilities.

b) Deficits in emotion regulation contribute to the development of psychopathological symptoms.

c) Other causes, (e.g., parental mental health, external risk factors) impact both the development of psychopathological symptoms and emotion regulation abilities.

Researchers like Calkins and Dedmon (2000) have provided evidence for the first hypothesis, whereby early behavioural problems interfere with the acquisition of appropriate emotion regulation skills. Equally, it has been demonstrated that emotion regulation difficulties resulted in increased internalizing and externalizing symptoms over time (Eisenberg et al., 2009; Kim-Spoon, Cicchetti, & Rogosch, 2013; Kranzler et al., 2016). In line with the suggestions above, Castro and colleagues (Castro et al., 2018) have discussed the links between emotion dysregulation and psychopathology in more detail and pointed out that it was not evident yet from research how the two constructs influence each other over time. According to the authors the following two directions were possible: a) emotion recognition deficits contribute to the increased experience of unsuccessful and negative social interactions, which then can cause the development of problem behaviours or b) problem behaviours result in reduced social interactions with peers, which in turn hampers further emotion regulation development due to limited opportunities to practice. This led Castro and colleagues (2018) to investigate the potential bidirectional effects between emotion recognition and internalizing and externalizing problems in 117 children. Their cross-lagged model indicated that emotion recognition difficulties in 1st grade (age 6) only predicted later internalizing problems in 3rd grade (age 8), but not hyperactivity or externalizing symptoms. In summary, children with emotion recognition deficits were more likely to develop internalizing problems over time. However, only early hyperactivity had an impact on later emotion recognition abilities, neither internalizing nor externalizing problems were predictive of later emotion recognition skills (Castro et al., 2018). Castro and colleague's study (2018) has been one of the very few studies that have investigated potential bi-directional effects between emotion regulation and psychopathological symptoms in children so far. Their study was limited by only involving two time points, thereby making it difficult to identify any long-term cascading effects or nuanced changes in relation to different developmental stages. Furthermore, their sample size only consisted of 117 children, which suggests that their study was highly underpowered.

Blandon and colleagues (2010) investigated potential bi-directional links between emotion regulation and externalizing symptoms in a sample of 440 high-risk children across multiple time points. This study included data at 6 time points from the age of 2 to 7. Emotion regulation was only assessed at 4, 5, 6, and 7 years through mother

and teacher ratings and captured aspects relating to emotion understanding, expression, and intensity. The resulting model suggested significant cascading effects indicating that children with better emotion regulation skills had decreased externalizing symptoms at a later time. While both of these studies supported the general involvement of emotion regulation processes in the development of psychopathology, they also reported different long-term associations for internalizing or externalizing problems. This may have been due to a wide range of factors, such as different sample characteristics (general vs at risk) or the type of emotion regulation processes that were assessed. Moreover, both studies only assessed emotion regulation at age 4 and 6, which makes it difficult to conclude whether emotion regulation difficulties at an earlier age may have preceded these behavioural difficulties.

In an attempt to answer this question, Halligan and colleagues (2013) assessed the longitudinal development of emotion regulation in a high-risk (n = 58) and low-risk group (n = 63) from a very early age. The researchers observed emotion regulation abilities during the neonatal stage (10 days, 4 weeks, and 12 weeks) and at 12 months, 18 months and 5 years. Interestingly, in their study neonatal emotion regulation was not associated with either later behavioural problems or emotion regulation. Only as of 12/18 month (entered as one variable) was emotion regulation significantly associated with concurrent and later externalizing problems. On the contrary, emotion regulation was at no age related to internalizing problems. As expected, high-risk children demonstrated poorer emotion regulation at all ages and the link between risk status and later externalizing problems could be explained by emotion regulation difficulties and maternal parenting behaviour. Lastly, maternal behaviour was a significant predictor for both emotion dysregulation and externalizing behaviour, thereby providing evidence for the third possible linkage point as mentioned above: where common causes (i.e., risk factors) impact the development of both emotion dysregulation and psychopathology.

All of the longitudinal studies presented above provided valuable insights regarding the long-term associations between emotion regulation and child psychopathology. However, only one study (Blandon et al., 2010) included three or more time points with an acceptable sample size that allows for the identification of developmental cascading effects (Cole & Maxwell, 2003). Furthermore, only Halligan and colleagues' study assessed emotion regulation early enough, to allow the detection of

temporal precedence effects between the two constructs. However, their study did not investigate bi-directional effects. Finally, all of the studies presented above were significantly underpowered (i.e., insufficient sample sizes). This can be problematic as it limits the possibility to correct for multiple correlations and high attrition rates, which is highly relevant in longitudinal data analysis.

3.1.3   The present study

The present study aims to address the above mentioned methodological limitations and extend our current understanding for the complex relationship between emotion regulation and psychopathology. This involves investigating potential bi-directional effects between these constructs in a cross-lag model spanning the ages of 3, 5, and 7 years in a large, nationally representative longitudinal cohort study. More specifically, the present study aims to answer the following research questions:

> a) Is it possible to identify temporal precedence between emotion dysregulation and psychopathology during early childhood?
>
> b) Are there any bi-directional effects between emotion regulation and psychopathology?

A cascade model including 3 time points (at age 3, 5, and 7) was conducted, based on existing data derived from the Millennium Cohort Study (MCS; see Chapter 2 for more details) in order to examine the proposed longitudinal associations between emotion dysregulation, internalizing and externalizing problems across childhood.

3.2   Methods

3.2.1   Participants and Sample

All participant data was derived from the MCS study, a UK-based cohort study, which has followed more than 19,000 children and their families since 2000. The present sample only included data from one child per family and from the waves 2, 3, and 4, when children were 3, 5, and 7 years old. The analytical sample included all cases for which data was available on one of the dependent variables - emotion dysregulation, self-regulation, externalizing, and internalizing symptoms - for at least one time point or more. For emotion dysregulation and self-regulation, no data was available for 261 participants, 2,089 participants had data for one, 3,427 participants for two, and 11,343 participants had data available at all three time points. For the internalizing and externalizing symptoms, no data was available for 263 participants, 2,088 participants had data for one, 3,427 participants for two, and 11,342 participants had data available at all three time points The final analytical sample was based on data from N=16,859 participants.

The sample characteristics for the present study are presented in Table 3.1. See Chapter 2, for a detailed description of full MCS sample.

Table 3.1 Sample characteristics

Variable	Sample	Percentage in sample
Gender	16,859	
Male	8,611	51.08%
Female	8,248	48.92%
Ethnicity		
White	14,044	83.3%
Mixed	512	3.04%
Indian, Bangladeshi, Pakistani	1,476	8.75%
Black or Black British	596	3.54%
Other	231	1.37%
Parental income in quartiles		
Lowest	3,885	23.04%

Second	3,731	22.13%
Third	3,282	19.47%
Fourth	3,088	18.32%
Highest	2,873	17.04%
Parental education (NVQ)		
Degree or higher	2,632	15.61%
Diploma	4,032	23.92%
A/AS levels	2,785	16.52%
More than 4 GCSEs	5,784	34.31%
Less than 5 GCSEs	1,626	9.64%
Parental employment status (NS-sec)		
Higher professional occupations	7,694	45.64%
Intermediate occupations	3,326	19.73%
Routine and manual occupations	5,114	30.33%
Unemployed	725	4.30%

3.2.2 Measures

3.2.2.1 Internalizing and externalizing symptoms

Symptoms of internalizing (INT) and externalizing (EXT) problems were assessed with the Strength and Difficulties Questionnaire (SDQ, Goodman, 1997). See Chapter 2 for more detail.

3.2.2.2 Emotion dysregulation

Emotion regulation and self-regulation were assessed with the Child Social Behaviour Questionnaire (CSBQ). See Chapter 2 for more detail.

3.2.2.3 Control variables

The following control variables were added to the model as past research has shown that they are shared risk factors for the development of emotion dysregulation and mental health difficulties in children.

Family environment. Factors such as paternal mental illness and low socio-economic status have been shown to contribute to the development of both emotion dysregulation and psychopathology (Gilman, Kawachi, Fitzmaurice, & Buka, 2002; Green et al.,

2010; Halligan et al., 2013). Lower socio-economic resources are an indicator of social, family and environmental adversity, which are associated with increased parental mental illness, harsh parenting practices and lack of cognitive stimulation, all of which have been shown to contribute to the emergence of both internalizing and externalizing symptoms, and emotion dysregulation (Campbell, 1995; Dodge & Pettit, 1994; Morris et al., 2007; Mortensen & Barnett, 2018).

Maternal psychological distress was assessed with the K6 screening scale for non-specific psychological distress (Kessler et al., 2002; Kessler et al., 2010). It consists of six items that assess six different domains: depressed mood, worthlessness, hopelessness, decreased motivation, increased fatigue, nervousness, and restlessness. Responses are given on a 5-point Likert Scale, ranging from "never" (1) to "all the time (5). Past research has reported good psychometric properties for the K6, which was the case as well in the present sample with alpha coefficients ranging between .84 and .86. Furthermore, socioeconomic position was represented by equivalized quantiles of continuous household income, parental educational qualifications (National Vocational Qualifications (NVQ) equivalence scale: NVQ5: degree or higher, NVQ4: diploma, NVQ3: A/AS levels, NVQ2>4GCSEs, NVQ< 5GCSEs, overseas qualification, none), and parental employment status (National Statistics Socio-economics Classification): higher managerial and professional occupations, intermediate occupations, routine and manual occupations, and unemployed. Where possible missing data was replaced with data from other sweeps.

Gender and ethnicity. Gender differences in psychopathology have been well-established, with boys being more likely to exhibit externalizing symptoms and girls showing more internalizing symptoms (Lahey et al., 2000). However, a majority of research has also indicated that for internalizing symptoms gender differences become more apparent throughout puberty (Wade, Cairney, & Pevalin, 2002). With respect to emotion dysregulation it has been reported that as of the age of 5 males demonstrated more emotion regulation difficulties relating to externalizing symptoms (Halligan et al., 2013), while girls (9-16 years) seem to exhibit more difficulties relating to internalizing problems (Bender, Reinholdt-Dunne, Esbjørn, & Pons, 2012). Furthermore, it has been suggested that girls and boys differ with respect to certain emotion regulation process. For instance girls seem to report less access to strategies

and greater non-acceptance of negative emotions, while boys reported more to be less emotionally aware (Bender et al., 2012; Neumann, van Lier, Gratz, & Koot, 2010).

With respect to ethnicity, evidence has suggested that certain ethnic groups are more or less likely to exhibit mental health problem. Goodman, Patel and Leon (A. Goodman, Patel, & Leon, 2008) conducted a systematic review on child mental health differences amongst ethnic groups in Britain and found that Black-African and Indian children had better mental health related outcomes, compared to White British children. Another meta-analysis summarizing data from longitudinal studies showed that Hispanic children were more likely to exhibit depression symptoms compared to White or Black ethnic groups (Twenge & Nolen-Hoeksema, 2002). The links between ethnicity and emotion dysregulation differences have not been clearly established yet, especially in youth populations. One study compared European and African American children regarding their use of emotion regulation strategies. The authors found that although both groups showed similar emotion regulation strategy use, some of the emotion regulation strategies (e.g., self-soothing) were positively related to externalizing symptoms in African Americans, but negatively related to externalizing symptoms in European American children (Supplee, Skuban, Shaw, & Prout, 2009). The authors suggest that African American mothers may value different strategies more and that self-soothing is considered as less mature. However, it was also pointed out that there were significant age differences between the two samples and that the study was originally not conceptualized for the investigation of ethnical differences. The authors had used two different data sets which may have contributed to the significant differences. However, a recent study by Lugo-Candelas and colleagues (Lugo-Candelas, Harvey, Breaux, & Herbert, 2016) also reported that parental socialization practices in the development of emotion regulation had different effects on children's mental health outcomes, depending on the mother's ethnicity. More specifically, they found that supportive practices resulted in fewer mental health symptoms but only in Latino American families, and unsupportive practices were related to more mental health difficulties in European, Asian and African American families. As discussed earlier, children's emotion regulation development is shaped by parents, siblings and peers. Children learn about the social appropriateness of their emotion regulation attempts through these interactions, which ultimately defines whether a child's emotion regulation patterns are considered as effective or not.

Cultures differ in their perception of what is socially acceptable and valued, such as the degree to which we express certain emotions. This was supported in a study including American and Chinese college students, where emotional suppression was associated with poor psychological functioning, but only in European Americans students (Soto, Perez, Kim, Lee, & Minnick, 2011). In sum, although there is a dearth of studies examining ethnical differences in emotion dysregulation, it can be assumed that ethnicity can influence the relationship between emotion dysregulation and psychopathology development.

Therefore, the subsequent analysis included each cohort member's sex (1=male and 2= female) that was taken at birth and ethnicity based on mother's report of child's ethnicity. Ethnicity includes, 5 categories: 1) White, 2) Mixed, 3) Indian, Pakistani, and Bangladeshi, 4) Black or Black British and 5) Other. Where possible, missing data was replaced when that data was present in another sweep.

3.2.3 Statistical analysis

Descriptive statistics were conducted in Stata 16. Reverse coded items were re-coded and unusual response items (e.g., "Can't say" is normally not included in the SDQ) were recoded into missing. If data for one of the control variables was missing, it was replaced with data from another sweep where available. Average scores for each subscale were calculated if no more than two items were missing per scale.

3.2.4 Cross-lagged models

All of the path models were performed in Mplus v8.1. With respect to the complexity of the present model, an attempt to run the model in one calculation based on item-level data resulted in a non-converging model, possibly due to the large number of factors in the model. Therefore, the following model was based on saved factor-scores. In doing so, I first, a series of confirmatory factor analyses (CFA) was conducted with the CSBQ and the SDQ for each sweep. The resulting factor scores were saved and used as latent variables in the cascade model. The cascade model was estimated using full maximum likelihood estimation (ML). Due to the extremely large sample size, pathways were considered to be statistically significant at $p < .001$.

To investigate temporal precedence and potential bi-directional effects between the constructs, a model with complete cross-lagged pathways between internalizing and externalizing symptoms and emotion dysregulation and self-regulation was conducted

across all time points (See Figure 3.1). Temporal stability of each construct over time and correlations between the constructs at each time point were accounted for. Sex, ethnicity, parent education, socioeconomic position, and parental mental health were included as control variables in the model.

After the model fit was estimated, a series of difference tests were conducted to examine changes in pathways over time. For the difference tests new parameter variables were created, whereby each variable represents one of the pathways in the model. Subsequently, the pathways of interest were compared and tested with respect to their strength and direction.

Table 3.2 Correlations between factors in the model

	N	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1.Emotion dysregulation (3y)	14709	9.42	5.1	-											
2. Self-regulation (3y)	14718	12.3	3.0	-0.10	-										
3.Externalizing symptoms (3y)	14721	7.82	4.2	0.59	-0.12	-									
4. Internalizing symptoms (3y)	14694	6.38	2.3	0.29	-0.14	0.31	-								
5. Emotion dysregulation (5y)	14682	8.66	5.3	0.53	-0.14	0.24	0.29	-							
6. Self- regulation (5y)	14709	12.62	3.0	-0.17	0.37	-0.18	-0.14	-0.26	-						
7.Externalizing symptoms (5y)	14712	6.52	2.3	0.39	-0.12	0.50	0.21	0.62	-0.27	-					
8. Internalizing symptoms (5y)	14694	6.39	2.5	0.23	-0.11	0.24	0.43	0.35	-0.18	0.32	-				
9. Emotion dysregulation (7y)	13415	8.64	5.6	0.49	-0.13	0.43	0.23	0.64	-0.24	0.51	0.28	-			
10.Self- regulation (7y)	13426	12.52	3.4	-0.18	0.317	-0.18	-0.13	-0.26	0.49	-0.24	-0.18	-0.32	-		
11.Externalizing symptoms (7y)	13401	6.39	2.4	0.34	-0.11	0.44	0.18	0.49	-0.21	0.59	0.24	0.63	-0.31	-	
12.Internalizing symptoms (7y)	13430	6.53	3.1	0.22	-0.09	0.24	0.36	0.32	-0.17	0.27	0.52	0.40	-0.25	0.37	-

* All of the correlations present above were significant at $p<0.001$.

3.3　Results

3.3.1　Descriptive statistics

The mean scores of emotion dysregulation and externalizing symptoms slightly decreased with age. Self-regulation and internalizing symptoms were stable over time. Table 3.2 provides an overview of the number of observations per variable and sweep, and descriptive statistics for each variable, including raw correlations. As expected, emotion dysregulation correlated positively with internalizing and externalizing problems within and across time, while self-regulation correlated negatively with internalizing, externalizing symptoms and emotion dysregulation within and across time. Attrition rates per sweep have been published in technical reports and indicated that non-response rates were higher for families from ethnic-minorities and disadvantaged areas (Ketende, 2010).

3.3.2　Cross-lagged models

To test the bi-directional links between psychopathological symptoms and emotion dysregulation development, a cross-lagged model across three time points was conducted. The model fit indices suggest a very good model fit for both the model without (CFI=.98, TLI=.93, RMSEA=.04) and with the control variables added (CFI=.98, TLI=.93, RMSEA=.04). Adding the control variables to the model resulted in attenuated pathways, and weak pathways regressing externalizing problems on internalizing problems diminished. Only the results of the hypothesised cascade model including the control variables are discussed (see Figure 3.1). All four constructs demonstrated moderate stability over time, as indicated by the auto-regressive paths. This suggests that a child's internalizing, externalizing, and emotion dysregulation levels at any age are related to previous stages. For the cross-lagged paths, emotion dysregulation was a significant predictor of later externalizing (age 3 β =.130, p < .001, age 5 β =.179, p < .001), internalizing problems (age 3 β =.084, p < .001, age 5 β =.125, p <.001), and self-regulation (age 3 β = -.128, p < .001, age 5 β = -.119, p < .001) at all times. The positive coefficient (i.e., EXT and INT) suggests that children with greater levels of emotion dysregulation show greater levels of internalizing and externalizing symptoms in subsequent years. The negative coefficient (i.e., SR) indicates that greater emotion dysregulation is linked to lower self-regulation abilities in later years.

Externalizing problems also significantly predicted later emotion dysregulation (age 3 β =.186, p < .001, age 5 β =.160, p < .001) and lower self-regulation (age 3 β = -.128, p < .001, age 5 β = -.119, p < .001) at any age. Following this, children exhibiting greater externalizing problems at a younger age, are more likely to show increased emotion dysregulation and lower self-regulation when they are older. Externalizing symptoms only significantly predict later internalizing symptoms at a younger age (3 years), but not at age 5 (age 3 β = .041, p < .001, age 5 β = -.003, p =.851). Internalizing symptoms only significantly predict later self-regulation at age 5 (β = -.048= p < .001) but not before that. Internalizing symptoms were only a predictor of itself, but not of any other construct over time. Self-regulation was a significant predictor of later emotion dysregulation (age 3 β = -.082, p < .001, age 5 β = -.047, p < .001) and internalizing problems (age 3 β = -.043, p < .001, age 5 β = -.036, p < .001) at all-time points. However, it was only a significant predictor at age 3 for externalizing symptoms at age 5 (age 3 β = -.050, p < .001), but not at a later age (age 5 β = -.016, p = .132). The negative coefficients suggest that greater levels of self-regulation are linked to lower levels of psychopathology and emotion dysregulation in subsequent years.
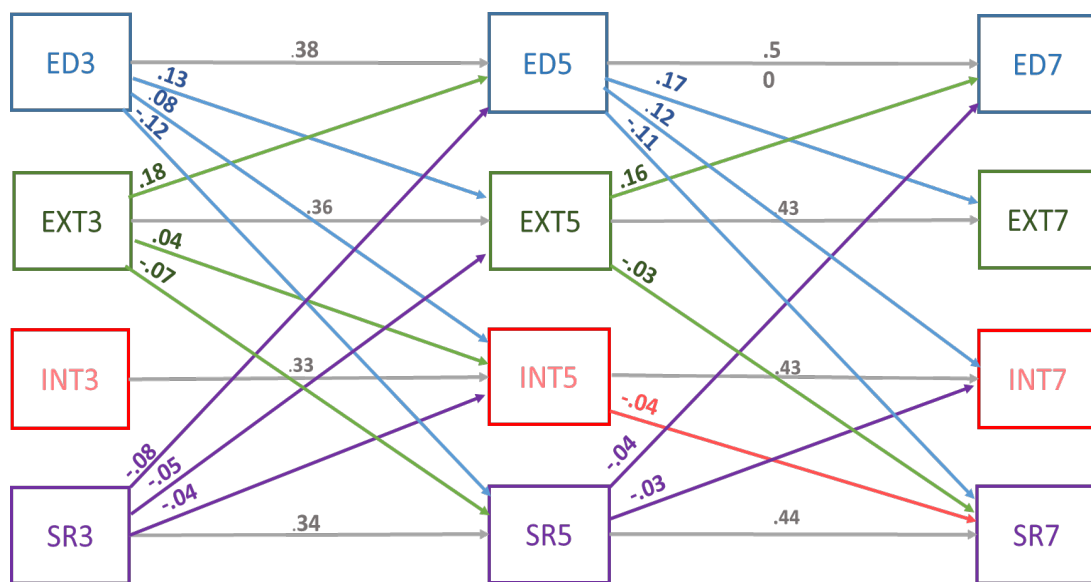
Figure 3.1 Cross-lagged model of internalizing (INT), externalizing (EXT) problems and self-regulation (SR) and emotion dysregulation (ED) across the ages of 3, 5 and 7. Only significant paths (p<.001) are shown. The model is controlled for gender, ethnicity, and socio-economic status and maternal psychological distress.

3.3.3 Path differences

Parameter difference testing was used to investigate whether certain cross-lag pathways were significantly different from each other (See Figure 3.2 to Figure 3.5). The results indicate that externalizing symptoms at age 3 were a stronger predictor of emotion dysregulation at age 5 than emotional regulation was of externalising (A: $z =$ .08, $p < .001$). However, there were no differences for these same paths between the ages of 5 and 7, suggesting that emotion dysregulation and externalizing symptoms influence each other in a similar way. Furthermore, there was a tendency (i.e. marginally significant) for emotion dysregulation to become a stronger predictor of internalizing symptoms and externalizing symptoms over time (B: $z = .02$, $p =.06$; C: $z = .20$, $p = .12$). Finally, emotion dysregulation was a stronger predictor of internalizing symptoms than vice versa at each age (D: $z = .05$, $p < .05$, E: $z = .09$, $p < .001$).
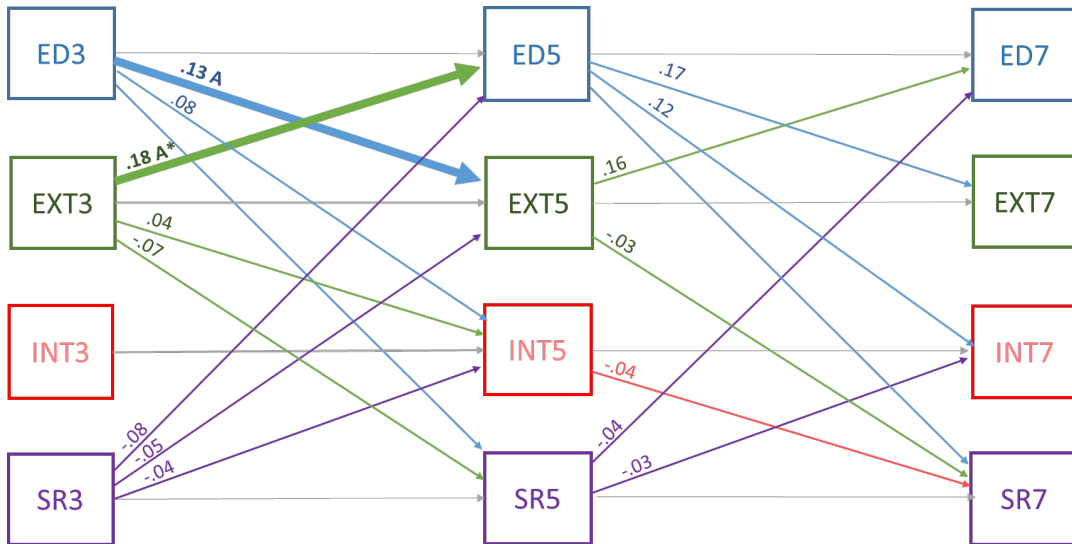
*Figure 3.2 Path difference tests between paths marked by A and as highlighted by a thicker lines. Path marked by * is a stronger predictor at = p<.001*
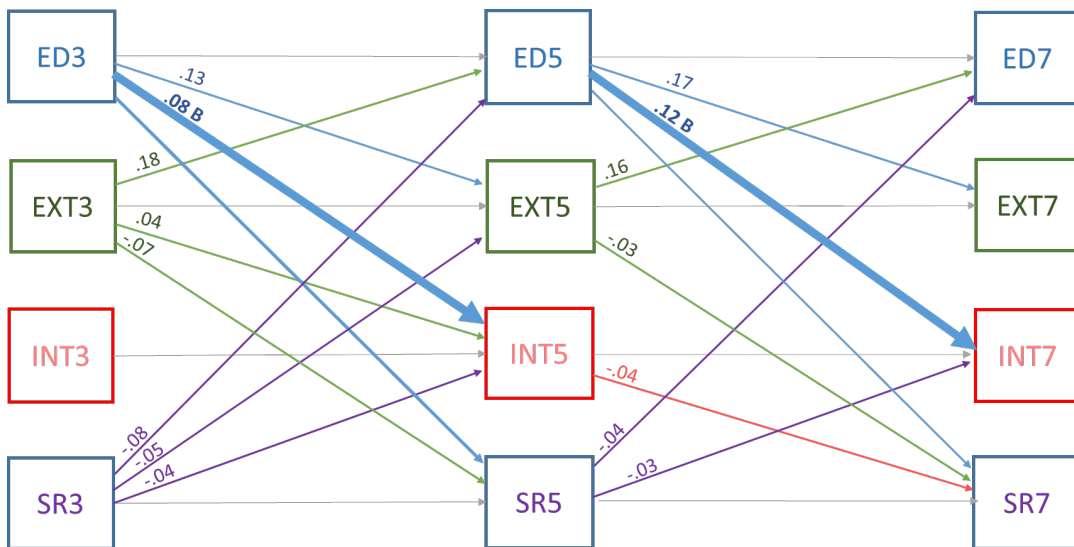
Figure 3.3 Path difference tests between paths marked by B and as highlighted by a thicker lines. Paths are not significantly different.
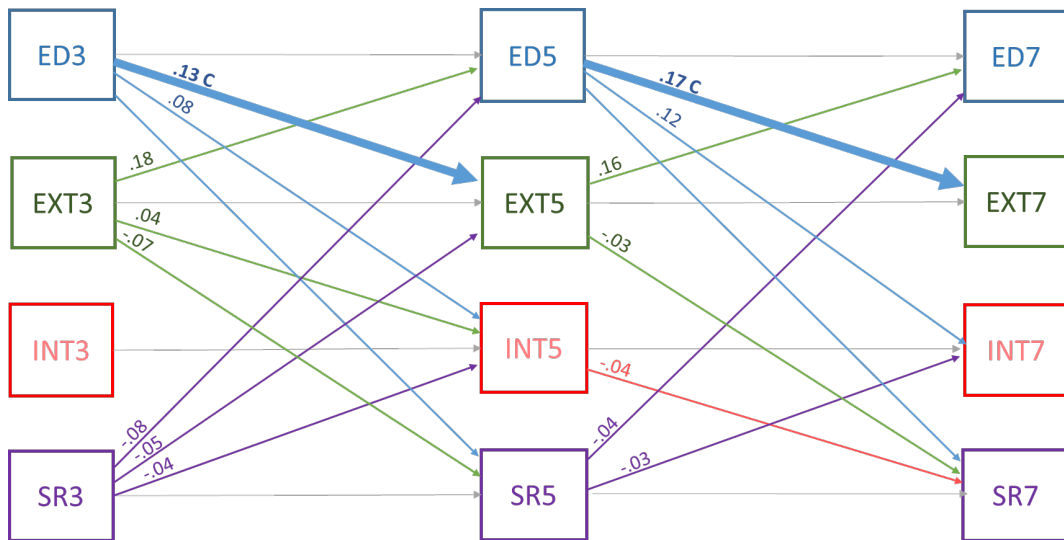
Figure 3.4 Path difference tests between paths marked by C and as highlighted by thicker lines. Paths are not significantly different.
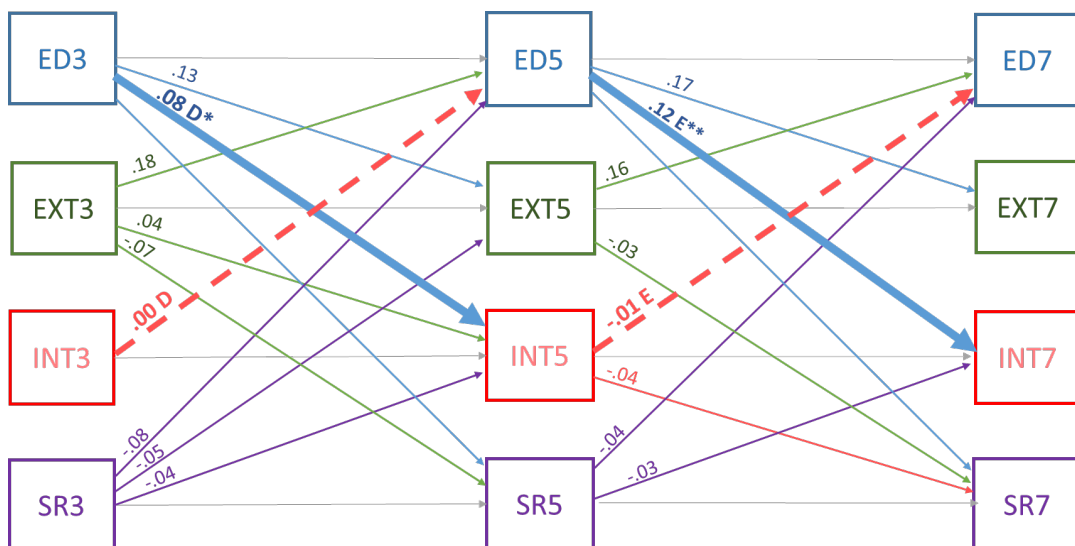
*Figure 3.5 Path difference tests between paths marked by D and E, respectively and as highlighted by thicker lines. Paths marked by * are stronger predictors with *p<.05 and **p<.001. Dashed line represents path that was not significant in the full model.*

3.4   Discussion

The present study investigated a developmental cascade model of children's externalizing, internalizing symptoms and emotion regulation, in order to increase our understanding for the complex relationship between these constructs over childhood. This approach is in line with current views in developmental psychology, which encourage more complex investigations that include multiple factors in order to show how these factors influence each other over time (Cox, Mills-Koonce, Propper, & Gariépy, 2010). While previous studies have attempted to investigate bi-directional effects between psychopathology and emotion regulation, they have often lacked sufficient power to detect reliable effects. I have addressed this gap in this study by utilising data from the MCS.

The identified model demonstrates significant bi-directional effects between the included constructs. Especially between externalizing symptoms and emotion dysregulation, which significantly influenced each other across all time points. As of age 3 both constructs significantly influenced each other, therefore, the question whether one starts before the other is unanswered, at least based on the present data. The possibility of one-directional effects before the age of 3 remains and needs to be investigated. The present findings support both the hypothesis of early bi-directional effects and that children with difficulties regulating their emotions are at increased risk of experiencing later externalizing and internalizing symptoms (Blandon et al., 2010; Eisenberg et al., 2001; Keenan, 2000). It additionally suggests that existing behavioural problems can hinder the development of further emotion regulation abilities (Blair et al., 2015; Calkins & Dedmon, 2000; Eisenberg et al., 2009; Kim-Spoon et al., 2013). With respect to this, the present findings are different from Blandon et al. (2010), who reported only one-directional effects, with emotion regulation levels predicting later externalizing problems, but not the other way around. Blandon and colleagues had hypothesized to find bi-directional effect in their study. As an attempt to explain their findings they explained that emotion regulation is just one component of a whole set of self-regulatory skills (e.g., physiological or attentional regulation), of which some processes develop sooner than others (Calkins, 2009). Following this, they argued that their study may not have captured any of these earlier-developing self-regulatory skills that could have shown bi-directional effects

with psychopathology. However, as mentioned earlier, their study as many others, lacked a sufficiently large sample size that is necessary for such complex analyses. This, however, is a significant strength of the present study.

Past research has repeatedly shown the close interconnections between emotion regulation and self-regulation, with various scholars asking for a greater integration of the two constructs so that a more comprehensive picture of the underlying mechanisms can be drawn (Diamond & Aspinwall, 2003). The present study included self-regulation (assessed as part of the emotion regulation measure) in the cascade model, which showed significant but small associations with internalizing as well as externalizing problems at an early age. These links decreased with internalizing symptoms over time and disappeared completely for externalizing symptoms by the age of 5. Thus, the present model only partly supports Blandon's suggestion, as it also identified bi-directional effects between emotion dysregulation and psychopathology from an early age. Nevertheless, both Blandon and colleagues' (2010) and the current findings highlight the importance of research methods being able to detect the dynamic nature of these constructs over time (Denham et al., 2009).

In contrast to Castro and colleagues' (2018) study, whose model suggested that difficulties in emotion recognition predicted later internalizing problems but not externalizing symptoms, I found that emotion dysregulation was a significant predictor of both. Thereby the present results lend further support to the notion that emotion dysregulation is a transdiagnostic factor underlying multiple disorders (Aldao et al., 2010; Berking & Wupperman, 2012). Castro et al. (2018) stated that neither internalizing nor externalizing symptoms were predictive of later emotion recognition levels, while the present model indicated that at least externalizing symptoms were a significant predictor of later levels of emotion dysregulation.

The inconsistent findings across previous studies could, besides the lack of power, also be related to the assessment of closely connected but potentially different sub-aspects of emotion regulation. As mentioned earlier, emotion regulation is a multidimensional construct that consists of many distinct processes, for which previous research has demonstrated that the associations with psychopathology can differ depending on how emotion regulation was assessed and which aspects of it (Aldao, 2012; Vine & Aldao, 2014). This inconsistency in assessment could also explain the difference in findings of the present research in comparison to Castro and colleagues' study (2018). Their

study specifically investigated emotion recognition abilities in children through the Assessment of Children's Emotion Scale, where children are presented with a set of cards that depict different facial expressions and children have to identify the correct feeling based on what they see on the card. This approach has various benefits over parental self-reports, as it provides more objective data and is based on the child's abilities, which is more in line with the idea that emotion recognition is a process. In other words, parental self-reports have been shown to be biased and are also more likely to tap into the outcomes of a failed or successful emotion recognition process (e.g., a child's reaction does not match the situation). While the Assessment of Children's Emotion Scale was appropriate for their study, it would not have been suitable for the first wave of the present research, where children were only 3 years old. Nevertheless, future research would highly benefit from additional measurement approaches that go beyond the use of parental self-report and assess emotion regulation processes more objectively through certain tasks as they are commonly employed in lab studies (Lewis et al., 2008; Rice, Levine, & Pizarro, 2007).

Thus, it needs to be pointed out that in the present study emotion dysregulation and psychopathology levels were solely assessed through parental reports of a child's behaviour and no data of other informants or objective measures were included to provide a more comprehensive picture (Aldao et al., 2016; Denham et al., 2009). This can be regarded as a significant limitation of the present study, as research has repeatedly demonstrated that there are substantial discrepancies between different informants' reports (e.g., parents versus teacher) and how reliably these predict a child's present or future mental health status (Collishaw, Goodman, Ford, Rabe-Hesketh, & Pickles, 2009).

In addition to that the use of parental observations to assess emotion dysregulation in the present study can be problematic for a few reasons. Firstly, as I have explained earlier, as children mature they start using more internal or cognitively based strategies to regulate their emotions. This can make observational assessments more difficult and less reliable. Secondly, a closer look at the emotion dysregulation items in the present study suggests a potential bias towards those aspects of emotion dysregulation that are closely related to externalizing symptoms (i.e., "gets over excited" or "acts impulsively"). This could be related to the fact that emotion dysregulation processes that are typical for internalizing disorders tend to be less expressive or discernible (e.g.,

avoidance, rumination, giving-up; Braet et al., 2014; Cole et al., 1996). Furthermore, this could explain the weaker links between internalizing symptoms and emotion dysregulation in the present model.

Past research by Braet et al. (2014) has examined the relationship between specific maladaptive and adaptive emotion regulation strategies in children exhibiting internalising and externalizing symptoms. The findings demonstrated that different emotion regulation strategies were associated with different symptom clusters and that only two strategies, "problem-oriented action" and "acceptance", were transdiagnostically related to both internalizing and externalizing symptoms. Furthermore, they found that children with mental health problems displayed rather a lack of adaptive strategies than an inadequate use of maladaptive strategies. These findings contradict the evidence that has been provided by adult studies, in which psychopathology symptoms were strongly related to maladaptive emotion regulation (Aldao et al., 2010), but hardly with the use of adaptive strategies. With respect to the developmental framework outlined above this is a highly interesting disparity between adult and youth samples. As young children are assumed to learn new adaptive emotion regulation patterns from their parents or caregivers, it has been suggested that children who lack to acquire sufficient emotion regulation skills at an early age, subsequently adopt/develop maladaptive strategies as they face more conflicts and challenges when they get older (Braet et al., 2014; Lunkenheimer, Shields, & Cortina, 2007). Following this, I suggest that future studies will benefit from the inclusion of measures that target both adaptive and maladaptive emotion regulation tendencies. This will allow us to examine different links between these constructs and the development of psychopathology more specifically.

As mentioned earlier (e.g., see Chapter 1 for more details) issues of measurement are always a concern in studies on emotion regulation. Emotion regulation, and related constructs like self-regulation have been repeatedly criticised for their lack of conceptual clarity or unity, and the overly-diverse set of measures through which researchers try to quantify such constructs (Nigg, 2017). To complicate the picture further, researchers have also identified multiple emotion regulation processes, which are assumed to: a) be related and b) share links with other behavioural, psychological and physiological systems. However, up to this point there is no agreement on how these components are related.

As a means to address the psychometric confusion around highly dynamic, multi-component constructs like emotion regulation, Eisenberg and colleagues (2019) have argued for an increased use of data-driven methods, which would allow the identification and description of different concepts in a domain and their relationship to each other. Furthermore, they emphasize the importance of investigating within- as well as across-construct correlations. More specifically, the authors state that if the structure of a multidimensional construct is only tested through the assessment of related theories or measures, one omits the chance to adequately challenge the construct in question and its border with other constructs (e.g., discriminant validity).

With respect to Eisenberg's recommendations, the results of the present study show that there are moderate correlations of .59-.63 between externalizing symptoms and emotion dysregulation at all time points. This, in addition to the significant longitudinal associations in the model, suggests that there is a significant amount of conceptual overlap between the constructs. In fact, research has already indicated that most mental health disorders (estimates range between 40-75%) involve symptoms (based on DSM-5) that are related to emotion and emotion regulation problems (Jazaieri, Urry, & Gross, 2013; Werner & Gross, 2010). Furthermore, there has been a steep increase in research highlighting the substantial role of emotion dysregulation as a transdiagnostic factor, suggesting that it is a key mechanisms that underlies multiple mental health disorders (Aldao et al., 2016; Chu, Chen, Mele, Temkin, & Xue, 2017; Fernandez et al., 2016).

Consequently, the question might arise of how distinct the two concepts of emotion dysregulation and psychopathology actually are. While there are substantial theoretical reasons to view them as distinct constructs, there has also been a growing body of evidence demonstrating their close inter-connection. With respect to Eisenberg's suggestions, there is currently insufficient evidence from a data-driven perspective that can shed a light on this relationship. Hence, the following study investigates the conceptual relationship between emotion dysregulation and psychopathology with a more data-driven approach (see Chapter 4).

3.4.1 Conclusion

By utilizing existing data from the MCS dataset, the present study extends the literature with further evidence on the cascading effects between emotion dysregulation and psychopathology across childhood. Strong statistical power (due to the large sample

size) and the inclusion of three assessment points represent significant strengths of the present study over past research. The model demonstrated significant bidirectional effects, whereby emotion dysregulation was a significant predictor of later externalizing symptoms and vice versa. Furthermore, emotion dysregulation was found to be a significant predictor of both internalizing and externalizing symptoms. Strong associations between the constructs may suggest a conceptual overlap between the constructs by the way they are currently assessed. These conceptual links between emotion regulation and psychopathology have not been explored so far and are therefore the focus of the investigation in the next chapter.

Chapter 4: A conceptual investigation of the relationship between emotion dysregulation and psychopathology

4.1　Introduction

With respect to the growing body of evidence demonstrating the close inter-connection between emotion dysregulation and psychopathological symptoms (see Chapter 3), the question arises of how distinct or similar the two concepts actually are. Recent advances in statistical methodology represent promising means to investigate conceptual relationships through data-driven approaches, such as confirmatory factor analysis. In line with this, the present study explores the relationship between emotion dysregulation and psychopathology further by employing such advanced statistical methods.

Data-driven methods have increasingly been employed to address questions around the conceptualization of psychopathology in recent years. Although the well-known categorical classification system, as found in the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Classification of Diseases (ICD), has guided many years of clinical and research practice, it has also been shown to have its limitations. For instance, high rates of comorbidity between mental health disorders (i.e., coexistence of two or more disorders have been estimated be up to 50%; Clark, Watson, & Reynolds, 1995; Kessler, Chiu, Demler, & Walters, 2005) as well as substantial heterogeneity within the disorder categories have repeatedly been stated as significant limitations of the categorical approach (Ronald C Kessler et al., 2005).

Following this and the availability of more advanced statistical methods, a new line of research started to investigate such conceptual issues by employing data-driven approaches that could reveal the empirical structure of psychopathology (see below for more detail on this approach). Initiated by the work of Achenbach and colleagues (Achenbach, 1966; Achenbach & Edelbrock, 1978), a growing body of evidence has suggested that a dimensional approach to psychopathology was superior to the categorical classification (Caspi et al., 2014; Eaton, 2017). Achenbach's work coined the terms of internalizing and externalizing dimensions to describe childhood psychopathologies. Hereby, the internalizing spectrum includes disorders primarily related to depressive and anxiety symptoms, while the externalizing spectrum encompasses conduct problems, oppositional-defiant disorder and substance abuse.

Despite being treated as separate factors, study results consistently indicated that the dimensions tended to significantly correlate with each other (.56-.67; Lahey et al.,

2008), thereby suggesting an extent of shared variance between them. The idea that mental health disorders are more similar than different, had also been supported by studies demonstrating that most psychopathologies seem to have common causes and risk factors (Andrews et al., 2009; Beauchaine, 2015; E. Pettersson, Larsson, & Lichtenstein, 2016). Furthermore, clinical observations had shown that different mental health disorders seemed to respond to similar types of treatments (Barlow, Allen, & Choate, 2004). Thus, Lahey and colleagues (2012) decided to investigate this communality further by comparing three alternative psychopathology models. They estimated two correlational models with either a two or a three-factor solution - each representing a specific psychopathology dimension (i.e., internalizing vs externalizing and distress, fear and externalizing) - and a bi-factor model with a general psychopathology factor (see Figure 4.1). In the bi-factor model all items were free to load onto the specific factors as well as a general psychopathology factor. In line with previous findings the correlational models fitted the data well and the specific dimensions correlated substantially with each other (.59 -.82). The bi-factor model, however, fitted the data significantly better, with all disorders loading on the general psychopathology factor. Furthermore, the general factor significantly predicted future levels of psychopathology over and above the specific dimensions and showed strong links with commonly reported etiological risk factors, including physical, sexual abuse, and neglect (Green, McGinnity, Meltzer, Ford, & Goodman, 2005; Green et al., 2010). Based on this Lahey and colleagues (2012) suggested that the general psychopathology factor underlies all forms of psychopathology and represents their level of commonality, including shared etiological factors.
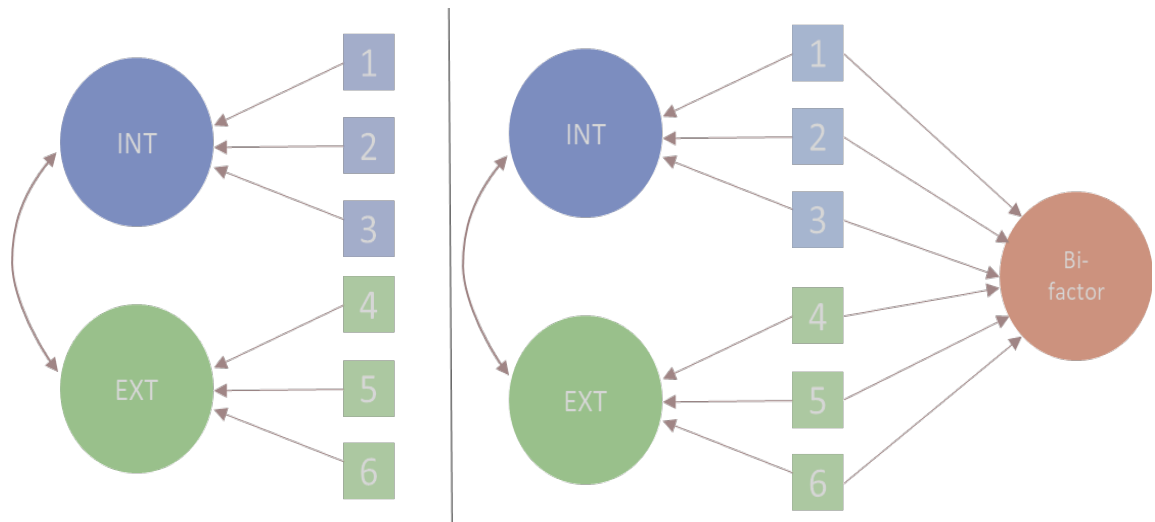
Figure 4.1 Correlation model left and bi-factor model right. The bi-factor or general factor represents the shared variance among all items (1-6).

These findings, led to a further push in research delving into the meta-structure of psychopathology resulting in additional evidence for the existence of a general psychopathology factor, also in youth samples (Caspi et al., 2014; Martel et al., 2017; A. L. Murray, Eisner, & Ribeaud, 2016; Patalay et al., 2015). A longitudinal analysis conducted by Caspi and colleagues (2014) replicated Lahey's findings and introduced the term p factor to describe the construct and emphasize its similarities to the factor *g,* which had commonly been used in intelligence research.

However, more interesting with respect to the present research, the researchers identified emotion dysregulation as an early developmental feature of p, as it cut across all disorders. This observation lends further support to the central role of emotion dysregulation as a transdiagnostic mechanism of psychopathology, which had also been emphasized by various other studies (Aldao et al., 2016, 2010; Lukas, Ebert, Fuentes, Caspar, & Berking, 2018).

As outlined in the previous chapters, there is a strong evidence base for the close connection between emotion dysregulation and psychopathology. One significant part of the evidence has derived from clinical research investigating the commonly observed emotion regulation difficulties in patients. Another body of evidence evolved from developmental research looking for childhood indictors anteceding later psychopathology, which proposed a concept very similar to p, namely the Dysregulation Profile (DP). The DP was introduced by Althoff and colleagues (2010)

who conducted a study with 13 birth cohorts to investigate whether certain childhood difficulties related to later adult levels of psychopathology. Based on the three scales of the Child-Behavior Checklist (CBCL) including an anxious/depressed, aggressive behaviour and attention-problem scale, the authors identified the DP as a significant precursor of later adult mental health difficulties. Subsequent studies investigated the structure of DP and suggested a similar underlying bi-factor structure as it had been found for p (Deutz, Geeraerts, van Baar, Deković, & Prinzie, 2016; Geeraerts et al., 2015).

Following this, two recent studies highlighted the profound similarities between p and DP and explored these links further. The first study by Haltigan and colleagues (2018) investigated the fit of a bi-factor model for both constructs based on the CBCL with a clinical child and adolescent sample. In this study, they tested the association of p and DP with symptoms of self-harm, suicidality and psychological distress. The results demonstrated that both p and DP could be estimated with a bi-factor model and had significant links with psychopathological symptoms. The second study, conducted by Deutz and colleagues (2019) extended the evidence in a longitudinal study where they estimated p and DP at the age of 8 and 14 years. They showed that both concepts were similarly related to early-childhood risk factors (e.g. maternal depression) and equally predicted negative mental health outcomes in adolescence. Furthermore, the authors explained that items relating to emotion dysregulation (e.g., "Sudden changes in mood or feelings") were most directly related to both p and DP, thereby lending further support to the notion that emotion dysregulation problems seem to lie at the core of psychopathology.

Despite the growing evidence for an underlying psychopathology factor, the psychological nature of p is still unclear and needs to be further explored. Most studies, including those by Deutz et al. (2019) and Haltigan et al. (2018) employed the same measurement tool to represent the psychopathology as well as the emotion dysregulation factor. However, as mentioned in Chapter 3, with respect to complex constructs like emotion regulation, Eisenberg et al. (2019) not only recommend the increased use of data-driven methods to investigate underlying domains and their relationship to each other, but also emphasized the importance of investigating cross-construct correlations as these allow us to adequately challenge the construct in question and its borders to other constructs (e.g., discriminant validity).

4.1.1 The present study

With respect to Eisenberg's suggestion and the demonstrated close association between emotion dysregulation and psychopathology (see Chapter 3), the present study extends the existing evidence base by investigating the conceptual relationship between the two constructs through a confirmatory factor analytic approach. More specifically, a classical correlational model is estimated as well as a bi-factor model. In the latter, the bi-factor captures the variance that is common across all measured items. The remaining covariance in the model is then captured by the specific factors (i.e., internalizing, externalizing, emotion dysregulation, and self-regulation). With respect to the current literature, I suggest that emotion dysregulation and the psychopathology factors overlap substantively, which will be reflected in the significant amount of shared variance captured by the bi-factor.

A significant strength of the present study is the inclusion of a specific emotion dysregulation factor that is based on a separate measure than the internalizing or externalizing factors. This allows for cross-construct validation, as it has been suggested by Eisenberg and colleagues (2019). In line with this, I also test the predictive validity and utility of the derived bi-factor in predicting future levels of self-harming behaviour and depression, for which the MCS has child self-report data available at the age of 14. Depression and self-harm have been shown to have strong links with emotion dysregulation (Peh et al., 2017). Furthermore, depression symptoms are currently one of the most prevalent mental health problems in young people in the UK and have increased significantly over past years (Patalay & Gage, 2019). Self-harming behaviours in young people have also reported to be on the rise, and were associated with a higher risks of suicidal behaviour.

Additionally, the present models are based on longitudinal data from the ages 3,5, and 7 years, which allows me to explore potential structural changes over time for an age group that has been widely neglected so far (with an exception: McElroy, Belsky, Carragher, Fearon, & Patalay, 2018).

Lastly, with respect to recent criticism around the application of bi-factor models in psychological research (Bonifay, Lane, & Reise, 2017), according to which bi-factors, such as p, might be the result of a statistical artefact, the present study also investigates reliability indices for the general and specific factors (Rodriguez, Reise, & Haviland, 2016b, 2016a). These indices allow us to determine the level of reliability for each of

the specific factors in the model relative to the bi-factor. The inclusion of reliability indices for the evaluation of bi-factor models has been considered a critical extension of prior work (Reise, 2012).

Based on the literature review above, I hypothesize that:

a) The bi-factor model fits the present data better than the correlational-model with 4 specific factors.

b) The bi-factor captures most of the psychopathology and emotion dysregulation item variance.

c) The derived bi-factor significantly predicts later self-harm behaviour and depressive symptoms

4.2 Methods

The present research was conducted in two stages. In Stage I a series of confirmatory factor analyses (CFA) was conducted to estimate the bi-factor and correlation model. For stage II the factor scores of both models were extracted to test their predictive validity and utility in predicting later mental health problems. In doing so a series of regression analyses was performed with depressive symptoms and self-harming behaviour at age 14 as outcome variables and factor scores as predictor variables.

4.2.1 Sample and Participants

4.2.1.1 Stage I

All participant data was derived from the MCS study. The present sample included data from one child per family and from the waves 2, 3 and 4, when children were 3, 5 and 7 years old. The analytical sample included all cases for which data was available on one of the dependent variables - emotion dysregulation, self-regulation, externalizing and internalizing symptoms - for at least one time point or more. This resulted in an analytical sample of N=16,859 participants. For emotion dysregulation and self-regulation, no data was available for 261 participants, 2,089 participants had data for one, 3,427 participants for two, and 11,343 participants had data available at all three time points. For the internalizing and externalizing symptoms, no data was available for 263 participants, 2,088 participants had data for one, 3,427 participants for two, and 11,342 participants had data available at all three time points

4.2.1.2 Stage II

Factor scores of the bi-factor and correlational models were extracted for each wave and saved into a new file. Data on self-harming behaviour and depressive symptoms at age 14 were added from wave 6 of the MCS data. Self-harm data was available for 10,915 (35% missing) cases and depressive symptoms for 10,934 (35% missing) cases in the analytical sample.

4.2.2 Missing data and imputation

For factor scores at age 3 complete data was available for 14,784 cases (12% missing). At age 5 factor score data was available for 14,740 cases (12% missing) and at age 7 for 13,448 cases (20% missing). At age 14, data for self-harming behaviour was available for 10,915 cases (35% missing) and for depression data was available for

10,934 cases (35%). In order to ensure that attrition over time does not bias the results multiple imputation was conducted in Stata 16. A single dataset based on all participants who provided at least some data on the relevant variables was created (N= 16,859)

4.2.3 Measures

4.2.3.1 Emotion regulation and psychopathology

A detailed description of the CSBQ and SDQ can be found in Chapter 2.

4.2.3.2 Self-harm

Self-harm was assessed at age 14 by a single self-report item ("Did you hurt yourself on purpose in any way in the past year?"), which was answered by the young person him or herself.

4.2.3.3 Depressive symptoms

Depressive symptoms at age 14 were assessed with the Short Moods and Feelings Questionnaire (SMFQ). The SMFQ consists of 13 items that assess depressive symptoms in children and adolescents (Angold, Erkanli, Silberg, Eaves, & Costello, 2002). The items are rated on a 3-point Likert-scale ranging from "not true" (1) to "true" (3). In the present study total scores were calculated, with larger scores indicating greater levels of depressive symptoms. The SMFQ has been shown to have good construct and internal validity across clinical (reported Cronbach's α = .85) and community samples (Sharp, Goodyer, & Croudace, 2006). In the present study the SMFQ also showed good internal reliability (Cronbach's α = .93).

4.2.4 Statistical Analysis

The statistical analysis was also conducted in two stages. All analyses of Stage I were performed in Mplus, while analyses of Stage II were conducted in Stata 16.

Stage I. Similar to the approach used by McElroy et al. (2018), a series of confirmatory factor analyses (CFA) was conducted for each time point. In doing so a correlational model with 4 specific factors was estimated, as well as a bi-factor model in addition to the four specific factors. All models were estimated using MPLUS 8 and the weighted least square means and variance estimator (WLSMV), which is most suited for categorical manifest variables. Evaluation of model fit was based on root-mean-square error of approximation (RMSEA $\leq$ 0.05), the magnitude of factor loadings, the

comparative fit index (CFI > 0.90) and the Tucker-Lewis index (TLI > 0.95; Hu & Bentler, 1999; Little, 2013). Sampling weights were included across all models.

Furthermore, in line with recent recommendations (Hancock & Mueller, 2001; Rodriguez et al., 2016b), construct reliability *H* was calculated for each factor in the correlational and the bi-factor model. *H* is calculated as the ratio of the variance explained by the latent variable relative to the variance left unexplained (see Formula 1). *H* determines how well a latent variable is represented by a certain set of items, with higher values (>.70) indicating good construct reliability (Hancock & Mueller, 2001, pp. 209-210).

$$(1) \qquad H = 1/[1 + \frac{1}{\sum_{i=1}^{k}\frac{\lambda_i^2}{1-\lambda_i^2}}]$$

4.2.4.1 Correlational Model

Correlational models have consistently been used in previous research to explore the underlying structure of psychopathology. This model assumes that all factors may be correlated but reflect and influence specific subsets of symptoms. The present correlational model was estimated with the following four factors: internalizing, externalizing symptoms, emotion dysregulation, and self-regulation.

4.2.4.2 Bi-factor model

The confirmatory bi-factor analysis included a bi-factor that was uncorrelated with the four specific factors, here internalizing, externalizing symptoms, emotion dysregulation, and self-regulation. The model assumes orthogonal factor correlations, thus correlations amongst the factors were set to zero. Furthermore, in this model, the bi-factor and the specific factors were situated on the same conceptual level (this is different for second-order models, which include higher and lower factor levels) and therefore compete for the amount of explained item variance in the model. This allowed for a direct comparison between the factors.

Furthermore, the amount of explained common variance (ECV) was calculated for both the general and the specific factors at each time point (Rodriguez et al., 2016a, 2016b). The ECV was calculated by dividing the variance explained by the factor of interest by the variance explained by all factors (i.e., general and specific factors

combined). ECV values range from 0 to 1, and values closer to 1 suggest that a greater share of the variance is explained by the respective factor (see Formula 2).

$$(2) \qquad \boldsymbol{ECV} = \frac{\sum \lambda^2 Gen}{\sum \lambda^2\, Gen + \sum \lambda^2 INT + \sum \lambda^2 EXT + \sum \lambda^2 ED + \sum \lambda^2 SR}$$

Stage II. To investigate whether the bi-factor was a significant predictor of future self-harming behaviour or depressive symptoms, factor scores from both models were exported from Mplus and imported to Stata 16. Due to missing factor scores, multiple imputation was conducted in Stata using the "mi" command. Multiple imputation uses the distribution of the observed data to estimate multiple values that help reproduce a variance matrix that is closest to the one that might have been observed, if the data had not been missing (van Buuren, 2007).

Following this, regressions were performed in Stata 16, with self-reported self-harm at age 14, reflecting either the presence or absence of self-harm, and depressive symptoms at age 14 (SMFQ total scores) as outcomes variables.

4.3 Results

4.3.1 Stage I

4.3.1.1 Correlational model

The first CFAs estimated a 4-factor correlational model for each year with the internalizing, externalizing symptoms, emotion dysregulation, and self-regulation factors. Correlations between the factors were estimated for all models. The correlation between the internalising and externalising factor was moderate (.52, .55, .56, $p < .001$), and also between internalizing and emotion dysregulation factor (.50, .56, .59, $p < .001$). The emotion dysregulation factor correlated highly with the externalizing factor (.88, .95, .97, $p < .001$). The self-regulation factor correlated negatively with the remaining factors: emotion dysregulation (-.14, -.40, -.46, $p < .001$), externalizing (-.18, -.49, -.52, $p < .001$), and internalizing factor (-.26, -.33, -.39, $p < .001$). Figure 4.2 demonstrates how strongly each item loaded onto the factors. (Standardised factor loadings are presented in Table A1 in appendix A).

As expected for the internalizing and externalizing dimensions, all items showed significant ($p < .001$), positive loadings with the respective factors. At most ages these items had loadings higher than 0.5, with some deviations. One item (22. "Can be spiteful to others") on the externalizing factor dropped to .43 (at age 5) and one internalizing item dropped to .48 (3. "Complains of headaches or stomach-aches or sickness"; at age 5 and 7). On the emotion dysregulation scale, the reverse coded item (7. "Gets over being upset quickly") consistently showed lower, but significant factor loadings between .25 and .32. One item on the self-regulation scale (5. "Chooses activities on their own") also showed consistently lower but significant loadings between .42 and .49. The model fit statistics for the correlational model are presented in Table 4.1 and represent adequate to good model fit (Little, 2013).

Table 4.1 Fit indices for correlational and bi-factor model

Model	Age	TLI	CFI	RMSEA	X^2 (df)
Correlation Model	3 years	0.91	0.92	0.04	4467.63* (164)
Bi-factor Model	3 years	0.92	0.94	0.03	3442.70* (150)
Correlation Model	5 years	0.92	0.93	0.04	4459.76* (164)
Bi-factor Model	5 years	0.94	0.95	0.03	2850.22* (150)
Correlation Model	7 years	0.92	0.93	0.04	4377.87* (164)
Bi-factor Model	7 years	0.94	0.95	0.03	2950.33* (150)

4.3.1.2 Bi-factor model

The second series of CFAs tested the bi-factor model with the same four specific factors and an additional bi-factor for all ages. In contrast to the correlational model, factors in this model were orthogonal. The model fit indices for the bi-factor model (see Table 4.1) suggest a good and slightly better model fit, in comparison to the correlational model. As expected, the internalizing, emotion dysregulation and externalizing items had significant, positive loadings on the bi-factor, while self-regulation items showed negative loadings (See Table A1 in appendix A for standardized factor loadings).

As stated earlier, due to the nature of this model, the factors compete for the variance in the model, which allows for direct comparison between the factors. Figure 4.3, displays how much variance is captured by each of the factors. It can be seen that most of the variance of the emotion dysregulation and externalizing symptoms is captured by the bi-factor. The self-regulation items on the other hand consistently show zero-order loadings on the bi-factor, but adequate factor loadings on the self-regulation factor, thereby highlighting the distinctiveness of the self-regulation factor as a separate construct to the bi-factor. Similarly, most of the internalizing items loaded higher on the specific internalizing factor than on the general bi-factor. However, the picture is less clear, as many items also showed moderate loadings on the bi-factor.
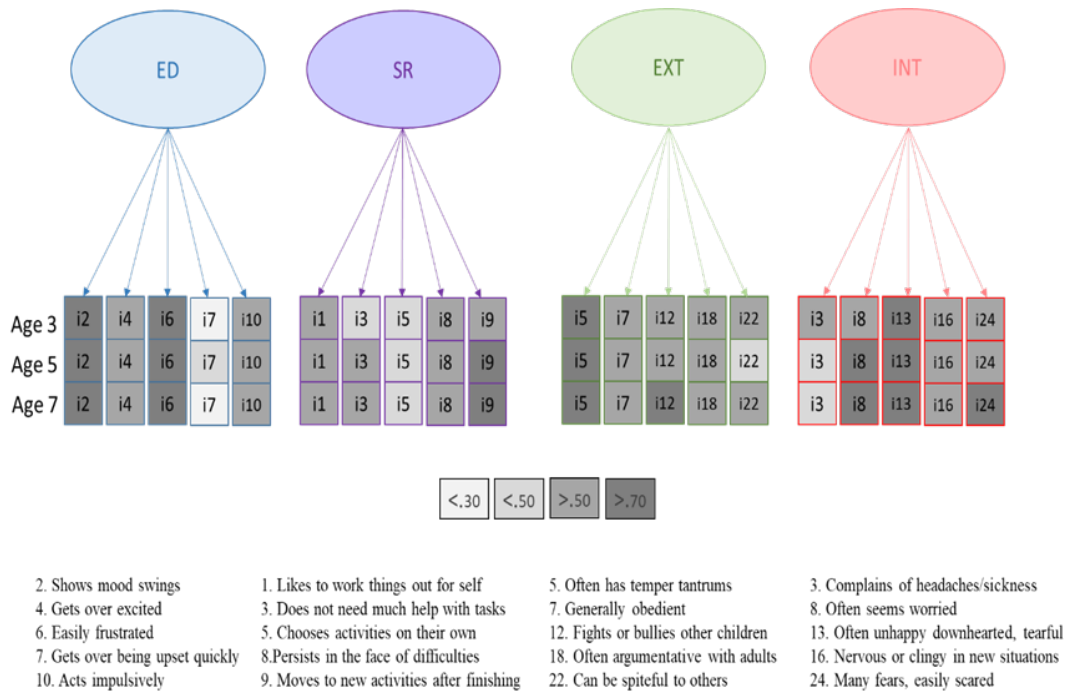
Figure 4.2 Correlational model with 4 specific factors
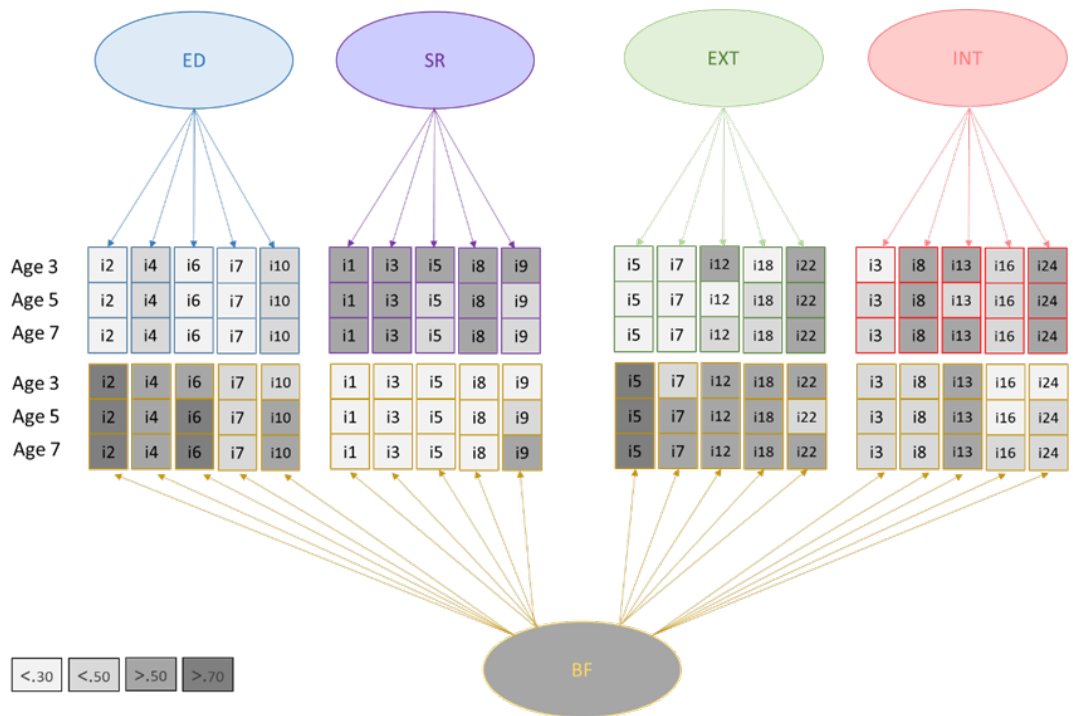
Figure 4.3 Bi-factor model with 4 specific factors and the bi-factor

4.3.1.3 Construct Reliability

Construct reliability (*H*) was calculated for each factor of the bi-factor and the correlational model at each wave. Table 4.2 provides an overview of the values of H for each factor in each model per wave. The factors in the correlation model show good construct reliability (<.70) apart from the self-regulation factor at age 3. Furthermore, it can be seen that *H* values for the bi-factor were the largest and increased over time. In contrast to the correlational model, the construct reliability of the specific factors decreased significantly in the bi-factor model. Emotion dysregulation (*H* = .38, at age 3 .38 at age 3 and .36 at age 7) had the smallest construct reliability, when p was added to the model.

Table 4.2 Construct reliability indices (H) per model and wave

Model	Correlational model				Bi-factor model				
Factor	ED	SR	EXT	INT	ED	SR	EXT	INT	BF
H (age 3)	.77	.69	.81	.82	.38	.67	.43	.67	.88
H (age 5)	.82	.79	.79	.82	.38	.68	.52	.68	.90
H (age 7)	.84	.80	.83	.83	.36	.69	.52	.68	.91

Note: ED = emotion dysregulation, SR= self-regulation, EXT = externalizing symptoms, INT = internalizing symptoms, BF = bi-factor

4.3.1.4 Explained common variance

The calculated ECVs for the bi-factor model allow us to compare the relative strength of both the specific and the bi-factor. As shown in Figure 4.4, the bi-factor explained most of the variance at all-time points (ECV_{BF}= .52 age 3, .54 age 5 and .58 age 7). This was again followed by self-regulation (ECV_{SR}= .17 age 3, .16 age 5 and .15 age 7) and internalizing symptoms (ECV_{INT}= .16 age 3, .15 age 5 and .14 age 7). Emotion dysregulation (ECV_{ED}= .06 age 3, .05 age 5 and .04 age 7) and externalizing symptoms (ECV_{EXT}= .07 age 3, .08 age 5 and .07 age 7) explained the least additional variance in the model. Although the bi-factor explained the majority of the variance in the model, its ECV values never exceeded .70, which suggests a significant contribution of some of the specific factors, here self-regulation and internalizing factor, in the model (Rodriguez et al., 2016a).
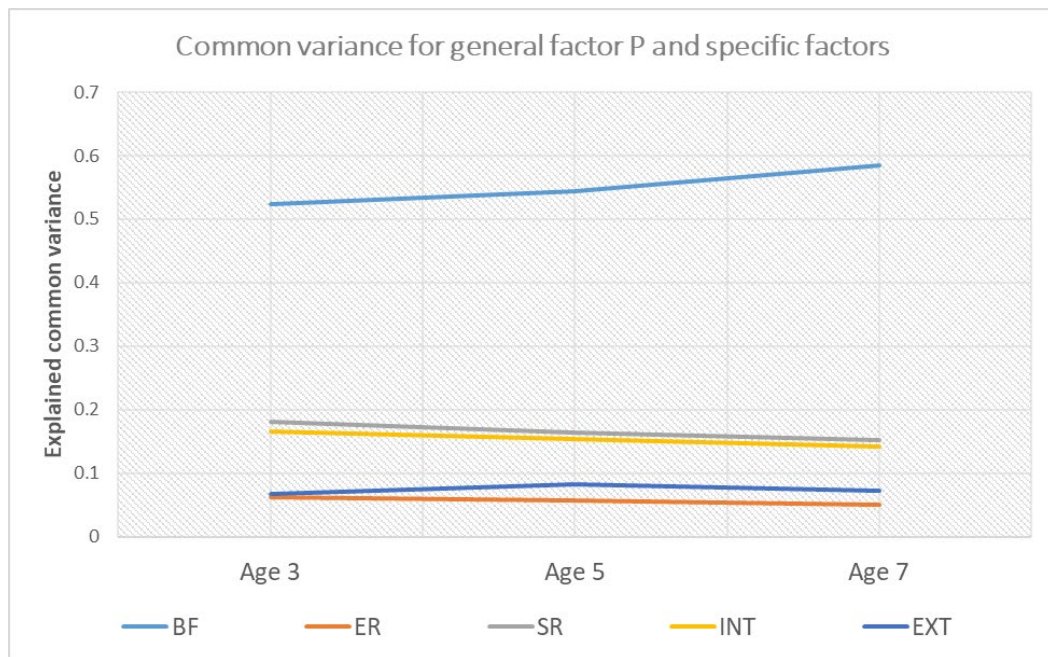
Figure 4.4 Common explained variance for the bi-factor and the specific factors over time

4.3.2 Stage II Predicting future psychopathology

To evaluate the predictive validity of the bi-factor and the specific factors, factor scores of both the correlational model and the bi-factor model were used to conduct regressions with self-harming behaviour and depressive symptoms at age 14 as outcome variables. Future levels of psychopathology were estimated while controlling for gender, socio-economic status, ethnicity, and maternal mental health.

4.3.2.1 Self-harm behaviour at age 14

At age 14, 14.8 % of the participants indicated that they engaged in self-harming behaviour in the past year. The logistic regressions indicate that the bi-factor was the only significant predictor that consistently predicted self-harm at age 14 (see Table 4.3). None of the specific factors significantly predicted later self-harm regardless of the model. Only at age 5 was emotion dysregulation a significant predictor in the bi-factor model in addition to the bi-factor itself.

Table 4.3 Logistic regressions with self-harm at age 14 as an outcome

	Correlational model			Bi-factor model		
Self-harm at age 14	**OR**	**p**	**95% CI**	**OR**	**p**	**95% CI**
Predictors at age 3						
Emotion dysregulation	0.84	.415	[0.54, 1.28]	0.97	.738	[0.86, 1.10]
Self-regulation	0.99	.924	[0.83, 1.17]	0.99	.842	[0.91, 1.07]
Externalizing symptoms	1.35	.133	[0.90, 2.02]	1.04	.443	[0.93, 1.17]
Internalizing symptoms	0.93	.659	[0.74, 1.20]	0.96	.440	[0.86, 1.06]
Bi-factor				1.10	.016	[1.01, 1.19]
Predictors at age 5						
Emotion dysregulation	1.21	.741	[0.37, 3.93]	1.14	.016	[1.02, 1.28]
Self-regulation	1.05	.750	[0.77, 1.40]	1.00	.991	[0.91, 1.09]
Externalizing symptoms	1.01	.981	[0.30, 3.39]	1.11	0.11	[0.97, 1.27]
Internalizing symptoms	1.08	.561	[0.82, 1.42]	1.05	.280	[0.95, 1.17]
Bi-factor				1.16	.001	[1.06, 1.26]
Predictors at age 7						
Emotion dysregulation	2.76	.138	[0.71,10.67]	1.05	.381	[0.93, 1.18]
Self-regulation	0.87	.318	[0.66, 1.14]	0.98	.777	[0.89, 1.08]
Externalizing symptoms	0.45	.267	[0.11, 1.83]	1.11	.121	[0.97, 1.29]
Internalizing symptoms	0.95	.738	[0.75, 1.25]	0.99	.942	[0.90, 1.09]
Bi-factor				1.24	.000	[1.14, 1.35]

4.3.2.2 Depressive symptoms at age 14

Regressions predicting future depressive symptoms based on the bi-factor model indicate that the bi-factor consistently showed greater predictive validity than the remaining specific factors, apart from at age 3 where the externalizing factor also significantly predicted later increases in depressive symptoms. With respect to the factors derived from the correlational model, only externalizing symptoms at age 3 significantly predicted later depressive symptoms. None of the factors significantly predicted later depressive symptoms at any other age (see Table 4.4).

Table 4.4 Regressions with depression at age 14 as an outcome

Depression at age 14	Correlational model			Bi-factor model		
	B	**p**	**95% CI**	**B**	**p**	**95% CI**
Predictors at age 3						
Emotion dysregulation	-0.26	.082	[-0.55, 0.03]	0.01	.692	[-0.07, 010]
Self-regulation	-0.08	.258	[-0.22, 0.06]	-0.04	.193	[-0.11, 0.02]
Externalizing symptoms	0.44	.002	[0.16, 0.72]	0.13	.010	[0.03, 0.23]
Internalizing symptoms	-0.17	.078	[-0.37, 0.02]	0.07	.092	[-0.16, 0.01]
Bi-factor				0.10	.003	[0.03, 0.16]
Predictors at age 5						
Emotion dysregulation	0.07	.885	[-0.94, 1.08]	0.03	.412	[-0.05, 0.12]
Self-regulation	0.07	.600	[-0.19, 0.34]	0.02	.500	[-0.04, 0.09]
Externalizing symptoms	0.13	.797	[-0.91, 1.19]	0.03	.527	[-0.07, 0.14]
Internalizing symptoms	0.14	.148	[-0.05, 0.35]	0.05	.174	[-0.02, 0.13]
Bi-factor				0.19	.000	[0.12, 0.26]
Predictors at age 7						
Emotion dysregulation	-0.50	.356	[-1.57, 0.57]	-0.06	.178	[-0.15, 0.02]

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Self-regulation	0.09	.315	[-0.09, 0.28]	0.02	.464	[-0.04, 0.09]
Externalizing symptoms	0.78	.156	[-0.30, 1.86]	0.08	.127	[-0.02, 0.19]
Internalizing symptoms	0.16	.173	[-0.07, 0.40]	0.01	.755	[-0.06, 0.09]
Bi-factor				0.26	.000	[0.20, 0.32]

4.4   Discussion

The present study investigated the conceptual and statistical overlap between the emotion regulation and psychopathology constructs by employing a series of confirmatory factor analyses. A four-factor correlational model and a bi-factor model were conducted to investigate underlying structures and the relationships between the constructs. As expected, both models fitted the data well, although the bi-factor model demonstrated a slightly better fit. These results supported the first hypothesis that the bi-factor model would fit the data better than the correlational model, thereby pointing towards an underlying dimension that summarises the significant overlap between the constructs (e.g., Haltigan et al., 2018; Patalay et al., 2015).

More specifically, it was hypothesized that emotion regulation would greatly overlap with psychopathological symptoms, which was expected to be demonstrated not only by significant correlations between the constructs, but also by high factor-loadings on the bi-factor. The present results supported this hypothesis, indicating moderate correlations between the emotion dysregulation and internalizing factor (.52 - .56), and high correlations between the emotion dysregulation and externalizing factor (.88 - .97) across all time points based on the correlational model. Additionally, there was a substantial overlap between the externalizing and emotion dysregulation dimensions as captured by the bi-factor. Moreover, it was demonstrated that once the bi-factor was added to the model, thereby removing all of the common variance, the "purified" emotion dysregulation and externalizing factors explained comparatively little of the variance left in the model.

In contrast, items of the self-regulation scale consistently showed moderate to high positive loadings on the specific factor, but low negative loadings on the bi-factor. Similarly, most of the internalizing items, showed higher loadings on the specific internalizing factor rather than the bi-factor. These findings could suggest a significant level of distinctiveness of the two constructs (i.e. self-regulation and internalizing symptoms) in relation to the bi-factor as estimated in the model, but other explanations are also possible (see below).

The present findings are in line with past research highlighting the close association between psychopathology and emotion dysregulation (Caspi et al., 2014; Deutz et al., 2019). Initially, researchers had explored the relationship between psychopathology

and emotion-related temperamental aspects, such as negative emotionality or affectivity, where it was found that negative affectivity accounted for a substantial amount of common variance between the internalizing and externalising symptoms (Kotov, Gamez, Schmidt, & Watson, 2010; Krueger & Markon, 2006; Lahey et al., 2012). These findings gave rise to further investigations in terms of its relationship to the general psychopathology factor p (Brandes, Herzhoff, Smack, & Tackett, 2019; Tackett et al., 2013).

Tackett and colleagues (2013) examined the association between p and negative affectivity in 1,569 twin pairs (ages 9-17) and demonstrated that the significant overlap between the two constructs could be explained on phenotypic (r = .58) as well as genetic levels (r = .71). Their study was one of the first to replicate the bi-factor structure based on genetic covariances, thereby counter-arguing growing criticism which suggested that the bi-factor was a result of a negative evaluation bias or simply a response style (Caspi & Moffitt, 2018). While Tackett et al.'s study provided promising results, their employed negative affectivity self-report measure had originally been designed to assess the risk of developing externalizing problems, thereby potentially neglecting relevant aspects of negative affectivity that are more typically associated with internalizing symptoms.

A later study by Hankin and colleagues (2017) examined the role of all three temperamental factors (i.e., negative affectivity, positive affectivity, and effortful control) as transdiagnostic factors in relation to the general psychopathology construct. Positive affectivity, negative affectivity, and effortful control are three related, but distinct temperamental factors. While positive affectivity and negative affectivity have been referred to an individual's tendency to experience positive or negative emotions, effortful control consists of the cognitive and behavioural self-regulatory processes that allow us to engage in effective goal-directed behaviours (Rothbart, 2007; see Chapter 1 for detailed description of these temperamental factors and how they differ from theoretical emotion regulation concepts). Hankin et al.'s study was a longitudinal investigation that involved a preadolescence (5-11 years) and adolescence sample (9-17 years). Their results indicated that psychopathology was associated with lower effortful control and higher negative affectivity in both samples based on parent and youth reports. Low positive affectivity was primarily associated with internalizing symptoms, highlighting it as a specific rather than general psychopathology feature.

Interestingly, the results also showed that low positive affectivity was linked to general psychopathology, but only in the adolescence sample, not the pre-adolescence sample. The authors argued that positive affectivity, similar to emotion regulation, is a multifaceted construct, hence the association of positive affectivity with other psychopathology dimensions might vary depending on context and type of measurement.

These findings tie in with a recent study by Weissman et al. (2019), who investigated the association between specific emotion regulation strategies, including rumination, attention bias, cognitive reappraisal, and emotional expression, with the general psychopathology factor in a sample of 262 children and adolescents (between 8-16 years). The authors reported interesting longitudinal effects, based on how each strategy differed in the way it was linked to p over time. For instance, attention bias to threat was not associated with p at baseline, but predicted future levels of p. On the other hand, expressive suppression was related to greater levels of p at baseline, but not two years later, and rumination showed significant links with both current and future levels of p.

The studies of Hankin et al. (2017) and Weissman et al. (2019) both support the idea that general psychopathology is closely associated with affect-related features. However, they also highlight the importance of looking at this relationship more closely from a developmental perspective. In line with that, the regression analyses in the present study demonstrated that the predictive validity of the different factors changed significantly over time. More specifically, while the bi-factor was a significant predictor at any age of later psychopathology levels, the predictive validity of the specific factors varied greatly over time. For instance, externalizing symptoms were only a significant predictor of later depressive symptoms at age 3, but at no other age. Thus, to the best of my knowledge, the present study is the first study that provides evidence for the strong and consistent overlap between emotion dysregulation and psychopathology, especially externalizing symptoms, for this age group.

Besides the importance of longitudinal studies, Weissman et al.'s study (2019) also highlights the need for more nuanced studies that can shed a light on how different emotion regulation processes relate to different psychopathological constructs over time. With respect to this, it needs to be acknowledged that the presently employed emotion dysregulation measure only consisted of five items. This prevents me from

drawing more detailed conclusions on how different emotion regulation processes relate to the different psychopathology dimensions.

Furthermore, I suggest that the emotion dysregulation measure partly explains the relatively small overlap with the internalizing factor. In relation to that, a paper by Carver and colleagues (2017) explored the potential functionality of p and described it as the way by which we cognitively or behaviourally respond to emotions (i.e. "control over emotions"). Moreover, the authors distinguished between low cognitive and low behavioural control, whereby the first is assumed to relate more strongly to internalizing symptoms and the latter to externalizing symptoms.

Following this, the patterns found in the present study could be a result of the type of data collected, which was solely based on parental observations. While observational approaches seem appropriate for the respective age group, it needs to be considered that low behaviour control is more "observable" than low cognitive control. Consequently, this may have resulted in a bias towards observable patterns and thus, emotion dysregulation symptoms primarily relating to externalizing symptoms. Hence, the significant overlap between externalizing and emotion dysregulation symptoms, as revealed in the present study, might reflect this methodological bias.

Alternatively, a closer inspections of the items loading on the bi-factor indicate that items such as "shows mood swings", "gets over excited", "acts impulsively", "has temper tantrums", and "often argumentative" directly and consistently contributed to the bi-factor, indicating that it could reflect responses relating to high arousal emotions in particular (Feldman, 1995). The presence of such a 'transdiagnostic dysregulation factor' is in line with research suggesting that high arousal emotions (e.g., anger, upset, excited) could explain comorbidities between externalizing disorders, while low arousal emotions (e.g., depressed, bored, calm) are typical for internalizing disorders (Posner, Russell, & Peterson, 2005). This approach could offer new opportunities to explore similarities and comorbidities between mental disorders, but more research is needed to support such a model (Posner et al., 2005).

In addition to the limitations associated with the employed emotion dysregulation measure, the present research could not draw on any data from other informants or more objective measures either. This is another significant limitation of the present study, considering that research has repeatedly demonstrated the substantial

discrepancies between different informants' reports (e.g., parents versus teacher) and how reliably they predict children's present or future mental health status (Collishaw et al., 2009).

Based on the above, I recommended that future studies include more balanced assessment approaches and emotion regulation measures that capture behavioural and cognitive features, as well as a broader range of emotion regulatory aspects including different strategies in relation to emotional valence and arousal levels.

As part of growing attempts to define possible meaning or function of p, recent critiques have noted that bi-factor models could solely be a statistical artefact and that one also needs to consider and test alternative explanations for this phenomenon (Bonifay et al., 2017; Morgan, Hodge, Wells, & Watkins, 2015; Watts, Poore, & Waldman, 2019). Besides the statistical artefact argument, which suggests that model fit indices favour bi-factor models (Morgan et al., 2015; Watts et al., 2019), it has been proposed these could also be the result of certain response styles, in that some individuals are more likely to report on either negative or positive aspects, respectively (Erik Pettersson & Turkheimer, 2010). This perspective might convey a possible explanation for the present findings, where I found that the self-regulation items, which are all positively phrased, showed comparatively small loadings on the bi-factor, although this would not explain the low-loadings of the internalizing items. In order to test for a potential evaluation bias, it has been recommended to investigate whether the estimated bi-factor is able to predict real-world life-outcomes (i.e., external validation; Caspi & Moffitt, 2018). In line with this recommendation I performed a series of regression analyses, which confirmed that the bi-factor in the present study significantly predicted later engagement in self-harming behaviour and depressive symptoms, above and beyond the specific factors, thereby providing additional evidence for its validity.

While the debate around constructs derived from bi-factor model approaches remains active, Snyder and Hankin (2017) have reminded the community that "all models are wrong", as all models are simplifications of a more complex picture, but that some models prove to be more useful than others. With respect to this statement, I agree with scholars who advocate for the clinical utility of some of these constructs (Caspi & Moffitt, 2018; Forbes et al., 2019), as data-derived concepts like the general psychopathology factor, or the here identified transdiagnostic dysregulation factor, can

be useful in identifying transdiagnostic mechanism to enhance treatment approaches for various mental disorders (Sauer-Zavala et al., 2017).

For instance, Forbes and colleagues (2019) recently highlighted the potential of using the general psychopathology factor concept to inform transdiagnostic prevention programmes for youth. The authors concluded that targeting transdiagnostic features in youth mental health programmes has numerous advantages over disorder-specific approaches including: a) reducing the heterogeneous landscape of available programs, which often leave parents, schools, and communities confused about what to choose and b) targeting early transdiagnostic factors has the potential of activating a range of beneficial developmental cascades, which in turn have a positive influence on other factors, such as academic performance or social skills. In line with this and the assumption that the general bi-factor has meaning, I propose that emotion dysregulation processes represent an exciting opportunity for the transdiagnostic prevention of psychopathology in youth.

4.4.1 Conclusion

In summary, the present findings extend the existing evidence, while building on previous research which has suggested the close interconnection between emotion regulation and psychopathology. The use of a large, longitudinal data set and a separate emotion regulation measure to test the conceptual overlap between psychopathology and emotion dysregulation are two significant strengths of the study. The results provide new evidence for the validity and reliability of a bi-factor that summarises the shared variance between emotion dysregulation and externalizing symptoms in early childhood. Furthermore, the findings demonstrate the significant overlaps between emotion dysregulation and psychopathology, thereby highlighting emotion dysregulation as a suitable intervention target to prevent and reduce multiple forms of psychopathology in youth.

Part I: Conclusion

The beginning of Part I reviewed the existing literature and introduced the relevant models and theories around emotion and emotion regulation. It highlighted the two emerging research frameworks, whereby one focuses on specific emotion regulation strategies and the other on broader emotion regulation skills and deficits that are linked to psychopathology. While these two frameworks seem to have evolved, researchers have also started to combine approaches from both frameworks, which has led to study results suggesting that certain emotion regulation strategies can be linked to various forms of psychopathology in broad and more specific terms.

Despite the consistent evidence demonstrating that the two constructs of emotion regulation and psychopathology are closely connected, there is still a significant level of uncertainty about what this relationship looks like. One profound aspect that feeds into this uncertainty are the methodological challenges relating to the definition, assessment, and terminology of the emotion regulation as construct. These methodological challenges are further associated with the mixed evidence-base in the field, the lack of studies involving young people - as well as longitudinal studies - that enable us to understand the complex interactions between emotion regulation and other developmental outcomes, such as psychopathology, over time. By utilising data from the MCS, I have been able to address some of these limitations and provide new directions for future research.

The results of the first study (Chapter 3) demonstrated, based on a developmental cascade model, the close relationship between emotion dysregulation and youth psychopathology by highlighting the existing bi-directional effects between the constructs from the age of 3 to 7. While previous studies have attempted to investigate such bi-directional effects, they often lacked sufficient power to detect reliable effects, thereby leading to mixed-evidence. The present research provides strong evidence, based on a large cohort study that these bi-directional effects exist from an early age. More specifically, the results supported the notion that children with difficulties regulating their emotions are at increased risk of experiencing later externalizing and internalizing symptoms - as well as that, existing behavioural problems can hamper the development of further emotion regulation abilities. As part of the aforementioned methodological challenges in the field, I also discuss relevant methodological

limitations regarding the MCS data and the respective findings. One limitation is the use of parental observations to determine a child's level of emotion dysregulation and psychopathology. This may have resulted in a bias towards reporting visible and therefore rather behavioural related symptoms, while emotion regulation patterns associated with internalizing symptoms, such as "worry" and "turning inwards", might have been neglected. This limitation brings us back to the initial issues of how to adequately measure and conceptualise a dynamic and constantly changing construct like emotion regulation.

In line with this, it has been suggested that the use of more data-driven methods, can help identify and describe such constructs as well as differentiate them from related constructs. As explained in the introductory chapter of Part I, emotion regulation is defined as a multi-dimensional construct, which involves a range of processes for which the boundaries to related concepts, such as self-regulation or temperamental aspects, have not been clearly defined yet. One of these questionable boundaries, which was also indicated in the cascade model, lies between emotion dysregulation and psychopathology. The significant longitudinal associations in the cascade model, suggests that there is a significant amount of conceptual overlap between the constructs, which is supported by research showing that most mental health disorders (40-75%) are characterised by emotion regulation problems (Jazaieri et al., 2013; Werner & Gross, 2010). Additionally, there has been a steep increase in research highlighting the substantial role of emotion dysregulation as a transdiagnostic factor underlying multiple mental health disorders.

Based on this, the second study (Chapter 4) investigated the conceptual links between emotion dysregulation and psychopathology through confirmatory factor analyses. The findings of this study demonstrated the significant overlap between emotion dysregulation and psychopathology. It needs to be pointed out though that there is a possibility that this overlap was the result of a measurement overlap, in that the CSBQ and the SDQ both rely on parental observations of certain child behaviours, which may reflect certain outcomes of deficient emotion regulation, rather than the emotion dysregulation process itself. As highlighted in Chapter 3 and 4, future research needs to utilise additional measures that are able to tap into the "mechanism" aspects of emotion regulation. Thus, while Chapter 3 and 4 address highly relevant research questions, the data and respective findings are limited by the type of measures

employed in the MCS. Following this, I would like to encourage the field to replicate these findings with further data based on objective measures that also reflect emotion regulation as a mechanism, for instance by adding more experimental approaches.

Despite these limitations, the findings of the bi-factor model are in line with previous research, suggesting that emotion dysregulation processes cut across multiple psychopathologies and should therefore be addressed in transdiagnostic treatment programmes, which have been proposed as a promising means to prevent and treat psychopathological symptoms in children and adolescents.

In order to take this line of evidence further, Part II of the thesis explores the opportunity of developing a digital intervention to improve emotion regulation abilities in children and how potential changes in emotion regulation relate to changes in their levels of psychopathology.

Part II: Targeting emotion regulation processes in the treatment and prevention of youth psychopathology

Chapter 5: Digital interventions for youth psychopathology

5.1   Introduction

It has been estimated that approximately 10-20% of children and young people worldwide experience mental health problems, thereby making it one of the leading causes of disability for this population (Erskine et al., 2015; Kieling et al., 2011). Considering the significant impact of youth mental health difficulties on a wide range of other developmental outcomes (e.g., academic achievement, physical health; Catalino & Fredrickson, 2011; Izard et al., 2001), the human and economic costs of rising prevalence rates are substantial, calling for new, innovative approaches to tackle this problem. Addressing the rising numbers of mental health problems in youth is a major public health concern. International studies indicate that more than 60% of troubled youth do not have access to adequate (or any) treatment (Nguyen, Hellebuyck, Halpern, & Fritze, 2018). Furthermore, concerns about confidentiality and feelings of shame related to stigma have resulted in low help seeking behaviour (Gulliver, Griffiths, & Christensen, 2010) thereby amplifying the magnitude of the problem further.

Digital interventions, such as mobile apps, have been suggested as an effective means to overcome such barriers to make mental health interventions more accessible to young people (Pennant et al., 2015; Richardson, Stallard, & Velleman, 2010). Furthermore, they provide a high degree of anonymity, are cost-effective and, if designed appropriately, they are highly applicable across different real-life contexts (Olff, 2015). Evidence for the effectiveness of online therapies has been well established across the literature (Pennant et al., 2015; Richardson et al., 2010). However, due to the fast and consistent progress of technology, mobile apps have been increasingly adopted, especially by children and young people. In 2017 more than 70% of children (age 0-11) and 90% of adolescents (age 12-17) had permanent access to mobile phones and tablets (OfCom, 2019). Following this, mobile-based interventions have been suggested to be a powerful tool to deliver effective mental health interventions to youth. A recent systematic review by Grist and colleagues (Grist, Porter, & Stallard, 2017) found that in comparison to the adult literature, research investigating the effectiveness of mobile interventions for young people is still lagging. Only a few apps have been developed specifically for young people, and even fewer have been tested for their effectiveness, especially with younger children,

thereby highlighting the lack of research and availability of suitable digital interventions for this group. Furthermore, only a handful of apps included evidence-based content. However, despite these considerable limitations, high acceptance rates of technology amongst children and young people, in addition to a growing evidence-base in the adult literature, suggest that mobile apps represent an acceptable and promising means to support children and young people's mental health (Grist et al., 2017).

Despite the significant increase and popularity of digital health interventions in the last decade (Hollis et al., 2017; Rubanovich, Mohr, & Schueller, 2017), it has been frequently reported that the majority of these interventions suffer from low uptake and insufficient engagement (Eysenbach, 2005). Technology, however, must be engaging enough for people to use it and benefit from it (Bardram et al., 2013; Doherty, Coyle, & Sharry, 2012). Although past research has suggested various methods to increase engagement with digital health interventions (e.g., involvement of users in the development and design process), the field seems to face persistent methodological issues due to a lack of interdisciplinary collaborations (Coyle & Doherty, 2009; Doherty et al., 2012; LeRouge, Dickhut, Lisetti, Sangameswaran, & Malasanos, 2016; Orlowski et al., 2015).

5.1.1 Interdisciplinary research in digital interventions

This lack of cross-collaborative work has created an incomplete picture, whereby digital interventions often only satisfy one side of the coin: a strong evidence-base or innovative design that fosters engagement (Doherty et al., 2012; Orlowski et al., 2015). As a recent meta-review of 21 reviews by Hollies and colleagues (Hollis et al., 2017) demonstrated, the majority of evidence-based digital health interventions, relied mostly on methods used in psychology and medical related fields, while disciplines with a larger focus on user-centred design, such as Human-Computer-Interaction (HCI), were widely neglected. This is also reflected in the highly uniform design characteristics of such interventions, where the majority focusses on providing psychoeducational content as the main intervention mechanism (Stiles-Shields, Ho, & Mohr, 2016). At the same time, it has been pointed out that the increasing number of commercially developed and publicly available mental health apps are raising concerns in mental health professionals because of their insufficient evidence-base,

but relatively high uptake (Donker et al., 2013; Grist, Porter, & Stallard, 2017; Hollis et al., 2018).

An early paper by Coyle and Doherty (Coyle & Doherty, 2009) emphasized the importance of interdisciplinary collaborations in the development of mental health technologies to overcome barriers relating to different ethical requirements that inhibit the development and evaluation process of such interventions, such as the restricted (repeated) access of HCI practitioners to vulnerable end-users. Moreover, the authors pointed out that even with the best intentions, effective cross-collaborations require considerable time and effort.

In line with these suggestions, Blandford et al. (2018) presented further insights and suggestions to facilitate interdisciplinary research in the development of digital health interventions. One of the areas highlighted is the development lifecycle of digital health interventions, where a pronounced medical approach can be overly structured (when in line with the Medical Research Council guidelines as described in Chapter 6) and puts the primary focus on distant outcomes (e.g., decrease in symptoms). This however can distract from proximal outcomes (e.g. how the user interacts with the intervention), which have significant importance for whether and how users engage with the interventions (Nunes et al., 2015; W. Smith, Wadley, Webber, Ploderer, & Lederman, 2014). The investigation of proximal outcomes is considered one of the key values of HCI research, as it provides important insights into why an intervention may not have worked in the first place, distant outcomes on the other side are often key priority in health research (Klasnja, Consolvo, & Pratt, 2011). Following this, it has been recommended to ensure a balanced approach between proximal, intermediate and distal outcomes, when developing digital health interventions. Similarly, the overly medical approach, according to which randomized-control-trials (RCT) are considered the gold standard to evaluate an intervention, has been criticised as being incompatible with some HCI design principles that ask for iterative evaluation and optimization processes (Mohr et al., 2015). As a result, researchers have increasingly asked for new evaluation methods that allow for more flexibility and allow us not only to answer questions relating to effectiveness, but also to understand relevant processes that occur between the user and the intervention and can therefore affect the effectiveness of an intervention (Cresswell, Blandford, & Sheikh, 2017). Therefore, the use of interdisciplinary research methods has been highly recommended, not only for the

design process, but also for evaluating digital interventions, which I discuss further in Chapter 9.

5.1.2 Digital interventions for youth psychopathology

Over the past decades, different types of digital interventions have been developed for a variety of platforms ranging from online tools to games and mobile apps. Moreover, a closer look at the digital intervention landscape indicates that the majority, with one or two exceptions, draws on existing, evidence-based treatments, such as CBT, which primarily address specific mental health disorders such as depression and anxiety (Mohr, Weingardt, Reddy, & Schueller, 2017; Pennant et al., 2015). This recycling approach of taking manualised interventions and transferring them onto a digital platform has been increasingly criticised, even if it helped the field to move forward quickly and in a productive way (Mohr, Weingardt, et al., 2017).

In accordance with the evidence provided in Part I and research suggesting that psychological interventions can be further improved by targeting transdiagnostic mechanisms (Berking et al., 2008; Fernandez et al., 2016; Rohde, 2012), I propose that especially for children and young people - where high comorbidity rates are common, (i.e., they transition between disorders and often show symptoms from more than one disorder) - the development of a transdiagnostic digital intervention should be considered.

Transdiagnostic treatment approaches have been broadly divided into three categories (Sauer-Zavala et al., 2017). The first category includes the application of similar therapeutic principles or "schools", such as CBT. This category involves methods that are generally applied across multiple disorders. Most third wave interventions, such as mindfulness-based cognitive therapy (Kabat-Zinn, 1982), dialectical-behavioural therapy (DBT; Linehan, 1993), or acceptance commitment therapy (S. C. Hayes, Strosahl, & Wilson, 1999) fall into this first category. In comparison to standard CBT, third-wave psychotherapy programmes often include specific components, such as mindfulness or acceptance modules that target emotion regulation processes, and evidence suggests that they effectively alleviate symptoms across various disorders (Dimidjian et al., 2016). Yet, developers of these interventions do not state that their main aim is to target core psychopathological factors (Sauer-Zavala et al., 2017).

The second category of transdiagnostic treatments refers to modular intervention programmes, where practitioners can pick and choose from a pool of evidence-based modules depending on the type of symptom that they aim to improve. The modules (i.e., exposure exercises for anxiety) are often based on evidence indicating that they effectively reduce a symptom (Sauer-Zavala et al., 2017).

The last category of interventions is based on processes that have been identified as underlying mechanisms, shared by a wide range of disorders. The present research focuses primarily on this category. In recent years, only a few transdiagnostic intervention programmes have been developed and most of them have specifically targeted emotion regulation processes, such as the Affect Regulation Training (ART; Berking, 2007; Berking & Lukas, 2015) or the Unified Protocol for Transdiagnostic Treatment (UP; Barlow, Allen, & Choate, 2004). This focus on emotion regulation resulted from the growing evidence demonstrating that emotion dysregulation was common amongst most mental health disorders, and had also been identified as a significant risk and maintenance factor (Gross & Muñoz, 1995; Keenan, 2000). More specifically, Barlow and colleagues (2004) who were one of the first to propose unified treatment for emotional disorders, explained that they had identified three fundamental components that were relevant to the treatment of all emotional disorders. Based on this they suggested that interventions should target a) cognitive appraisal tendencies, b) emotional avoidance, and c) maladaptive behavioural responses to emotional experiences. Similarly, ART was developed based on a set of adaptive emotion regulation skills, as identified by Berking, which were proposed to be integral to good mental health (Berking, 2007; Berking et al., 2008).

Preliminary evidence of ART has shown that, when added to regular CBT, ART and CBT in combination resulted in better emotion regulation skills and significantly greater decreases in depressive symptoms than CBT alone (Berking et al., 2008). These findings provided further support to the notion that intervention effects can be enhanced through an additional focus on emotion regulation. While the initial evidence for ART is promising, it is also limited at this point. However, research investigating the effectiveness of UP has grown substantially, since it was introduced. A recent systematic review summarized the evidence for UP across 15 studies, reporting large effect sizes for the reduction of anxiety, depression, obsessive-compulsive disorder, panic disorder, and borderline personality disorder symptoms (Sakiris & Berle, 2019).

Furthermore, the authors found moderate effect sizes for the increased use of adaptive emotion regulation strategies and decreased use of maladaptive strategies following UP. These findings have provided increasing evidence for the effectiveness of UP.

ART, UP, and similar interventions have primarily been developed and tested with adult populations (Berking, 2007; Ellard, Fairholme, Boisseau, Farchione, & Barlow, 2010). Although a UP for youth has been suggested, research evaluating this approach is missing (Trosper, Buzzella, Bennett, & Ehrenreich, 2009). An exception is the work by Izard and colleagues, who developed an emotion-based prevention program for children (Izard et al., 2008). Studies including this intervention have shown that in comparison to a control condition, children in the emotion-based programme displayed greater emotion knowledge and regulation skills. They also exhibited fewer negative emotions, anxiety, and depressive symptoms and displayed better social competences. Despite these findings, the availability and evidence-base of transdiagnostic treatments targeting emotion regulation processes in children and young people is still scarce.

In line with the growing evidence base for transdiagnostic treatment approaches, Forbes and colleagues (2019) recently highlighted the potential of targeting transdiagnostic risk factors, including emotion dysregulation, in youth mental health prevention programmes. The authors have argued that transdiagnostic programmes would have numerous advantages over disorder-specific approaches, especially with respect to their potential of activating a range of beneficial developmental cascades. This in turn would be highly beneficial for other developmental factors, such as academic performance and social skills.

A similar line of thought has guided the development of social emotional learning (SEL) programmes that have been widely implemented across schools in the past decades (Greenberg, Domitrovich, & Bumbarger, 2001; Greenberg et al., 2003). Initially, the SEL framework was introduced as a response to the wide array of interventions that were being introduced to schools, to support them with their increasing responsibility for children's academic, but also mental and physical development. However, the implementation of highly fragmented and short-lived initiatives, ranging from drug and sex education to social competence and character training, had been perceived as highly inefficient and increasingly disruptive (Greenberg et al., 2003). Hence, the SEL framework aimed to identify programmes that target underlying processes, including risk and protective factors, that commonly

shape different development outcomes. Following this, it was decided that SEL programmes primarily focus on five core competencies, which have been assumed to facilitate positive youth development: self-awareness, social awareness, self-management, relationship skills, and responsible decision-making (Greenberg et al., 2003; Weissberg & Utne O'Brien, 2004). Emotion regulation competences are specifically addressed as part of the self-management and awareness competences, but also play a key role in the development of relationship skills and responsible decision making (Weissberg & Utne O'Brien, 2004).

SEL programmes have been primarily implemented as universal, whole-school interventions, with growing and consistent evidence highlighting their effectiveness to enhance students' social-emotional skills, mental health, and wellbeing (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Taylor, Oberle, Durlak, & Weissberg, 2017). Moreover, a recent meta-analysis showed that SEL programmes had significant positive long-term effects (up to 18 years post-intervention) and that the benefits were similar for students from different ethnic or socioeconomic backgrounds, thereby strengthening the importance of SEL programmes (Taylor et al., 2017).

Although primarily based on work conducted in non-digital contexts, there is substantial evidence (as summarised above) that supports the idea of utilising transdiagnostic approaches for the development of digital mental health interventions to support youth.

As discussed earlier, most (digital) mental health interventions have been developed for specific disorders, leaving a significant gap for research looking at how technology can address transdiagnostic factors like emotion regulation, which would ultimately support a wider range of mental health problems.

Nonetheless, a group of researchers recently investigated the effectiveness of a virtual game to enhance social skills in elementary school children (Craig, Brown, Upright, & DeRosier, 2016). While the authors did not provide an exact description of the intervention components or design, they explained that it was based on SEL approaches. Furthermore, they mentioned that the interventions targets six key social skills, including impulse control, communication, cooperation, social initiation, empathy, and emotion regulation. Their findings indicated that children in the

intervention group (n=23) showed significant improvements in their impulse control, emotion regulation, assertiveness, and externalizing behaviour in comparison to the control group (n=24). However, the results showed no significant effects in terms of children's communication, cooperation, and empathy skills, which the authors explain to be more complex skills that may require more intervention time. The findings of the study highlight the potential benefits of using virtual game-based interventions to enhance children's emotion regulation skills. Yet, the study's sample size was rather small, and there is insufficient information available regarding the change mechanisms that were potentially activated through the intervention.

Research involving technology-based interventions that specifically target emotion regulation processes in children, has been very limited, but recently there have been promising developments (Slovák et al., 2018). In response to the lack of technology-based interventions for children, Slovak and colleagues (2018) explored new design opportunities with a reactive toy. Based on interviews with parents and children from deprived communities, the team developed a soft toy with an internal vibrating motor and sensors. The toy was designed to vibrate as a way to mimic anxious "behaviour" and it calms down when it detects a child's soft touch on its back. It was hypothesised that children can calm down their own intense emotions, by stroking and calming down the toy. The research team tested the usability of the toy with 14 families over a 2-4 day period and interviewed the children afterward. The results stated that children felt attached to the toy after a short time and used it to calm down. Furthermore, the results suggested that children may have gained increased confidence from the experience of being able to successfully change the toy's emotional state (i.e. stopping the vibration by stroking it). While these are exciting developments, as the intervention seems suitable for universal intervention approaches, more research needs to be conducted to explore the long-term impact of such an intervention.

The majority of technology-based interventions that target emotion regulation have been developed for specific populations, such as children exhibiting autism-spectrum disorder symptoms, who demonstrate significant difficulties with emotion recognition and expression. In relation to that, the use of serious games and digital coaches has been explored, also resulting in promising but limited evidence (Grossard et al., 2017; Lee, Lam, Tsang, Yuen, & Ng, 2018; Park, Abirached, & Zhang, 2012). Furthermore, the emotion regulation deficits that are associated with autism-spectrum disorder

symptoms are very unique to this population, thereby making it difficult to transfer existing technology-based systems into other contexts or with other populations.

Another line of research has utilized biofeedback games to improve emotion regulation either in adults or children with attention-deficit hyperactivity disorder (Lobel et al., 2016; Sonne & Jensen, 2016). For the latter, the computer game ChillFish has been developed, where users can control the position of the fish in the game through their own breathing. Although ChillFish was developed to teach children new breathing techniques, so far, the game's usability has only been tested with adults and more extensive research is needed before it can be tested with children.

To summarise, the existing research highlights the potential of technology-based interventions, but also demonstrates the significant lack of such interventions to address emotion regulation processes in youth as a novel way to prevent youth psychopathology.

5.2   Conclusion

With respect to the increasing prevalence rates of mental health problems in youth and the literature reviewed above, I argue that children and young people's mental health could highly benefit from technology-based interventions targeting transdiagnostic processes, such as emotion regulation. Furthermore, as indicated above there is a significant lack of digital emotion regulation interventions that are easily accessible (i.e., mobile apps) and designed for a population that exhibits less specific or multiple symptoms from a wide range of mental health disorders.

The second part of the present thesis addresses these gaps and aims to contribute to the existing digital mental health landscape by developing a new mobile app intervention with a specific focus on emotion regulation, while also addressing previously mentioned limitations in the field, including low engagement rates and lack of evidence-based content by utilising an interdisciplinary framework to guide this research.

The following Chapter 6 describes the adopted design and development process for the intervention based on three different frameworks derived from the disciplines of HCI, psychology, and design.

Based on the chosen development approach, I first summarise the existing evidence regarding the effectiveness of existing interventions to enhance emotion regulation skills in youth (Chapter 7).

In Chapter 8, I explain how the utilization of certain HCI methods, including the participatory design workshops, guided important design decisions. Furthermore, I describe the different intervention components and how they evolved from a psychology and a HCI perspective.

Chapter 9 presents the final study, which evaluates the acceptability and usability of the new mobile app intervention from a user perspective as part of a 3-month exploratory trial with four primary schools in the UK.

Chapter 6: Intervention design and development approach

6.1 Introduction

The present chapter provides a detailed description of the design and development processes that were adopted in order to create a new mobile app that aims to reduce emotion dysregulation and promote adaptive emotion regulation processes in children. It outlines the three different frameworks that were employed as a means to structure the development and design process of the app intervention. The resulting three stages are then described with respect to the employed methodology and objectives. The outcomes of this approach and the resulting intervention content and design features are presented in Chapter 8.

6.1.1 Complex intervention development

Most mental health interventions, including CBT and the following digital app intervention, have been referred to as complex interventions, as they involve a set of multiple, interconnected, and interacting components (Campbell et al., 2000; P. Craig et al., 2008). In order to guide the design and evaluation process of such complex health interventions, Campbell and colleagues first published the Medical Research Council (MRC, See Figure 1) framework, which consisted of five phases: theory, modelling, exploratory trial, randomized-control-trial, and long-term implementation (Campbell et al., 2000).

The first stage of the framework concerns the exploration of relevant theory and a review of existing evidence to ensure that the most reliable intervention components are chosen. Subsequently, as part of the intervention modelling stage, the framework states that researchers should focus on identifying potential underlying mechanisms that influence the preferred outcome, which are then to be included in the intervention. Following the design of the initial intervention, the researcher is advised to explore its components further through exploratory trials in order to identify constant and variable components, including acceptability of intervention, compliance, delivery of the intervention, recruitment, and retention rate. Based on the results the researcher prepares a replicable study protocol before continuing to the next stage. The next stage concerns the conduction of randomised control trials, whereby the newly developed intervention is compared to appropriate alternative interventions as part of a controlled study. This allows researchers to detect statistically reliable effects. In the last stage of

the framework, it is suggested that the intervention is further tested in uncontrolled settings so that its applied effectiveness can be determined.
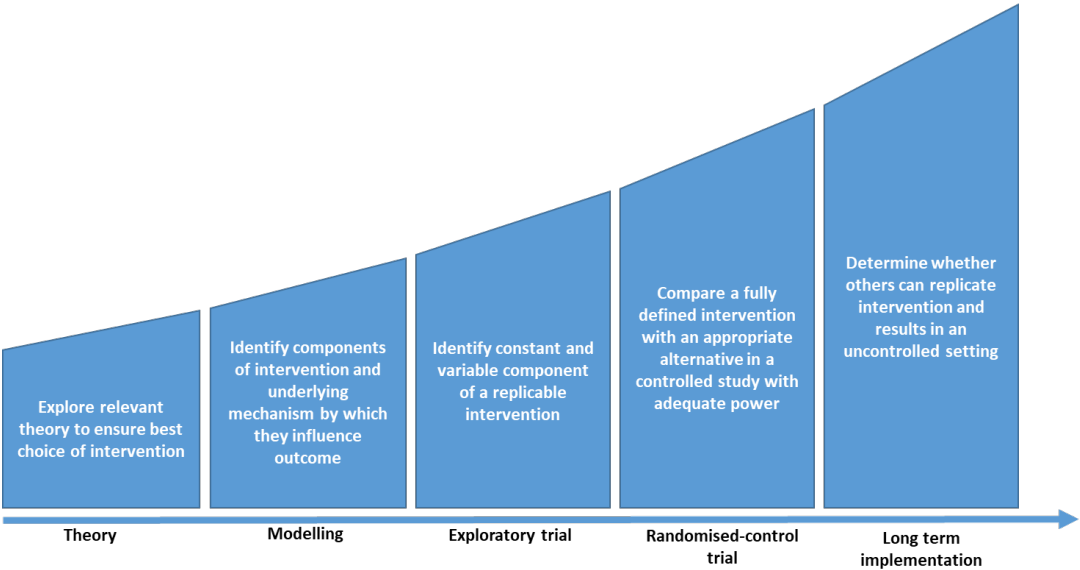
Figure 6.1 Medical Research Council framework for the development and evaluation of complex interventions

Since Campbell and colleagues' publication, the framework has been further amended in response to criticism, stating that its linear approach was not versatile enough (P. Craig et al., 2008; P. Craig & Petticrew, 2013). It had been recommended that greater attention should be paid to the importance of iteration, and the use of qualitative and quantitative methods throughout the early stages, as this allows researchers to establish sufficient understanding around active intervention components, prior to testing their combined clinical effectiveness as part of a randomized control trial. Furthermore, others emphasized that complex interventions that are tailored to the local context could be more beneficial than completely standardised packages (Shiell, Hawe, & Gold, 2008). Although these suggested changes would be highly useful, especially in the context of digital interventions (see Introduction to Part II), it has been pointed out that many digital health interventions are still being developed and evaluated in a strict linear manner. This in turn has been suggested to present one of the main barriers to facilitate successful inter-disciplinary collaborations in the field (Blandford et al., 2018). Thus, the present research covers primarily the first three stages of the MRC

framework, with adjustments based on recommendations to facilitate interdisciplinary research as explained in the previous chapter and as further outlined below.

The MRC framework provides valuable guidelines for the development and evaluation of complex interventions, but provides little information on how to model or design appropriate intervention content (Corry, Clarke, While, & Lalor, 2013). Hence, I decided to draw on other frameworks rooted in the field of HCI and design. Due to the young history of digital health interventions, the availability of suitable frameworks is still in development and sparse. The Patient-Clinician-Designer (PCD) Framework was developed to fill this gap and provides guidance on how to structure the design and content creation process of digital interventions for mental illness (Marcu, Bardram, & Gabrielli, 2011). The PCD framework aims to meet the complex requirements when designing user-centred interventions for mental illness by taking into account different perspectives (i.e., patient vs clinician) and design goals. In doing so, it describes how five key principles, based on user-centred design methodology, can be applied in the design process. Furthermore, it divides the process into four design phases: a) understand the illness and its challenges, b) involve users in the design, c) mediate co-design between users and professionals and d) accommodate different evaluation goals. I discuss the implications of these steps in relation to the present intervention in more detail below. Overall, the MRC and PCD frameworks complement each other well and were therefore combined to guide the structure of development and design process.

With respect to the main target group of the app, which is defined as children at the end of primary school or between the ages of 10-12 years, I also incorporated Druin's *cooperative inquiry* framework (CO); this provides specific techniques on how to involve young users in the design process of technologies for children, which draws on years of experience and is widely used by others in the field (Druin, 1999). The CO framework highlights the importance of involving children as partners in the whole process, instead of merely letting them test an almost finished prototype or end product. Furthermore, Druin emphasizes the benefits of conducting field work (i.e. "contextual inquiry"), especially when working with children, which allows researchers to detect relevant contextual information, including patterns of activities, ways of communication and other artefacts. Additionally, it has been reported that discussing design features in the relevant context (e.g., school, home), makes it easier

for children to express ideas and provide suggestions (Druin et al., 1998). Lastly, the framework calls for the importance of visualizing ideas through low- and high-tech prototypes, as this offers children more concrete ways to elaborate on ideas, and reject or refine them.

By combining the frameworks from the different fields, the present research adopts a truly interdisciplinary approach, the lack of which has been frequently criticised in existing digital mental health interventions (Hollis et al., 2017; Orlowski et al., 2015). Based on these frameworks the present research comprises three development and design stages (See Figure 6.2). Each stage employed a unique set of methodologies based on the primary focus and objective of each stage.
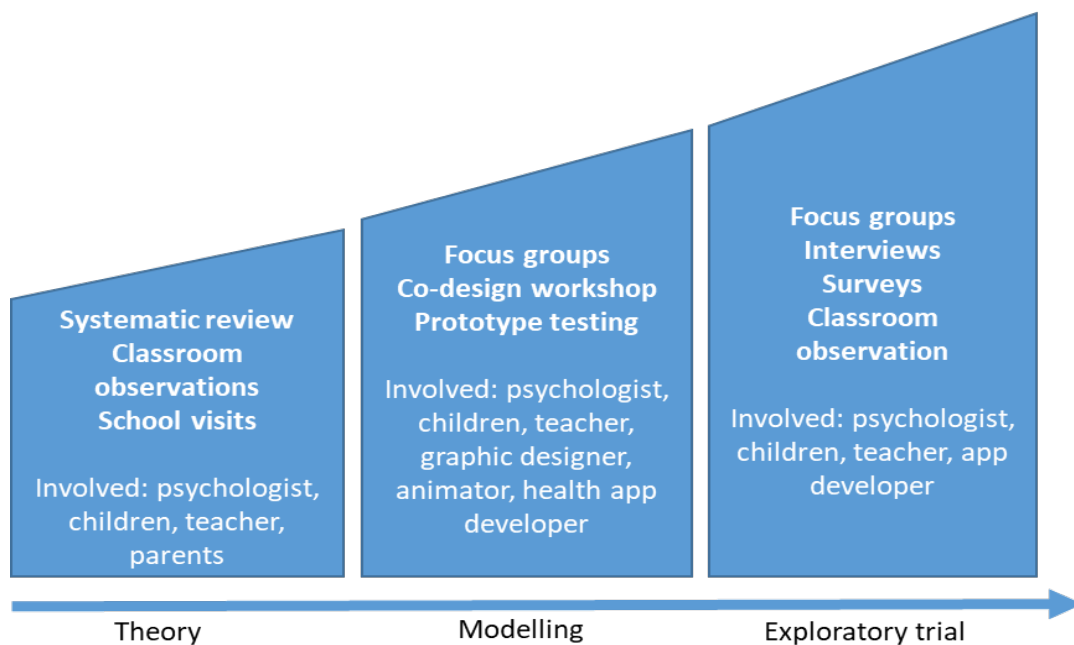
Figure 6.2 Development and Design framework for the present research

6.2   Development and design stages

6.2.1 Stage I: Identifying theory, evidence and challenges

As recommended within the MRC framework, I first conducted a systematic review and meta-analysis to summarise the existing evidence and theory on targeting emotion regulation processes through existing intervention components. In addition to that, and in line with the PCD and CO framework, the results of the meta-analysis were complemented by school and classroom observations. The observations allowed me to

identify and understand common emotion regulation challenges in children within the school setting and the strategies, which are employed within that context, to support children experiencing emotion regulation difficulties.

6.2.1.1 Systematic Review

A systematic review and meta-analysis according to the PRISMA guidelines (Moher et al., 2015) were conducted to assess the effectiveness of current psychological interventions to improve emotion regulation difficulties in youth. The systematic review identified 21 studies, of which two included some type of digital intervention. The results of the systematic review not only supported the hypothesis of the significant lack of technology-based interventions for youth, it also provided insights into the theory and evidence-base of existing psychological interventions' impact on emotion regulation. Additionally, the findings suggested that changes in emotion regulation were associated with changes in psychopathology. Moreover, the outcomes provided an overview of intervention components and helped increase my understanding around important change-mechanisms that the proposed app could address. Lastly, the review also highlighted the great diversity of the ways by which emotion regulation processes are currently assessed. The full systematic review and meta-analysis are described in Chapter 8. Chapter 9 demonstrates which features of the interventions were informed by the outcomes of the systematic review and meta-analysis.

6.2.1.2 School visits and classroom observations

A common tenet in user-centred design approaches is the familiarisation with the user and their environment. While this type of contextual fieldwork is an essential component of the CO framework, clinical research has also shown that the identification of user resources within the intervention context is a significant determining factor for the interventions' effectiveness (Assay & Lambert, 1999).

Following this, I conducted contextual fieldwork within schools, which are also considered to be a key player in terms of youth mental health provision, as children spend a substantial part of their time there. Furthermore, it has been suggested that schools serve as an ideal setting to implement mental health interventions (Caan et al., 2015; Stephan et al., 2007). Accordingly, I collaborated closely with two different schools for this project. This resulted in weekly school visits across a 6-month period,

with the opportunity to conduct classroom observations. These visits significantly enhanced my understanding of some of the common challenges that children and teachers face, especially in relation to emotion dysregulation and the resulting behavioural difficulties (e.g., not being able to concentrate, disrupting the teaching process, distracting other children). Furthermore, it helped me become familiar with the every-day practices and issues related to the school setting and provided me with valuable insights into what children and teachers do to manage difficult emotions in the classroom (e.g., time out zones). These insights significantly influenced later design concepts in the app (e.g., tools list, see Chapter 9). Additionally, the collaboration with schools gave me access to parents and other mental health professionals, which also contributed to the design of the app. No written or recorded data was collected during the school observations. However, Chapter 9 discusses how these observations influenced some of the design features in the app.

6.2.2   Stage II: Modelling and co-participatory design

The outcomes of Stage I determined some of the basic pillars for the intervention, which were further explored and adjusted during the modelling and co-design stage. The second stage consisted of a highly iterative process, combining two patient and public involvement (PPI) events, three co-design and participatory workshops, and lastly three testing sessions to make final design decisions and test the functionality of the prototype. The combined use of PPI and user-centred design methods has been highly recommended for the development of complex interventions (Muller et al., 2019). Ethical approval to conduct these workshops was obtained from the University College London Research Ethics Board (number 11701/001).

6.2.2.1 Patient and public involvement groups

The two consultation groups were conducted as part of a PPI event. The involvement of potential end-users to ensure adequate levels of engagement with technology has been common practice in the HCI context (O'Brien & Toms, 2008). However, in health research the importance of involving members of the public has only increasingly been acknowledged in recent years (Ghisoni et al., 2017). PPI has been defined as research "carried out with or by members of the public" and can involve a wide range of activities (Bagley et al., 2016; NIHR, 2018). Emerging evidence suggests that PPI in health research may be linked to enhanced intervention engagement, study designs and recruitment rates (Brett et al., 2014).

The conducted PPI events involved a total of 21 "young research advisors" between the ages of 12 and 19. Each group was facilitated by myself and two PPI leaders who were employed by the collaborating organisation with a role of leading and coordinating PPI events. Participants were recruited through local child mental health organisations (e.g., charities) that were part of the research centre's network. The term 'young research advisor' is a special term that is used to describe a group of young people, who have been service users themselves and received specific training that prepares them to work with researchers. The young advisors were reimbursed for their time in line with the organisation's internal arrangements.

Each PPI event started with an ice-breaker exercise that was followed by an introduction to the topic and a discussion where the following questions were explored:

1) What are young people's perceived barriers and facilitators to the use of mental health apps?

2) How can technology support mental health or emotion regulation in young people?

3) How can research involve children and young people in the design process of mental health technology?

The outcomes of the PPI groups provided important insights around basic technology and design-requirements, which influenced initial design goals (See Chapter 9 for a detailed description). Moreover, in line with the PCD framework, I explored the acceptability of potential co-design methods with this group, before employing them with younger, non-trained children. However, the age range of the PPI participants (12 -19 years) was significantly larger than the proposed age range for the users of the final intervention, which was set to 10-12 years. When designing for (young) users, it has been pointed out though that different age groups have particular needs that are influenced by their own cultures and complexities. Therefore, it is highly recommended to include the target user group directly into the design process, which was achieved through the co-design and participatory workshops (Druin, 1999).

6.2.2.2 Co-design workshops and prototype testing
Following the two PPI groups, I conducted three co-design (N=15) and three participatory workshops (N=18), across two primary schools with a total of 33 children. Each workshop was accompanied by a teacher. The first two workshops were

exploratory and introduced children to the project and their role in the workshops. After an initial ice-breaker exercise, I explored with the children what they already know about mental health and emotion regulation, including what strategies they use in different types of emotion-eliciting situations. Furthermore, basic design features were discussed around activities that they engage in to regulate feelings and how these could inform the design of the app (e.g., themes, modules, tasks). The result provided input for the development of wireframes and content ideas for psychoeducational components of the app.

Based on the outcomes of the first two workshops, the wireframes and potential screen designs were built. These were used in the third workshop, where children were provided with pens, stickers, and paper to add ideas for new features, give suggestions on existing features and scratch out design aspects that they would not like. In contrast to Druin's reports (1999), but in line with recent observations by Jones and colleagues, children sometimes seemed to struggle with the creation of visual representations for potential app functions (Jones, McIver, Gibson, & Gregor, 2003). It seemed as if they could not imagine how something that was drawn would be transferrable to an app or relevant. Many children were therefore hesitant to draw out ideas and preferred to describe them. Following this observation, a basic, but high-tech prototype was built for the second round of workshops. During the subsequent workshops, children were able to access the prototype on a tablet and were encouraged to make suggestions for existing and new features in the app. In comparison to the low-tech, paper prototypes, the high-tech prototype seemed to make it significantly easier for children to find their role in the process and provide suggestions for potential features.

Additionally, based on the PPI group outcomes and the identified evidence in the systematic review on existing interventions, it was decided to include a psycho-educative module in the app, which would teach children about different feelings and strategies to regulate them. In order to make this module of the app engaging and suitable for the age group, a series of animated films was developed. The content of these films reflected upon some of the emotion-eliciting situations that children had shared in the first round of workshops (e.g., having a fight with a friend and not being able to concentrate in class) and were complemented with theories grounded in cognitive behavioural therapy (e.g., the behaviour-thoughts-feelings triangle). Children were able to watch the films on the tablets, which were then discussed in the

group to ensure that the content was age-appropriate and children could identify with it.

Based on the outcomes of the three participatory workshops, the first fully-functioning prototype of the app was built. The prototype was tested in another primary school with 15 children across another three workshops. During these workshops broad design features, such as the flow of screens, as well as more detailed design questions regarding language and use of colours were discussed. Furthermore, the schools provided the tablets that were used in their school, which allowed me to test the functionality of the app across different devices and in line with the school's technology-infrastructure (e.g., access to Wi-Fi, school's digital safety policies).

At the beginning of the workshops children were informed about the purpose of the app, but were not given any instructions on how to use the app. This approach allowed me to observe whether the current design was intuitive enough so that children could use it without much explanation. I observed and took written notes regarding the way the children explored the app to identify pitfalls, popular items, technical difficulties, and features that they did not discover on their own. Following this step, children received an in-depth introduction and were asked to be my tech-detectives who helped me find glitches and errors. All children were encouraged at all times to provide honest feedback and suggestions on the likability of the app and how it could be further improved.

The results of the focus groups and all workshops are presented in Chapter 9, which also discusses the impact on subsequent design decisions.

6.2.3 Stage III: Exploratory feasibility trial

In line with existing evaluation guidelines for digital health interventions, which emphasize the importance of optimizing a newly developed intervention prior to any feasibility or efficacy testing (Murray et al., 2016; World Health Organization, 2016), the usability and acceptability of the present app was evaluated in an exploratory trial. This study followed a single-arm, pre- and post-assessment design, with 145 children (age 10-12) recruited from four different primary schools across the country. Ethical approval was given by the University College London Research Ethics committee (number 7969/001).

The trial investigated the following research questions:

a) How acceptable and usable is the app intervention from the children's perspective?

b) How do children interact and engage with the intervention?

c) What are the perceived barriers and facilitators to implement and deliver the intervention?

d) How can the existing app intervention be further improved?

Chapter 10 provides a full description of the exploratory feasibility trial and its results.

6.3   Summary and Conclusion

The present chapter provides an overview of the design and development framework that has been adopted to develop a new mobile app for children.

In an attempt to take a truly interdisciplinary approach, I drew on three different frameworks derived from the medical, HCI, and design fields. This resulted in three development stages, each of which combined a different set of methodologies to facilitate the development and design process.

In line with the framework described above, the following three chapters present the outcomes and implications of each of the three stages. Starting with the theory and evidence to inform the initial content and design of the app. This is followed by the modelling stage, which describes how the different intervention components were shaped by the outcomes from the focus groups, co-design workshops, and testing of wireframes and prototypes. The final stage includes the exploratory trial to evaluate the present intervention, and understand how it can be further improved in terms of its design and implementation in the school context.

Chapter 7: Effectiveness of existing psychological interventions to enhance emotion regulation in youth: a meta-analysis

7.1   Introduction

As outlined in the previous chapter, the first stage of MRC framework for the development and evaluation of complex interventions suggests to identify the existing evidence of similar interventions, underlying theories, as well as the employed methods to evaluate them (P. Craig et al., 2008). By performing a systematic review and meta-analysis of the empirical literature, researchers are able to systematically and comprehensively summarise the existing evidence, which in turn can be used to inform the development of a new intervention. Thus, with respect to the overarching research goal of the second part of the thesis - the development of a new intervention that enhances emotion regulation processes in youth - I conduct a systematic review and meta-analysis that investigates the effectiveness of current psychological interventions to enhance emotion regulation difficulties in youth. Chapter 1 provided a comprehensive overview of existing emotion regulation models and theories, hence, in the following I only briefly revisit concepts that are most relevant for the present review.

7.1.1   Emotion regulation and its links to psychopathology

As mentioned before, the concept of emotion regulation has faced significant definitional challenges over the past decades, with hundreds of research papers referring to it each year in various ways, but the majority not providing a clear definition. Broadly speaking, emotion regulation has been defined as "the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals" (Thompson, 1994). These regulatory processes comprise physiological, experiential, behavioural, as well as psychological components (Werner & Gross, 2010).

Despite the definitional challenges, there are two conceptual frameworks that have convened the largest amount of evidence so far, which I outline below. There is empirical and conceptual evidence that the two frameworks tap into different aspects of emotion regulation research. Hence, I draw on both frameworks for the present review (Bardeen & Fergus, 2014).

The first framework evolved based on Gross' process model of emotion regulation which proposes a set of strategies, which are employed to modify emotional

experiences at different points in time. Gross clustered the emotion regulation strategies into categories based on the point in time at which they are applied during the emotion regulation process: situation selection (e.g. "I am worried that I will do badly on the test today, so I might rather not go"), selection modification (e.g., "My mom dropped me off at school, although I wasn't feeling well. I could turn around or perhaps, I can ask my friend Johnny for help before the test), attentional deployment to certain aspects of the situation (e.g., "I am so nervous, I can hear my heart racing. I will try distracting myself with some music"), cognitively changing the meaning of a situation (e.g.," It would be bad if I failed this test today. Luckily there is another test in 4 weeks"), and finally modifying the response to the emotion eliciting event (e.g., "The test was a catastrophe". I told my mom about it and cried. I was so sad. She gave me a hug and said: "We cannot change what happened, but we can prepare better for the next test"). So far, research has identified various emotion regulation strategies for each of the above stages. Following this, researchers have frequently attempted to divide them into maladaptive (e.g., catastrophizing, rumination, avoidance, suppression) or adaptive (e.g., problem-solving, acceptance, savouring, cognitive reappraisal) strategies depending on their assumed impact on psychopathological symptoms.

One of the most comprehensive systematic reviews by Aldao et al.(2010) looked at the relationship between six different emotion regulation strategies and four different psychopathologies, including depression, anxiety, eating disorders, and substance abuse. The authors found that the six strategies, avoidance, problem-solving, reappraisal, suppression, rumination, and acceptance, were all associated with the different types of psychopathology. More specifically, they found that avoidance and suppression were positively associated with anxiety, depression and eating disorders, while rumination was positively associated with anxiety, depression, eating, and substance-abuse disorders. Problem-solving and reappraisal correlated negatively with psychopathological symptoms, while acceptance showed no significant association with depressive or anxiety symptoms. Further moderator analyses demonstrated that age (child vs. adult) significantly moderated the association between suppression, problem-solving, and depression, with adults showing significantly larger effect sizes than children. Age group was however not a significant moderator for the links between rumination and depression.

Aldao's systematic review results were primarily based on data derived from adult studies, with only six of the 114 studies including data on children or adolescent samples. However, similar findings demonstrating the close association between emotion dysregulation and psychopathology have also been reported for studies focusing on young populations. Schäfer and colleagues (2017) summarized the evidence for different emotion regulation strategies in youth exhibiting sub-clinical symptoms of anxiety and depression. Similarly, they found that depression and anxiety had the strongest positive association with avoidance and rumination; but the strongest negative association with acceptance. Their review focused on adolescents in the ages of 13 to 18 years with sub-clinical symptoms, therefore no conclusions could be made regarding younger groups or those displaying severe clinical symptoms. Evidence from studies looking at other youth mental disorders such as attention-deficit/hyperactivity disorder, conduct disorder, eating disorders, and borderline-personality disorder have reported similar patterns (Czaja, Rief, & Hilbert, 2009; Herts, McLaughlin, & Hatzenbuehler, 2012; Lougheed & Hollenstein, 2012; Marieke et al., 2012).

The second framework derived from research having a more clinical outlook. It is primarily based on the work by Gratz and Roemer who developed the Difficulties with Emotion Regulation Scale (DERS). Their work and related research identified specific emotion regulation difficulties or competences that are assumed to be integral to good mental health (Berking et al., 2008; Gratz & Roemer, 2004; Mennin et al., 2007; Saarni, 1999). Based on this, the framework primarily focuses on emotion regulation processes relating to emotion understanding, awareness, and acceptance, and the access to and flexible use of effective strategies. From a conceptual perspective, Berking's nine emotion regulation skills also fall into this framework, however studies have only been conducted with adult samples (Berking & Wupperman, 2012), which makes it less suitable for the present review.

A meta-analysis by Trentacosta and Fine (2010) summarized the existing evidence for the links between emotion understanding and internalizing, and externalizing problems in children and adolescents. They found that emotion understanding had small to medium relations with internalizing problems (based on 19 studies) and externalizing problems (34 studies). Furthermore, a systematic review by Mathews and colleagues (2016) investigated emotion regulation competences in youth

experiencing anxiety, which found medium to large effect sizes for anxious youth being generally less effective at expressing, understanding and accepting negative emotions.

In terms of studies that have employed the DERS with young populations, Weinberg and Klonsky (2009) researched 400 adolescents and found that higher DERS scores correlated significantly with psychopathological symptoms, including depression, anxiety, suicidal ideation, eating disorders, alcohol, and drug use. Similarly, another study with 870 adolescents found that greater emotion regulation difficulties significantly correlated with enhanced internalizing and externalizing problems. This study also showed that certain subscales of the DERS were linked to different types of psychopathology: "difficulties controlling impulsive behaviours" and "engaging in goal-directed behaviours" were related to aggressive behaviour, while "lack of emotional clarity", "non-acceptance of negative emotional responses", and "limited access to strategies" were associated with anxiety and depression (Neumann et al., 2010).

Further clinical research has been able to demonstrate that emotion regulation processes could partly explain the large comorbidity of different disorders, as well as the frequent transitions from one disorder to another in youth populations (Seymour et al., 2012). However, most research involving clinical populations has focused primarily on emotion dysregulation and strategies to regulate negative emotions, such as sadness or anger; while emotion regulation in terms of an ability or competence, and strategies to regulate positive emotions (e.g. savouring or gratitude) have been widely neglected (Gilbert, 2012). Hence, in the present review the term emotion dysregulation refers to emotion regulation difficulties, while the term emotion regulation is used to refer to abilities or skills. Furthermore, the review aims to capture evidence for both, strategies to regulate positive as well as negative emotions. In addition to that, Aldao and others have highlighted that effective emotion regulation does not come down to mere down-regulation of negative emotions and up-regulation of positive emotions, but is defined by whether the individual is able to flexibly apply effective strategies that match the respective situation (Aldao et al., 2015; Bonanno & Burton, 2013). Hence the present study also includes emotion regulation measures that assess flexible emotion regulation.

7.1.2 Objectives of the present study

The present meta-analysis aims to summarize the effectiveness of psychological interventions to improve emotion regulation processes in youth. To my knowledge there is no meta-analysis that has summarised the evidence of existing research involving youth samples. Moreover, in contrast to currently available reviews, the present study focuses on emotion dysregulation and its related strategies as well as emotion regulation abilities and its related strategies. Finally, mediation analyses of changes in emotion regulation or dysregulation, and changes in psychopathology in response to interventions is examined. I aim to answers the following research questions:

a) Do existing psychological interventions effectively improve emotion (dys-) regulation in youth?

b) Are improvements in emotion (dys-) regulation associated with changes in psychopathological symptoms?

7.2 Methods

7.2.1 Literature research

I followed the PRISMA guidelines for the present systematic review (Moher et al., 2015). The literature search of the electronic databases was conducted on the 4th of December, 2017 and updated on the 9th of April, 2018 using the following electronic databases: Ovid/Medline, Ovid PsychINFO and Web of Science (a detailed overview of the search strategy can be found in the appendix B). Identified publications were downloaded from the databases and saved to a reference manager on the dates specified above. If relevant literature reviews were identified during the abstract screening process (see below), the reference lists was manually screened for further important publications. The literature search was restricted to peer-reviewed journal articles written in English, because peer-reviewed publications have been assumed to increase the inclusion of studies with higher research quality.

7.2.1.1 Inclusion and exclusion criteria

Inclusion criteria

- Children and adolescents between the ages of 6 to 24 years. Research with younger children was excluded because it primarily involves observational methods. In line with recent definitions of "adolescence" I included the age of 24 (Sawyer & Azzopardi, 2018).

- Sample with symptoms of depression, anxiety, eating disorder, substance abuse, attention-deficit hyperactivity disorder, borderline personality disorder symptom, as these have been shown to share common emotion regulation difficulties (Aldao et al., 2010; Schäfer et al., 2017; Sloan et al., 2017). Symptoms had to be assessed and reported through a validated measure of psychopathology. If symptoms of specific psychopathologies were not assessed and reported the study was excluded.

- Intervention aims to improve emotion regulation and symptoms relating to any of the mental health disorders mentioned above.

- Randomized and quasi-randomized control studies

- Any control condition

- Self-, parent, teacher or professional report through validated emotion regulation measure

Exclusion criteria

- Adult population

- Symptoms not relating to disorders mentioned above

- No measure of emotion regulation included

- Special populations (e.g. autism spectrum disorder, intellectual impairment, medical condition)

- Medical or pharmacological intervention

- No manual or description of intervention and the assumed active component

- No control group present

- Studies reporting outcomes of neural correlates only (e.g., fMRI)

7.2.2 Study selection

All identified articles were added to a systematic review software (Eppi-Reviewer). Duplicates were removed and abstracts and titles were screened based on the inclusion and exclusion criteria. The method section of each paper was screened for valid ER measures. All studies with a valid emotion regulation measure entered the full-text screening stage. A second researcher randomly reviewed and rated 25% of the selected title and abstract papers. Where there was a disagreement (4%) regarding the inclusion of a study, the two researchers reviewed the article and discussed its eligibility until an agreement was achieved.

7.2.3 Data extraction

Information relating to study characteristics including: authors, year of publication, study design, intervention type, definition and measurement of emotion regulation, comparison group, study results (including sample size, age group, participation rate, attrition, relevant clinical, and emotion regulation outcomes), and information to determine any study bias was extracted from each study. Correlations between changes in emotion regulation and clinical outcomes were collected if reported.

7.2.4 Outcome measures

7.2.4.1 Emotion regulation and dysregulation

Studies with any validated self-report measure to assess emotion regulation difficulties or skills, either as a single factor or in terms of the emotion regulation strategies, were included (see Table 5-B appendix B for an overview of included measures). I used Adrian and colleagues (Adrian et al., 2011) review of emotion regulation assessment and similar reviews (Aldao et al., 2010; Sloan et al., 2017) as guidance to decide on a measures' eligibility. I acknowledge that some emotion regulation measures may have substantial overlap with measures assessing psychopathological symptoms, which are addressed in more detail in the discussion. The two meta-analyses included a) studies that assessed emotion dysregulation (e.g., lack of access to strategies, difficulties accepting negative emotions) or any of the associated maladaptive emotion regulation strategies including: avoidance, suppression, catastrophizing and rumination, and b) emotion regulation abilities (e.g., emotion regulation flexibility, emotional understanding) and any of the associated adaptive emotion regulation strategies including: acceptance, savouring, gratitude, cognitive reappraisal, problem solving and mindfulness (a complete list is provided in the appendix B). I extracted all available data reported for subscales and overall mean scores. If possible I calculated overall mean scores, based on the subscales data provided. For the meta-analyses, all available effect sizes (subscale or full scale) were combined according to their categorization into emotion regulation or dysregulation.

7.2.4.2 Psychopathology

Psychopathology was treated as a secondary outcome measure in the present review as it was only used to answer the second research question regarding the association between change in emotion regulation and change in psychopathology in response to treatment. Psychopathology symptoms were either based on self-report measures or clinician ratings (e.g., Beck Depression Inventory). If a study reported more than one scale for the same disorder category, I chose one measure based on its reliability and whether it had been used in one of the other studies in the present review. Reported mean scores were used to calculate standardised effect sizes, which were then entered in the meta-regression analysis.

7.2.5 Quality and risk of bias assessment

Two researchers (PhD candidate and a research assistant) independently assessed the methodological quality of the included studies (interrater agreement = 98%) using the Effective Public Health Practice Project Quality Assessment tool (EPHPP). The EPHPP evaluates the quality of each study based on their rating, ranging from strong, moderate to weak, across the following six categories: selection bias, study design, the presence of confounding variables, blinding, data collection methods, and participant withdrawals and drop-outs. The EPHPP has been reported suitable for systematic reviews and evidence has shown good content and construct validity (Deeks et al., 2003; Thomas, Ciliska, Dobbins, & Micucci, 2004).

7.2.6 Data analysis

A primary analysis was conducted to detect any influential studies in the dataset. This was done through the "metaninf" command in Stata, which indicates each studies' impact on the overall effect size if that study is omitted from the analysis. Furthermore, I assessed each studies level of heterogeneity through a Galbraith plot ("galbr" command in Stata) (Bax et al., 2009). Studies with a great impact on the overall effect size and larger than expected level of heterogeneity, were regarded as influential studies. Subsequent meta-analyses were conducted with and without these studies, in order to identify their respective impact on the results. In line with current recommendations for meta-analysis models in psychology, I conducted two random effects models: one with emotion dysregulation as a primary outcome and one with emotion regualtion abilities as the primary outcome (Schmidt, Oh, & Hayes, 2009). To explore sources of heterogeneity I conducted a series of sub-group analyses. Subgroup analyses help identify whether there are differences in effect size or heterogeneity due to study-level factors (see "Meta-regression and subgroup-analyses" for more detail below). Furthermore, I conducted a meta-regression with effect size as the dependent variable and intervention type, age group, control group, and quality rating as the predictor variables. A combination of these two approaches has been recommended (J. P. Higgins & Green, 2019). In order to answer the second research question I conducted a second meta-regression, with effect sizes of psychopathological symptoms as the dependent variable, and effects sizes of improved ER as the predictor variable.

7.2.6.1 Effect size

Treatment effect was estimated using the weighted mean effect size Hedges' *g*. Hedges' *g* is interpreted like Cohen's *d*, with effect sizes ranging from small (0.2), medium (0.5), to large (0.8) (Hedges & Olkin, 1985). Hedges'*g* (see Formula 1) and the standard error were calculated based on standardized mean-differences, standard deviations, and sample sizes. This data was entered into Stata and the "meta" command was used to conduct the random effects models.

$$g_{hedges} = \frac{M_1 - M_2}{s_{pooled}} \text{ with } s_{pooled} = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}} \quad (1)$$

Formula 1- Hedges' g

For studies with multiple treatment groups, the decision on how to include them was made on a case-by-case basis with regards to the research question. In accordance with the Cochrane handbook the following options were considered (J. Higgins & Green, 2011):

a) One of the treatment conditions was excluded if the treatment's main target was not emotion regulation or any related concept and did therefore not add any additional insight to the research question.

b) Effect sizes of two treatment groups were pooled and compared to the control group if the intervention groups were similar enough to be combined.

c) Each treatment group was entered as a single comparison group, by splitting the control group in half, if combining or excluding one condition would have resulted in loss of information. This approach was adopted where both interventions were assumed to improve emotion regulation processes, but differences between the conditions added valuable insights, e.g., whether one intervention could be more effective than the other.

7.2.6.2 Heterogeneity

Heterogeneity between the studies was assessed with the Q-statistic, I^2, and T^2. The Q-test follows the chi-square distribution and estimates the probability of sampling error being the only cause for variance. A significant Q-test indicates that heterogeneity is present. However, it does not provide sufficient information about the source of heterogeneity. Therefore, I^2, and T^2 were also taken into account. T^2 describes the between-study variance, while I^2 describes what proportion of the observed variance in the effect estimates is due to systematic differences between the studies rather than sampling error. Smaller values of I^2 suggest that the observed heterogeneity is mostly random, while larger values suggest study-level differences. The following levels of heterogeneity have been identified for I^2: low: $I^2 = 25\%$, medium: $I^2 = 50\%$, and high: $I^2 = 75\%$ (Michael Borenstein, Higgins, Hedges, & Rothstein, 2017). I also calculated 95% prediction intervals (PI; see Formula 2) (Riley, Higgins, & Deeks, 2011), which aim to predict the range of possible population parameters in future empirical studies (e.g., it is expected that in future studies 95% of the true effects lie within this interval). Hence, PI's are different from confidence intervals, which estimate the precision of the mean effect size in the general population.

$$\hat{\mu} - t_{k-2} \sqrt{\hat{\tau}^2 + SE(\hat{\mu})^2} \, , \quad \hat{\mu} + t_{k-2} \sqrt{\hat{\tau}^2 + SE(\hat{\mu})^2}$$

Formula 2 - Prediction Interval

7.2.6.3 Meta-regression and sub-group analysis

A meta-regression was performed to identify possible moderating effects of certain between study-level characteristics. The meta-regression was conducted with the "meta regress" command in Stata 16. Categorical variables are automatically dummy-coded by the software and the resulting estimates indicate how the effect size of each subgroup differs with respect to the chosen reference group. Furthermore, separate subgroup analyses with each relevant moderator were conducted to explore potential sources of heterogeneity and their impact on the overall effect size. With respect to the present research question the following subgroup analyses were conducted:

a) *Type of intervention*: distinguished between two types of interventions, those with a specific focus on ER (e.g., emotion focused CBT, emotion regulation

training, or any of the third wave interventions) and non-specific interventions (e.g., standard CBT, motivational interviewing). An intervention was coded as ER specific, if they included specific ER modules or tasks; or if these were stated to take up most of the content or time, compared to other modules in the intervention programme. (see Table 5-B in appendix B for intervention descriptions).

b) *Type of control group*: compared studies with active versus passive control groups. Passive control groups included studies with a waitlist or assessment-only design, while active control groups included any type of intervention, including treatment as usual.

c) *Type of emotion regulation strategy*: compared studies based on different types of ER strategies. Subgroups could only be formed if sufficient data was available (see appendix B for specific ER strategies).

d) *Type of disorder*: compared effectiveness of studies relating to different types of disorders. Studies were categorized based on the authors' description of the recruited sample and the diagnostic tools employed. Six main categories were included: a) anxiety disorders, including generalized anxiety, phobias, PTSD, obsessive compulsive disorder; b) depression, including major depressive disorder, bipolar disorder, suicidal thoughts; c) ADHD; d) borderline personality disorder; e) substance abuse f) eating disorders.

e) *Age groups*: differences in effectiveness for different age groups was explored by creating a new categorical variable for age with four levels. Studies with a participant mean age under 10 years, were categorised as "child" population. "Early adolescence" included samples with a mean age between 10 and 13 years. Studies with participants older than 13 years, but younger than 17 were categorised as "adolescence". The fourth category "late adolescence" included all samples with a mean age larger than 17 years but younger than 25 years.

f) *Quality of study*: to investigate whether there was a difference in effect size depending on quality ratings. Studies were rated as being of low (3), moderate (2) or high (1) quality.

7.2.6.4 Publication bias

Publication bias was visually assessed with the help of a funnel plot. No publication bias was assumed if the points in the scatter plot form the shape of a funnel, while an asymmetrical shape would suggest a publication bias. Furthermore, the Egger's test was applied to test for small-study effects whereby precision seems to be related to the effect size estimate. Fail-safe N statistics were not performed due to its suggested unreliability (Sterne et al., 2011)

7.2.7 Relationship between emotion dysregulation and psychopathology

To assess whether improvements in psychopathological symptoms were associated with changes in emotion dysregulation, a meta-regression was conducted, with effect sizes of psychopathological symptoms as the dependent variable, and effect sizes of improved emotion regulation as the predictor variable.

7.3 Results

7.3.1 Study selection

The search identified 1418 articles. After duplicates (n=171) were removed 1250 papers were included for the abstract and title screening. 1049 articles were excluded based on the abstract and title screening. Of the remaining 201 papers, 122 papers had to be excluded due to missing emotion regulation measures. In total, 79 studies entered the full-text screening, of which 34 studies matched the selection criteria and provided sufficient data. Another 17 studies, matched the criteria, but the authors had to be contacted to provide additional information that could not be derived from the published article. During the data extraction phase, 30 studies were excluded. Four of those were excluded because the authors were not accessible (Fishbein et al., 2016; Goldstein, Axelson, Birmaher, & Brent, 2007; Latimer, Winters, D'Zurilla, & Nichols, 2003; P. Smith et al., 2015). Finally, 21 independent studies were included in the meta-analysis, from which 33 treatment effects were extracted (19 emotion dysregulation, 14 emotion regulation; See Figure 1 for study selection process).

7.3.2 General study characteristics

The characteristics of the included studies are summarized in Table 7.1. For studies with multiple treatment conditions, where both treatment conditions were assumed to have an effect on emotion regulation, both groups were included in the analysis, by splitting the control group in half and pairing it with each treatment group. For the remaining studies (k=3), the second treatment group was excluded. All of the included studies showed a large variety regarding the type of emotion regulation measure and intervention employed (a detailed description of these is provided in the appendix B, see Table 5-B). CBT was the most commonly employed intervention (k=16) and almost all interventions included some kind of CBT components. Eight studies stated to specifically address emotion dysregulation (i.e. emotion regulation training). Four interventions targeted specific emotion regulation strategies (i.e., rumination or mindfulness; see Table 7.1)

7.3.3 Quality and publication bias

Quality ratings for each study are shown in Table 7.1. All studies were randomized control studies, however nine studies reported baseline differences between the groups, and two studies did not provide any information on potential baseline

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differences. One study did not provide any information about the control condition, six studies compared the intervention with a treatment as usual condition.
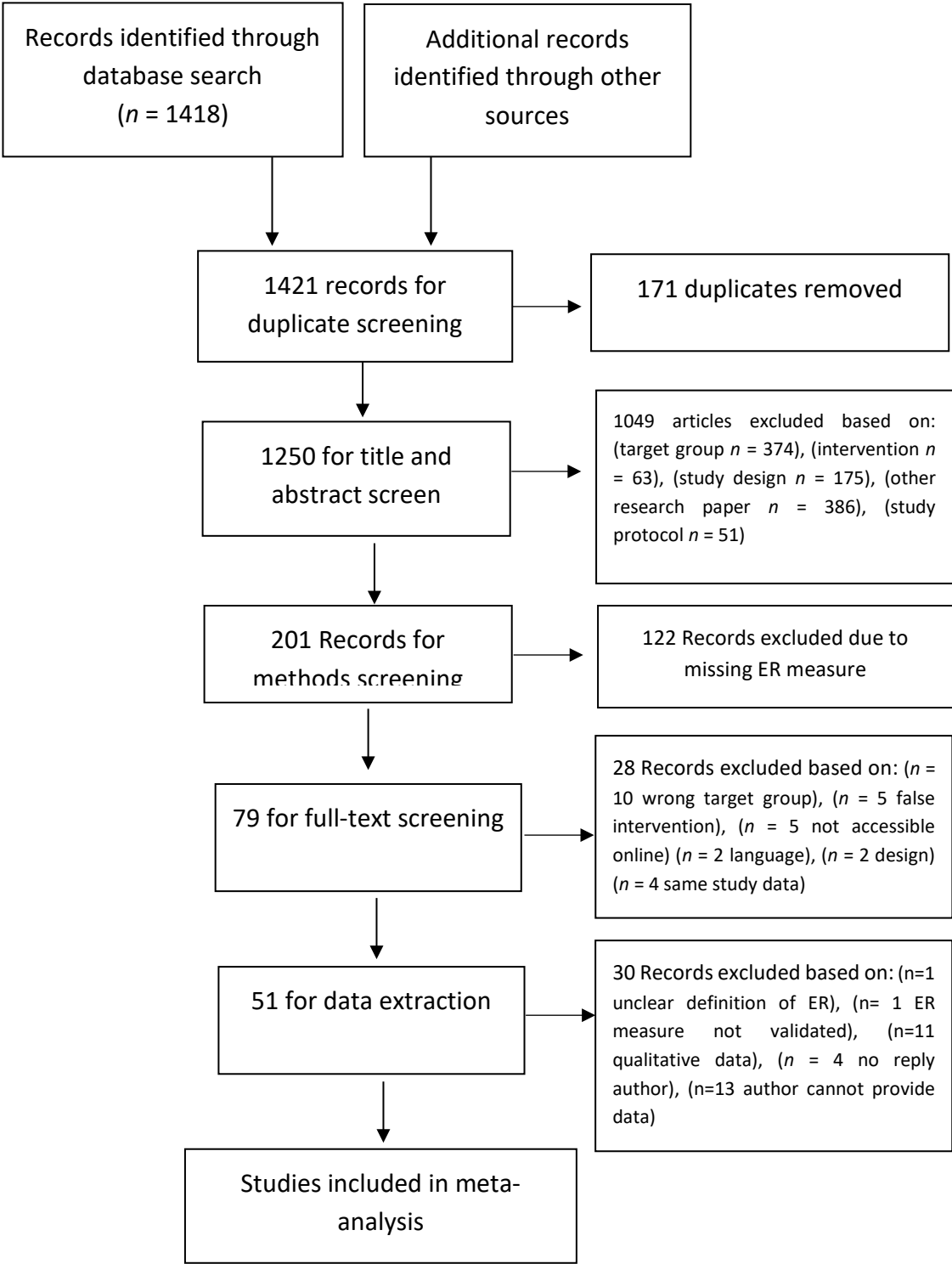
Figure 7.1 Flow Diagram

Table 7.1 Study characteristics

Study	Psychopathology	Design	N	Age	Conditions	ER measure	Quality rating
Slee et al.,2008	BPD	RCT	82	24.2	CBT - TAU	DERS	Strong
Schuppert et al., 2012	BPD	RCT	109	15.98	ERT - TAU	LPI-Subscale.	Strong
Suveg et al., 2017	AD	RCT	92	8.93	ECBT -CBT	ERC	Moderate
Dingle et al., 2017	AD, MD	RCT	51	18.68	ERP - WL	DERS	Moderate
Hides et al., 2011	MD, SUB	RCT	88	19.2	CBT+MI - TAU	CISS	Weak
Atkinson et al., 2016	ED	RCT	33	20.57	MF - WL*	FFMQ	Weak
Azrin et al., 2001	CD, SUB	RCT	56	15.4	CPS - FBT	SPSI-R	Moderate
Stasiak et al., 2014-	MD	RCT	34	15.2	cCBT - TAU	ACS-PS	Moderate
Jacobs et al., 2016	MD	RCT	33	15.5	RCBT -WL	RRS	Strong
Livheim et al., 2015 -	MD	QRCT	51	14.6	ACT -TAU	AFQ	Strong
[1]Livheim et al., 2015	MD	RCT	32	14.5	ACT - TAU	AFQ, MAAS	Weak
Kaufman et al., 2005	MD, CD	RCT	93	15.1	CBT -LS	IC - PS	Strong
Hennesdottir et al., 2017	ADHD	RCT	30	9.2	CBT - WL	ERC	
					Parent training*		Strong
Meisner-Stedman et al.,	AD	RCT	29	24.56	CTPTSD - WL	Rumination items	Strong
[1]Essau et al., 2012 -	AD	CRCT	638	10.91	CBT - WL	CSCY- PS	Moderate

Latimer et al., 2003 -	SUB	RCT	43	16.07	CBT - DHPE	SPSI	Moderate
Winters et al., 2012	SUB	QRCT	192	16.13	MI-A – WL MI-P*	PSQ	Moderate
Smith et al., 2015	MD	RCT	109	13-16	cCBT - WL	CRSQ	Strong
Fitzpatrick et al., 2005 -	MD	RCT	94	19.02	PS - Health Educ.	SPSI-R	Moderate

Multi-treatment trials entered with split groups

Hancock et al, 2016-	AD	RCT	99	13.8	ACT - WL	AFQ	Strong
	AD	RCT	94	13.8	CBT - WL	AFQ	Strong
Afshari et al., 2014 -	AD	RCT	77	10.57	ERT - WL	CERQ, CEMS	Weak
	AD	RCT	55	10.57	CBT - WL	CERQ, CEMS	Weak

BPD= Borderline Personality Disorder, AD=Anxiety Disorder, MD=Major Depression, SUB= Substance abuse, ED= Eating Disorder, CD= Conduct Disorder, ADHD= Attention Deficit Hyperactivity Disorder, RCT=Randomized Control Trial, QRCT= Quasi-Randomized Control Trial, CBT=Cognitive Behavioural Therapy, TAU=Treatment as usual, ERT=Emotion Regulation Training, ECBT=Emotion-focussed CBT, ERP=Emotion Regulation Program, WL=Waitlist, MI=Motivational Interviewing, MF=Mindfulness, CPS=Cognitive Problem Solving, FBT= Family Behavioural Therapy, cCBT=computerized CBT, RCBT= Rumination focussed CBT, ACT=Acceptance and Commitment Therapy, LS= Life Skills, CT-PTSD=Cognitive Therapy for PTSD, DGPE= Drugs Harm Psychoeducation Curriculum, MIA=Motivation Interviewing Adolescence, MI-P= Motivation Interviewing Parents, PS=Problem Solving, DERS= Difficulties with Emotion Regulation Scale, LPI=Life Problems Inventory, ERC=Emotion regulation checklist, CISS=Coping Inventory for Stressful Situations, FFMQ=Five Factor Mindfulness Questionnaire, SPSI-R=Social Problem Solving Inventory-Revised, ACS-PS= Adolescent Coping Scale-Problem solving, RRS= Ruminative Response Scale, AFQ=Avoidance and Fusion Questionnaire, MAAS=Mindful Attention Awareness Scale, IC-PS= Issues Checklist-Problem Solving, CSCY= Coping Scale for Children and youth, PSQ=Problem Solving Questionnaire, CRSQ =Child Response Style Questionnaire, CERQ=Cognitive Emotion Regulation Questionnaire, CEMS=Children's Emotion Management Scale, * Condition was part of multi-treatment trial and was excluded from meta-analysis [1] outlier study removed from main analysis.

7.3.4 Meta-analysis: Effectiveness of interventions to reduce emotion dysregulation

The first random effects model was based on the original 19 effect sizes from 17 independent studies, which indicated a medium treatment effect ($g = .52$, 95% CI [-0.86, -0.18], $p < .001$). Due to large heterogeneity $I^2 = 90.87\%$ ($Q = 129.64$, $df = 18$, $p <.001$), I decided to run the "metainf" command and a Galbraith plot to identify highly influential studies (Bax et al., 2009; Harrer, Cuijpers, Furukawa, & Ebert, 2019). The results (see Plots 1 and 2 in appendix B) indicated that two studies, one by Slee et al. (Nadja Slee, Arensman, Garnefski, & Spinhoven, 2007) and one of Livheim and colleague's studies (based in Sweden; 2015) had a significant impact on the overall effect size, while also contributing to a large amount of heterogeneity. I regarded these studies as highly influential studies and removed them from the main model, which effectively decreased the level of heterogeneity by $I^2=18.05\%$ (Harrer et al., 2019). Results of the full and the reduced meta-analysis model are presented in Table 7.2 and Table 7.3 below. Results of the reduced model are discussed in more detail below.

The forest plot and confidence intervals (CI) show that eight studies significantly reduced emotion dysregulation (CIs are entirely on the negative side), while the remaining studies ($k = 9$) showed no significant treatment effect (Figure 7.2). Overall, the results indicate a medium treatment effect ($g = -.46$), 95% CI [-0.67, -0.26], $p < .001$). The confidence interval (no value of 0 is present), and the z-statistic ($z = -4.44$, $p < .001$) suggest that the null hypothesis (H_0: Intervention had no impact on emotion dysregulation) can be rejected. The Q-statistic ($Q = 54.06$, $df = 16$, $p < .001$) indicated that the effect sizes differed significantly across the studies. I^2 of 72% suggests that most of the observed variance was due to differences on a study-level. T^2 of 0.12 suggests a small amount of absolute dispersion. Calculation of the 95% PI [- 0.67, -0.25] suggests that the true effect size of a similar future study would fall within this range 95% of the time. Most of the PI lies in the negative range, thereby indicating that interventions would be effective in most settings (Michael Borenstein et al., 2017; Riley et al., 2011).

Study	Treatment N	Mean	SD	Control N	Mean	SD		Hedges's g with 95% CI	Weight (%)
Afshari(ECBT)	44	36.07	10.8	33	51.9	12.9		-1.33 [-1.83, -0.84]	5.89
Afshari(CBT)	22	46.44	10.46	33	51.9	12.9		-0.45 [-0.99, 0.09]	5.54
Hannesdottir	16	31.79	6.17	11	35.36	6.16		-0.56 [-1.32, 0.20]	4.02
Schuppert	48	32.87	11.63	49	36.37	11.63		-0.30 [-0.70, 0.10]	6.70
Dingle	27	77.48	18.92	24	83.38	20.16		-0.30 [-0.84, 0.25]	5.49
Suveg	49	28.35	6.91	43	27.95	6.04		0.06 [-0.35, 0.47]	6.63
Livheim (A)	32	10.23	1.24	26	11.21	1.62		-0.68 [-1.21, -0.15]	5.64
Hancock(ACT)	68	22.3	11.96	31	30.53	13.5		-0.66 [-1.09, -0.22]	6.41
Hancock(CBT)	63	19.67	12.02	31	30.53	13.5		-0.86 [-1.30, -0.42]	6.31
Meisner-Stedman	14	6.7	2.7	15	10	1.6		-1.46 [-2.26, -0.66]	3.79
Jacobs	15	40.26	11.71	15	51.71	13.53		-0.88 [-1.61, -0.15]	4.19
Azin	27	10.48	6.7	29	8.88	6.47		0.24 [-0.28, 0.76]	5.69
Essau	302	4.85	3.2	336	5.29	3.3		-0.14 [-0.29, 0.02]	8.51
Fitzpatrick	47	18.25	9.84	47	20.61	10.66		-0.23 [-0.63, 0.17]	6.66
Kaufmann	45	1.43	1.54	48	1.45	.61		-0.02 [-0.42, 0.39]	6.65
Latimer	21	4.76	3.49	21	7.14	3.95		-0.63 [-1.23, -0.02]	5.01
Smith	54	24.09	9.32	55	28.96	10.22		-0.49 [-0.87, -0.12]	6.86
Overall								-0.46 [-0.67, -0.26]	

Heterogeneity: $\tau^2 = 0.12$, $I^2 = 72.82\%$, $H^2 = 3.68$

Test of $\theta_i = \theta_j$: Q(16) = 54.06, p = 0.00

Test of $\theta = 0$: z = -4.44, p = 0.00

Random-effects REML model

Figure 7.2 Random effects model (reduced) with emotion dysregulation as primary outcome

7.3.5 Meta-analysis: Effectiveness of interventions to enhance emotion regulation

The original random effects model was based on 14 effect sizes from 13 independent studies with emotion regulation abilities as an outcome. The full model indicates a treatment effect of (g = 0.43, 95% CI [0.18, 0.69], $p < .001$). The metaninf and the Galbraith plot suggested two influential studies, Livheim et al. (Livheim et al., 2015) and Essau et al. (2012) (see appendix B Plots 3 and 4). In comparison to Essau et al (N = 638), the study by Livheim (N = 25) was significantly underpowered, hence I decided to remove this study from the following analysis (results of the full and the reduced model are both presented in Table 7.3). The forest plot of the reduced model indicated that three studies (Afshari, Neshat-Doost, Maracy, Ahmady, & Amiri, 2014; Essau et al., 2012; Nadia Slee, Spinhoven, Garnefski, & Arensman, 2008) showed a significant positive effect, while the remaining 10 studies had no significant effects (see Figure 7.3). Overall, the results suggest a small treatment effect (g = .36, 95% CI [0.14, 0.58], $p < .001$). Based on the CI and the z-statistic (z = 3.22, $p < .001$), the null hypothesis that the intervention has no impact on emotion regulation was rejected. The Q-statistic (Q = 66.56, df = 12, $p < .001$) suggests that effect sizes differed significantly

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across the studies. I^2 of 70.8% suggests that most of the observed variance was due to differences on a study level (e.g., sampling error). T^2 of 0.10 suggests a small amount of between-study variance. The 95% PI = [0.14, 0.58] is in the positive range, suggesting that future studies will most likely find a positive effect size within this range (Michael Borenstein et al., 2017; Riley et al., 2011).

Study	Treatment N	Mean	SD	Control N	Mean	SD	Hedges's g with 95% CI	Weight (%)
Afshari(ECBT)	44	58.13	11.1	33	49.11	14.75	0.70 [0.24, 1.16]	7.95
Afshari(CBT)	22	54.92	13.1	33	49.11	14.75	0.41 [-0.13, 0.94]	7.07
Hannesdottir	16	25.8	2.73	11	25.07	3.65	0.23 [-0.52, 0.97]	5.09
Suveg	49	28.58	3.16	43	28.81	3.51	-0.07 [-0.47, 0.34]	8.60
Slee	40	32.55	11.66	42	25.7	13.99	0.53 [0.09, 0.96]	8.24
Azin	27	11.69	3.77	29	12.76	4.3	-0.26 [-0.78, 0.26]	7.27
Hides	60	43.4	1.8	28	42.7	2.4	0.35 [-0.10, 0.79]	8.10
Stasiak	17	64.06	14.07	17	58.41	10.23	0.45 [-0.22, 1.11]	5.78
Essau	302	10.49	4.9	336	6.47	2.5	1.05 [0.88, 1.21]	11.35
Fitzpatrick	47	9.06	9.06	47	9.03	4.63	0.00 [-0.40, 0.41]	8.67
Latimer	21	12.19	3.33	21	10.1	4.31	0.53 [-0.07, 1.14]	6.36
Atkinson	17	3.03	.81	16	2.81	.43	0.33 [-0.34, 1.00]	5.73
Winters	136	18	4.9	56	16.9	3.7	0.24 [-0.07, 0.55]	9.78
Overall							0.36 [0.14, 0.58]	

Heterogeneity: $\tau^2 = 0.10$, $I^2 = 70.80\%$, $H^2 = 3.42$

Test of $\theta_i = \theta_j$: Q(12) = 66.56, p = 0.00

Test of $\theta = 0$: z = 3.22, p = 0.00

Random-effects REML model

Figure 7.3 Random effects model (reduced) with emotion regulation as primary outcome.

7.3.6 Heterogeneity and bias assessment

To explore possible causes of heterogeneity and investigate whether effect sizes varied for certain subgroups, a meta-regression and subgroup analyses were conducted (See Table 7.2 and Table 7.3).

7.3.7 Moderator meta-regression

7.3.7.1 Emotion dysregulation

The meta-regression model with effect size (k=17) as the dependent variable and age group, intervention type, quality of study and control group as predictor variables, was non-significant ($\chi^2 = 14.37$, p=.07) thereby suggesting that none of the coefficients in

the model, apart from the intercept, are significantly different from zero. Similarly, none of the moderators had a significant impact on the overall effect size. Furthermore, the I^2 index (66%) suggest a moderate level of heterogeneity in the model and that only 31.5% of the between-study variance is explained by the moderators ($R^2 = 31.47$). Based on the meta-regression results none of the included study-level factors seem to influence the overall effect-size. However, with respect to recent meta-regression recommendations, one should not conclude that a covariate is unrelated to the effect size if there are less than ten studies per covariate (M. Borenstein, 2009). Consequently, I explore this relationship further in the subgroup analyses.

7.3.7.2 Emotion regulation

The meta-regression model with effect size (k = 13) as the dependent variable was significant ($\chi^2 = 20.58$, $p < .05$) thereby suggesting that at least one of the coefficients in the model, apart from the intercept, is significantly different from zero. The results indicate that the control group variable had a significant impact on effect size (See Table 7.4). The I^2 index (40%) suggest a moderate to small level of heterogeneity in the model and that 75% of the between-study variance is explained by the moderators in the model ($R^2 = 75.09$). As stated above, due to the limited amount of studies per covariate in the model, the following subgroup-analyses were conducted to explore this relationship further.

7.3.8   Subgroup analysis: type of intervention

7.3.8.1 Emotion dysregulation

The results indicate that for individuals who received a specific emotion regulation intervention, emotion dysregulation decreased by $g = -.51$, and in non-specific interventions emotion dysregulation decreased by $g = -.40$. This suggests that interventions with a greater focus on emotion regulation processes could be more effective in reducing emotion regulation difficulties. However, the large amount of heterogeneity ($I^2 = 70\%$ and 59%) makes direct comparisons between the subgroups difficult. This is also supported by the non-significant test of group differences ($Q_b(2) = 0.36$, $p = .84$) (See Figure 6 in appendix B).

7.3.8.2 Emotion regulation

The results indicate that for individuals who received a specific emotion regulation intervention, emotion regulation improved by $g = .22$, and in non-specific

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interventions emotion regulation improved by $g = .45$. Heterogeneity is large for all subgroups (71% and 58%) and the test of group difference non-significant ($Q_b (2) = 1.29, p = .51$). Furthermore, one of the subgroups only consisted of fours studies, which has been considered as too small to derive definite conclusions (See Figure 7 in appendix B).

7.3.9 Subgroup analysis: type of control group

7.3.9.1 Emotion dysregulation

The results indicate that for studies with an active control condition emotion dysregulation decreased by $g = -.19$, while for studies with passive control conditions emotion dysregulation decreased by $g = -.66$. The significant Q statistic ($Q= 6.88, df = 1, p < .001$), suggests that the true mean effect varies depending on the type of control condition. Heterogeneity within the active control subgroup was significantly lower ($I^2 = 39\%$) compared to the passive control subgroup ($I^2 = 71\%$). Thus differentiating between types of control groups partially explained the level of heterogeneity (See Figure 8 in appendix B).

7.3.9.2 Emotion regulation

Similarly, for emotion regulation effect sizes, studies with an active control condition improved emotion regulation by $g = .20$, while for studies with passive control conditions emotion regulation improved by $g = .57$. The significant Q statistic ($Q = 3.09, df = 1, p < .001$), suggests that the true mean effect varies depending on the type of control condition. Heterogeneity within the active control subgroup was significantly lower ($I^2 = 32\%$) compared to the passive control subgroup ($I^2 = 77\%$, see Figure 9 in appendix B).

7.3.10 Subgroup analysis: type of disorder and emotion regulation strategy

Subgroup analyses for different types of disorders and different emotion regulation strategies were conducted, but due to insufficient numbers of studies ($n \leq 4$) in the respective subgroups no meaningful interpretations were possible. (Results of these are provided in the appendix B, see Figure 10 and 11.)

7.3.11 Subgroup analysis: age group

7.3.11.1 Emotion dysregulation

Subgroup analyses for different age groups indicate that that emotion dysregulation decreased by $g = -.16$ in children, $g = -.62$ in early adolescence, $g = -.45$ in adolescents and $g = -.59$ in late adolescents. Heterogeneity is large for all subgroups (50-89%) and the test of group difference non-significant ($Q_b(3) = 1.28$, $p = .73$). Furthermore, apart from the age group "adolescence" all other subgroups only consisted of 2-3 studies, which has been considered as too small to derive definite conclusions (See Figure 12 in appendix B).

7.3.11.2 Emotion regulation

Subgroups in this analysis did not exceed more than 4 studies per group, which is suggested to be too small in order to derive meaningful interpretations. (Results of these are provided in the appendix B, see Figure 13.)

7.3.12 Subgroup analysis: quality rating

7.3.12.1 Emotion dysregulation

Studies ($k = 7$) with strong quality ratings decreased emotion dysregulation by $g = -.59$, which was higher than the overall effect-size $g = -.46$. Studies of moderate quality ($k = 6$) had smaller effect sizes $g = -0.13$, while studies with the lowest quality ratings ($k = 2$) decreased emotion dysregulation by $g = -.81$.

7.3.12.2 Emotion regulation

For emotion regulation only one study was rated as strong ($g = .53$), while the other studies were moderate ($k = 7$, $g = .29$) or weak ($k = 4$, $g = .44$). Due to the limited number of studies, I recommend that these results are treated with caution.

7.3.13 Sensitivity analysis

7.3.13.1 Effect of heterogeneity

Due to the large amount of heterogeneity in the presented models, further sensitivity analyses were conducted to test the robustness of the results. Hence, I fixed the value I^2 to 10% to represent a small level of heterogeneity. The result suggest that with a smaller level of heterogeneity there is a smaller, but significant effect size of $g = -.33$ ($z = -6.64$, $p < .001$) with a 95% CI of [-0.46,-0.23] for emotion dysregulation. The

same analysis was performed for the emotion regulation model, indicating that lower heterogeneity would result in a larger effect size of $g = .57$ ($z = 8.3$, $p < .001$) with a 95% CI [0.47, 0.68]. These results suggest that heterogeneity has an impact on the overall effect size, but also that current interventions effectively improve emotion regulation processes whether heterogeneity is small or large.

Table 7.2 Random effect models and sub-group analyses with emotion dysregulation as outcome

Reduced dataset	m	k	n	Hedges g	95% CI	p (z test)	Q	p (Q)	T^2	I^2
Emotion dysregulation	17	15	1744	-0.46	-0.67, -0.26	0.00	54.06	0.00	0.12	72.82%
Emotion dysregulation by										
Intervention										
CBT Intervention	8	8	1058	-0.40	-0.64,-0.15		14.84	0.02	0.06	59.37%
ER Intervention	7	7	598	-0.51	-0.82,-0.20		23.34	0.00	0.46	70.38%
Control group										
Active Control	8	8	532	-0.19	-0.41, -0.03		10.44	0.11	0.03	39.45%
Passive control	9	7	1212	-0.66	-0.93, -0.39		39.33	0.00	0.12	71.47%
Quality rating										
Strong	9	8	612	-0.59	-0.85, -0.33		16.35	0.02	0.08	57.22%
Moderate	5	5	973	-0.13	-0.26, -0.01		5.95	0.31	0.00	0.0%
Weak	3	2	159	-0.81	-1.40, -0.22		6.38	0.04	0.18	66.58%

Full dataset										
Emotion dysregulation	19	16	1851	-0.52	-0.86, -0.18	0.00	129.64	0.00	0.49	90.87%
Emotion dysregulation by										
Intervention										
CBT Intervention	8	8	1143	-0.71	-1.26,-0.15		73.69	0.00	0.58	93.20%
ER Intervention	9	8	623	-0.35	-0.80,0.10		44.07	0.00	0.40	86.54%
Control group										
Active Control	8	8	639	-0.32	-0.99, -0.35		90.31	0.00	0.98	94.03%
Passive control	9	7	1212	-0.66	-0.92, -0.39		38.31	0.00	0.12	70.89%
Quality rating										
Strong	9	8	691	-0.86	-1.35, -0.36		61.08	0.00	0.50	89.23%
Moderate	6	6	973	-0.13	-0.26, -0.01		5.74	0.33	0.00	0.0%
Weak	4	3	187	-0.81	-1.37, -0.84		33.81	0.02	1.16	91.87%

Table 7.3 Random effect models and sub-group analyses with emotion regulation as outcome

Reduced dataset	m	k	n	Hedges g	95% CI	p (z test)	Q	p (Q)	T²	I²
Emotion regulation	13	12	1513	0.36	0.14, 0.58	0.00	66.56	0.00	0.010	70.80%
Emotion regulation by										
Intervention										
CBT Intervention	8	8	969	0.45	0.15, 0.75		35.96	0.00	0.12	71.32%
ER Intervention	4	4	269	0.22	-0.15, 0.58		58.86	0.06	0.08	58.86%
Control group										
Active Control	8	8	521	0.20	-0.01, 0.42		9.99	0.19	0.03	32.10%
Passive control	5	4	992	0.57	0.22, 0.93		25.71	0.00	0.12	77.35%
Quality rating										
Strong	1	1	82	0.53	0.09, 0.96		0.00			- %
Moderate	7	7	1148	0.29	-0.07, 0.65		63.03	0.00	0.19	84.30%
Weak	5	4	283	0.44	0.20, 0.68		1.82	0.77	0.00	0.00%

Full dataset										
Emotion regulation	14	13	1538	0.43	0.18, 0.69	0.00	77.82	0.00	0.16	77.89%
Emotion regulation by										
Intervention										
CBT Intervention	7	7	969	0.58	0.30, 0.85		59.96	0.00	0.07	59.96%
ER Intervention	5	5	321	0.57	-0.17, 1.32		23.53	0.00	0.63	90.13%
Control group										
Active Control	9	9	546	0.37	0.01, 0.73		26.64	0.00	0.22	75.35%
Passive control	5	4	992	0.57	0.22, 0.93		25.71	0.00	0.12	77.35%
Quality rating										
Strong	1	1	82	0.53	0.09, 0.96		0.00			- %
Moderate	7	7	1148	0.29	-0.07, 0.65		63.03	0.00	0.19	84.30%
Weak	5	4	308	0.63	0.16, 1.10		14.38	0.01	0.24	72.89%

Table 7.4 Meta- regression with effect size as dependent variable and potential moderators as predictors

Predictor Variables	Emotion Dysregulation					Emotion Regulation				
	β	SE	z	p	95% CI	β	SE	z	p	95% CI
Intercept	-.48	.19	-2.54	.01	-0.86,-0.11	1.24	.56	2.19	.02	0.13,2.35
Intervention										
CBT Intervention										
ER Intervention	-.27	.21	-1.32	.18	-0.69,0.13	.23	.29	0.81	.41	-0.33,0.81
Control group										
Active Control										
Passive control	.24	.21	1.18	.23	-0.16,0.66	-.63	.32	-1.92	.05	-1.27,0.01
Quality rating										
Strong										
Moderate	.07	.36	0.22	.82	-0.63,0.79	-.42	.35	-1.20	.23	-1.11,0.26
Weak	-.72	.52	-1.39	.16	-1.75,0.29	-.34	.34	-1.01	.31	-1.01,0.32
Age group										
Child	.55	.46	1.20	.23	-0.35,1.45	-.54	.41	-1.32	.18	-1.35,0.26
Early Adolescence	.23	.42	0.55	.58	-0.60,1.07	.20	.36	0.56	.57	-0.51, 0.92
Adolescence										
Late Adolescence	.13	.41	0.32	.75	-0.68,0.95	-.08	.29	-0.29	0.77	-0.66,0.49

7.3.14 Publication bias

The contour-enhanced funnel plot (see Figure 4) shows an asymmetric pattern. Visual inspection of the funnel plot indicates more studies on the left side. Furthermore, one sees missing data points at the top and bottom of the funnel, for both the significant (light grey) and non-significant (dark grey) areas. In the case of a publication bias, one would expect to see missing studies in the non-significant areas. The present funnel plot seems to rather suggest a gap for studies including larger sample sizes. Most of the studies included in this review involved similar, small to medium-size samples (great density in the middle), which can result in spuriously increased effect sizes. Therefore, I conducted the Egger's test, which was significant, thereby suggesting a bias, due to small-study effects ($z = -2.22$, $p < .05$). It has been reported however that funnel-plot asymmetry can be caused by publication bias, as well as other factors such as poor methodological quality or between study heterogeneity (Sterne et al., 2011). Due to the large amount of heterogeneity in the analysis I performed the Egger's test again, this time taking into account between-study heterogeneity, as a result of different types of interventions, emotion regulation measures and control groups. I found that heterogenity due to different intervention types, significantly influenced the results of the the Egger' s test, which was nonsignificant when intervention type was added to the model($z = -1.31$, $p = .19$).
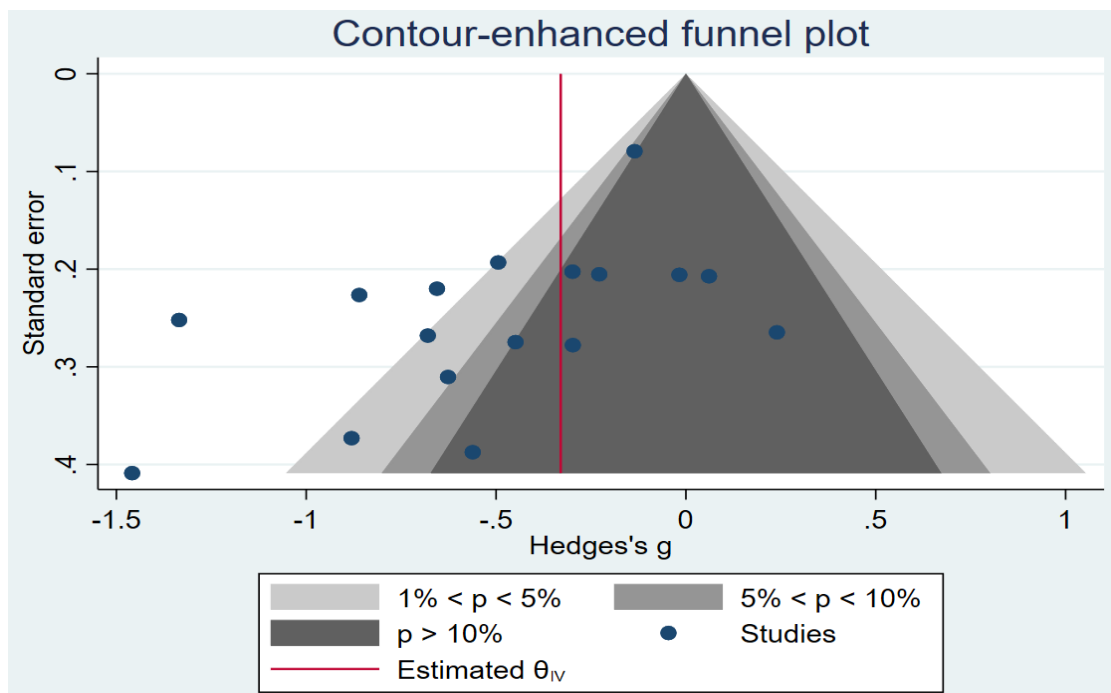
Figure 7.4 Funnel plot to detect publication bias

7.3.15 Meta-regression: are changes in emotion regulation associated with changes in psychopathology?

Only two studies reported whether changes in emotion regulation were associated with changes in psychopathology. The first study investigated adolescents engaging in deliberate self-harm, and found that changes in emotion dysregulation partially mediated decreases in deliberate self-harm (Nadja Slee, Spinhoven, Garnefski, & Arensman, 2008). The second study found that changes in acceptance mediated decreases in anxiety and depression (Swain, Hancock, Hainsworth, & Bowman, 2015b). The meta-regression indicated a significant positive relationship between larger effect sizes of reduced ED and larger effect sizes of reduced psychopathology (see Figure 5; $\beta = 0.76$, $t = 2.93$, $p = .01$). In other words, studies showing greater effectiveness in reducing emotion regulation difficulties were also more effective in reducing psychopathological symptoms.

Figure 7.5 Meta-regression: showing significant positive relationship between reduced emotion regulation problems and reduced psychopathology

7.4 Discussion

The results of the meta-analyses suggested small to medium effect sizes for current interventions to improve emotion regulation processes in youth, regardless whether the full or reduced data s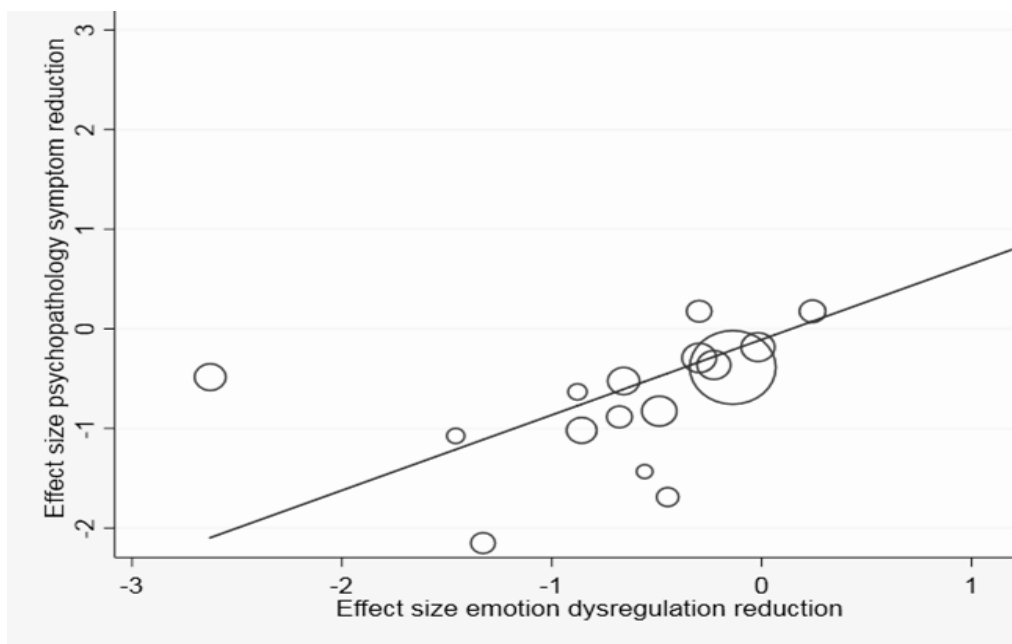et was employed. For emotion dysregulation effect sizes ranged between $g = -.46$ and $g = -.52$, and for emotion regulation effect sizes ranged between $g = .36$ and $g = .43$. Furthermore, the findings indicate that interventions, which effectively improved psychopathology also improved emotion regulation difficulties. These results are in line with the adult literature showing that interventions which effectively improved emotion regulation difficulties also decreased psychopathology (Sloan et al., 2017). Furthermore, the findings suggest that the type of control group had a significant impact on the effect size, whereby studies with a waitlist (passive) control group showed larger effect sizes in comparison to studies including an active control group. Unfortunately, the nature of the active control conditions was not always described in detail, therefore making any further conclusions difficult. The present meta-analysis adds to existing findings by synthesizing data from randomized control studies that involve children and adolescents as a target population, which has been neglected so far. Despite the limited evidence for this population, the present findings encourage the further development and evaluation of interventions that specifically target emotion regulation in youth.

The average effect sizes suggest that interventions effectively change emotion regulation, irrespective of the type of the intervention program. However, the validation of existing interventions represents an important area for future work. As the present systematic review demonstrates there is a significant variety across intervention protocols in the way they target emotion regulation, and it is not clear yet which of the included components effectively enhance emotion regulation. Furthermore, there is still limited evidence with respect to different age groups and psychopathologies, which is of particular importance.

First, past research has shown that emotion regulation does not develop in a linear pattern, but that different developmental stages are characterised by certain advancements and deficits (Cracco et al., 2017; Zimmermann & Iwanski, 2014). For instance Cracco et al. (2017) and Zimmermann et al. (2014) have demonstrated that there is a significant shift in adolescents' emotion regulation patterns (e.g., access to

strategies, use of adaptive vs maladaptive strategies), which current interventions do not seem to take into consideration. Therefore, I argue that more efforts need to be made to increase our understanding of what works for who and when, so that relevant changes can be implemented in current clinical treatment plans. Secondly, young people frequently display a wide range of psychopathological symptoms and comorbidities (Aldao et al., 2016; Merikangas et al., 2010). This can make interventions that have been designed for single-disorder symptoms, less suitable for this group. Thus the present review supports existing recommendations that emotion regulation interventions could be effective in reducing a wider range of psychopathological symptoms by targeting underlying processes like emotion regulation, which makes them highly suitable for young populations where high rates of comorbidity are common (Berking et al., 2008).

Furthermore, the results suggest the potential of transdiagnostic treatments being added as adjunctive modules in existing treatment protocols. This approach has already found support in adult studies where emotion regulation interventions in combination with CBT have resulted in better mental health and wellbeing outcomes than CBT alone (Berking, Ebert, Cuijpers, & Hofmann, 2013).

7.4.1 Strengths and limitations

The results were based on a relatively small number of studies, which primarily involved small to medium sized samples. It can be assumed that the variety in populations, intervention settings (e.g., digital, inpatient and outpatient, schools), and use of emotion regulation measures lead to large between-study variation, which may have led to a bias in the present findings. With respect to the latter it has been highlighted recently that meta-analyses with an increased psychometric focus could provide more insights regarding the impact of measurement error on outcome biases (Schmidt & Hunter, 2017). In the present meta-analysis, only 11 of the 19 studies reported information on reliability, which did not provide sufficient data to correct the analyses for measurement error. Following this, I highly encourage future meta-analysts to also consider bias due to measurement error. Moreover, there was a great variety between interventions, even though CBT formed the basis of most interventions. However, due to the limited amount of data available, it was impossible to provide further insights regarding the impact of certain study artefacts on the overall effect size.

Furthermore, due to missing evidence from longitudinal mediation analyses, the present study could only partly address the second research question whether changes in emotion regulation precede changes in psychopathology. Only two studies (Nadja Slee, Spinhoven, et al., 2008; Swain et al., 2015b) reported whether changes in emotion regulation were associated with changes in psychopathology. Both studies found that changes in emotion regulation mediated decreases in psychopathology. Similarly, our meta-regression showed a significant, positive relationship between effect sizes of improved emotion regulation difficulties and effect sizes of improved psychopathology. Moreover, most studies only assessed changes in anxiety or depression even though a wider range of symptoms was reported at baseline. Due to the current lack of research reporting on emotion regulation outcomes in relation to different psychopathology outcomes, I was not able to conduct more specific mediation analyses. Similar issues have been raised in previous systematic reviews (Riosa, McArthur, & Preyde, 2011). I recommend that future research includes measures of emotion regulation so that underlying mechanisms of change can be identified.

The quality of the included studies ranged from weak to strong. Even though the focus was primarily on RCTs, there was a significant lack of high-quality studies. The limited evidence may have made it difficult to detect differences in effect sizes relating to study quality. Moreover, it has frequently been pointed out that the level of quality found in primary research has a significant impact on the quality of any systematic review, due to the fact that systematic reviews rely on data from existing studies. Following this we can only emphasize that future research needs to focus on the delivery of more high-quality studies that provide high-quality research outcomes. In line with this, it needs to be acknowledged that while I was hoping to identify more high-quality studies by excluding non-peer-reviewed articles, the exclusion of such unpublished data may have resulted in biased outcomes. Although the publication bias assessment did not indicate the presence of a publication bias, this may have been due to the high level of heterogeneity. However, it should be emphasised that there was a significant lack of large-sample size studies that included a comprehensive psychopathology assessment and targeted youth populations.

7.4.2 Future suggestions

Further RCTs including larger sample sizes, different age groups and mental disorders are needed. While evidence suggests that research has widely neglected populations under the age of 25, future research should specifically address youth populations between the ages of 10 to 12 years. They form an interesting age group as research has emphasized a significant drop in emotion regulation skills at this age (Zimmermann & Iwanski, 2014). Furthermore, studies involving youths mostly investigated anxiety or depressive symptoms, while only a few looked at emotion regulation in relation to other mental disorders, even though some of them reported that symptoms from other disorders were present at baseline. Similarly, interventions with a specific focus on emotion regulation often target specific disorders, such as borderline personality disorder (Schuppert et al., 2009). Considering the suggested transdiagnostic nature of emotion regulation, future studies should involve participants from a broader psychopathological spectrum.

To increase our understanding of emotion regulation interventions and associated change mechanisms, future research needs to assess and actually report emotion regulation processes. A large number of studies was excluded, due to missing emotion regulation assessment. This can not only improve future interventions, but would also reduce the exploratory nature of current interventions, as it could identify important change mechanisms. In line with this I suggest that future research should also focus on the impact of measurement error in their studies. As mentioned above, studies included a wide range of emotion regulation measures, which have been based on different theories and models around emotion regulation. Thus, a psychometric meta-analysis of current emotion regulation measures would be highly beneficial to the field.

Finally, I found that the investigation of positive emotion regulation strategies and emotion regulation abilities is still widely neglected. Although past research has highlighted that adaptive emotion regulation strategies, as opposed to maladaptive strategies, were more strongly related to psychopathology in youth (Braet et al., 2014). The opposite has been reported in adult studies (Aldao & Nolen-Hoeksema, 2012b). I identified only one study that assessed a positive emotion regulation strategy (gratitude, Kwok, Gu, & Kit, 2016). This could either be related to the fact that positive psychology is still a rather young field in comparison to traditional CBT approaches or that the use of emotion regulation strategies has been less frequently studied in youth

populations. Nevertheless, in line with previous research (Braet et al., 2014; Gilbert, 2012) and the present findings, I argue for a greater focus on the positive dimensions of emotion regulation especially when researching and working with young populations.

7.4.3 Considerations for the present intervention

The present findings suggest small to moderate effect sizes for existing intervention to improve emotion regulation processes. A closer look at the interventions reveals that most of them were CBT based. Only two studies included a technology-based intervention, one was a pilot study with 34 adolescents and the other an RCT with 112 adolescents. Both studies involved computerised CBT to target depressive symptoms. While both studies reported positive treatment outcomes, the findings also highlight the significant evidence gap concerning the use of digital interventions to support young people. In the past, researchers have also evaluated other computerised CBT interventions, such as the MoodGym, SPARX, or THINK-FEEL-DO, with a recent meta-analysis suggesting their potential for treating and preventing anxiety and depression in young people (Pennant et al., 2015). The authors reported small positive effects and highlighted that the evidence is particularly scarce for children between the age of 5 and 11.

In order to move the field forward, I suggest that future research needs to not only investigate the effectiveness of digital interventions further, but should also explore the impact of other platforms (e.g., mobile apps, virtual reality games), modalities (e.g., visual, audio, typing, digital phenotyping), therapy approaches (e.g., acceptance and commitment therapy), and different populations, including age groups and symptom profiles.

Furthermore, with respect to the present research it was found that none of the interventions was described as a transdiagnostic intervention that was specifically developed to target emotion regulation processes in youth, although similar interventions (i.e., UP or ART) have been developed and extensively evaluated for adults, with growing evidence supporting their effectiveness (Sakiris & Berle, 2019). This demonstrates that there is a significant gap that needs to be explored concerning the use of (digital) transdiagnostic interventions for children and young people.

In sum, the present findings suggest that the evidence is the strongest for CBT components to be included in the app. Furthermore, in contrast to existing interventions, the proposed app will put a greater focus on adaptive emotion regulation processes, as evidence has suggested that the lack of adaptive emotion regulation in early childhood is associated with increased emotion dysregulation later in life (Braet et al., 2014).

Chapter 8: Design implications and description of the mobile app intervention Eda

8.1 Introduction

As outlined and explained in Chapter 6, the development of the app involved a set of interdisciplinary methods, derived from the fields of psychology and HCI. Chapter 6 describes these methods and how they were implemented in more detail. The present chapter presents how the employed methods influenced the design of the app intervention.

In this chapter, I first provide a summary of some of the broader outcomes for each development stage. This is followed up with a detailed intervention description, where I also reflect on how specific features were informed by the employed methods and activities.

8.1.1 Stage I

8.1.1.1 Systematic review

The findings from the systematic review and meta-analysis suggested that the evidence is the strongest for CBT to effectively enhance emotion regulation abilities in children and young people. Basic CBT components built the foundation of the app and were included across the different modules (see detailed description below). Common CBT models and theories (e.g., thought-feelings-behaviour triangle) were specifically addressed in the animation videos, which served as psychoeducational components in the app. The animations also discussed strategies that are commonly addressed in CBT interventions to enhance emotion regulation, such as problem-solving, cognitive restructuring, mindfulness and relaxation. A more detailed description of common CBT components as identified in the systematic review, can be found in Table 5-B. CBT components such as psychoeducation, relaxation and mindfulness exercises, and skills were reflected in particular in the animations, the relax module and the tools module (see section 8.3 below for more detail).

In contrast to existing interventions and the limited evidence, as identified in the systematic review, the present app puts a greater focus on adaptive emotion regulation processes, as evidence from developmental studies suggested that the lack of adaptive emotion regulation in early childhood is associated with increased emotion dysregulation later in life (Braet et al., 2014).

8.1.1.2 School observations

As mentioned before, no data was actively collected during the school visits, but I used the classroom observations as opportunities to get initial inspirations for the app content and design. During the school visits, teachers and children reported two main strategies that were frequently applied to manage difficult behaviour in relation to emotion dysregulation in the classroom: quiet corners and time out zones.

Many teachers reported the use of time out zones in a defined area in the classroom. Students can be directed to the area when they show difficult behaviour, struggle to concentrate or distract other pupils in class. Some classrooms were divided into different zones, which signalled a different type of support (e.g., zone closer to the front to facilitate concentration and zones closer to the back for time outs). The quiet zones often included a sofa or pillows to sit on and children had access to books or other tools that could help them to calm down. Based on this observation, storing a tablet with the app intervention installed near the quite zone, seemed to be a suitable approach to implement the app in the classroom context.

Children reported that they themselves or together with a teacher had identified ways to manage difficult feelings, this included activities such as playing with blue tack, stepping outside for a "breather", reading a book, or listening to music in the quiet corner. This list of activities inspired the implementation of the digital tools box, which is in the current version of the app.

8.1.2   Stage II: Consultation groups and workshops

8.1.2.1 PPI groups

As described in Chapter 6, the PPI groups were conducted with 21 young research advisors, who are service users themselves and have been trained to work with researchers. The young advisors were between 12 and 19 years old, and the groups had an even distribution of female and male participants (see Chapter 6 for more details on methods).

I explored the following research questions with the two PPI groups:

1) Use of mental health apps in youth, including facilitators and barriers.

2) How can technology support mental health or emotion regulation in young people?

3) How can research involve children and young people in the design of mental health technology?

Notes were taken in writing by myself. Furthermore, each group collected their answers and ideas on large paper sheets and sticky notes (examples are provided in the appendix). Based on the data collected, we identified a list of "preferred" and "to-be-avoided" items for mental health apps, as well as potential solutions, which influenced subsequent design goals for the app (Table 8.1).

Table 8.1 Young people's preferences for mental health apps and how we addressed them in the present app

Theme	Please do	Please avoid	App solution
Accessibility	•Available across devices •Affordable for a young person •Available offline	• Advertisement • In-app purchases •Too much data or WIFI	• Web-based app • No costs •Data/WIFI for first-time login/ updates
Engagement	•Interactive, games, tracking •Social connection, community •Make use of users' feedback and provide relevant updates	•Push notifications •Dead website/app •Information/text only	• Selection of games • Digital agent for interaction • Multi-media content • Feedback option in app
Design	•Customizable features •Age appropriate (language, design) •Intuitive, easy to use	• Childish • Clunky • Text only	• Customizable features • Designed and tested by users
Data & Technology	•Use cloud service to limit storage space •Transparent data tracking •User control over data/tracking •Data security and privacy	• Requires too much data • Crashes or is slow • Hidden data tracking	•Google analytics provides insight for general use of app content • No individual data tracking through app
Mental Health specific	•Teach and educate •Increase understanding •Opportunity to practice •Facilitate social connectedness •Sign-posting to services	•Sign posting only •Text only	•Content that educates and increases understanding •Practice modules •Digital agent to feel socially connected •Sign-posting

8.1.2.2 Workshops and piloting

The participatory and testing workshops were conducted across two primary schools with children between the ages of 9 and 11 (see Chapter 6 for more details regarding the employed methods).

During the first round of workshops (N=15), I explored with the children what emotion regulation strategies they already used and how an app could provide additional support to them. The children reported which feelings they experienced the most and identified which ones they found difficult to manage. Here, children reported that intense negative as well as positive emotions can have a negative impact on their behaviour (e.g., "*When I am super excited, I cannot concentrate*" or "*when I am angry, I don't want to do stuff.*").

In addition to that, children reported which activities they usually engage in if they have strong negative feelings, which included activities such as: playing online games, listening to music, drawing and painting, watching something funny on YouTube, playing with their pet, and doing physical activities like cycling and playing football with friends. In line with that some children also shared personal situations that had elicited strong feelings at school or at home.

When children were asked to give suggestions for potential app features that could help them with difficult feelings, the following core components evolved, some overlapped with the findings from the consultation groups:

  a) Games to play
  b) Something to relax
  c) Something to watch

During the three participatory workshops (N=18), children raised the need for in-the-moment support. They reported that it was difficult to remember some of the strategies that they had previously agreed with a teacher when they were experiencing strong feelings. Based on this, the following features were discussed and added to the prototype:

  a) A "help button" in the app, which the children can press when they experience strong emotions and cannot remember the tools or strategies available to them.

b) A digital chat bot or buddy, who they can interact with and tell how they feel in order to get some guidance on what to do, when they experience strong emotions (*"Can I tell it how I feel and it tells me what to do?"*).

This possibility was first explored through a chatbot function. In a subsequent workshop this function was tested, where it became evident that some children struggled to understand that they were not speaking to a real person (i.e. "*Who is on the other side?"*). Based on this, I decided against the use of the chatbot function for this group, as it seemed questionable from an ethical perspective and could have borne potential risks, in case a child was in need of actual help and would try seeking it through the chatbot. While the chatbot function could represent an exciting opportunity to engage children with the app, developing this function further seemed to be beyond the scope of the present research. Hence, I decided to replace the chatbot with an alternative "check-in function", which required less functionality, which was more feasible with respect to the present project. The check-in function is described in more detail below.

8.2   Intervention description

The present intervention includes four different modules: Play, Relax, Watch, and Tools. The different modules are expected to provide users with opportunities to learn, practice and develop new emotion regulation skills (see Figure 8.1). The content was presented through different channels including: audio tracks, images, animated films and games. A more detailed description of each module is provided in section 8.3).

Due to the complex nature of the intervention, I present different components, change mechanisms, moderators and proposed intervention outcomes in the logic model below (see Figure 8.2). This, model has been developed to clarify the conceptual and logical underpinnings of complex interventions used in child mental health services (Wolpert, Sharpe, Humphrey, Patalay, & Deighton, 2016).
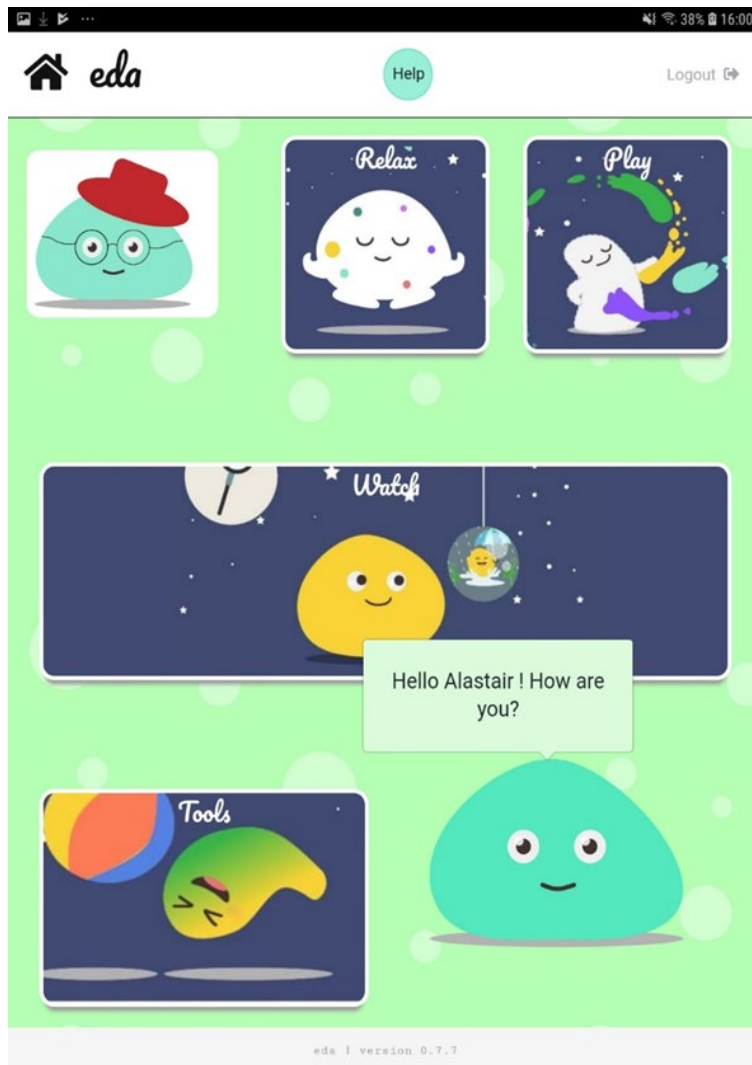
Figure 8.1 Emotion regulation app homescreen with the four modules Relax, Play, Watch and Tools.

TARGET
Who is the intervention for?

10 – 12 year olds

Primary schools: year 6

Difficulties with regulating emotions

Symptoms related to internalising problems, e.g., anxious or nervous

Symptoms related to externalizing symptoms, e.g, misbehaving in class

At risk of developing mental health problems

INTERVENTION
What is the intervention?

Universal, preventative

Tablet app

Calming activities

Psychoeducation

Check – in function

Increase positive affect

CHANGE MECHANISMS
How and why does your intervention work?

Provides emotion regulation strategies

In-the-moment support

Exercises to calm down when agitated

Recognise "bursting point" to prevent a similar incident

Increases emotional awareness and understanding

Games to increase positive affect and shift attention bias towards positive stimuli

OUTCOMES
What difference will it make?

3 month change

Improvements in mental health outcomes

Improved emotion-regulation abilities

Classroom engagement, concentration, interaction and reintegration

Improved social and academic skills

Relieve stress and lower experience of negative feelings

Teacher engagement and understanding of the app

Understanding of the activities and purpose

App/tablet availability

Engagement with the app

MODERATORS   What factors will influence the change process?

Figure 8.2 Logic model of the intervention

8.2.1 Technical specifications

The intervention was developed as a responsive web-based app, which was believed to increase the accessibility of the app, as it allowed users to access it across different mobile devices, as well as desktop computers and smartboards. While it works across multiple platforms, it was optimised for tablets, as young children are more likely to have access to tablets at school and at home (OfCom, 2019). The app can be accessed through the following link: https://eda.me.uk.
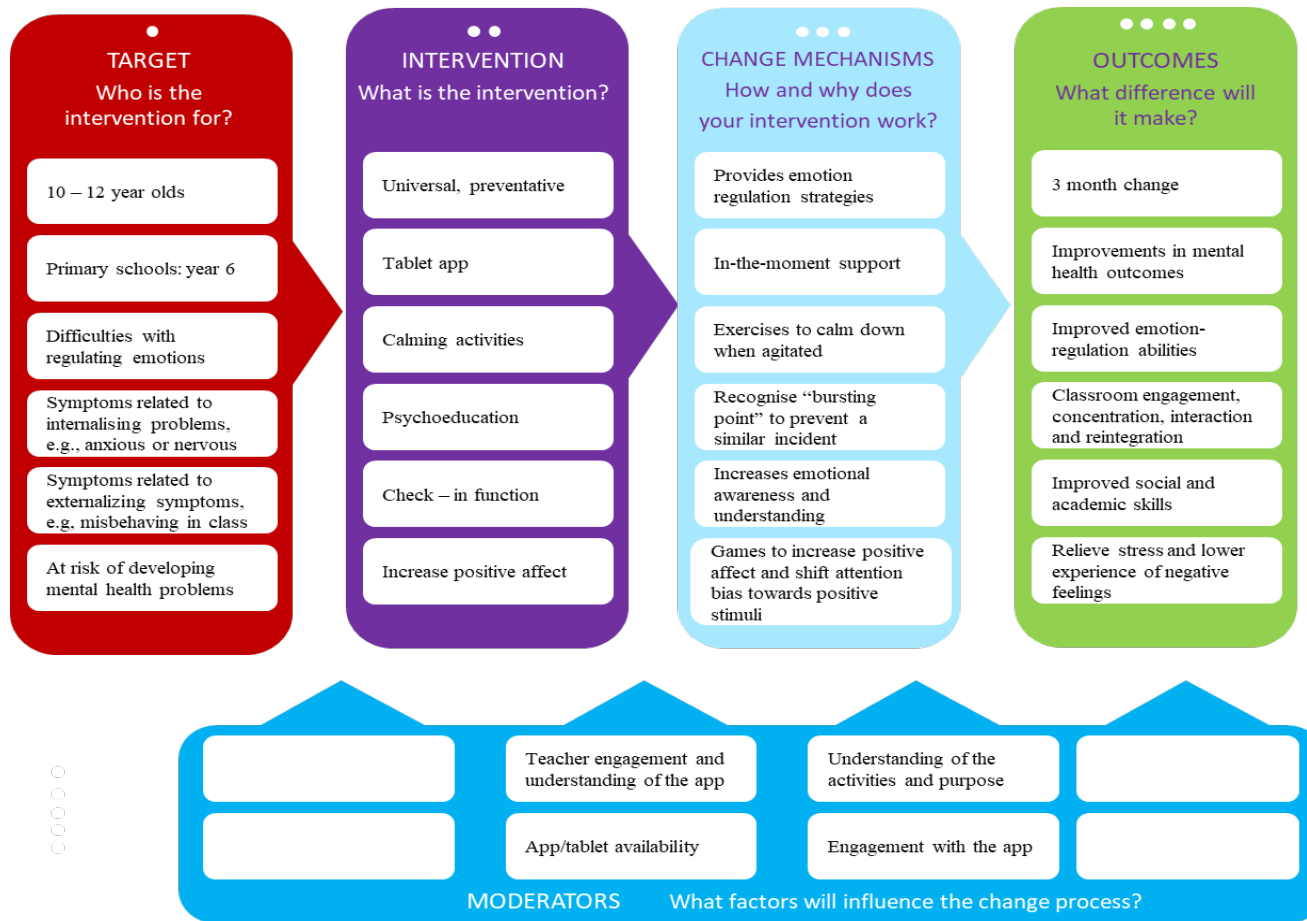
The app is delivered through the browser, meaning over-the-wire updates can be pushed out instantly, and the app uses advanced HTML5, CSS3, and JavaScript (ES6) techniques to render a smooth and performant user experience. The underlying development platform used was Meteor.js, a full-stack Node.js application development framework, hosted on a resilient AWS EC2 instance with a MongoDB database hosted via MongoDB Atlas. The app only requires internet connection when users access it for the first time, after which it can be saved to the home screen of the device. This feature was chosen to mitigate the risk that the intervention could not be accessed when schools had reduced or limited Wi-Fi infrastructure.

The app offers two different types of logins a guest login and a registered account login. The guest-login serves the following purposes: a) new users could explore the app without having to register an account, b) children without access to an email address could use the app, and c) it allowed easy and fast access for the whole class. The second login allows users to set up a personal account that is registered through an email address and password. The app only remembers personalized features (e.g., design features) when users access it through their personal account. The app does not store any individual user data and adheres to existing general data protection regulations.

8.3 App flow and design

8.3.1 Onboarding process and home screen

First time users go through an onboarding process, before they reach the homescreen of the app. During this process they learn about the purpose of the app, provide account details (e.g., user name), and select a preferred colour scheme and profile picture (see Figure 8.3).
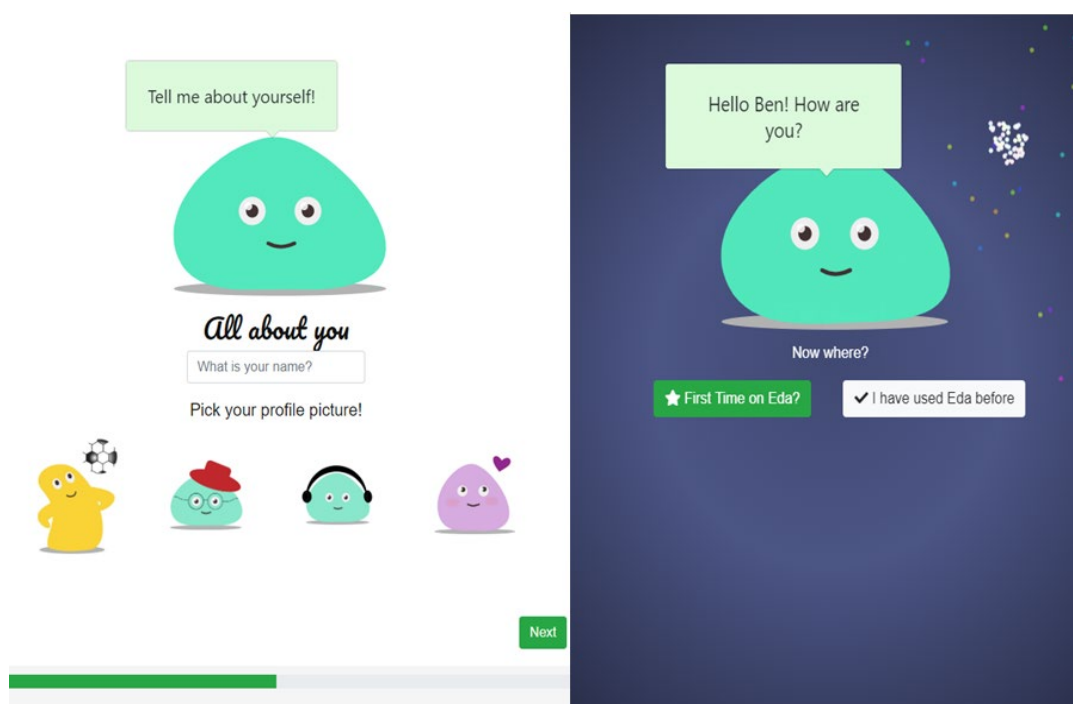
Figure 8.3 Onboarding process

After the onboarding process, the user enters the home screen, an animated, digital agent (big turquoise blob with a face) greets the user with their chosen username and encourages them to explore the app or tap on the body of the agent itself, which opens further functions.

8.3.2 Digital agent

The aim was to design a gender-neutral, animated agent who accompanies the user through the different modules in the app. This feature was added based on the requests of children in the workshops to have someone to turn to in situations where strong emotions are experienced. Additionally, research has shown that the use of virtual agents can facilitate the experience having a personal relationship, which in turn

increased long-term engagement with a digital intervention (LeRouge et al., 2016). The digital agent has been designed as a moving (or "wobbling") blob with big, blinking eyes to add a human-feel to it, which may enhance a feeling of connectedness and engagement in the user (Hyde, Kiesler, Hodgins, & Carter, 2014).

The blob, also called "Eda" is located at the bottom right corner of the homescreen and opens new features, when the user taps on it. In contrast to the originally explored chatbot idea, the functionality of Eda was reduced to the following two functions: a) "tell me something" – which activates a random selection of jokes or funny facts that are expected to increase the level of engagement with the app – and b) a "check-in" function, where users indicate how they feel by selecting from a list of feelings, how they currently feel.
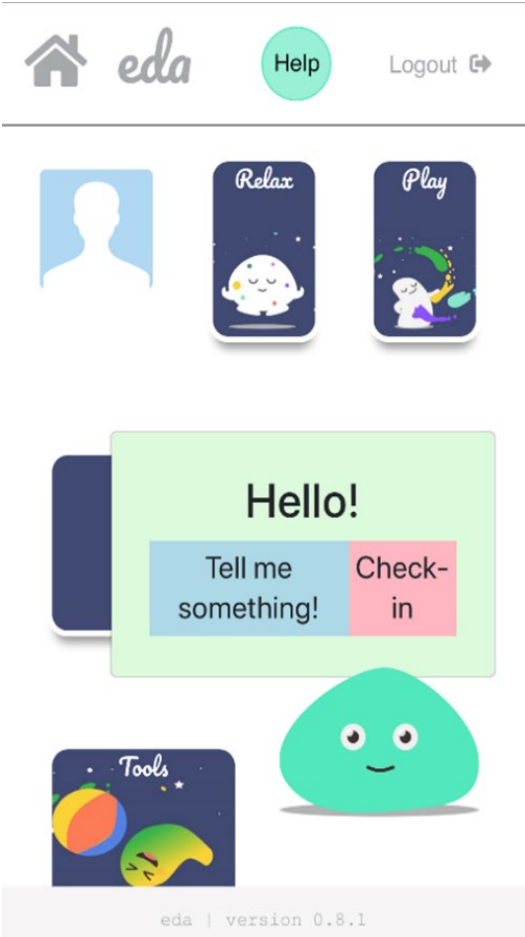

Figure 8.4 Screenshot of home screen with activated tapping function

8.3.3 Check-in function

The "Check-in" function (see Figure 8.5) displays a set of 18 different feelings to the user. When the user selects a specific feeling, a new window opens-up that provides more information about the chosen feeling and gives suggestions regarding potentially helpful emotion regulation strategies. Where appropriate cross-links to other modules in the app are provided (e.g., relax), so that the user has the opportunity to immediately apply or practice these strategies.

An initial list of 12 feelings was created based on the most common feelings that children reported in the first round of the co-design workshops. This list and the images were further adjusted by showing children the images without the description and letting them rate what emotions were represented. Furthermore, children were asked whether any important emotions were missing, if so the list was further extended. The current list aims to reflect a full range of feelings, ranging from emotions with positive, neutral to negative valence as well as different levels of arousal. For instance "feeling excited" represents an emotion of positive valence and high arousal, while "feeling grateful" is a state of positive emotional valence, but low arousal. This approach is in line with past research which has structured emotions along the two dimensions of arousal (high versus low) and valence (positive versus negative; Feldman, 1995). Furthermore, it has been suggested that internalizing symptoms are associated with the primary experience of low arousal emotions, while externalizing symptoms are rather linked to high arousal emotions (Posner et al., 2005).

Moreover, as explained earlier, the check-in function evolved from children's requests that it would help them if they could tell Eda how they felt and Eda would tell them what they could do about their feelings. While it is hoped that this developed function meets that request, it is also assumed to help children expand their emotional literacy and emotion differentiation skills, as these and the experience of a broader range of emotions have been linked to better mental health (L. F. Barrett, Gross, Christensen, & Benvenuto, 2001; Demiralp et al., 2008; Quoidbach et al., 2014).
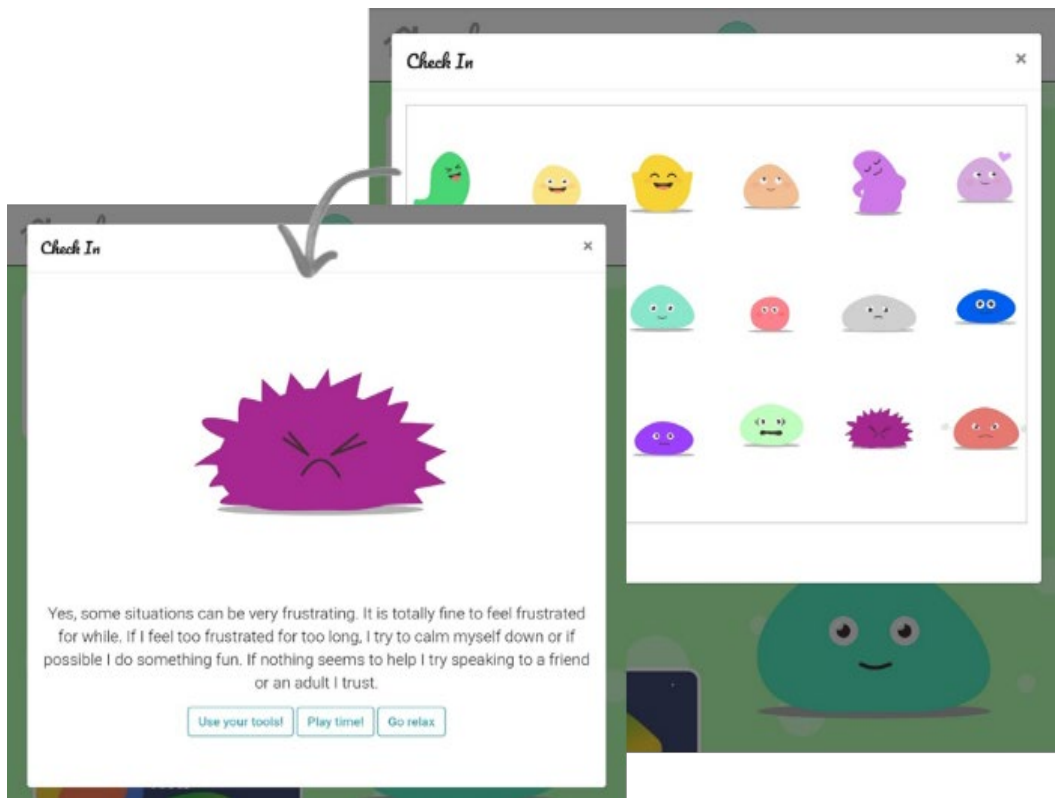
Figure 8.5 Check in function |selected feeling with explanation and cross link | access to check-in via home screen

8.3.4 Education and practice modules

As mentioned above, the user can enter four main modules either manually through the home screen, or through selecting a certain emotion in the check-in function. The specific content of each module is described below.

Figure 8.6 Content overview of the three modules Play, Relax, and Watch

Happy Faces

Click the happy faces on the grid. The more you click in 30 seconds, the higher the score!

🔄 New
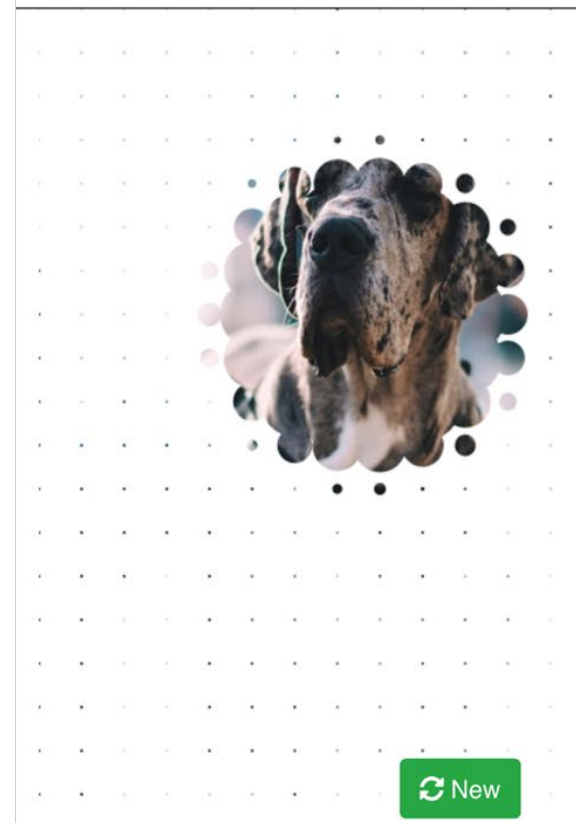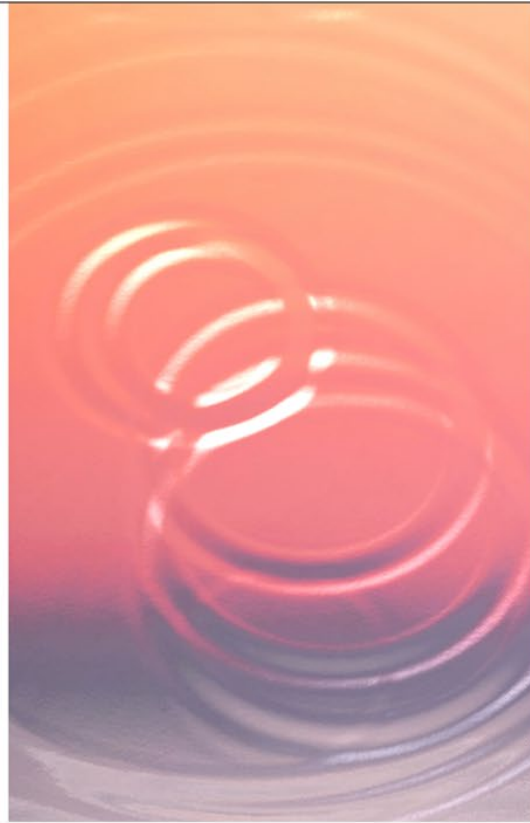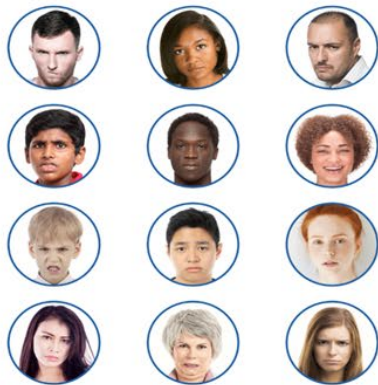
Figure 8.7 Examples of the three games Happy Faces, Water Ripples, and Reveal
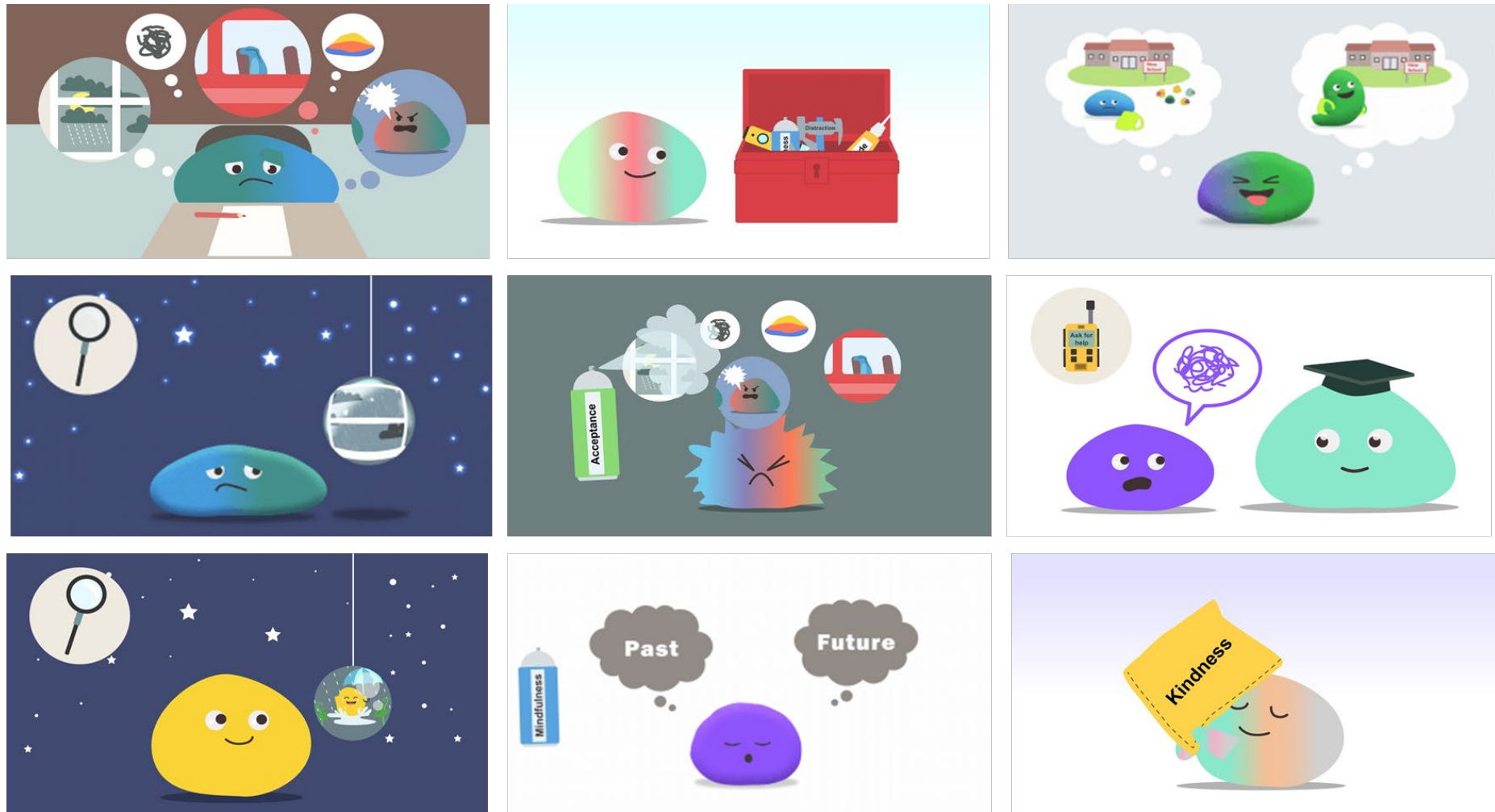
Figure 8.8 Screenshots of animated psychoeducative films that introduce different emotion regulation strategies

Play. This module contains three games which meets the request of young users to add games to the app and is in line with the list of activities that children reported to engage in when they experience difficult emotions. In the first game "Happy Faces", the user has to identify one happy face amongst 12 neutral or angry faces. This design was chosen due to research showing that search tasks like these can result in an attention bias shift towards positive stimuli, which in turn increases the likelihood to experience more positive emotions (Waters et al., 2015). The second game "Water Ripples" presents a colourful picture with an animated water surface. Through tapping the screen, the water animation creates circular waves that slowly expand to the sides of the screen. The design evolved from the co-design workshops, where children reported that water had a calming effect on them. Furthermore, it resembles a commonly employed mindfulness exercise, where the individual imagines their emotions as waves that come and go (Rathus & Miller, 2014). The third game "Reveal" also shows a colourful picture that is covered by a white layer. By touching the layer with a finger, parts of the white layer disappear and reveal sections of the underlying picture. The user is encouraged to guess the theme/object of the underlying picture. While there was no specific psychological theory to guide the design of this game, especially in the context of a mental health intervention, research has shown that games like the ones chosen here foster engagement(O'Brien & Toms, 2008). Furthermore, games have been shown to increase positive affect and wellbeing, although more research is needed to identify which specific aspects initiate the change and whether or how this might differ for different users (Lazzaro, 2004; Vella & Johnson, 2012).

Other potential games, such as music making or colouring-in had been suggested as well during the workshops, but were eventually disregarded as they conflicted with other user-engagement goals (e.g., slowed down app, too much data required, etc.).

Relax. The inclusion of the relax module was inspired by the school observations and reports from children during the workshops, which indicated that most schools already employed similar methods, hence many children are already familiar with relaxation exercises. Furthermore, there is increasing evidence showing that mindfulness interventions enhance emotion regulation and exert positive effects on mental health and wellbeing (Flett, Hayne, Riordan, Thompson, & Conner, 2019; Sheinman, Hadar, Gafni, & Milman, 2018). The relax module contains three sections that encourage the

user to actively engage in some type of relaxation or mindfulness exercise. The user can choose from video animated breathing exercises, audio-guided mindfulness exercises and a selection of calming sounds (e.g., guitar or rain). The decision to include sounds or relaxing music was based on children's suggestions in the workshop, as well as classroom observations, where teachers used music to keep children concentrating during a task.
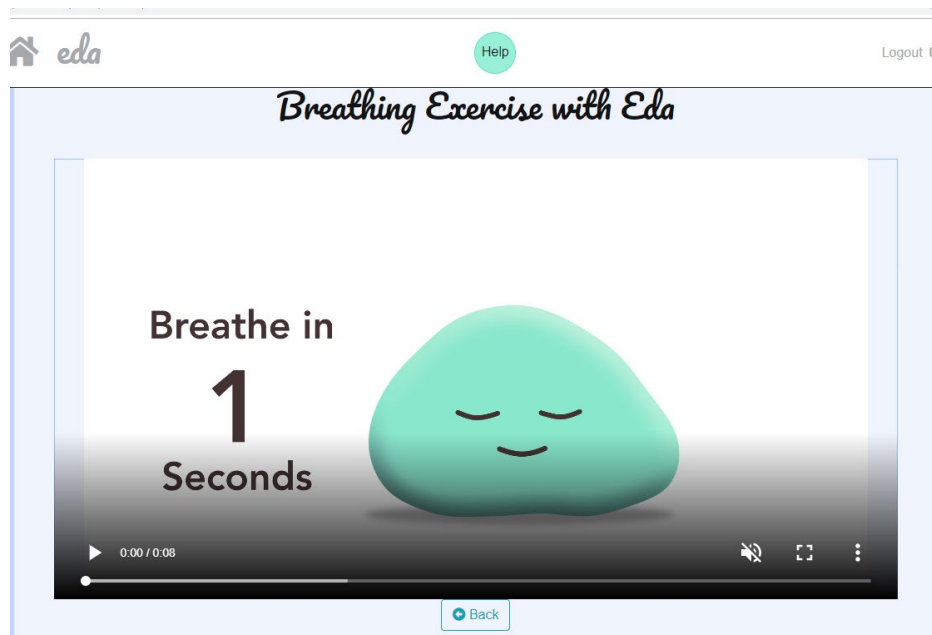
Figure 8.9 Example of animated breathing exercise with Eda

Tools. The tools module evolved from conversations with children, who indicated that they used different methods to regulate their emotions, some of these methods were developed through the help of the teacher. Thus, the tools module consists of a list of behavioural and cognitive strategies that are expected to help with regulating intense emotions. The list is divided into a general tools list that can be referred to outside of the classroom (e.g., doing something fun, getting support from a friend) and a specific list of tools suitable for the classroom (e.g., going to the quiet zone). That list was created with the input from children and teachers, who stated certain tools that were already applied in the classroom.

With respect to existing evidence demonstrating that the lack of and limited access to appropriate emotion regulation strategies contributes to mental health difficulties, it was expected that by giving users increased access to these tools, it would positively

influence their emotion regulation abilities (Jennissen et al., 2016). Furthermore, research has shown that early school years represent a crucial time for children to expand their repertoire of emotion regulation strategies, including cognitive and behavioural strategies (Sala, Pons, & Molina, 2014), hence, it was assumed that the tools list function could positively support this development.
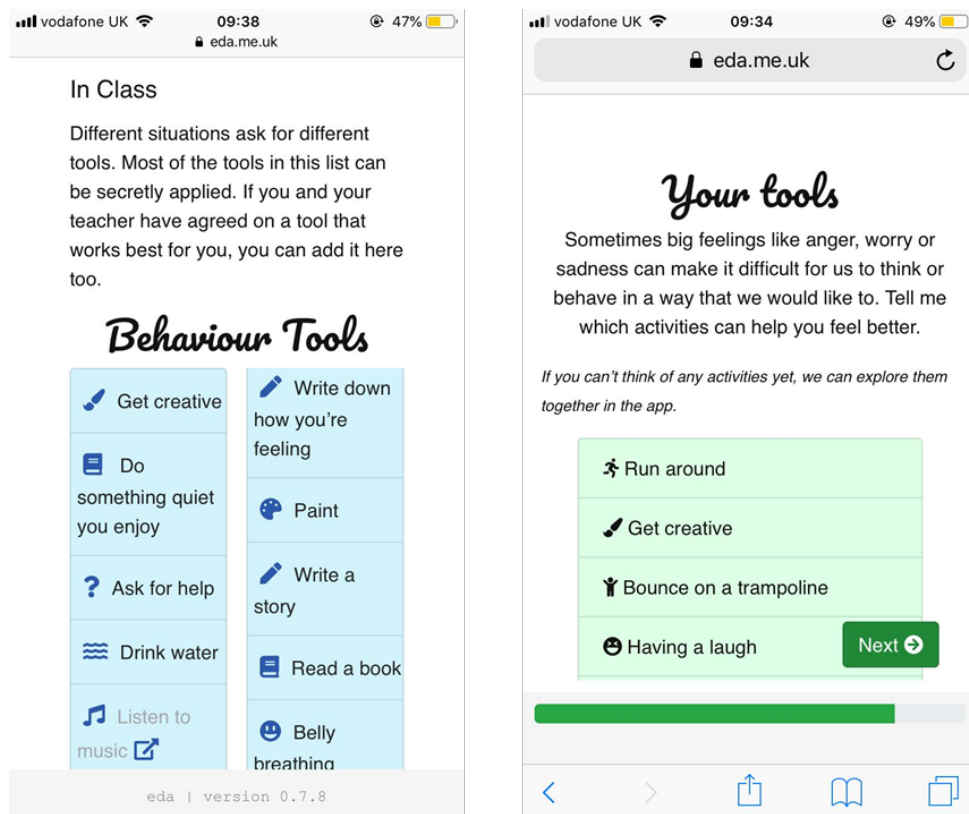
Figure 8.10 Tools list showing strategies to regulate feelings in class and personalised selection of strategies

Watch. Contains a set of psychoeducational animated films, with the main character of the app Eda. Its primary purpose is to improve the users understanding of emotions, emotion regulation strategies and how thoughts and behaviours influence an emotional experience. This is achieved by explaining commonly applied CBT principles in simple terms and by introducing some of the more complex emotion regulation strategies, such as cognitively restructuring one's thoughts (i.e., cognitive reappraisal) or mindfulness (Beck & Beck, 2011; McRae, 2016).

Each film's storyline and script was first drafted by myself and further discussed and refined in a meeting with six other mental health professionals associated with the

Anna Freud National Centre. For the initial script I drew on my prior clinical experience of working with children and the conversations with children during the workshops. This allowed me to integrate different CBT components into an age-appropriate storyline that children can identify with. Following this, I reviewed every film with the children in the workshops and incorporated their feedback into the final version.

Research has shown that CBT based interventions successfully improve a variety of psychopathological symptoms, even if delivered through technology-based platforms (Hollis et al., 2017). Furthermore, the results of the systematic review in Chapter 7 demonstrated that CBT-based interventions were also effective in improving emotion regulation difficulties in youth.

8.3.5 Help function

On the top of the screen the user can access a small "help" button. This function was included based on children's requests to have more in-the-moment- support when they experience high levels of negative emotions, which can prevent them from engaging in adaptive decision making.

Therefore, by clicking on the help button a series of emotion regulation methods is presented to the user (i.e., stop what you are doing, count to 3, and breathe), who is instructed to follow these until the initial emotional reaction decreases to allow for more adaptive actions. This functionality is also in line with research indicating that the duration of an emotional experiences is influenced by the type of emotion regulation strategy employed (Brans & Verduyn, 2014). It was expected that the help function would support children to distract themselves from the emotion eliciting stimuli. Distraction is an emotion regulation strategy that been shown to quickly decrease levels of negative emotions (Bushman, 2002; Kanske, Heissler, Schönfelder, Bongers, & Wessa, 2011). Similarly, the use of distraction strategies to regulate intense emotions is a substantial part of dialectic-behavioural therapy, which has been shown to effectively support individuals with severe emotion regulation problems (Burmeister et al., 2014; Linehan, Bohus, & Lynch, 2007).

8.4   Summary and further considerations

The present chapter outlines the specific intervention components of a new emotion regulation app and describes how the different features evolved over the three-stage development process with respect to the employed methods from the HCI, design, and psychology disciplines.

As outlined in Part I of the present thesis, emotion dysregulation and psychopathological symptoms are closely connected not only from a developmental perspective, but also conceptually. Furthermore, a growing body of evidence suggests that existing mental health interventions can be further improved by targeting transdiagnostic factors, like emotion regulation processes (Berking, 2007; Sakiris & Berle, 2019). This approach is also has been shown to be highly suitable in the prevention of youth psychopathology (Forbes et al., 2019; Taylor et al., 2017).

Therefore, the presented app intervention aims to support children's mental health by supporting the development of a wide range of emotion regulation abilities through various education and practice modules. The educational models introduce children to CBT concepts that are expected to facilitate effective emotion regulation. The practice modules consist of relaxation and mindfulness exercises, a toolbox with relevant cognitive or behavioural emotion regulation strategies, and games that are assumed to increase positive affect. Furthermore, a digital agent accompanies them through the content and provides a check-in function where children can learn more about their feelings and get support with existing feelings by entering them to the system.

To address existing critiques regarding the often one-sided approach in the development of digital health interventions, I put a specific focus on balancing the input of each of the disciplines' methodologies when developing the intervention (Hollis et al., 2017; Newell & Gregor, 2000). In line with that I present above how each feature was informed by existing psychology research as well as the involvement of the different stakeholders. With respect to that, Newell and colleagues pointed out that when striving for the right interdisciplinary balance, it can be difficult to respond to all requests and that disappointment by one party is sometimes inevitable (Newell & Gregor, 2000). This is also in line with the Patient-Clinician Framework, where goal moderation is stated as one of the key processes. Currently, there is no framework in place that provides further guidance on this moderation process, hence I tried to

estimate the impact of each possible feature by a) identifying existing research that could support its potential success, b) repetitively testing and evaluating it in the workshops and c) consulting mental health professionals, teachers or parents. A feature was more likely to be included, the more an expected positive impact was confirmed through these three pathways. While this approach helped to decide on the existing features in the app, it did not mitigate the need and associated benefits of conducting further iterative testing to refine the intervention further.

Further testing could hopefully reduce the impact of some of the limitations associated with the described development process. First of all, despite my best efforts to employ interdisciplinary strategies, and involving different stakeholders, as well as a graphic designer and web developer, there was no HCI expert involved to lead on the HCI methods. Consequently, important design decisions could not always be discussed in an interdisciplinary team, but were primarily made by myself. Although past research could demonstrate that some intervention designs have benefited more from decisions driven by one individual instead of a team, I agree with other scholars that working with an interdisciplinary team is highly valuable for the development of digital health interventions (Blandford et al., 2018; Newell & Gregor, 2000).

Furthermore, children in the workshops were primarily selected by teachers, which may have resulted in biased groups. Although teachers had been asked to select children with varying academic and social emotional abilities to take part in the workshops, past studies on classroom research have shown that children who do not participate in research are also reported to be less competent socially and academically (Noll, Zeller, Vannatta, Bukowski, & Davies, 1997). While this bias needs to be taken into account, it was noticeable in the present workshops that some children visibly and reportedly exhibited emotion regulation difficulties.

As outlined in Chapter 6 it is highly encouraged that complex digital interventions undergo an iterative evaluation and refinement process (Blandford et al., 2018; P. Craig et al., 2008). This allows to not only to test the system's stability and improve the intervention further, but also to increase our understanding of underlying processes and potential barriers and facilitators regarding its implementation. Therefore, this newly developed intervention is tested further as part of an exploratory feasibility trial, which explores a) how users interact with the app, b) whether the intervention is usable

and acceptable, c) potential barriers and facilitators to implementing the intervention, and d) how the existing intervention can be further improved.

Chapter 9: Eda a new emotion regulation app for children: Outcomes from an exploratory feasibility trial

9.1 Introduction

Prevalence rates of mental health problems in children and young people are increasing (Patalay & Gage, 2019). Furthermore, mental health problems in childhood have been shown to affect various other developmental domains, including academic achievements and social skills (McLeod, Uemura, & Rohrman, 2012). Hence, there has been growing support and recognition for the importance of early community-based interventions to prevent mental health difficulties from arising as well as the associated long-term ramifications of such difficulties (Allen, Balfour, Bell, & Marmot, 2014).

Considering the amount of time that young people spend at school, and the existence of available structures, schools have been identified as an ideal setting to provide mental health support to children and young people (Caan et al., 2015; Stephan et al., 2007). It has been suggested that implementing mental health support in a school environment helps overcome social and environmental barriers to accessing community-based mental health services, such as costs, family demographic factors, transport, and social stigma around mental health (Memon et al., 2016; Weist & Evans, 2005). Additionally, schools also offer an optimum location to support young people who experience mental health difficulties but do not meet clinical cut-off scores or are unable to access Child and Adolescent Mental Health Services (P. Barrett & Turner, 2001; Essau et al., 2012). Weare and Nind summarised the evidence based on 52 systematic-reviews and meta-analysis to determine the effectiveness of school interventions to improve young people's mental health and concluded that schools represent key facilitators to the development and implementation of such intervention (Weare & Nind, 2011).

When comparing the outcomes of the vast amount of available school interventions, research findings have indicated that social-emotional learning programmes (SEL) are among the most successful programmes, having a significant impact on students' social-emotional competences, academic performance, and mental health (Payton et al., 2008). As outlined earlier (see Introduction Part II) SEL programmes aim to target underlying mechanisms, risk and protective factors that are known to commonly influence children's developmental outcomes, including their mental health.

Accordingly, the development of emotion regulation competences represents a key component in SEL interventions (Greenberg et al., 2003).

As shown in the previous chapters, emotion regulation difficulties are closely associated with mental health difficulties from an early age. Findings from the developmental cascade study showed that emotion regulation difficulties significantly predicted later internalizing and externalizing symptoms during childhood, which further emphasises the role of emotion regulation difficulties in the development of youth psychopathology. Additionally, the results from the bi-factor study demonstrated the significant conceptual overlap between emotion dysregulation and psychopathology symptoms, thereby highlighting it as an ideal intervention target. With respect to this, I agree with Forbes and colleagues (2019) who highlighted the importance of targeting transdiagnostic factors, such as emotion dysregulation, in youth mental health prevention programmes, as these have the potential to activate other beneficial developmental cascades and can reduce some of the challenges that schools often face when implementing these programmes.

Environment specific challenges, such as the increasing pressure on teachers to meet academic targets, are pertinent when implementing new interventions in schools. Thus, interventions that are difficult to implement or ask for a substantial amount of time or preparation are most likely discarded by schools (Bishop, Bryant, Giles, Hansen, & Dusenbury, 2006). Following this, it has been suggested that digital interventions could provide an effective solution, as they have the potential to minimise costs, time, and personal resources in comparison to face-to-face interventions (Bishop et al., 2006).

Technology-based interventions in mental health services have received increasing attention in the past years (Hollis et al., 2015), with growing evidence supporting the effectiveness of online platforms in clinical and school settings (Fridrici & Lohaus, 2009; Pennant et al., 2015). However, due to the fast and consistent progress of technology, mobile apps have been increasingly adopted by young people, thereby making them a promising new tool to deliver mental health interventions. In order to build on these developments, I developed a new mobile app intervention to support children with their emotion regulation abilities in the classroom (a detailed description of the development process and the specific intervention components can be found in Chapter 8).

Until today, only a few app interventions have been developed and evaluated specifically for young people, and even less so for the school setting with a few exceptions (Edbrooke-Childs et al., 2017; Grist et al., 2017; Hollis et al., 2017). Only recently, the self-management intervention ReZone for young has been developed with the aim to reduce internalizing and externalizing symptoms in young people. Early findings showed that the app, which was primarily developed and tested in alternative provision and primary schools, was perceived as useful and easy to use by students (Edbrooke-Childs et al., 2017). While findings from a proposed randomized control trial have not been published, the authors have shared valuable insights regarding the intervention's implementation in the school setting (Edridge, Deighton, Wolpert, & Edbrooke-Childs, 2019). Similar to other school-based interventions their findings highlighted that teachers played a key role in implementing and delivering the intervention. More specifically, they found that teachers were more likely to use the intervention, if technology-enabled interventions were already part of the school culture. Otherwise, teachers reported that additional resources, time, reminders, and local support was needed to facilitate successful implementation. The results are also in line with past research that has highlighted the role of teachers to implement digital technologies in the classroom (Haydn & Barton, 2008; Hermans, Tondeur, van Braak, & Valcke, 2008; Olofsson, Lindberg, Fransson, & Eiliv Hauge, 2017). Based on this, the authors of ReZone recommended to refine and adjust digital intervention characteristics so that they meet the requirements of the user group, but also the context in which they are implemented (Edridge et al., 2019).

In fact, existing evaluation guidelines for digital health interventions consistently emphasize that any early evaluation process should focus on optimizing the newly developed intervention to ensure its uptake by the intended population and in the intended context prior to feasibility or efficacy testing (E. Murray et al., 2016; World Health Organization, 2016). Furthermore, considering that effectiveness studies are highly resource demanding, it has been shown to be beneficial and hence recommended that researchers follow a staged and highly iterative evaluation strategy prior to testing a digital intervention's effectiveness (Bardram et al., 2013). Especially for digital interventions, which add another layer of complexity in terms of the underlying technology, evaluation studies allow researchers to identify and solve issues around the systems stability, usability, and acceptability, which could otherwise

significantly impact the intervention's implementation and hence effectiveness (Coyle, McGlade, Doherty, & O'Reilly, 2011; Matthews & Doherty, 2011).

9.1.1 Study objective

Based on the evidence reviewed above, the present study aims to evaluate the newly developed app intervention, as described in the previous chapters, within the school setting. The evaluation is conducted as part of a 3-month exploratory feasibility trial with four primary schools in the UK, based on which I aim to answer the following research questions:

a) How acceptable and usable is the app intervention from the children's perspective?

b) How do children interact and engage with the intervention?

c) What are the perceived barriers and facilitators to implement and deliver the intervention?

d) How can the existing app intervention be further improved?

9.2 Methods

9.2.1 Recruitment and participants

The recruited schools had indicated an interest in participating at the Anna Freud National Centre for Children and Families' research programme in response to a network-wide email that was sent out as part of the regular newsletter. Initially, 19 schools had actively indicated their interest, of which 11 took part at the initial screening phone call. Schools were eligible to take part if they were primary schools in the UK and were able to provide access to tablets with the intervention via an internet connection for the duration of the trial. During initial phone contact, the research project and intervention were discussed as well as the schools' involvement if they agreed to participate. Following the initial screening four schools were excluded for the following reasons: one school was a secondary school, one was a youth learning centre, one was a pupil referral unit, and one school had a no phone/tablet policy.

The remaining seven schools confirmed their participation for the project, three of them stepped down before the start of the trial, and provided the following reasons a) they felt that the research aspect of the intervention would take up too much time, b) a large percentage of parents whose first language was not English struggled to understand the consent or information sheets, and c) they experienced a lack of parental engagement.

Ultimately, four primary schools across the UK took part at the trial. Data of 144 children (female = 55%, male = 43%, N/A = 2%) was collected at baseline and of 132 children post intervention. Of the total sample 56.3% indicated that they were "white", 6.9% were "black", 18.8% were "Asian", 15.3% were "mixed", and 2.8% chose "other" as their ethnicity. Eight teachers, all female, took part in the post intervention interviews. Two teachers from one school were not available due to illness on the day of the interviews.

9.2.2 Intervention

A detailed description of the intervention development process and the resulting app intervention is presented in Chapter 9. For the feasibility trial, teachers and children were instructed to freely explore different ways to use the intervention. This flexible approach was adopted so that teachers could use the intervention in their preferred way and perceive it as less of a burden. Furthermore, it was expected that this would

ultimately increase our understanding for how the app could be used and implemented in the school setting for future trials.

9.2.3 Measures

9.2.3.1 Quantitative assessment

Demographics, mental health and acceptability were assessed through paper questionnaires that were distributed to the children before and after the intervention phase.

Demographics. Age, gender, ethnicity, and primary language spoken were self-reported by children at baseline. Ethnicity categories included were: "white/white British", "black/black British", "Asian/Asian British", "Mixed", and "Other".

Mental health and wellbeing. The Short Mood and Feelings Questionnaire (SMFQ) consists of 13 items that assess depressive symptoms in children and adolescents (Angold et al., 2002). The SMFQ has been shown to have good construct and internal validity across clinical (reported Cronbach's α = .85) and community samples (Sharp et al., 2006). Furthermore, 5 items (" I get very angry", "I lose my temper", "I hit out when I am angry", I do things to hurt people", and "I break things on purpose") of the Me & My School Questionnaire (M&MS) were added to assess externalizing symptoms (Deighton et al., 2013). The M&MS was developed as a self-reported mental health measure for the school setting and has been shown to have good psychometric properties across clinical and community samples (reported Cronbach's α = .78 -.82; Deighton et al., 2013; Patalay, Deighton, Fonagy, Vostanis, & Wolpert, 2014). Items on both scales were rated on a 3-point Likert-scale, ranging from "Not true" (1), "Sometimes" (2), and "True" (3).

The Satisfaction with life scale for children (SWLS-C; Gadermann & Bruno, 2010) was employed to complement the scales focusing on psychopathological aspects. It assesses the individual's personal perception of their wellbeing and satisfaction in life. The SWLS-C consists of 5 items which are rated on a 7-point Likert scale, ranging from strongly disagree (1) to strongly agree (7), and has been reported to have good psychometric properties (reported Cronbach's α = .84; Gadermann & Bruno, 2010).

Emotion regulation. The How I feel - Questionnaire (HIFQ) is a multidimensional self-report scale that was used to assess emotional arousal and regulation abilities in children between the age of 8 and 12 years of age. It consists of 30 items which are rated on a 5-point Likert-scale ranging from "very true of me" (5) to "not at all true of me (1). The items assess frequency, intensity, and regulation of five different emotions: sadness, fear, anger, happiness, and excitement. This leads to three subscales: 1) a positive emotion subscale (PE), where higher scores indicate that happiness and excitement are experienced with high frequency and intensity, 2) a negative emotion subscale (NE), with high scores indicating that fear, anger and sadness are experiences with high frequency and intensity, and 3) an emotion regulation subscale (ER), where high scores reflect a strong ability to regulate the frequency and intensity of either positive or negative emotions.

The HIFQ has been reported to be a reliable and valid measure (reported Cronbach's α = .84 -.90) for research and school interventions targeting pupils' emotion regulation and mental health (Ciucci, Baroncelli, Grazzani, Ornaghi, & Caprin, 2016; Walden, Harris, & Catron, 2003).

Engagement. Engagement data was collected through Google Analytics and through the paper questionnaires where children were asked how often they have been using the app in the past three months.

9.2.3.2 Qualitative assessment

To increase the understanding around the usability and acceptability of the app intervention, I also conducted brief semi-structured interviews with teachers and children after the 3-month intervention phase. The detailed interview schedule can be found in appendix C. Broadly the interview aimed to assess: a) what children and teachers generally thought about the app, b) what aspects they found helpful or unhelpful, and c) how they used the app and in which contexts.

9.2.4 Study design and procedure

Schools who agreed to participate signed a memorandum of understanding, which explained the nature of the project and included important stages and the responsibilities of the research team and the school for the duration of the project. By signing the document schools agreed to support the research project and collaborate with the research team. Consent forms and information sheets for each child were sent

to the school, which were then distributed to the children by the class teacher. Only children between the ages of 10 and 12 and whose parents had signed the consent forms were allowed to take part.

Prior to the interventions the research team installed the app on the school tablets and when necessary sought approval to access the link to the app from school devices.

On the first day of the intervention phase a researcher visited the schools to collect consent forms. In cases where it was not clear whether parents had provided full consent (e.g., some boxes were not ticked, they had signed with the child's name), audio consent was taken and recorded over the phone. Following this, the research team distributed the questionnaires in each classroom and introduced the app to each class. One of the researchers explained the different functions of the app, answered questions and provided the link to the app (e.g., poster with link was put up in classroom).

After the first six weeks the research team scheduled a phone call with the main contact person at each school to discuss the use of the app and any technology related difficulties. Following the 3- month intervention phase, the same set of questionnaires was distributed in each class to collect post-intervention data. The post-intervention survey including eight additional questions in order to also assess users' perceptions of the app's usability and acceptability. Furthermore, one of the researchers visited each classroom again on the last day of the intervention to observe the use of the app in the classroom. Following this, semi-structured interviews with 19 children and 6 teachers were conducted. Children and teachers were encouraged to provide feedback on the use of the app (e.g., actual, preferred, recommended), indicate whether it was helpful or not, what aspects they liked and disliked, provide suggestions for improvements and potential barriers, and facilitators to using it. All interviews with children were audio-recorded with encrypted dictaphones and later transcribed. Due to logistical issues teacher interviews were not audio-recorded, but answers were written-down by a researcher during the interview.

Each student received a unique identifier for the duration of the project, which allowed the research team to link the pre-and post-intervention data from the paper surveys, which was entered to Excel before being transferred to a statistical software.

The University College London Research Ethics committee provided ethics approval (number: 7969/001), and the study adhered to the relevant ethical guidelines (e.g., the British Psychology Society).

9.2.5 Analytic strategy

9.2.5.1 Quantitative data

Quantitative data from the paper questionnaires was used to calculate descriptive statistics for the baseline and post-intervention assessment in SPSS.

Google Analytics data is presented below to show overall usage and engagement. Google analytics does not provide data on individual subjects only the general usage of the website it has been linked to.

9.2.5.2 Qualitative data

The interviews were transcribed and analysed using thematic analysis (Braun & Clarke, 2006).

Thematic analysis is a flexible method that can be used to analyse qualitative data by identifying patterns in the data. Furthermore, this method can be applied either within a set theoretical framework that guides the identification of patterns or without. In terms of the present study no existing framework was used, but patterns were identified with the specific research questions regarding usability, acceptance, user-intervention interaction, and implementation in mind.

Braun and Clarke (2006) have outlined six steps as a structured, but flexible way to conduct thematic analysis. Although all six steps need to be completed when analysing the data, the six-step process is not linear and the researcher is allowed to move flexibly between the stages. In the first step, the researcher familiarises themselves with the data through reading and re-reading the data and becoming aware of the overall content. In this step ideas for potential codes may form. In the second step the researcher actively goes through the data, line by line, to generate initial codes based on the content. These initial codes built the foundation for the development of themes. Following this, in step three, the researcher searches for potential patterns that may emerge from the codes, which are then used to develop initial themes. In step four, all themes are reviewed and refined until they represent meaningful themes that are

supported by the available data. While themes can be closely related, they should also be distinct from each other (Braun & Clarke, 2006). In step five, the identified themes are named and defined, in doing so the researcher aims to describe the essence of the theme in a few words. The last step involve the write up of the final report where the identified themes are discussed in relation to the research question.

When analysing qualitative data, the researcher needs to be aware that their own beliefs, experiences, and expectations could influence the development of the themes as well as their interpretation.

9.3 Results

9.3.1 Quantitative outcomes

Mean scores and standard deviations for the pre and post-intervention assessments with the children are presented in Table 9.1. Between 90% - 91% of the children completed the measures at baseline and follow up, thus resulting in an attrition rate of 9 -10%.

Table 9.1 Descriptive statistics for mental health and emotion regulation questionnaires

Outcome	N	Mean (SD)
SMFQ baseline	144	18.5 (4.6)
SMFQ post	132	17.8 (4.8)
SWLS-C baseline	140	4.13 (.79)
SWLS-C post	126	4.13 (.83)
HIFQ- PE baseline	144	3.8 (.84)
HIFQ- PE post	132	3.7 (.87)
HIFQ- NE baseline	144	2.1 (.79)
HIFQ- NE post	132	1.8 (.72)
HIFQ- ER baseline	144	3.3 (.83)
HIFQ- ER post	132	3.3 (.87)

9.3.1.1 Engagement

Questionnaires. In terms of the app engagement, 53% (n =76) of the children indicated that they had used the app at least once, while 37% indicated that they had never used the app in the past three months. At post assessment 8% of the children reported that they had used the app on a weekly basis. Of the 76 children who indicated that they had used the app, 68% (n = 51) said that they found it helpful and 58% (n = 44) said that they would recommend the app to a friend.

Google analytics. Data collected via Google Analytics for the duration of the trial indicated that 426 users had accessed the website, of which 30% were returning users, and 70% new visitors. Furthermore, the average time spent on the app per session was 6 min and 22 seconds and the "play" module was most frequently visited, followed by "relax", and "watch".
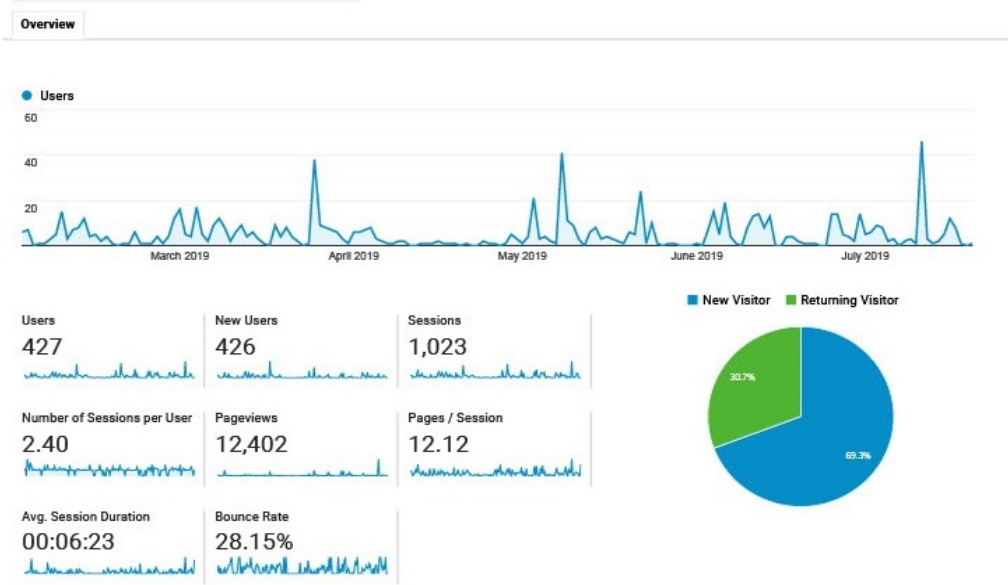
Figure 9.1 Engagement data as derived from Google Analytics

9.3.2 Qualitative outcomes

9.3.2.1 Children's reported usability and acceptability

Nineteen children, selected by their teachers, agreed to share their experiences using the app. Overall, 18 of these children reported positive experiences with the app and also provided insights regarding specific strengths and weaknesses.

Feeling calm and relaxed. Nearly all children (18/19) reported that using the app made them feel calm and relaxed. They spoke about using the app especially during stressful times (e.g., *test at school, argument with friend or sibling, having a bad day at school*). Some of them also reported using the app to fall asleep at night. The children seemed to enjoy two features in particular, the "water ripples" game (9 times) and the music function (6 times).

> *"I think the app's helpful, um, if you're stressed or if you like, it's*
> *a good way to relax and you can use it to calm down"*

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Helpful. Seventeen of the 19 children reported that they found some of the features (i.e., check-in function, videos, tools-list) particularly helpful and useful:

> "…the thing I also found was quite helpful was where you could
> sort of tell how you were feeling, and it sorta gave what you should
> do."

They explained that it increased their understanding or knowledge of their feelings and provided suggestions regarding possible solutions or actions to take:

> *"…like it makes you understand it, your feelings are something in*
> *you and it's ok to have them".*

Design and technical issues. With respect to some of the apps limitations, children most frequently reported back on technical or design issues. Most commonly mentioned were problems (e.g., *"didn't work", "too slow", "took too long to load"*) related to the "Reveal" game and the video clips, which appeared to happen more frequently on some devices than others (assumed to be related to certain versions of web-browsers). Furthermore, children mentioned that they would have preferred to have more options to choose from for the colour scheme and design of the homescreen and other personalization features.

Feelings of anger. Two children reported that they found the app less helpful when they were very emotional or experiencing strong feelings of anger.

> *"I liked the app. Although it didn't help me with my anger, no one*
> *could help me with this yet."*

In relation to that, one child explained that when they were angry they preferred to "*do something to kind of get it out*".

9.3.2.2 Children's interaction with the intervention

Children reported different preferences for where, when, and how to use the app.

Location. Most of them used the app at school, where it was introduced to them and already installed on the classroom tablets. Some children reported using the app primarily during times when teachers allowed them to choose an activity for a set amount of time. Other children said that they had agreed with their teacher to use it for situations in which they struggled to concentrate and participate in class. Half of the

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children said that they had also used it at home, where they accessed the app either on their parents tablet and computer or on their own smartphone.

Emotional prompts. Generally, children suggested that the app is most suitable during stressful times or for children who seem to struggle with their feelings. Some reported accessing the app in specific situations, for instance when they had a fight with someone and couldn't concentrate or when they felt bored.

> *"The best way to use the app is if you're stressed out, or um, if you need something to take your mind off something."*

Children reported less frequent use of the app, during times when they felt less stressed and were generally happy.

> *"It's not for someone who is happy, but some people get a bit angry sometimes, I'd recommend it to them."*

Design prompts. While most children reported that they found the app easy to use ("*I just knew how to use it"*), it also became apparent that that some features, like the help-function, had not been accessed as it had not been discovered by the children. Furthermore, some children reported that they had forgotten about the app when they had not used it for a while.

Access barriers. Due to the decision to develop the intervention as a web-based app, children were not able to find or download the app through the app store, which they reported was their primary way to access apps. Hence, one major limitation was the difficulty for children to find the app, one child explained that

> *"I couldn't remember what it was called, so I couldn't find it."*

Furthermore, relating to the decision to deliver the intervention in schools children reported difficulties with accessing tablets as they were either not permanently available or locked-up in a drawer, so that they had to ask for it. The latter was mentioned by some children as a barrier to accessing the app, as they were too shy to request it and "*didn't want to ask the teacher for it*".

9.3.2.3 Teacher reported facilitators and barriers to implementation and delivery

Access barriers. Similar to the children's reports, teachers mentioned that the app was hard to find if the link to the website was not available or in reach. This was perceived

as a barrier, as teachers reported that that would inhibited them from using the app in class.

Technical issues. Teachers reported experiencing technical issues of videos crashing or content taking too long to load, which was perceived as a significant barrier to using the intervention.

Flexible use. Every teacher reported a slightly different way of using the app in their classroom, with some preferring a whole-class approach and others directing individual children to the app. The possibility to use the intervention in different ways was perceived as a facilitator as it made it easier for them to find opportunities to use the app in the classroom.

Compatibility with teaching style. When speaking to teachers it became apparent that they were more likely to use the app if it was compatible with their teaching and did not require additional work from their side. Hence, some teachers pointed out that they liked that they could direct children individually to the app, when needed, and that it "*doesn't take away too much time from the teaching*" or interrupts the classroom atmosphere.

Moreover, in classrooms where mindfulness and relaxation exercises were already used in other ways, teachers reported that they primarily used the relaxation module in the classroom by projecting the breathing or mindfulness exercises on the smartboard or playing the music, which seemed to "*help(ed) to calm them* [the children] *down during work times*".

In relation to that teachers also provided suggestions for the app that could support their existing teaching method and ways to interact with the kids (e.g., a *timer*, "*noise meter*" with a traffic light system to signal children when they are too noisy, etc.) and that this would therefore facilitate the implementation of the app.

For teachers who did not see suitable opportunities to integrate the app in their teaching, it was reported that it took them some time to "*remember the app*" and that there was a tendency to rely on "*old habits*" or methods in difficult situations ("*in the heat of the moment*"). However, these teachers also reported that they felt confident that using the app could become a "*habit*".

9.3.2.4 Recommendations for further improvements

Content and functionality. Children and teachers both reported that they would like more content in any future version of the app. When asking the children, two reported that they "*got a bit bored*" by having to play the same game, and mentioned that there were "*only four videos*" to watch, which resulted in decreased interaction with the app over time.

In line with that teachers also indicated that it was more likely that they would continue using the app, if there were more frequent updates with new content (e.g., more mindfulness or breathing exercises).

Furthermore, children reported that they would like to add more features, such as making the embodied agent more responsive, so that more interactions are possible. One child compared it to "*a robot that you can talk to*".

Individual needs. Teachers highlighted specific needs of children who were more likely to experience emotion regulation difficulties and that these needs could be further addressed to improve the intervention.

Some of them mentioned that "*activating*" features, would be helpful "*for children with too much energy*" or "*when they are angry*" or after "*a long time of sitting*". In relation to that, one teacher explained that she uses online dance videos with the children as an activating exercise.

Additionally, teachers saw a need for interventions that could specifically support children with learning disabilities or autism-spectrum-disorder symptoms, as they seem to be more likely to experience specific emotion regulation difficulties that are associated with the existing neuro-developmental disorder.

9.4   Discussion

The present study evaluated a newly developed app intervention that targets emotion regulation difficulties in children. By assessing users' interaction with the app, and its perceived acceptability and usability, the results inform the further development of the app. To the best of my knowledge, this is the first mental health app for children with a specific focus on emotion regulation abilities that has been developed and evaluated for the school context.

9.4.1   Acceptability and usability of the app

Through questionnaires and post-intervention interviews, the present study collected data on the perceived usability and acceptability of the app. The interviews with the children indicated that they generally perceived the app as acceptable, usable, and helpful. Furthermore, the interviews provided preliminary evidence that the app helped children to calm down and relax in stressful situations, and that it increased their understanding and knowledge of emotions and how to regulate them.

Some children reported that they found the app less helpful when they experienced great levels of anger. These findings suggest that children require a different type of support for different emotional experiences. A similar idea has been supported in past research with infants, where it was shown that certain strategies (i.e., distraction) were more effective for regulating anger than fear (Buss & Goldsmith, 1998).

In terms of the intervention's usability, most parts of the intervention functioned sufficiently well. However, it was also reported that certain technical issues were experienced with one of the games and when watching some of the videos. These issues need to be addressed to enhance the app's usability prior to any future evaluation.

9.4.2   Interaction and engagement

Children reported that they used the app primarily at school, while some also accessed it at home. Children's interaction with the app at school could differ from the way they used it at home, as this was influenced by the way the teacher decided to integrate the app in the classroom. Based on this it seemed that most children accessed the app as part of the teaching activities while some used it specifically when they experienced

difficulties. Most children indicated that the experience of stressful situations was one of the main motivators to access the app at home.

The collected data on engagement suggested that 30% to 37% of the users repeatedly accessed the app over the 3-month period. While this number would ideally be higher, it is similar to adherence rates reported for other mental health apps (Torous, Nicholas, Larsen, Firth, & Christensen, 2018). Although the data derived from Google Analytics suggested an acceptable level of engagement, unfortunately it does not provide a reliable picture of the level of engagement of the participants in the trial. For example, some of the data indicated that users had been accessing the app from countries outside of the UK, and it was not possible to identify which users accessed the app as part of the trial or through other sources.

In an attempt to mitigate low levels of engagement, one of the most common limitations in digital health interventions, a significant focus was put on involving children throughout all development phases (see Chapter 6 and 8 for more detail) and integrating interactive features, such as games, in the app. Interviews with the children indicated that the 'Water Ripples' game was perceived as one of the most positive and helpful features in the app, which supports the interdisciplinary approach that was adopted when developing the interventions.

With respect to children's (and teachers') requests to have more content or frequent updates to maintain the level of novelty, one could explore the possibility of timed updates, whereby sections of the current content are released one after another. I recognize that this would only be one piece of the puzzle and that future versions could benefit from more content.

Generally, issues around user engagement are a recurring topic in the field, having posed the question of how much engagement is actually needed. Terms like "effective engagement" have been introduced as an attempt to clarify that one might not be looking for "as much as possible", but enough for an intervention to have an effect (Yardley et al., 2016). The data from the present study do not provide sufficient evidence to determine how much engagement is needed to achieve adequate levels of effectiveness. More research is needed to establish enough evidence for this.

Nevertheless, based on the children's reports, it can be assumed that some of the included features positively influenced users' engagement, such as the digital agent,

which could be further developed to facilitate more interactions with the user (e.g., chat bot, getting clothes or other objects as rewards or incentives to change the look of it).

9.4.3 Delivery and Implementation

As mentioned earlier teachers play a significant role in terms of an intervention's implementation and delivery. Therefore, the present study tried to gain valuable insights regarding potential barriers and facilitators to implementing the app in the school setting.

Generally, teachers reported positive experiences with the app and indicated an interest to use it further in the future. However, they also mentioned difficulties to access the intervention and technological issues as one of the main barriers to implementing the intervention successfully.

Furthermore, in the interviews with the teachers it became apparent that teachers were more likely to use the app if it was compatible with their existing teaching methods. Teachers that saw fewer natural opportunities to integrate it in existing processes reported needing more time and reminders to use the app. Both findings are in line with previous research findings (Edridge et al., 2019) and highlight the importance of taking into account design goals and intervention features that are relevant from a teacher's perspective and could therefore serve the implementation process.

Another barrier relating to the school environment, as mentioned by children, was the small number of tablets available per class, which limited the accessibility of the intervention. Additionally, due to tablets being highly costly assets, some schools only provided access to them upon request, thereby limiting the general access to the intervention further. Similarly, the possibility to access the app through other devices, such as computers or smartboards, enhanced the general uptake of the intervention in the school context.

9.4.4 Feasibility of conducting school-based app evaluation

While the primary purpose of the present study was to explore the usability and acceptability of the Eda app in the school setting, there are also some important conclusions to be drawn regarding the feasibility of testing the effectiveness of the app as part of a randomised control trial. In terms of recruitment three of seven schools had stepped down after the initial phone screening, meaning that I was only able to retain

57% of the originally recruited schools. In light of the three reasons that schools had mentioned for their drop out, a future trial should consider translating some of the information and consent forms. Furthermore, it could potentially help to provide schools with more specific guidance on the possible ways of using the app and exploring with the respective teachers beforehand how this could be integrated in the curriculum and teaching methodology. With respect to usage rates and engagement, many children and teachers had reported that they were unable to find the app, as they had lost the link or weren't able to search for it fast enough. After speaking to the children, I would suggest to making the app available on common app stores, as this was reportedly the first place where children tried to find the app. Nevertheless, for children who were able to find the app, engagement levels were comparable with other studies. The use and integration of the app in the classroom could be further enhanced by more frequent check-in from the research team with schools and teachers. In the present study, I only contacted schools once they were half-way through the intervention phase. Moreover, on average, children and teacher reported that the app was acceptable and usable, despite some technological issues which need to be solved prior to further testing. In terms of the employed measures a high number of questionnaires was completed at baseline and follow-up (90% - 91%), thereby pointing towards acceptable completion rates.

In sum, the findings suggest that it is feasible to evaluate the Eda app in the school setting, however prior to any effectiveness trial, another feasibility trial should be conducted to ensure a) an enhanced recruitment strategy, b) improved integration of the app intervention in the curriculum and teaching methods, and c) easier access to the app, potentially by making it available on the app store. Furthermore, I would suggest that a set of feasibility criteria is defined prior to conducting the study, so that more definite conclusions can be drawn whether an effectiveness trial is the next appropriate step (e.g., Edbrooke-Childs et al., 2019).

9.4.5 Considerations for future app features and research

Besides the suggestions mentioned above, I would like to share further considerations or "lessons learned" from my personal experiences and observations during the trial, which will hopefully help improve the present or similar school-based app interventions.

9.4.5.1 The school setting

With respect to one of the primary design goals, the prioritisation of engagement, I had opted for a multi-media app that included various audio and video materials. This however, partly presented itself as unsuitable for the school environment, as sounds can be disturbing or require additional access to headphones. This observation emphasises that new types of interventions are accompanied by new challenges, which need to further explored and taken into account in future versions of the app.

9.4.5.2 Specific emotion regulation app features

Based on previous research a range of mindfulness and relaxation exercises were included in the app (Wetter, 2015), which children experienced as positive. While mindfulness and relaxation apps have gained increased popularity in recent years, the present study shows that in the context of regulating certain negative emotions, "activating" instead of calming features, could be equally important. These features potentially tap into a different set of emotion regulation strategies (e.g., behaviour activation, physical activity), which should not be neglected (Livingstone & Srivastava, 2012; Pascual-Leone, Gillespie, Orr, & Harrington, 2016). The finding that some children asked for something else rather than a relaxation exercise when they were angry is in line with findings from emotion regulation research indicating that effective emotion regulation is not merely about the frequency by which we apply certain strategies (Aldao et al., 2015; Dixon-Gordon, Aldao, & De Los Reyes, 2015b), but whether we have access to a diverse set of emotion regulation strategies that can be flexibly applied dependent on a situation's demands (Aldao & Nolen-Hoeksema, 2012a; Lougheed & Hollenstein, 2012).

This again highlights the complexity of the emotion regulation construct which has sometimes been applied in an overly simplistic manner (Aldao, 2013; Yoon, Li, Hao, & Kim, 2018). In order to account for this complexity, I had decided to develop psychoeducational films, which introduce children to the emotion regulation concept. Interviews with the children indicated that the films could have the potential to increase children's understanding and knowledge around emotion regulation.

Similarly, as described in Chapter 3, emotion regulation abilities show the greatest changes throughout the early years of life and do not follow a linear pattern (Kopp, 1989; Zimmermann & Iwanski, 2014). Hence, it is of great importance to take age

dependent developmental differences into account when teaching these concepts to children as part of the intervention. In other words, emotion regulation apps for older and younger children would require considerable adjustments to the content of these films.

Another important feature to enhance emotion regulation is the check-in function, which was designed as a means to support children with accessing adaptive emotion regulation strategies and increase their awareness for the diverse range of emotions one can experience. Research has shown that both of these concepts have been related to positive mental health outcomes (Ciarrochi, Heaven, & Supavadeeprasit, 2008; Gonçalves et al., 2019; Quoidbach et al., 2014). In addition to that, children in the present study reported that they found this feature helpful and tended to use it either as a guide when they felt a particular feeling or to explore and learn about different feelings and strategies. I believe that this feature could serve as an ideal assessment tool in the future to collect data about the user's day-to-day feelings.

With the included help function, it turned out that many children had never used or seen it. After consulting the children about it, most of them agreed that it was generally a good idea, to provide additional support for emotionally intense situations. However, they also explained that having it in the app may not have addressed this need, as they did not have permanent or immediate access to a device. I think future research could explore this idea further through the use of wearable devices, which are more accessible compared to tablets or mobile phones. Additionally, wearable devices provide an ideal opportunity to integrate more advanced health-technology concepts, such as Just-in Time Adaptive Interventions (Nahum-Shani et al., 2018).

9.4.6 Strengths and Limitations

A significant strength of the present study concerns the development process of the app intervention. By involving children and young people at every stage of the design and development process and adopting a truly interdisciplinary approach, I was able to partly address previously identified limitations around user-engagement and the inclusion of evidence-based content in digital mental health interventions (Hollis et al., 2017; Torous et al., 2018).

Another strength relates to the collaborative approach with schools throughout this project, which had various benefits. It ensured regular access to the user group, which

helped me gain significant insights regarding children's day-to-day emotion regulation challenges as well as integrate more context compatible features. Additionally, teachers contributed tremendously with their views and expertise from working with the user group.

At the same time, the lack of taking teachers' roles as intervention deliverers into account while developing the app is a significant limitation, which is assumed to have had a considerable impact on the limited intervention uptake.

Another limitation concerns the employed evaluation measures. It turned out that the use of Google Analytics to assess engagement for the present sample provided only limited insights, as the platform collects data for any user that ever accessed the app, and did not allow to filter the data for certain groups or individuals. Regarding the implementation interviews, teachers had very limited time available and were therefore either not able to take part in the interview or were rushing through it. I suggest that regular classroom observations by a researcher may have provided better insights into how the app was actually used in class. However, this method may cause more interruptions to the teaching process and may therefore not be favoured by teachers.

9.4.7 Conclusion

A new app intervention to improve emotion regulation abilities in children was evaluated. The results of the present study suggest that the intervention presents a promising opportunity to enhance young users' emotion regulation abilities by taking into account the complex nature of the construct itself. The app aims to assist children with their emotion regulation by offering guidance in identification of feelings and selection of adaptive emotion regulation strategies. Furthermore, by including age-appropriate teaching and practice modules, the app is expected to enhance children's emotion regulation knowledge and skills.

The app was perceived as acceptable and usable, although some technological issues need to be addressed prior to its further use. The data provided valuable insights regarding important facilitators and barriers to implement the app in the school setting. Based on which, I shared important lessons learned and suggested possible solutions, which hopefully benefit the development and evaluation of other digital mental health interventions.

More research is needed to further refine the intervention for the intended context of use and eventually determine its effectiveness as part of a controlled study. With respect to the intervention development framework that was outlined earlier, I recommend to repeat the co-design and testing workshops for any new feature that should be added to the app. After that another feasibility trial should be conducted with the implemented changes to the app. The evaluation and adaptation processes should be repeated until the app intervention is stable and functions without major technological issues when applied in the school context. Following this, a more robust evaluation can be performed to explore levels of effectiveness and relevant intervention moderators. This however, should only be conducted if acceptable levels of engagement can be expected.

I hope that my work motivates the development of further technology-based interventions that target transdiagnostic mechanisms like emotion regulation in youth, as these are of particular importance considering the high rates of comorbidity and less specific symptom profiles. It is hoped that an intervention like this could support children experiencing emotion regulation difficulties and who may or may not exhibit disorder-specific symptoms.

Chapter 10: General Discussion

The present thesis consists of two parts, of which the first part investigated the role of emotion regulation in the development of psychopathology during childhood. More specifically, Part I aimed to increase our understanding of the complex relationship between emotion dysregulation and psychopathology symptoms from a developmental framework perspective, by utilizing data from the Millennium Cohort Study (MCS). In doing so, I first validated the psychometric properties of the CSBQ, which was employed as an emotion dysregulation and self-regulation measure in Study 2 and 3. In Study 2 a developmental cascade analysis was conducted to investigate the temporal precedence of emotion dysregulation and psychopathology symptoms in early childhood, which demonstrated a close relationship between emotion dysregulation at all times. In order to improve our present understanding of this relationship, I continued to investigate the conceptual overlap between the two constructs through a more data-driven approach.

Building on Part I the second part of the thesis investigated the potential of targeting emotion regulation difficulties in psychological interventions to treat and prevent youth psychopathology. This was explored through the development of a new, digital intervention. In order to develop this new intervention, a systematic review and meta-analysis was performed to investigate the effectiveness of current interventions to enhance emotion regulation in youth. The results indicated that current interventions can effectively improve emotion regulation processes in children and young people, and that these changes correlate with decreases in psychopathology. The interventions that were identified through the meta-analysis informed the initial content development for the new interventions. Following this, a series of patient-involvement events and user-centred design workshops was conducted, which shaped the further development of the intervention's content and design. After the initial prototypes were tested to ensure an adequate level of functioning and usability, the app was further evaluated as part of an exploratory feasibility trial.

In this general discussion chapter, I first summarise the key findings for each study, which are then evaluated in terms of their strengths and limitations. After that, I reflect on the wider implications of the presented findings and how they could influence future research and practice.

10.1 Summary of findings

The first study assessed the psychometric properties of the CSBQ, which is used in the MCS to assess emotion dysregulation and self-regulation in children. Before the CSBQ was employed in the two main studies of Part I, an exploratory and confirmatory factor analysis were performed. The findings were in line with previous suggestions of a two-factor structure with an emotion dysregulation and a self-regulation subscale. While the CSBQ showed acceptable internal consistency for all time points, the results also suggested that it improved as an instrument over time and might be more suitable to assess emotion dysregulation and self-regulation in older children. This could be due to it focusing more on visible, behavioural aspects of emotion dysregulation and self-regulation. However, as expected, the emotion dysregulation scale correlated positively with internalizing and externalizing symptoms, while the self-regulation subscale was negatively correlated, thereby supporting its usability for the present research. By validating the CSBQ, this research also partly addressed one of the key limitations in current emotion regulation research, the absence of appropriate measures to assess emotion regulation in children.

Study 2 was conducted based on the growing, albeit mixed, evidence base suggesting that emotion regulation difficulties and psychopathology are not only closely connected, but that one may lead to the other. Previous studies had found that emotion dysregulation had predicted later levels of psychopathology, while others suggested that the effect was the other way around in that psychopathology predicted later emotion dysregulation. Subsequently, a limited number of studies attempted to examine the potential bi-directional effects, but most of these either lacked sufficient power to detect reliable effects or did not exceed more than two time points. Hence, I utilised existing data from the MCS to investigate such potential bi-directional effects between the two constructs. A developmental cascade model was estimated across the ages of 3, 5 and 7 years, which demonstrated that significant cascading effects existed from an early age on. More specifically, it was shown that children with higher levels of emotion dysregulation had greater levels of internalizing and externalizing symptoms in subsequent years. Additionally, externalizing symptoms were a significant predictor of later emotion dysregulation. Contrary to my expectations, internalising symptoms neither predicted later emotion dysregulation nor externalising symptoms. Enhanced self-regulation was associated with fewer emotion regulation

difficulties and psychopathological symptoms at an early age. However, this association decreased over time and disappeared completely for externalizing symptoms at age 5. This observation is in line with suggestions from previous research, according to which the relationship between different self-regulation processes and psychopathology varies with age (Blandon et al., 2010; Denham et al., 2009). Thus, the findings of Study 2 reliably supported the hypothesis of existing bi-directional effects between emotion dysregulation and psychopathology in a large, nationally representative sample. Based on this, it can be assumed that children with emotion regulation difficulties are at a greater risk of developing internalizing and externalizing problems later in life, but also that existing behavioural problems hamper the development of adaptive emotion regulation.

The findings in Study 2 also indicated that the emotion dysregulation and psychopathology factors were highly correlated at all times, thereby raising the question of how distinct or similar they are. Previous studies have rarely explored this question from a conceptual viewpoint. Therefore, Study 3 investigated this further, by conducting a series of confirmatory factor analyses, including a bi-factor model. In doing so, the study also addressed recent demands to investigate complex constructs like emotion regulation through increased data-driven methods and to explore their borders with other constructs (I. W. Eisenberg et al., 2019). The results pointed towards an underlying dimension, a transdiagnostic dysregulation factor, that summarised the significant overlap between the emotion dysregulation and the psychopathology construct. The performed regression analyses indicated that this transdiagnostic dysregulation factor also significantly predicted levels of self-harm and depression symptoms at age 14.

A closer look at the transdiagnostic-dysregulation factor indicated that particular items relating to the dysregulation of high arousal emotions, such as "gets over excited" or "has temper tantrums" were characteristic for this dimension. This is in line with research suggesting that difficulties with high arousal emotion (e.g., excitement or anger) can explain comorbidities between externalizing disorders, while low arousal emotions (e.g., depressed, bored, calm) are more typical for internalizing disorders (Posner et al., 2005). Following this, the present finding highlights a new research direction, whereby dysregulation of low or high-arousal emotions could help explain similarities between mental health disorders.

While the bi-factor model indicated that there was a significant overlap between the emotion dysregulation and the externalizing factor, the overlap between emotion dysregulation and the internalizing factor was only marginal. However, the correlational model showed high correlations between emotion dysregulation and both the internalizing and the externalizing factor. I suggested that the relatively small overlap with the internalizing factor as indicated by the bi-factor model could be partly explained by the fact that the emotion dysregulation scale is based on parental observations, and that internalizing symptoms are less observable than externalizing symptoms, which is discussed in more detail below.

Thus, the evidence resulting from both Study 2 and 3 supports the idea that emotion dysregulation and psychopathology are highly overlapping and conceptually not distinct from a developmental and a structural point of view. Following this, the present findings add to existing research emphasizing that emotion regulation is a transdiagnostic factor that underlies different forms of psychopathology and should therefore be targeted to enhance existing mental health intervention and prevention programmes.

Part II explored the role of emotion regulation as a transdiagnostic factor further in the context of youth mental health treatment and prevention. Past reviews of adult studies had indicated that interventions which effectively improved emotion regulation difficulties also decreased psychopathology (Sloan et al., 2017), however, for children and young people the picture has been less clear. Thus, in light of the increased interest in targeting emotion regulation processes in interventions, Study 4 identified the evidence for the effectiveness of current psychological interventions to enhance emotion regulation in youth, and how these changes relate to changes in psychopathological symptoms. The conducted meta-analysis, one of the first that specifically looked at children and young people with different psychopathological symptoms, indicated small to medium effect sizes for current interventions to improve emotion regulation. Furthermore, it was found that decreases in emotion dysregulation were associated with reductions in psychopathological symptoms, thereby supporting the development of interventions with an increased focus on emotion regulation processes.

In line with the evidence established in Study 2, 3 and 4 a digital app intervention with a focus on emotion regulation processes was developed with the main target group

being children. Digital interventions have been suggested to present promising means to provide effective mental health support to children and young people, as they help overcome barriers relating to stigma, geographic or other socio-demographic factors. Mobile phones have been increasingly adopted by children and young people, however, very few mental health apps have been developed for children and young people so far. Even fewer have been evaluated for their acceptability or effectiveness (Grist et al., 2017; Hollis et al., 2017), thereby highlighting a significant lack of research and availability of innovative interventions for this age group. Part II of the present thesis addresses this gap, by developing and evaluating a new digital app specifically for young children.

The present research addressed another concern that is commonly raised with respect to existing digital interventions: the lack of interdisciplinary approaches in the development and evaluation process of these interventions (Hollis et al., 2017; Orlowski et al., 2015). Therefore, the present app intervention followed a three-step approach that allowed for the integration of cross-disciplinary methods. The resulting framework, as described in Chapter 6 and 7, can be used by other researchers, practitioners or app developers to guide the development process of future evidence-based, digital interventions.

As part of this, the present mobile app intervention was evaluated and tested over a three months period in a school setting. In doing so, the present research explored new ways to support children within the school context, which is of great importance, as schools are considered to have an important role in youth mental health provision. The findings of the exploratory feasibility trial indicated that children perceived the app as acceptable and usable. However, a few technological issues were reported which need to be addressed prior to further testing. The interviews conducted with children and teachers provided valuable insights for further improvements and how both interacted with the intervention. In order to refine the existing intervention, suggestions for new features that provide increased opportunities for interaction, and the role of teachers as deliverers need to be taken into account. Additionally, the findings highlighted the complexity of the emotion regulation construct and that future app interventions, including the present one, need to focus on providing support for the whole range of emotions, in particular anger. Nevertheless, based on the teacher interviews it can be concluded that digital interventions can reduce barriers that have been commonly

reported for non-digital interventions, by reducing preparation time and providing easy access to the intervention content. In sum, Part II of the thesis extends existing research by developing a new, digital intervention to support young children's emotion regulation abilities within the school setting and presents an integrated framework to inform the development of future digital interventions.

10.2   Strengths and limitations

10.2.1 Part I: Millennium Cohort Studies

The use of the MCS dataset to examine the longitudinal and conceptual relationship between emotion dysregulation and psychopathology is a significant strength of the present thesis. Utilising this dataset allowed me to apply more advanced methodologies while maintaining sufficient power to reliably answer the research questions.

While validating and including the CSBQ as an emotion regulation measure in the present study is one of the key strengths, the measure itself comes with some limitations. First, the results of validation study suggested that the CSBQ might not be time invariant and may therefore not have reliably measured emotion dysregulation and self-regulation across the different age groups in Study 2 and 3. The issue of detecting true change in longitudinal studies is a recurring problem that has been frequently discussed in developmental research and may also weaken the conclusions drawn from the present research (Widaman, Ferrer, & Conger, 2010).

Furthermore, the results of Study 2 and 3 were primarily based on parental observations, and no other sources were available to support the findings from another perspective. This is of particular importance for two reasons: First, it has been agreed that complex constructs, such as emotion regulation, are better researched through a multi-level approach that involves a wide array of cognitive, behavioural, physiological and even contextual measures (Thompson, 2019). For instance, by employing self-report and psychophysiological instruments a recent study demonstrated that anxious adolescents, who had received emotion regulation training, improved in their emotion regulation abilities, but that this required them more efforts than adolescents without anxiety symptoms (De Witte, Sütterlin, Braet, & Mueller, 2017).

Second, past research has repeatedly demonstrated that there are substantial discrepancies between different informants' reports which should be taken into account (Collishaw et al., 2009; De Los Reyes, 2013). With respect to parent reports, it has been shown that they often differ from children's own views about their personal mental health and quality of life, especially when rating internalizing problems (Cantwell, Lewinsohn, Rohde, & Seeley, 1997; Cremeens, Eiser, & Blades, 2006). Additionally, it has been shown that external observers, such as parents and teachers, are often better at recognising externalizing or behavioural symptoms in children, while reports on internalizing symptoms are significantly less accurate (De Reyes & Kazdin, 2005; Kolko & Kazdin, 1993).

Moreover, the five items of the CSBQ primarily capture emotion dysregulation symptoms relating to observable, externalizing problems and neglect emotion dysregulation pattern that are more typically related to internalizing symptoms. Thus the present findings may not accurately reflect the relationship between emotion dysregulation and internalizing symptoms in early childhood. This may explain some of the weak associations between the emotion dysregulation and the internalizing symptoms. In relation to that, the CSBQ, similar to other self-report measures, is limited in its ability to assess emotion regulation as a mechanism, and may rather reflect outcomes of the mechanism. Thus there is a possibility that this may have caused the data to show an overlap due to the way emotion dysregulation and psychopathology were assessed. This is a limitation of the present research but also of the wider field, as current measures seem to blur the lines between the two constructs further.

More specifically, study 2 and 3 demonstrated a clear progression in learning, whereby the findings (i.e. great interconnection between constructs) of the cascade model gave rise to the bi-factor investigations that explored how similar or different the two constructs are. Further reflection on the bi-factor model, which indicated a strong overlap between the two constructs, could pose the question of what conclusions we can draw from the cascade model if the two constructs turned out to be more similar than different – at least by the way they are currently assessed (i.e. as outcomes). Taken together, the use of more complex data analyses, a significant strength of the present research, allowed me to show the great overlap between the constructs, but also highlight the urgent need for more advanced data collection

methods in the field. I discuss the implications of this in terms of future research further below 10.4.

Additionally, the five items did not allow for the investigation of the role of specific emotion regulation strategies (e.g. acceptance, avoidance or rumination) or processes (e.g. emotion awareness or understanding) in relation to the development of internalizing and externalizing symptoms. In doing so, a study by Braet and colleagues (2014) has shown that the lack of adaptive strategies was related to both internalizing and externalizing symptoms in children, while "problem-oriented action" and "acceptance" were trans-diagnostically linked to all internalizing problems. They found that the two maladaptive strategies "giving-up" and "self-devaluation" were specifically linked to depressive symptoms only. Such findings can help enhance the development of youth interventions, which could broadly address strategies that are related to general psychopathology, but focus on specific strategies in the presence of certain symptoms.

Braet and colleagues study also provided further support to the notion that there is a significant relationship between adaptive emotion regulation and psychopathology in children (Braet et al., 2014; Schmitt et al., 2012), while the opposite has been reported in adult studies, which only found links with maladaptive emotion regulation strategies (Aldao & Nolen-Hoeksema, 2010). In an attempt to explain this, the authors argued that this association could be due to early childhood development being characterised by the acquisition of adaptive strategies, and that a failure to do so subsequently leads to the development of maladaptive strategies (Braet et al., 2014). In other words, the authors proposed that there is a shift in the way emotion regulation relates to psychopathology, and that this shift is closely linked with certain developmental milestones. This is in line with scholars who have suggested that certain developmental milestones could explain more individual differences in emotion regulation during times when they played a dominant role (Diaz & Eisenberg, 2015). For instance, the development of language skills has been shown to be closely linked to emotion regulation, however this relationship was most pronounced when children were 36 month old, in comparison to younger or older children (Roben, Cole, & Armstrong, 2013; Wang, Aarø, & Ystrom, 2018).

The role of adaptive emotion regulation strategies in childhood mental health has been widely neglected - this was also reflected in the meta-analysis finding in Chapter 7 –

hence, our understanding of how children acquire adaptive emotion regulation skills is still limited. Only recently have researchers demonstrated that toddlers learn to employ an effective emotion regulation strategy such as distraction by observing adults (Schoppmann, Schneider, & Seehagen, 2019). To enhance our understanding of how children adopt adaptive emotion regulation skills is of great value, because fostering children's early emotion regulation repertoire is not only expected to lead to increased resilience later in life, but also to allow children to build on earlier-acquired strategies as they learn to master more complex strategies (Schoppmann et al., 2019).

Following this, I suggest that future research should investigate more closely how different emotion regulation processes, and especially adaptive ones, related to the general and more specific psychopathology dimensions in youth, and how this relationship changes over time.

Parents have been shown to play a key role in children's emotion regulation development. This has been primarily supported in studies where children of parents with mental health or emotion regulation problems were also more likely to exhibit emotion dysregulation and psychopathological symptoms (Buckholdt, Parra, & Jobe-Shields, 2014; Silk, Shaw, Skuban, Oland, & Kovacs, 2006). Multiple mechanisms have been suggested to be important (Beauchaine, 2015; Beauchaine et al., 2019), ranging from a) transmitted genetic dispositions that are associated with maladaptive temperamental or psychophysiological components (Kim-Spoon et al., 2013; Lin et al., 2019), b) certain parenting behaviours (e.g., neglect, maltreatments, modelling of maladaptive emotion regulation; Heleniak, Jenness, Vander Stoep, McCauley, & McLaughlin, 2016; Morris, Silk, Steinberg, & Robinson, 2007) and shared environmental risk factors (Criss, Morris, Ponce-Garcia, Cui, & Silk, 2016), all of which can inhibit the development of adequate emotion regulation. Additionally, it has been reported that the parents' own mental health influences how they rate their children's mental health (Eiser & Morse, 2001). Thus, it is a strength of the analyses conducted in Study 3 and 4 that these could be controlled for relevant confounding factors, including maternal psychological distress and socioeconomic status. At the same time, I suggest that future research compares the models for different subgroups. In doing so we might discover that some of the effects found here differ by gender, or children of parents with mental health problems.

Moreover, the two studies 3 and 4 did not take into account any processes or contributing factors that could have had an impact prior to the age of 3, and it was not possible to answer questions around temporal precedence before that age. However, Study 3 is one of the first studies to reliably demonstrate the bi-directional effects between emotion dysregulation and psychopathology across early childhood, for which previous studies have lacked sufficient power. Moreover, through the data driven approach that was adopted in Study 4, I was able to demonstrate that there is a close conceptual overlap between emotion dysregulation and psychopathology, which has not been done before. This finding is of significant value as it provides evidence for underlying structures that can be addressed in new interventions.

In sum, Part I of the thesis has contributed significantly to the existing evidence by demonstrating the close association between emotion dysregulation and psychopathology. However, with respect to the limitations outlined above, I suggest that future studies should include multi-level instruments to measure emotion regulation processes and that the complex relationships between different risk-factors and their role in the development process is further explored, ideally through longitudinal study designs.

10.2.2 Part II: Digital intervention

As discussed in Part II, the interdisciplinary approach that was adopted to develop the new intervention is a significant strength of the present research, as it ensured that the new intervention has evidence-informed content as well as an HCI- informed design. The lack of interdisciplinary approaches has frequently been criticised in the development of digital health interventions (See Part II).

Despite the best intentions, there are some limitations that need to be discussed in relation to the present intervention development processes. First, it could not be ensured that a HCI researcher was continuously part of the team, hence most of the HCI related activities were performed by myself after some training and/or consultation with experienced HCI researchers. This could have led to a bias in some of the design features in the present app, and may have lowered the quality of the workshops and the respective outcomes. In particular, it was noticeable that children, who were described by teachers as having difficulties or being vulnerable, sometimes showed very little involvement during the workshops and therefore contributed less to the outcomes. Although obtaining their input for the intervention could have been

extremely valuable, it was not possible to make more time for these children or re-do parts of the workshops with different methods.

In terms of the intervention's evidence-informed content, which was primarily based on the meta-analysis, it needs to be mentioned that the great heterogeneity between the included studies weakened the findings of the meta-analysis (See chapter 7 for more details). Furthermore, the meta-analysis only included two digital and five school-based intervention studies, thereby limiting the transferability of the identified evidence to the present intervention context.

Similarly, there was a lack of studies looking at adaptive emotion regulation in youth, which may have been a result of the employed search strategy focusing on populations exhibiting psychopathological symptoms. This may have increased the likelihood of interventions with a treatment focus to be included, which might put a greater focus on emotion dysregulation processes. Due to this, only limited evidence was available to inform the development of the app intervention, which was primarily preventative in nature. Nevertheless, the findings also emphasise that there is a significant bias in clinical practice and research towards emotion dysregulation, while neglecting the potential of fostering adequate emotion regulation in youth. This however, is worth looking into considering the growing evidence that has suggested that adaptive emotion regulation might play a greater role in youth populations (e.g., Braet et al., 2014). Moreover, it has been stated that from a developmental perspective, interventions could benefit from focusing on both promoting competence and reducing ineffective processes or symptoms (Ialongo et al., 2006).

Despite the aforementioned limitations, the presented app intervention is one of the first digital, trans-diagnostic interventions that targets emotion regulation processes in children and has been developed with an inter-disciplinary focus and evaluated within the school context. This represents an exciting milestone in the young history of digital mental health prevention, although, more research needs to be conducted to improve this existing prototype further and ensure its effective implementation and uptake.

10.3   Implications and further considerations

Specific implications of each study have been outlined in the respective chapters. In the following, I reflect on the broader implications of the research in this thesis.

In light of the rising prevalence rates of mental illness, there has been a growing interest in preventing disorders from developing, instead of waiting for symptoms to develop until treatment is offered (World Health Organization, 2004). However, in order to prevent mental illnesses from developing, we need to have a sound understanding of how they develop, what the differences are between typical and atypical development and which mechanisms are activated at what point in time. This makes developmental psychopathology research highly suitable for providing the foundation to mental health prevention as it provides us with the relevant insights necessary to change developmental trajectories by targeting the right mechanisms at the right time (Hinshaw & Beauchaine, 2017; Ialongo et al., 2006).

As outlined in Chapter 1, developmental psychologists have investigated the determining factors of adaptive and maladaptive outcomes for more than 50 years, with consistent evidence highlighting the role of emotion regulation. Nonetheless, evidence from longitudinal research and/or intervention trials has been limited, in order to identify whether and when emotion regulation processes present themselves as risk or protective factors in childhood development.

By applying advanced statistical methods to existing, longitudinal data, the performed cascade model (see Chapter 3) showed that emotion dysregulation in childhood is a significant predictor of concurrent and future levels of psychopathology. Furthermore, the identified bi-directional effects demonstrate that from a developmental perspective the association between emotion dysregulation and psychopathology cannot be explained by a simple or linear equation of what comes first, but requires more complex research designs and statistical approaches. While developmental scientists have long highlighted the importance of using "transactional" or "open-systems" models when researching developmental pathways (Masten & Obradović, 2006; Richters, 1997), this approach has not been widely adopted in the context of emotion dysregulation and psychopathology research yet.

Moreover, similar to many other psychopathology concepts, the boundaries between typical and atypical development are often not clearly demarcated. Thus, it may well have been the case that even if the presented cascade model had included data prior to the age of 3, I would not have been able to answer the question of what comes first: emotion dysregulation or psychopathology?

Taking these complexities into account, simple questions of whether emotion dysregulation precede psychopathology or vice versa may not be as helpful as we might think. Such questions could potentially inhibit future progress, because they require us to oversimplify a complex model, which in turn leads to the risk of losing important information (Hinshaw & Beauchaine, 2017). The present research, however, accounted for this complexity by adopting advanced statistical methods, and was therefore able to illuminate some of the interactive mechanisms at play.

Similarly, early developmental psychopathologists highlighted that the boundaries between the numerous types of mental disorders were rather diffuse, and that many disorders seemed to have more in common than they were actually different (Achenbach, 1966; Achenbach & Edelbrock, 1978). As outlined in Chapter 4, this initial research has encouraged the adoption of factor analytic approaches, which focus on empirically-derived structures, instead of clusters of symptoms. This inductive approach has since given rise to new models indicating a hierarchical latent structure of psychopathology. Achenbach's two-factor model of internalizing and externalizing disorders and the recent developments of a higher-order general psychopathology factor p, are two examples (Achenbach, 1966; Caspi et al., 2014; Patalay et al., 2015). See Chapter 4 for more detail.

With respect to the growing evidence supporting the validity and usefulness of the new factor-analytic models of psychopathology, Beauchaine had suggested that most of these models had been incomplete as they had not accounted for emotion dysregulation (Beauchaine, 2015), although it is known to cut across most forms of psychopathology. By applying the same statistical approaches, the present research addresses the growing requests of moving towards empirically derived, bottom-up models that include transdiagnostic processes, like emotion regulation. As a result, I have been able to demonstrate that emotion dysregulation is a central underlying component of youth psychopathology, both temporally and conceptually. Following this, the present findings support the suitability of emotion regulation as a trans-diagnostic factor, which can enhance existing and future mental health prevention and treatment programmes in many ways (Meier & Meier, 2018).

As a means to build on the established evidence in the first part of the thesis, I developed a new, digital intervention. The described development process can serve as a framework for researchers and clinicians who would also like to develop a digital

intervention for children and young people. The present research also demonstrates that it is feasible to develop and implement a mental health app within the school context. With respect to schools being a key player in providing youth mental health provision, but often faced with limited resources, the present findings hopefully encourage the uptake of digital interventions in the school context.

Despite being in its early stages, this new intervention represents a timely, acceptable and promising opportunity to support children's emotion regulation in the near future. If taken further, this new digital intervention could allow researchers to investigate emotion regulation processes in youth and extend the currently scarce evidence-base for this populations. Furthermore, by implementing it in future trials, important moderation (e.g., age or gender) and mediation effects can be identified, which in turn will increase our understanding for the complex developmental pathways of psychopathology and resilience (Ialongo et al., 2006). Additionally, the successful integration and implementation of such a technology-based intervention for children and young people bears exciting new possibilities, where assessment of complex constructs including emotion regulation can go beyond parent or self-report measures. These can take contextual-information into account, so that ultimately just-in-time, person-and context specific interventions can be provided (Nahum-Shani et al., 2018). (More on this in the section below).

In sum, the present research lays substantial building blocks for future mental health research and practice, but it also highlights where more work is required in order to improve our understanding of what emotion regulation is, which aspects promote or inhibit normal development, and how we can successfully address these processes in prevention and treatment programmes.

10.4 Future opportunities and directions

In the present research it has become clear that our understanding of emotion regulation is only as good as the measures that we use to assess it, which again are influenced by the existing theories, evidence and practice. Many researchers have already emphasized the importance of multilevel assessments that include biological and environmental components, besides the typical parental or children's report measures (Adrian et al., 2011; Beauchaine, 2015). While this is a good and relevant

suggestion, I believe that we must go a step further in order to improve existing emotion regulation measures.

As outlined in the thesis, emotion regulation is a multifaceted constructs for which a vast amount of measures has been developed over the past years. However, while the different measures have served their purposed in increasing our understanding around emotion regulation, the large heterogeneity and inconsistency of these measures (see also Chapter 7), has also contributed to an array of mixed and inconsistent finding. Eisenberg and colleagues (2019) discussed a similar problematic for the self-regulation construct and demonstrated that there was only a very small relationship between behavioural tasks and self-report measures that aimed to assess self-regulation. Furthermore, they found that surveys modestly predicted real-world outcomes, while tasks did not. Following this, the authors suggested that more data-driven approaches should be employed to help the field produce cumulative knowledge around complex constructs like self-regulation, or in the present case: emotion regulation.

In relation to the points raised above - that self-report measures may not allow to us to adequately assess emotion regulation as a process, and may rather tap into emotion regulation outcomes - future research should therefore also focus on methods that reliably assess different emotion regulation mechanisms. However, when doing so, we need to ensure that the different assessment modalities are aligned and that we understand their relationship with each other (Naragon-Gainey, Mcmahon, & Chacko, 2017). As shown in previous research, different assessment modalities (e.g., surveys, fMRI, psychophysiology, observational) and their outcomes often do not converge well, thereby creating mixed evidence and significant gaps in the literature (Eisenberg et al., 2019; Mauss et al., 2005). It has been suggested that over the past decades different sub-disciplines (e.g., clinical psychology, affective sciences, developmental psychology, etc.) have proceeded independently from theories and concepts to developing their own measures in line with their research focus, while ignoring advances made in other fields (Tracy, David Klonsky, & Proudfit, 2014). Based on the above, I suggest that in moving forward the different sub-disciplines increase their cross-collaboration to a) enhance existing assessment approaches, b) review and reduce the large amount of heterogeneity, while taking into account the complexity of the construct, and c) increase our understanding of how different assessment methods

and their outcomes relate to each other. In other words, when adding experimental approaches in order to assess emotion regulation mechanisms, we also need to understand how the results relate to the outcomes of as self-report measures or observational methods.

If we remind ourselves of the four patterns that have been suggested to distinguish adaptive emotion regulation from emotion dysregulation (Cole, Hall, & Hajal, 2017; see Chapter 1 for more detail): a) regulatory attempts are ineffective, b) emotions interfere with appropriate behaviour and c) emotions are context inappropriate – it is obvious that for at least three of them, we have to take the individual's goals and context into account in order to measure emotion (dys-) regulation appropriately. These two aspects of emotion dysregulation have not been heavily assessed in existing studies, with two exceptions (Somerville & Whitebread, 2019; Troy et al., 2013). However, especially for children and young people for whom it can be assumed that there is great variety with respect to the developmental stages, assessing the impact of different contexts and goals would be of great value. Furthermore, I believe that this would also allow us to better distinguish between adaptive and maladaptive emotion regulation and when certain emotion regulation patterns represent a risk or protective factor.

In the past it has been suggested that the gold standard for researching requires observational research methods, but these have been rarely employed in field studies with children yet (Adrian et al., 2011; Somerville & Whitebread, 2019). With respect to the recent developments in the digital mental health field, highly promising opportunities are evolving, whereby mobile phone data or wearable devices can be used to provide geographical data, besides physiological and self-report data (Onnela & Rauch, 2016). I think that future measures would highly benefit from HCI methodology, which put a greater focus on environmental factors and how to integrate them in research design (this was outlined in Part II in detail).

The comprehensive data made available through technological devices can in turn encourage the application of data-driven approaches to describe and define complex constructs such as emotion regulation. Eventually this will help researchers to identify which aspects of emotion regulation are trans-diagnostic and which are disorder specific so that existing intervention can be more effective.

Although digital interventions can provide exciting new opportunities to advance the assessment and treatment of mental health component, I would like to add my concerns that we have not yet found a way to make them sustainable and lasting (Mohr, Lyon, Lattie, Reddy, & Schueller, 2017; Mohr, Weingardt, et al., 2017). Many digital health interventions that have been developed in research institutes face the problem that they are not treated as commercial products. The lack of a business strategy is consequently a significant risk-factor that prevents many good digital interventions from thriving (e.g., integration in health care services; Ward, Davies, Dugdale, Elison, & Bijral, 2017). Hence, I recommend that researchers or clinicians who wish to develop a lasting product would highly benefit from collaborations with the industry sector.

10.5   Conclusion

The thesis contributes to the growing evidence base that supports the significant role of emotion dysregulation in the development, treatment and prevention of youth psychopathology. By adopting more advanced statistical approaches, the present research highlights the complex dynamics between the constructs, and hopefully paves the way for the increased use of data-driven approaches to enhance our understanding for youth psychopathology. In line with that I also demonstrate the importance of reviewing, improving and aligning emotion regulation measures across the field, and our understanding of how the different outcomes relate to each other. In moving forward, reliable and conclusive assessment of emotion regulation is integral, because knowing what we measure has a huge impact on what we can learn from the data and how it influences existing theories and models. Additionally, this work demonstrates how the established evidence can be implemented in an integrated framework to develop a new, digital mental health intervention to target emotion regulation processes in children. The findings share important lessons that help future researchers and clinicians who also wish to develop and evaluate digital interventions for children and young people. Finally, this research identifies vital future directions to enhance the assessment of emotion regulation processes, and to create sustainable, digital interventions by embracing cross-disciplinary collaborations.

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Appendices

Appendix A: Standardized factor loadings

Table A1. Standardised factor loadings for both models at age 3

Model (age 3)	Correlational Model				Bi-factor Model				
Item	EXT	INT	ED	SR	EXT	INT	ED	SR	BF
Often has temper tantrums	.80				-.06				.81
Generally obedient	.51				.11				.49
Fights with or bullies other children	.68				.50				.60
Often argumentative with adults	.65				.22				.62
Can be spiteful to others	.64				.50				.57
Complains of headaches/ stomach-aches/sickness		.53				.29			.35
Often seems worried		.64				.58			.33
Often unhappy downhearted, tearful		.86				.50			.53
Nervous or clingy in new situations		.51				.46			.26
Many fears, easily scared		.59				.67			.28
Shows mood swings			.74				.14		.70
Gets over excited			.59				.44		.51
Easily frustrated			.73				.24		.68
Gets over being upset quickly			.25				-.25		.31
Acts impulsively			.56				.42		.48
Likes to work things out for self				.52				.55	-.05
Does not need much help with tasks				.49				.51	-.07
Chooses activities on their own				.49				.51	-.06
Persists in the face of difficult tasks				.59				.58	-.13
Move to new activity after finishing task				.64				.54	-.23

Table A2. Standardised factor loadings for both models at age 5

Model (age 5)	Correlational Model				Bi-factor Model				
Item	**EXT**	**INT**	**ED**	**SR**	**EXT**	**INT**	**ED**	**SR**	**BF**
Often has temper tantrums	.81				-.05				.82
Generally obedient	.61				.07				.61
Fights with or bullies other children	.65				.28				.63
Often argumentative with adults	.52				.46				.50
Can be spiteful to others	.43				.65				.37
Complains of headaches/ stomach-aches/sickness		.48				.35			.30
Often seems worried		.71				.63			.40
Often unhappy downhearted, tearful		.81				.48			.53
Nervous or clingy in new situations		.53				.48			.29
Many fears, easily scared		.69				.64			.39
Shows mood swings			.80				.09		.79
Gets over excited			.61				.45		.54
Easily frustrated			.77				.22		.73
Gets over being upset quickly			.32				-.28		.38
Acts impulsively			.62				.42		.56
Likes to work things out for self				.50				.59	-.16
Does not need much help with tasks				.65				.61	-.29
Chooses activities on their own				.46				.46	-.18
Persists in the face of difficult tasks				.56				.53	-.25
Move to new activity after finishing task				.81				.49	-.47

Table A3. Standardised factor loadings for both models at age 7

Model (age 7)	Correlational Model				Bi-factor Model				
Item	EXT	INT	ED	SR	EXT	INT	ED	SR	BF
Often has temper tantrums	.82				-.08				.83
Generally obedient	.63				.06				.63
Fights with or bullies other children	.71				.30				.69
Often argumentative with adults	.61				.46				.58
Can be spiteful to others	.60				.64				.53
Complains of headaches/ stomach-aches/sickness		.49				.32			.32
Often seems worried		.75				.64			.45
Often unhappy downhearted, tearful		.79				.50			.53
Nervous or clingy in new situations		.59				.48			.35
Many fears, easily scared		.71				.63			.41
Shows mood swings			.82				.06		.81
Gets over excited			.63				.41		.58
Easily frustrated			.80				.18		.78
Gets over being upset quickly			.29				-.30		.34
Acts impulsively			.66				.42		.60
Likes to work things out for self				.58				.59	-.23
Does not need much help with tasks				.68				.61	-.34
Chooses activities on their own				.42				.46	-.19
Persists in the face of difficult tasks				.62				.53	-.31
Move to new activity after finishing task				.80				.49	-.51

Appendix B: Meta-Analysis

Search strategy for systematic review and meta-analysis

Search Terms Ovid: PsychInfo and Medliner, Embase

1. Emotion regulation strategies

(Reapprais* or suppress or expressive suppression or distract* or ruminat* or problem-solving or avoidance or experiential avoidance or attentional deployment or cognitive change or response modulation or situation selection or Accept* or savouring or reminisc* or gratitude or mindful or humor or positive emotion* expression or Emotional awareness or emotional understanding or emotion regulation strategy or affect regulation or emotion dysregulation or emotion regulation or emotion regulation flexibility).ti,ab.

2. Population

(Adolescen* or youth* or young pers* or teenager or child*).ti,ab.

3. Emotion regulation intervention

(Affect regulation training or emotion regulation training or CBT or cognitive behav* therapy or DBT or dialectical behav* therapy or emotion regulation skills training or compassion focused therapy or behav* therapy or acceptance therapy or emotion therapy).ti,ab.

4. Mental disorders

(depress* OR anxiety).ti,ab.

(borderline personality disorder OR BPD OR deliberate self harm OR self injury OR NSSI OR non suicidal).ti,ab.

(eating disorder OR Binge OR purge OR bulimia OR anorexia).ti,ab.

(substance abuse OR substance misuse OR drug abuse OR drug misuse OR drug addict* OR alcohol abuse OR alcohol dependen* OR alcohol addict OR cannabis abuse OR cannabis dependen* OR cannabis addict* OR marijuana abuse OR marijuana dependen* OR marijuana addict* OR amphetamine abuse OR amphetamine stimulant dependen* OR stimulant addict).ti,ab.

(attention deficit disorder OR ADHD OR conduct disorder OR oppositional defiant disorder OR ODD).ti,ab.

5. RCT

((randomized controlled trial or controlled clinical trial).pt. or randomized.ab. or randomised.ab. or placebo.ab. or or randomly.ab. or trial.ab. or groups.ab.) not (exp animals/ not humans.sh.)

Search Terms Web of Science

1. Emotion regulation strategies
TS=(Reapprais* or suppress or expressive suppression or distraction or rumination or problem-solving or avoidance or experiential avoidance or attentional deployment or cognitive change or response modulation or situation selection or Accept* or savouring or reminisc* or gratitude or mindful or humor or positive emotion* expression or Emotional awareness or emotional understanding or emotion regulation strategy or affect regulation or emotion dysregulation or emotion regulation or emotion regulation flexibility)

2. Population
TS=(Adolescen* or youth* or young pers* or teenager or child*)

3. Emotion Regulation Intervention
TS=(Affect regulation training or emotion regulation training or CBT or cognitive behav* therapy or DBT or dialectical behav* therapy or emotion regulation skills training or compassion focused therapy or behav* therapy or acceptance therapy or emotion therapy)

4. Mental disorders
TS= (depress* OR anxiety or borderline personality disorder OR BPD OR deliberate self harm OR self injury OR NSSI OR non suicidal or eating disorder OR Binge OR purge OR bulimia OR anorexia or substance abuse OR substance misuse OR drug abuse OR drug misuse OR drug addict* OR alcohol abuse OR alcohol dependen* OR alcohol addict OR cannabis abuse OR cannabis dependen* OR cannabis addict* OR marijuana abuse OR marijuana dependen* OR marijuana addict* OR amphetamine abuse OR amphetamine stimulant dependen* OR stimulant addict OR attention deficit disorder OR ADHD)

5. RCT

TS=(randomized controlled trial or controlled clinical trial OR prospective stud* OR single blind* OR double blind) NOT TS= (exp animals/ not humans)

References of studies included in the meta-analysis

Afshari, A., Neshat-Doost, H. T., Maracy, M. R., Ahmady, M. K., & Amiri, S. (2014). The effective comparison between emotion-focused cognitive behavioral group therapy and cognitive behavioral group therapy in children with separation anxiety disorder. *Journal of research in medical sciences*, *19*(3), 221–227.

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Outlier analysis
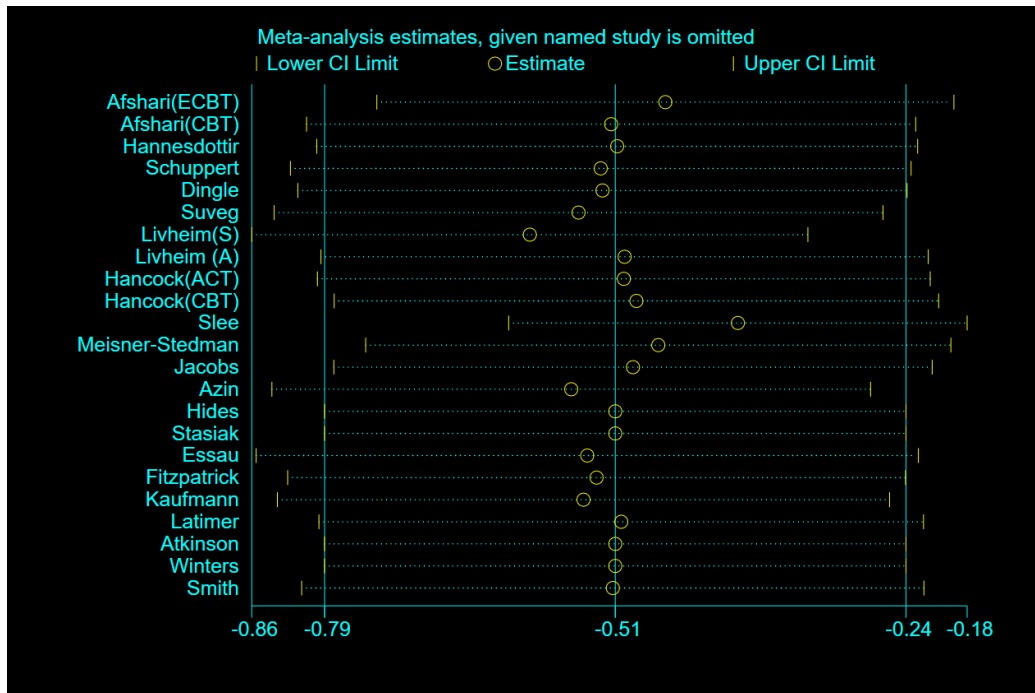
Plot 2. "Metainf" plot indicating impact of individual studies on effect size
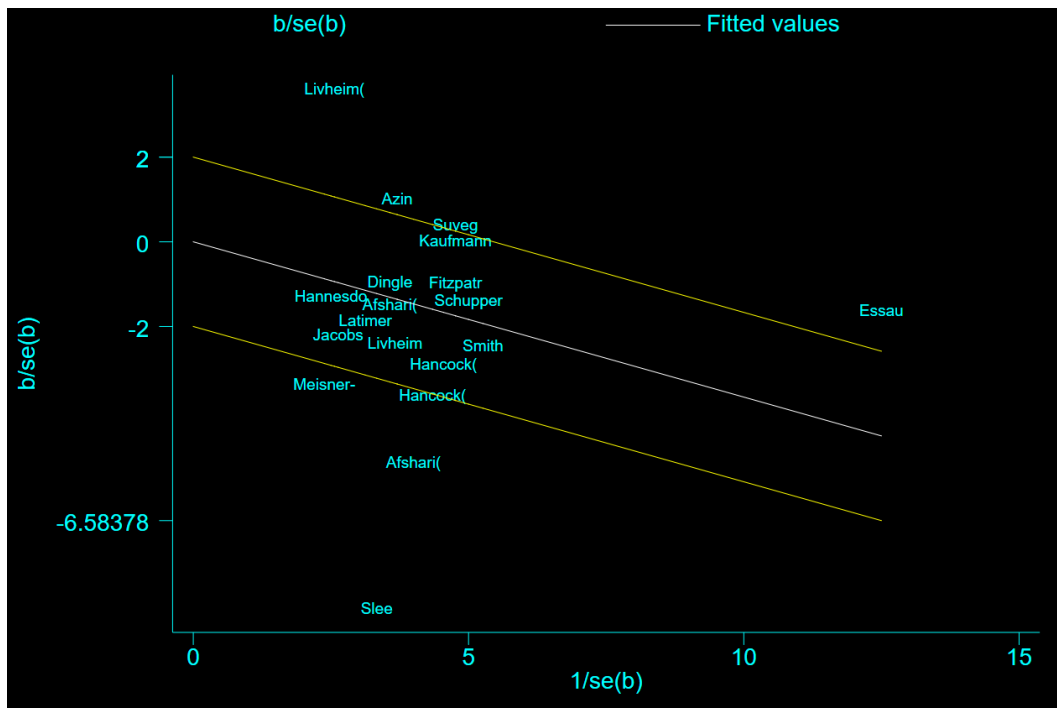
Plot 2 Galbraith plot for studies with emotion dysregulation as primary outcome

Plot 3 - Galbraith plot for studies with emotion regulation as primary outcome

Plot 4. "Metainf" plot indicating impact of individual studies on effect size

Further subgroup analyses

ADD FIGURES FOR TYPE OF INTERVENTION (6 and 7)

Study	Treatment			Control				Hedges's g with 95% CI	Weight (%)
	N	Mean	SD	N	Mean	SD			
ACTIVE									
Schuppert	48	32.87	11.63	49	36.37	11.63		-0.30 [-0.70, 0.10]	6.70
Suveg	49	28.35	6.91	43	27.95	6.04		0.06 [-0.35, 0.47]	6.63
Livheim (A)	32	10.23	1.24	26	11.21	1.62		-0.68 [-1.21, -0.15]	5.64
Azin	27	10.48	6.7	29	8.88	6.47		0.24 [-0.28, 0.76]	5.69
Fitzpatrick	47	18.25	9.84	47	20.61	10.66		-0.23 [-0.63, 0.17]	6.66
Kaufmann	45	1.43	1.54	48	1.45	.61		-0.02 [-0.42, 0.39]	6.65
Latimer	21	4.76	3.49	21	7.14	3.95		-0.63 [-1.23, -0.02]	5.01
Heterogeneity: $\tau^2 = 0.03$, $I^2 = 39.45\%$, $H^2 = 1.65$								-0.19 [-0.41, 0.03]	
Test of $\theta_i = \theta_j$: Q(6) = 10.44, p = 0.11									
WL									
Afshari(ECBT)	44	36.07	10.8	33	51.9	12.9		-1.33 [-1.83, -0.84]	5.89
Afshari(CBT)	22	46.44	10.46	33	51.9	12.9		-0.45 [-0.99, 0.09]	5.54
Hannesdottir	16	31.79	6.17	11	35.36	6.16		-0.56 [-1.32, 0.20]	4.02
Dingle	27	77.48	18.92	24	83.38	20.16		-0.30 [-0.84, 0.25]	5.49
Hancock(ACT)	68	22.3	11.96	31	30.53	13.5		-0.66 [-1.09, -0.22]	6.41
Hancock(CBT)	63	19.67	12.02	31	30.53	13.5		-0.86 [-1.30, -0.42]	6.31
Meisner-Stedman	14	6.7	2.7	15	10	1.6		-1.46 [-2.26, -0.66]	3.79
Jacobs	15	40.26	11.71	15	51.71	13.53		-0.88 [-1.61, -0.15]	4.19
Essau	302	4.85	3.2	336	5.29	3.3		-0.14 [-0.29, 0.02]	8.51
Smith	54	24.09	9.32	55	28.96	10.22		-0.49 [-0.87, -0.12]	6.86
Heterogeneity: $\tau^2 = 0.12$, $I^2 = 71.47\%$, $H^2 = 3.51$								-0.66 [-0.93, -0.39]	
Test of $\theta_i = \theta_j$: Q(9) = 39.33, p = 0.00									
Overall								-0.46 [-0.67, -0.26]	
Heterogeneity: $\tau^2 = 0.12$, $I^2 = 72.82\%$, $H^2 = 3.68$									
Test of $\theta_i = \theta_j$: Q(16) = 54.06, p = 0.00									
Test of group differences: $Q_b(1) = 6.88$, p = 0.01									

Random-effects REML model

Figure 8 Subgroup analysis of type of control group for emotion dysregulation

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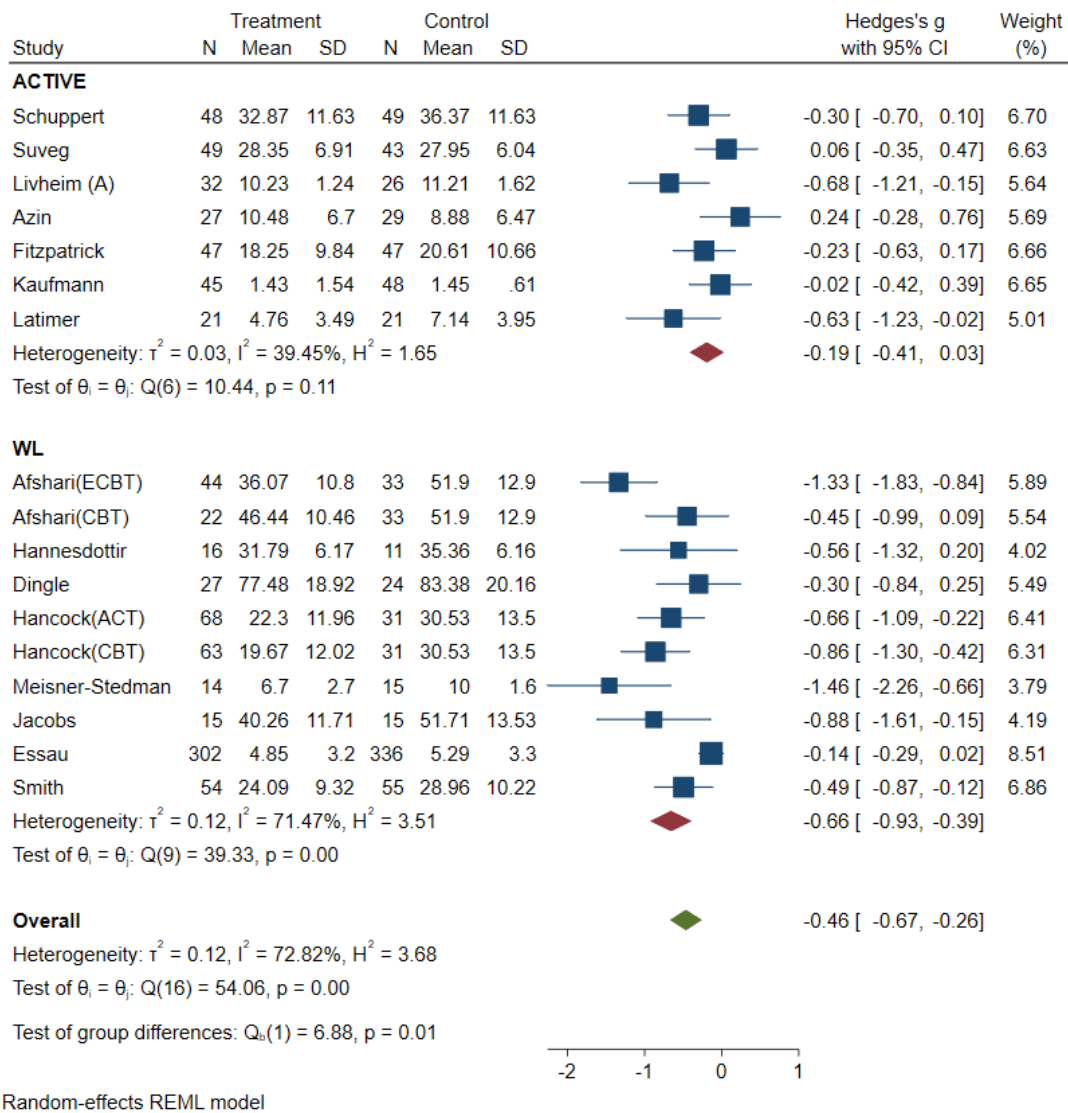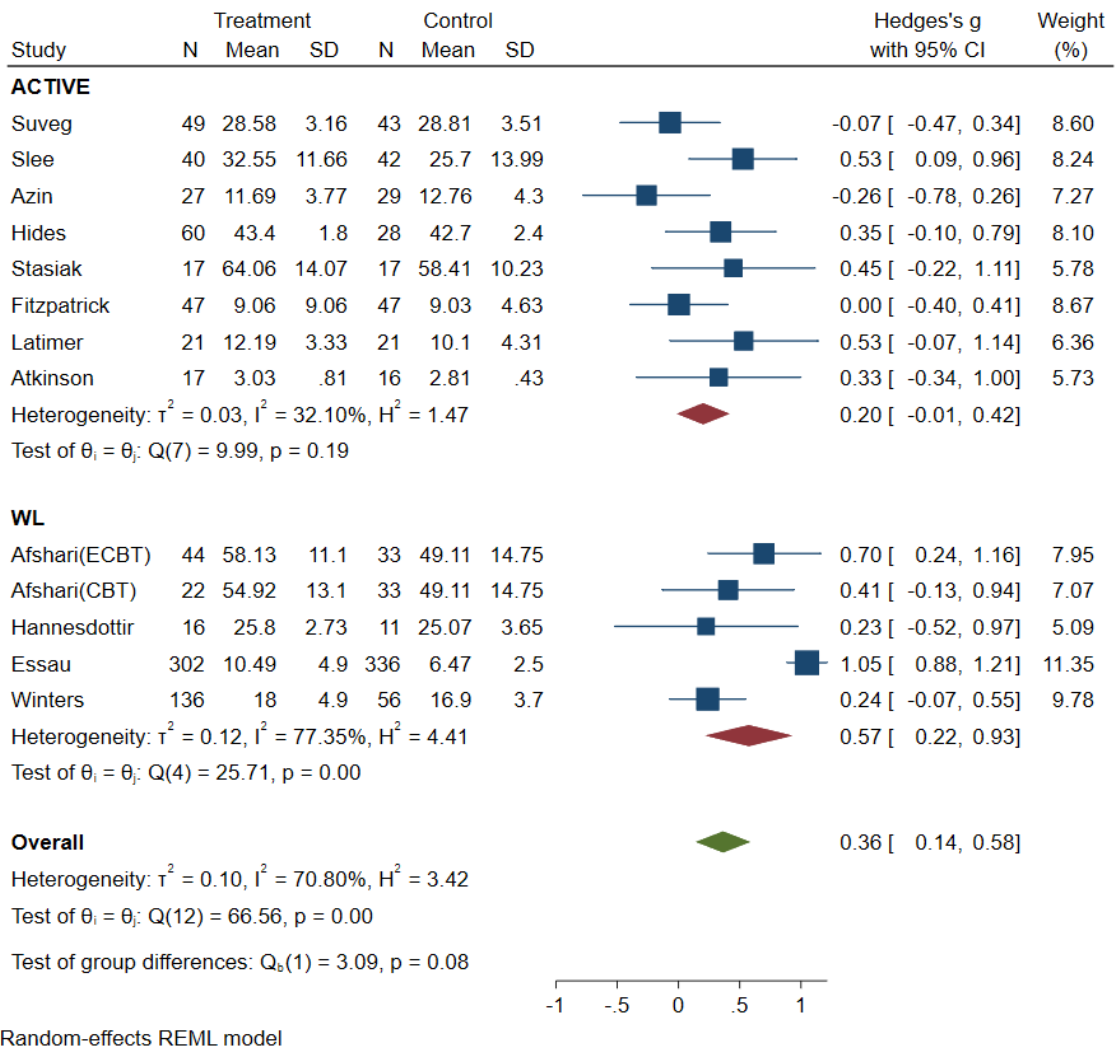| Study		Treatment			Control		Hedges's g with 95% CI	Weight (%)
	N	Mean	SD	N	Mean	SD		
ACTIVE								
Suveg	49	28.58	3.16	43	28.81	3.51	-0.07 [-0.47, 0.34]	8.60
Slee	40	32.55	11.66	42	25.7	13.99	0.53 [0.09, 0.96]	8.24
Azin	27	11.69	3.77	29	12.76	4.3	-0.26 [-0.78, 0.26]	7.27
Hides	60	43.4	1.8	28	42.7	2.4	0.35 [-0.10, 0.79]	8.10
Stasiak	17	64.06	14.07	17	58.41	10.23	0.45 [-0.22, 1.11]	5.78
Fitzpatrick	47	9.06	9.06	47	9.03	4.63	0.00 [-0.40, 0.41]	8.67
Latimer	21	12.19	3.33	21	10.1	4.31	0.53 [-0.07, 1.14]	6.36
Atkinson	17	3.03	.81	16	2.81	.43	0.33 [-0.34, 1.00]	5.73
Heterogeneity: $\tau^2 = 0.03$, $I^2 = 32.10\%$, $H^2 = 1.47$							0.20 [-0.01, 0.42]	
Test of $\theta_i = \theta_j$: Q(7) = 9.99, p = 0.19								
WL								
Afshari(ECBT)	44	58.13	11.1	33	49.11	14.75	0.70 [0.24, 1.16]	7.95
Afshari(CBT)	22	54.92	13.1	33	49.11	14.75	0.41 [-0.13, 0.94]	7.07
Hannesdottir	16	25.8	2.73	11	25.07	3.65	0.23 [-0.52, 0.97]	5.09
Essau	302	10.49	4.9	336	6.47	2.5	1.05 [0.88, 1.21]	11.35
Winters	136	18	4.9	56	16.9	3.7	0.24 [-0.07, 0.55]	9.78
Heterogeneity: $\tau^2 = 0.12$, $I^2 = 77.35\%$, $H^2 = 4.41$							0.57 [0.22, 0.93]	
Test of $\theta_i = \theta_j$: Q(4) = 25.71, p = 0.00								
Overall							0.36 [0.14, 0.58]	
Heterogeneity: $\tau^2 = 0.10$, $I^2 = 70.80\%$, $H^2 = 3.42$								
Test of $\theta_i = \theta_j$: Q(12) = 66.56, p = 0.00								
Test of group differences: $Q_b(1) = 3.09$, p = 0.08								

Random-effects REML model

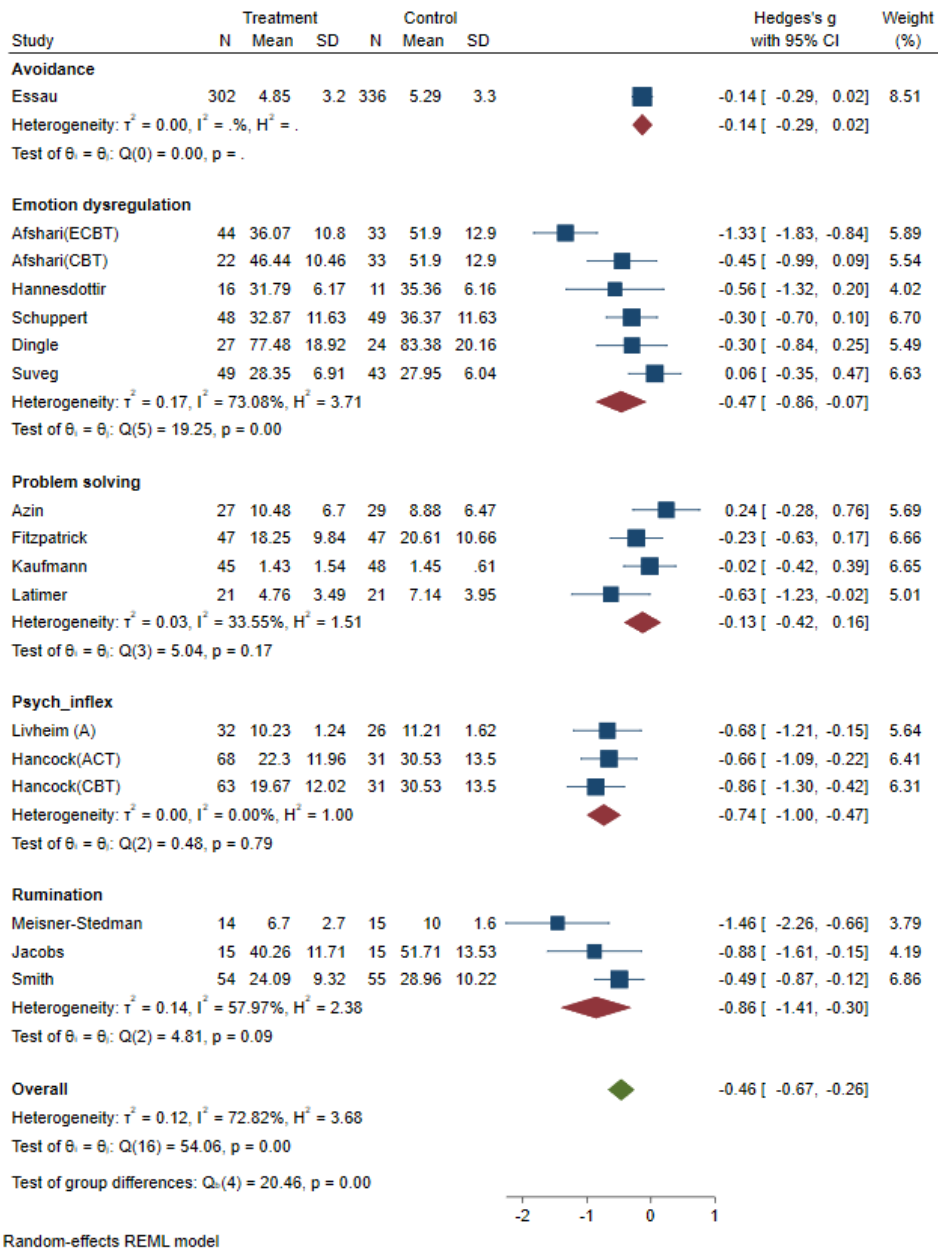*Figure 9. Subgroup analysis of type of control group for emotion regulation*

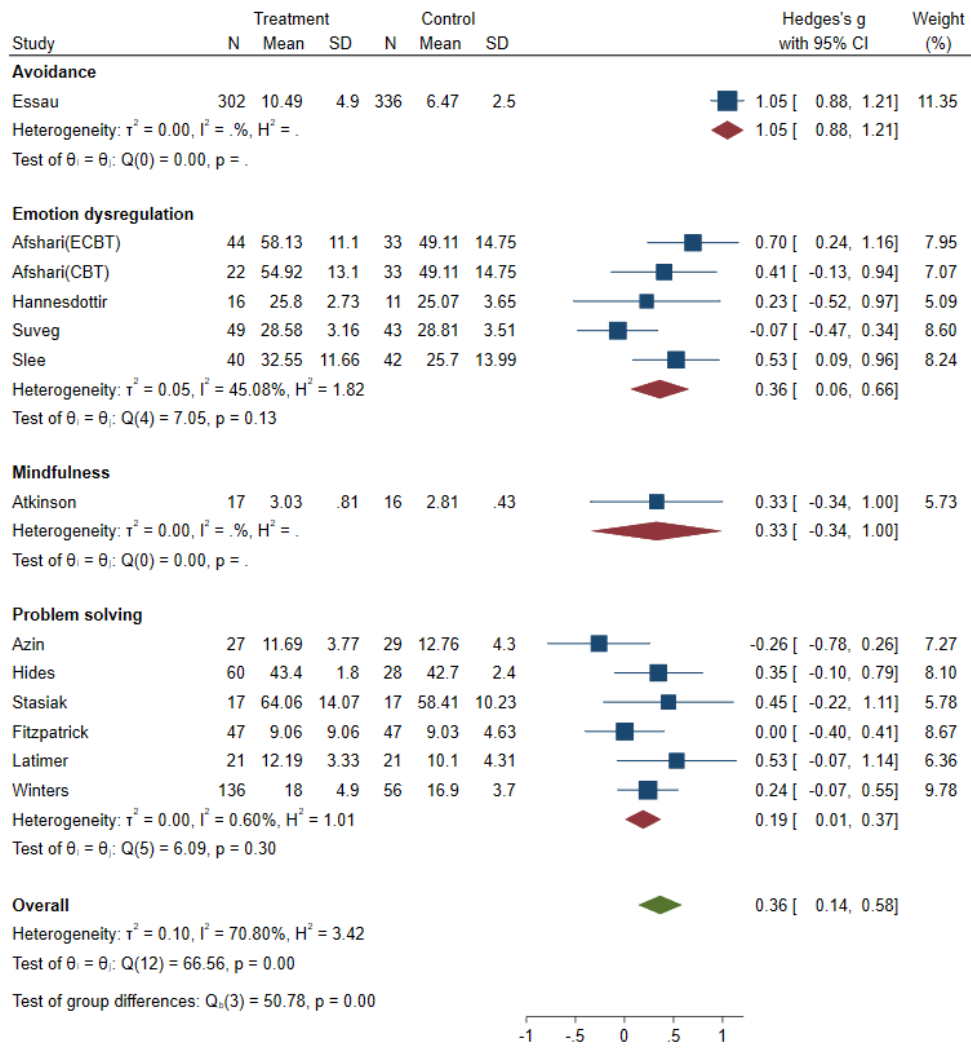*Figure 10. Subgroup analysis of type of emotion dysregulation measure*
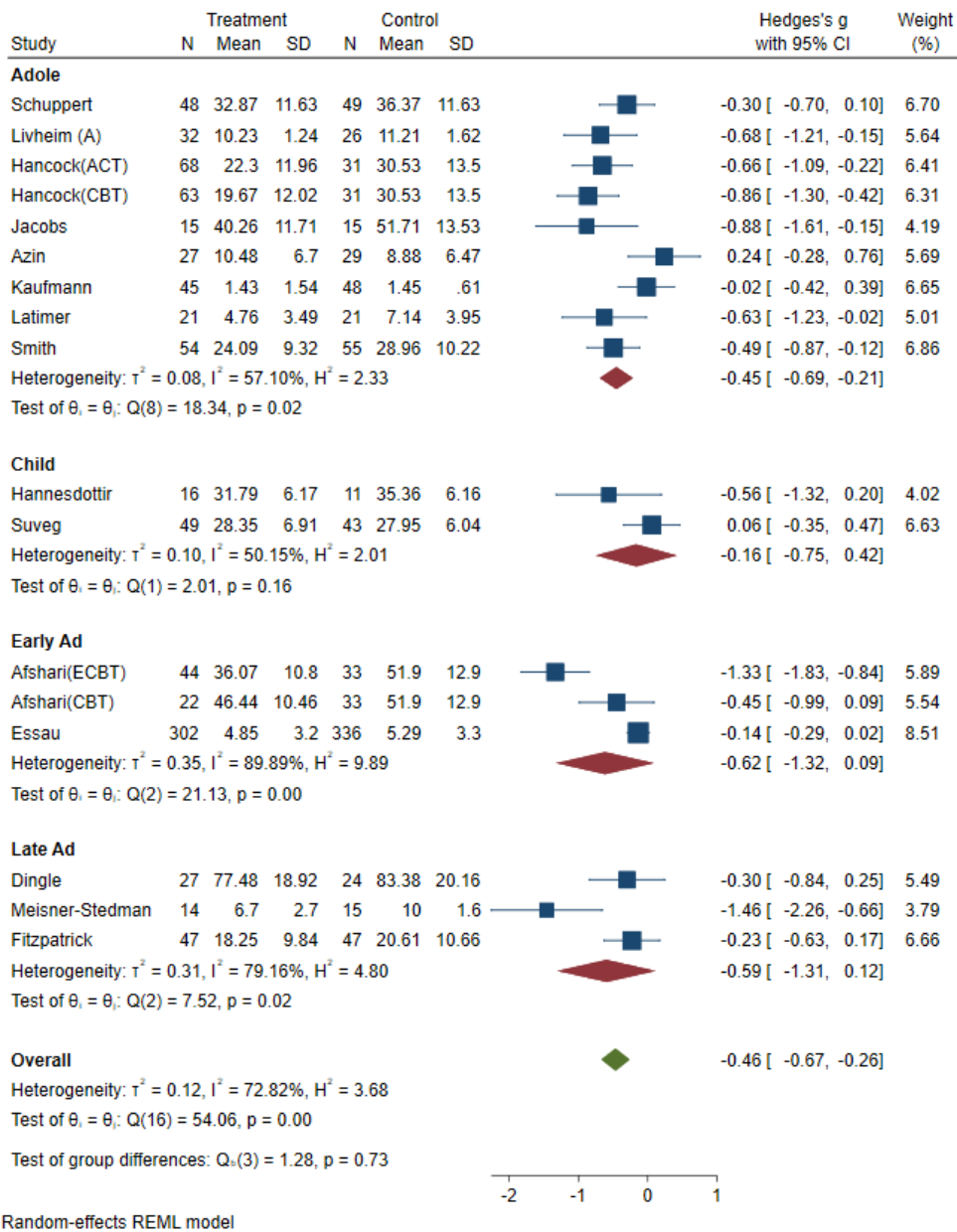
Figure 11. Subgroup analysis of emotion regulation measures

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Study	Treatment N	Mean	SD	Control N	Mean	SD	Hedges's g with 95% CI	Weight (%)
Adole								
Schuppert	48	32.87	11.63	49	36.37	11.63	-0.30 [-0.70, 0.10]	6.70
Livheim (A)	32	10.23	1.24	26	11.21	1.62	-0.68 [-1.21, -0.15]	5.64
Hancock(ACT)	68	22.3	11.96	31	30.53	13.5	-0.66 [-1.09, -0.22]	6.41
Hancock(CBT)	63	19.67	12.02	31	30.53	13.5	-0.86 [-1.30, -0.42]	6.31
Jacobs	15	40.26	11.71	15	51.71	13.53	-0.88 [-1.61, -0.15]	4.19
Azin	27	10.48	6.7	29	8.88	6.47	0.24 [-0.28, 0.76]	5.69
Kaufmann	45	1.43	1.54	48	1.45	.61	-0.02 [-0.42, 0.39]	6.65
Latimer	21	4.76	3.49	21	7.14	3.95	-0.63 [-1.23, -0.02]	5.01
Smith	54	24.09	9.32	55	28.96	10.22	-0.49 [-0.87, -0.12]	6.86
Heterogeneity: $\tau^2 = 0.08$, $I^2 = 57.10\%$, $H^2 = 2.33$							-0.45 [-0.69, -0.21]	
Test of $\theta_i = \theta_j$: Q(8) = 18.34, p = 0.02								
Child								
Hannesdottir	16	31.79	6.17	11	35.36	6.16	-0.56 [-1.32, 0.20]	4.02
Suveg	49	28.35	6.91	43	27.95	6.04	0.06 [-0.35, 0.47]	6.63
Heterogeneity: $\tau^2 = 0.10$, $I^2 = 50.15\%$, $H^2 = 2.01$							-0.16 [-0.75, 0.42]	
Test of $\theta_i = \theta_j$: Q(1) = 2.01, p = 0.16								
Early Ad								
Afshari(ECBT)	44	36.07	10.8	33	51.9	12.9	-1.33 [-1.83, -0.84]	5.89
Afshari(CBT)	22	46.44	10.46	33	51.9	12.9	-0.45 [-0.99, 0.09]	5.54
Essau	302	4.85	3.2	336	5.29	3.3	-0.14 [-0.29, 0.02]	8.51
Heterogeneity: $\tau^2 = 0.35$, $I^2 = 89.89\%$, $H^2 = 9.89$							-0.62 [-1.32, 0.09]	
Test of $\theta_i = \theta_j$: Q(2) = 21.13, p = 0.00								
Late Ad								
Dingle	27	77.48	18.92	24	83.38	20.16	-0.30 [-0.84, 0.25]	5.49
Meisner-Stedman	14	6.7	2.7	15	10	1.6	-1.46 [-2.26, -0.66]	3.79
Fitzpatrick	47	18.25	9.84	47	20.61	10.66	-0.23 [-0.63, 0.17]	6.66
Heterogeneity: $\tau^2 = 0.31$, $I^2 = 79.16\%$, $H^2 = 4.80$							-0.59 [-1.31, 0.12]	
Test of $\theta_i = \theta_j$: Q(2) = 7.52, p = 0.02								
Overall							-0.46 [-0.67, -0.26]	
Heterogeneity: $\tau^2 = 0.12$, $I^2 = 72.82\%$, $H^2 = 3.68$								
Test of $\theta_i = \theta_j$: Q(16) = 54.06, p = 0.00								
Test of group differences: $Q_b(3) = 1.28$, p = 0.73								

Random-effects REML model

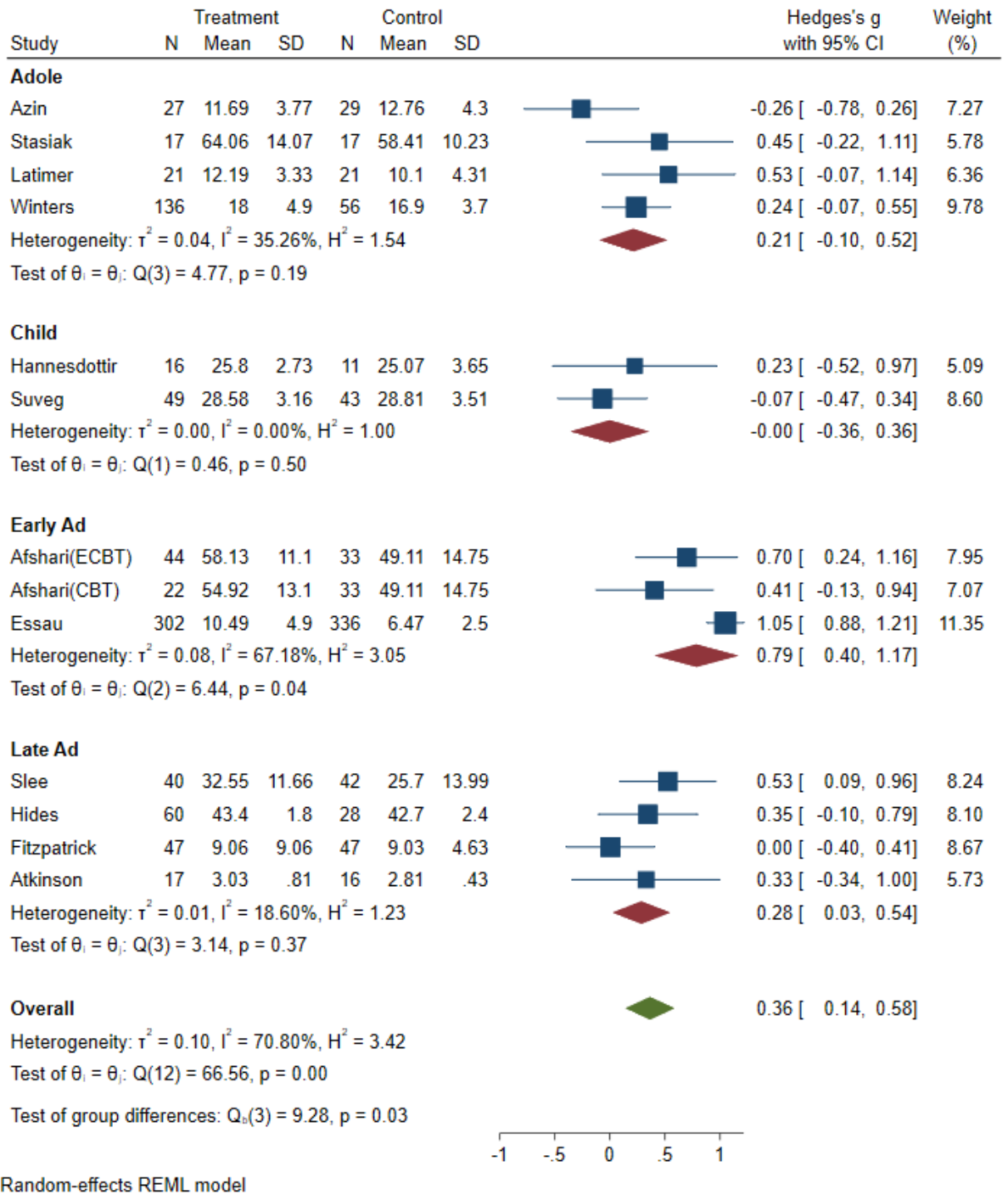*Figure 13. Subgroup analysis of age group for emotion dysregulation*

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Figure 14. Subgroup analysis of age group for emotion dysregulation

Table 5-B. Overview of Intervention and Emotion Regulation Measures

Study	PP	Intervention	Control group	ER measure
Slee et al., 2008	BPD	**Cognitive Behavioural Therapy:** 10 weekly sessions developed for preventing self-harm (SH).Targets self-harm maintenance factors, including dysfunctional cognition, emotion regulation and problem solving. Emotion regulation targeted by mindfulness, acceptance and exposure with response prevention. (Standardized manual is available from authors)	**Treatment as usual:** Any treatment warranted. Most interventions involved limited number of individual CBT or inter-personal psychotherapy sessions. Social skills training was common. Authors did not record specific types of therapy or medication.	**Difficulties with Emotion Regulation Scale (DERS):** contains 6 scales of ER difficulties including (a) lack of awareness of emotional responses (e.g., I pay attention to how feel= reverse), (b) lack of clarity of emotional responses (e.g., I have difficulty making sense out of my feelings), (c) non-acceptance of emotional responses (e.g., When I'm upset, I feel ashamed with myself for feeling this way), (d) limited access to ER strategies (e.g., When I'm upset, I believe that there is nothing I can do to make myself feel better), (e) difficulties controlling impulses (e.g., When I'm upset, I feel out of control), and (f) difficulties engaging in goal-directed behaviours when experiencing negative emotions (e.g., When I'm upset, I have difficulty concentrating). All questions are self-rated from 1 (almost) never to 5 (almost) always. Scores on subscales range from 5–25 (Clarity, Goals), from 6–30 (Awareness, Non-acceptance) and from 7–35 (Impulses, Strategies). All of the subscales have adequate internal consistency, with alpha reliabilities of 80 or higher. (See: *Gratz, K.L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: development, factor structure, and initial validation of the difficulties in emotion regulation scale. Journal of Psychopathology and Behavioural Assessment, 26, 41– 54.)*
Schuppert et al., 2012	BPD	**Emotion Regulation Training:** Improve feeling of control over intense, strong emotions by increasing cognitive, social, and behaviour coping skills. ERT is based on CBT and DBT. 17 weekly sessions (a 105min).Consists of 3 stages. Stage 1: psychoeducation on emotion dysregulation, automatic thoughts and cognitive-behavioural chain analysis, skills. Phase 2: Improve locus of control and insight regarding personal strengths and pitfalls. Phase 3: learning ER skills (e.g., taking distance, or challenging negative, distorted assumptions), followed by attention to lifestyle.	**Treatment as usual:** included medication, psychotherapy, inpatient psychiatric care and emergency services in case of self-harm or suicidal behaviour.	**Life Problems Inventory (LPI)** with 15item **emotion dysregulation subscale.** LPI assesses core aspects of. Emotional Dysregulation scale measures high sensitivity, high reactivity of emotional responses, slow return to baseline mood, episodic depression and suicidal ideation, irritability, anxiety, and problems with anger and other emotions. A sample item is: "Once I get upset, it takes me a long time to calm down. Authors reported that no specific instruments were available to assess ER problems in youth. (See: *Miller AL, Rathus JH, LinehanMM. Dialectical Behaviour Therapy with Suicidal Adolescents. New York: Guilford Press; 2007.)*

| Suveg et al., 2017 | AD | **Emotion focused CBT:** 10 weekly, 1h sessions based on CBT (e.g., cognitive restructuring, relaxation, homework, exposure tasks) Specific content to address emotion regulation problems (e.g., guilt, sadness, anger, etc.). Sessions begin with discussion how therapist and child are feeling that day. Focus on how they know (e.g., behavioural and physiological cues) and why they feel that way. Therapist describes how doing or thinking can help themselves feel better. Therapist normalizes experience of emotion and models adaptive ER. Child is can practice ER by generating strategies to manage situations. In first sessions emotion is introduced for which causes and consequences are discussed. Last sessions, focus on practicing skills during exposure tasks. ECBT has exposure tasks for all emotional experiences. (Standardized manual is available from authors) | **Active control**: CBT based on Coping Cat protocol with 10 weekly 1h sessions. The first half of treatment focused on helping children learn skills to manage anxiety and the second half had children practice using their skills during exposure tasks. | **Emotion Regulation Checklist (ERC)** includes 24 items rated from never to always on a 4-point scale with 2 subscales. The **Emotion Regulation subscale (9 items)**, measures appropriate affective expressions, empathy, and emotional self-awareness (e.g., displays appropriate negative emotion in response to hostile, aggressive, or intrusive acts by peers, Can say when s/he is feeling sad, angry or mad, fearful, or afraid) The **Lability/ Negativity subscale** (15 items) assesses inflexibility, lability, and dysregulated negative affect (e.g., Responds angrily to limit setting by adults, Displays excessive energy or excitement that others find intrusive or disruptive).Higher scores indicate greater emotion regulation and greater emotion dysregulation, respectively. The ERC has been found to have substantial interrater reliability, discriminant validity and construct validity.

(See*: Shields, A, & Cicchetti, D. (1997). Emotion regulation among school-age children: The development and validation of a new criterion Q-sort scale. Developmental Psychology, 33, 906-917)*

Children's Emotion Management Scale (CEMS) self-report measure to assess the ability to manage anger, sadness, and worry using a 3-point scale ranging from hardly ever to often. There are 3 subscales for each emotion: Inhibition, Dysregulated Expression, and Emotion Regulation Coping. Emotion Regulation Coping subscale serve as indices of adaptive emotion regulation. Inhibition and Dysregulated Expression subscales reflect maladaptive methods of managing emotions. The reliability and validity of CEMS have been established.

*(*See*: Zeman J, Cassano M, Suveg C, Shipman K (2010). Initial validation of the Children's Worry Management Scale. Journal of Child and Family Studies,19,381-392.* and *Zeman J, Shipman K, Penza-Clyve S.(2001). Development and initial validation of the Children's Sadness Management Scale. J Nonverbal Behav;25, 187-205)* |

Dingle et al., 2017	AD, MD	**Emotion regulation program** (TuneIn): 4 weekly 90min sessions. Helps young people identify, name, tolerate, and modify emotions strategically, using music as a tool. Each session participants are asked to a) draw an image that they associated with the music, b) indicate where they feel a physical response to music, and c) complete lyric analysis task to evoke and explore different emotional responses.	**Waitlist**	**Difficulties with Emotion Regulation Scale:**: See this Table: Slee et al., 2018
Hides et al., 2011	MD, SUB	**Cognitive Behavioural Therapy:** and motivational interviewing for 12 weeks. Authors did not provide detailed information on structure or content	**Treatment as usual:** Case management and motivational interviewing for substance misuse by social worker.	**Coping Inventory for Stressful Situations (CISS):** is a 48 item self-report measure that assesses 3 coping dimensions: task- (e.g., Think about how I solved similar problems), emotion- (e.g., Worry about what I am going to do) and avoidance oriented coping (e.g., watch TV, call a friend). The task-coping subscale has been shown to be negatively related to psychopathology and distress, while emotion-oriented coping was positively related to these constructs. CISS has been shown to have good validity and reliability (See: *Endler &Parker, (1994). Assessment of multidimensional coping: task, emotion, and avoidance strategies. Psychological Assessment, 6, 50-60)*
Atkinson et al., 2011	ED	Based on the **Mindfulness-based cognitive therapy**. Session 1: Identifying internal experiences relating to body and coping strategies. Thought suppression and magnification exercises demonstrate effects of avoidance and rumination. Guided raisin exercise and breathing. Session 2: Barriers to practising mindfulness. Guided decentring exercise. Session 3: Welcoming negative internal experiences. Negative body-related judgement and self-criticism. Suggestions for acceptance-based responses. Guided experiential exercise to practise acceptance. Daily homework: breathing, awareness and acceptance.	**Assessment only**	**Five Facet Mindfulness Questionnaire (FFMQ)** measures 5 key mindfulness constructs: Observing ('I notice the smell and aroma of things'), describing ('I am good at finding words to describe my feelings'), awareness ('I find myself doing things without paying attention'-reverse), non-judging ('I think some of my emotions are bad or inappropriate'-reverse) and non-reactivity ('I perceive my feelings and emotions without having to react to them'). Participants rate 39 statements on a 5-point scale from never, very rarely, very often or always true. Higher scores reflect greater mindfulness. Good psychometric properties have been reported. (See: *Baer R, Smith GT, Lykins E et al. Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. Assessment 2008; 15: 329–42.)*

Azrin et al, 2011	CD, SUB	**Individual Cognitive Problem-Solving**: based on problem-solving methods to improve self-control and problem-solving deficits. Purely cognitive: Use of the problem-solving steps reinforced (e.g., the youth was praised for generating or selecting a solution, but not for content or social wisdom of the solutions). Problem solving steps included: stop and think, state problem, brain storm solutions, consequences of solutions, pick best option.	**Active control:** Family behavioural therapy (FBT) addressing cognitive, verbal, social, and familial factors that are believed to influence drug use and antisocial behaviour.	**Social Problem-Solving Inventory-Revised** (SPSI-R) a 52-item self-report measure that yields five problem-solving summary scores (i.e., Negative Problem Orientation, Impulse Control Style, Avoidant Style, Positive Problem Orientation, and Rational Problem Style). Lower scores indicate better use of problem-solving strategies for the former three summary scales (NPO, ICS, AS), and higher scores indicate better problem-solving strategies for the latter two scales (PPO, RPS). The revised version was derived from the original SPSI) (See: *D'Zurilla, T. J., Nezu, A. M., & Maydeu-Olivares, A. (in press). Manual for the Social Problem-Solving Inventory-Revised (SPSI-R). North Tonawanda, NY: Multi- Health Systems, Inc)*
Stasiak et al., 2014	MD	**Computerized Cognitive Behavioural Therapy:** fantasy game. User selects avatar, different themes linked to particular content (e.g. cognitive restructuring techniques in Sky and Star Cities). Points for completion and rewarded at the end. Seven modules, each takes 25–30 minutes. Include mood monitoring, quiz, agenda setting, interactive exercises, animations and videos, summary of content and challenge. Paper Guidebook, with summaries, space to write down goals, answers and challenges (CBT education, behavioural activation, problem solving, cognitive restructuring, relaxation)	**Active control:** matched for module length, basic structure as cCBT but different content. (depression education, physical health, friends, time management, stress management, personal fulfilment)	**Adolescent Coping Scale** (short form) comprises 18 behaviours that adolescents use to deal with their concerns. Items are endorsed on a 5-point response scale (doesn't apply or don't do it; used very little; used sometimes; used often; used a great deal). It generates three subscales: Problem Solving, Reference to Others, and Non-Productive Coping. High scores on the Solving the Problem and Reference to Others subscales indicate positive coping strategies, whereas high scores on the Non-Productive Coping subscale indicate a less productive style of coping. (See: *Frydeberg, E. and Lewis, R. (1993). Adolescent Coping Scale Admininistrator's Manual. Melbourne: Australian Council for Educational Research (ACER))*
Jacobs et al., 2016	MD	**Rumination-Focused Cognitive Behaviour** Therapy (RFCBT): 8 weekly 45-60min sessions that target rumination through psychoeducation and adopting functional analytic approach. Noticing rumination triggers, consequences and how to shift to more adaptive strategy such as mindfulness, behavioural activation, or problem-solving. Based on RFCBT for adults with adjustments.	**Assessment only**	**Ruminative response scale (RRS)** is a: 22-item self-report measure, with three subscales: reflection ('Analyse recent events to try to understand why you are depressed'), brooding ('What am I doing to deserve this?) and depression ('Think about how alone you feel') related. The RRS has been shown to be valid and reliable in young adolescent populations. (See: *Treynor W, Gonzalez R, Nolen-Hoeksema S.(2003). Rumination reconsidered : A psychometric analysis. Cognitive Ther Res; 27: 247–259.*)

Livhei m et al., 2015	MD	**Acceptance Commitment Therapy**: Increase psychological flexibility: the ability to contact the present moment, based upon what the situation affords, to change or persist in behaviour in accordance with one's values. ACT uses a unified model through six core processes: defusion, acceptance, flexible attention to the present moment, self-as-context, values, and committed action. These six core processes together make up the construct psychological flexibility.	**Treatment as usual**	**Avoidance and Fusion Questionnaire-Youth,** (AFQ-Y8) 8 items self-report measure to assess psychological inflexibility .Psychological inflexibility is seen in excessive cognitive fusion ('the bad things I think about myself must be true'), and experiential avoidance. The AFQ-Y8 provides a single score with higher scores suggestive of greater inflexibility. Based on original 17 item measure, (See: *Greco, L. A., Baer, R. A., & Lambert, W. (2008). Psychological inflexibility in childhood and adolescence: Development and evaluation of the Avoidance and Fusion Questionnaire for Youth. Psychological Assessment, 20(2), 93–102. doi:10.1037/ 1040-3590.20.2.93*) **MAAS Mindful Attention Awareness Scale** is a 15-item scale designed to assess how attentive a person is of what is taking place in the present, with higher scores indicating higher levels of mindfulness. The scale has been validated in a number of studies and shows strong psychometric properties. (See: *Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. Journal of Personality and Social Psychology, 84(4), 822–848*)
Kaufm an et al., 2005	MD , CD	**Cognitive Behavioural Therapy**: Adolescent Coping With Depression (CWD-A): group intervention that combines cognitive and behavioural strategies targeting problems that commonly characterize depressed youth. Behavioural skills precede cognitive skills. Intervention includes mood monitoring, increasing pleasant activities, social skills, and relaxation training	**Active control**:.Life Skill training (e.g., filling out a job application, renting an apartment), developed to fill a void in the upbringing of many at-risk youths.	Issues Checklist **Problem solving items**. Adolescents completed 18 potential conflict events from the Issues Checklist a measure of the number of parent–adolescent conflicts during the past 2 weeks and the average intensity of discussions regarding these issues (5-point scale ranging from 1 (calm) to 5(angry). (See: *Clarke, G. N., Rohde, P., Lewinsohn, P. M., Hops, H., & Seeley, J. R. (1999). Cognitive–behavioral treatment of adolescent depression: Effi- cacy of acute group treatment and booster sessions. Journal of the American Academy of Child and Adolescent Psychiatry, 38, 272–279.)*
Hannes dottir et	AD HD	**Cognitive Behavioural Therapy:** OUtSMART focuses on teaching children social and emotional skills through cognitive-behavioural techniques and various executive function training components,	**Parent treatment program**: increase parenting self-esteem to reduce child's ADHD symptoms. Parents	**Emotion Regulation Checklist (ERC)** see this Table: Suveg et al. 2017

al., 2017		including computerized working memory training. The latter has never been combined with CBT.	learned about behaviour modification and environmental adjustment	
Meisner-Stedman et al., 2017	AD	**Cognitive therapy** for PTSD: 10 weekly sessions a 90 min. Treatment components included: psycho-education, activity scheduling/ reclaiming life, imaginal reliving, cognitive restructuring, re-visiting the site of trauma, stimulus discrimination with respect to traumatic reminders, direct work with nightmares, image transformation techniques and behavioural experiments The current programme did not include relaxation training or other arousal reduction techniques	**Waitlist**	**Trauma related rumination**: a 3 item self-report measure including: 'I keep wishing that I could go back in time and prevent the event from happening', 'Whenever I think of the event I wonder why it happened to us' and 'I am always wondering if my family or I might get hurt again.' Participants can respond "never," (1) "sometimes,"(2) "often," (3) or "almost always" (4). The measure has been shown to have good internal consistency. (See: *Meiser-Stedman, R., Shepperd, A., Glucksman, E., Dalgleish, T., Yule, W., & Smith, P. (2014). Thought control strategies and rumination in youth with acute stress disorder and post-traumatic stress disorder following single-event trauma. Journal of Child and Adolescent Psychopharmacol- ogy, 24,47–51)*
Latimer et al., 2003	SUB	**Cognitive Behavioural Therapy:** Integrated Family and Cognitive-Behavioural Therapy. Modules (e.g. problem solving therapy) to foster cognitive skills (e.g. executive function-type skills). Three modules delivered to youth in a group format (i.e. Rational Emotive Therapy, Problem Solving Therapy, Learning Strategy Training) and one family therapy module (i.e. Problem-Focused Family Therapy)	**Active control**: Drugs Harm Psychoeducation curriculum (DHPE) by National Institute on Drug Abuse(see http:// www.nida.nih.gov/Info fax/Infofaxindex.html)	**Social Problem Solving Inventory** see this Table: Azrin et al., 2011 or *D'Zurilla, T.J., Nezu, A.M., 1990. Development and preliminary evaluation of the social problem solving inventory. Psychol. Assess. 2, 156-163*
Winters et al.,2012	SUB	**Motivational interviewing**: Session 1 focuses on eliciting information about alcohol and drug use and related consequences, assessing willingness to change. Examining pros and cons of use. Discussing goals. Session 2: progress in achieving goals, identifying high- risk situations, strategies to deal with social situations, willingness to change, negotiating long-term goals	**Waitlist**	**Social Problem-Solving Inventory**: see this Table: Azrin et al., 2011 or *D'Zurilla, T.J., Nezu, A.M., 1990. Development and preliminary evaluation of the social problem solving inventory. Psychol. Assess. 2 (2), 156-163*

Smith et al., 2015	MD	**Computerized Cognitive Behavioural Therapy**: Psycho education about depression and its treatment; behavioural activation; identifying and changing negative automatic thoughts; improving problem solving; improving social skills; relapse prevention. Treatment components are individually delivered via computer in an age-appropriate and appealing way, through the use of secure, interactive multimedia	**Waitlist**	**Child Response Styles Questionnaire** (CRSQ)-This 25-item questionnaire of ruminative thinking style has been shown to predict the severity and persistence of depression in adolescents. (See: *Abela, J. R. Z., Rochon, A., & Vanderbilt, E. (2000). The children's response style questionnaire. Montreal, Canada: McGill University (Unpublished questionnaire)*
Fitzpatrick et al., 2005	MD	**Problem Orientation** unit (35min video) of their skills manual: (a) increasing sensitivity to problems and to encourage an active coping model, (b) focusing attention on positive problem solving thoughts versus rumination and worry; (c) maximizing effort and persistence in the face of setbacks and emotional dis- tress; and (d) minimizing emotional distress while maximizing positive emotions.	**Active control:** Health Education video about general health	**Social Problem Solving Inventory-Revised** see this Table: Azrin et al., 2011 or *D'Zurilla, T.J., Nezu, A.M., 1990. Development and preliminary evaluation of the social problem solving inventory. Psychol. Assess. 2 (2), 156-163*
Hancock et al., 2016	AD	**Acceptance and Commitment Therapy:** ProACTive based on ACT incorporating all six core therapeutic processes. Mindfulness practice each session. Psychoeducation of the ACT model . Values cards supported understanding of the concept of living a valued life. Defusion through experiential exercises. Graded exposure to enhance psychological flexibility. Emphasis was placed on mindful observation and acceptance of anxiety while faced with fear in order to foster committed action in line with self-identified values. Problem solving and social skills were incorporated.	**Waitlist**	**Avoidance and Fusion Questionnaire-Youth**, (AFQ-Y8) See this Table: Liveheim et al., 2015
Afshari et	AD	**Emotion focused CBT**: facilitates the development of both emotion understanding and emotion regulation skills" 12 weekly sessions of approximately 1 h each. Therapists followed a treatment manual. The ECBT condition included	**Waitlist**	**Cognitive Emotion Regulation Questionnaire (CERQ-k):** 36-items with 9 subscales: refocus on planning (positive strategy); rumination (negative strategy); putting into perspective (positive strategy); catastrophizing (negative strategy); positive refocusing (positive strategy); positive reappraisal (positive strategy); acceptance (positive strategy; self-blame (negative strategy); and

al.,2014	core components of CBT (e.g., cognitive restructuring, relaxation, homework, exposure tasks). In ECBT children were engaged in different emotions other than anxiety.	other-blame (negative strategy). The higher the score, the more the strategy is employed. (See: *Garnefski N, Rieffe C, Jellesma F, Terwogt MM, Kraaij V.(2007). Cognitive emotion regulation strategies and emotional problems in 9-11-year-old children: The development of an instrument. Eur Child Adolesc Psychiatry;16,1-9.*) **Children's Emotion Management Scale (CEMS)** see this Table: Suveg et al. 2017

Appendix C: Feasibility Trial

EBPU Evidence Based
Practice Unit

A partnership of

UCL Anna Freud
National Centre for
Children and Families

Information Sheet (Parent/Carer)

EDA: the mental health app for your child

Your child is being invited to take part in a research trial of the app Eda. Before you decide if you and your child will take part, it is important for you to understand why the research is being done and what participation will involve. Please take time to read the following information carefully and discuss it with your child. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Who we are

The Evidence Based Practice Unit (EBPU) is a collaboration between the Faculty of Brain Sciences at University College London, and the Anna Freud National Centre for Children and Families which is a mental health charity. The EBPU carries out research trials to determine whether new interventions, such as the Eda app, might help to support young people's wellbeing.
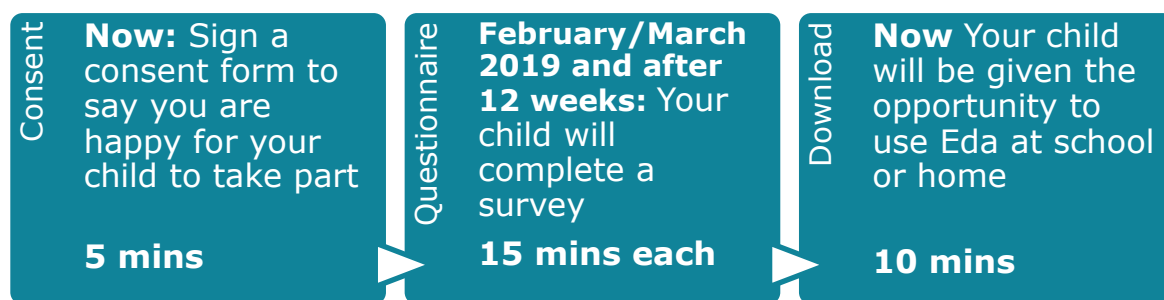
We want to know if Eda helps young people

Eda has been developed for young people to help them learn about their feelings and different tools that they can use when they feel stressed, restless or overwhelmed. To help us find out whether Eda is effective and can be effectively implemented in schools to support children, all children of year 6 are given the opportunity to use Eda for three months. To test its effectiveness all participating children will fill in a questionnaire before and after they have had a chance to use the app.

You are being invited to take part

Your child attends a school taking part in the Eda trial. We are asking for your permission for your child to take part. It is up to you to decide if you and your child will take part or not. Your child is free to withdraw at any time, without giving a reason, and you can choose to return your questionnaire uncompleted. If, after you have taken part, you or your child decide that you want us to remove your responses, you can contact us within 3 months from now and ask us to delete them. You and your child will not be disadvantaged in any way if you decide not to participate in the study.

What will happen if my child and I take part?

Consent	Questionnaire	Download
Now: Sign a consent form to say you are happy for your child to take part **5 mins**	**February/March 2019 and after 12 weeks:** Your child will complete a survey **15 mins each**	**Now** Your child will be given the opportunity to use Eda at school or home **10 mins**

What are the benefits and risks of taking part?

Benefits	Risks
Help shape an app that will benefit young people in the future	No known risks or disadvantages to taking part – if any become known you will be informed straight away
Many people find taking part in research rewarding as they contribute to the development of knowledge	

In the unlikely event that your child become upset whilst completing the survey or using the app, you can stop immediately, and speak to your school's lead for pastoral care and well-being.

All information we collect is confidential

All the information that we collect about you and your child during the course of the research will be kept strictly confidential. We will assign your responses a unique code, and this will appear on any data we collect from you. Consent forms will be kept in their own locked filing cabinet, and responses will be identified only by the unique code we assign to them.

All information we collect from you is strictly confidential, though we may have to break confidentiality in the highly unlikely event that you tell us something that puts you or others at risk. In this unlikely event, we will inform you that there is a need for us to discuss the issue with others, for example someone working in the Power Up research team.

Results of the study will be published, but you won't be identifiable

You and your child will not be able to be identified in any ensuing reports or publications. The anonymised survey results will be shared with the funders of Power Up Plus and your child's school and they will be published in project reports, scientific journals, presented at conferences and disseminated on our website (http://www.ucl.ac.uk/evidence-based-practice-unit). The results will be shared once the last person completes

the research and the results have been analysed. You will not be identified in any report or publication, nor will any data you enter into the app appear in the analysis or report. Please let us know if you would like a copy of the results.

Who is sponsoring and funding the research?

This research is insured and sponsored by University College London. This research is funded by the EU's Horizon2020 Research and Innovation Programme. This research is being carried out by researchers at the Evidence Based Practice Unit.

UCL Ethics Committee has approved the study

All research is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This research has been reviewed and given a favourable outcome by University College London Research Ethics Committee. This research is being funded by the Anna Freud National Centre for Children and Families.

What if something goes wrong?

Contact details:

If you have any questions about research in general, this research in particular, your child's rights as a participant, or would like to report any problem or complaint arising from this research, please contact any of the following:

- Dr. Julian Edbrooke-Childs, Senior Research Fellow.
    - Tel.: 020 7794 2275. Email:Julian.Edbrooke-Childs@annafreud.org

- Ms. Bettina Moltrecht PhD candidate:
    - Tel.: 020 7794 2313. Email: bettina.moltrecht@annafreud.org.

If you feel your complaint has not been handled to your satisfaction University College London (UCL) complaints mechanisms are available to you. You can contact the Chair of the UCL Research Ethics Committee by email to: ethics@ucl.ac.uk

Thank you for taking the time to read this information sheet.

Data Protection Privacy Notice

The data controller for this project will be University College London (UCL). The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk. UCL's Data Protection Officer can also be contacted at data-protection@ucl.ac.uk.

Your personal data will be processed for the purposes outlined in this notice.
The legal basis that would be used to process your personal data will be performance of a task in the public interest. The legal basis used to process special category personal data (i.e., ethnicity) will be for scientific and historical research or statistical purposes
Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible. Only authorised members of the research team will have access to your personal information. The anonymised data set will be kept for 10 years after the end of the project, after which it will be reviewed to determine whether it would be appropriate to delete it.

If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

Your data will not be transferred to third parties.

You will receive a digital copy of this information sheet and consent form at the email address that you have provided to us.

For more information, please read our privacy notice: https://www.ucl.ac.uk/legal-services/privacy/participants-health-and-care-research-privacy-notice

Consent Form (Parent/Guardian for Child)
Eda – the mental health app for your child

Thank you for your interest in taking part in this research study. Please complete this form after you have read the Information Sheet and someone has explained the project to you. We are agreeing that these consent forms with any personal details (such as your child's name) on them will be kept in a locked drawer. We will also keep your questionnaire responses separately from any personal details.

Please tick each box below if you agree with the sentences below:

1. I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction. ☐

2. I consent to my child participating in the study. I understand that my child's personal information *(survey and interview/focus group responses)* will be used for the purposes explained to me. I understand that according to data protection legislation, performance of a task in the public interest will be the lawful basis for processing. ☐

3. I understand that all personal information will remain confidential and that all efforts will be made to make sure my child cannot be identified. I understand that my child's data collected in this study will be stored anonymously and securely. It will not be possible to identify my child in any publications. ☐

4. I understand that my child's information may be subject to review by responsible individuals from the University (to include sponsors and funders) for monitoring and audit purposes. ☐

5. I understand the potential risks of participating and the support that will be available to my child should he/she become distressed during the course of the research. ☐

6. I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study. ☐

7. I understand that I will not benefit financially from this study or from any possible outcome it may result in in the future. ☐

8. I am happy for my child to take part in the above study. ☐

9. I am happy for my child to complete a questionnaire before the start of the study. ☐

10. I am happy for my child to complete a questionnaire in 12 weeks. ☐

11. I am happy for the research team to let the school know I have consented for my child to take part in the study ☐

12. I am happy for my child to be invited to take part in an audio recorded interview or focus group (optional) ☐

If you **do** want your child to take part, please write your name below:

My name   Date   Signature

My child's name

Name of researcher   Date   Signature

Information Sheet (Young person)

Eda

We are asking if you would like to join in with a research project, which is trying to find out what young people think of a new mobile app. The app has been developed for young people to help them learn about their feelings and different tools that we can use when we feel stressed, restless or overwhelmed. You can use the tools within school either with or independently from teachers.

Why are we doing this research?

We want to know whether the mobile app helps young people when they are feeling overwhelmed in class. To find this out, we are asking young people about their experiences when using the app in class.

Why have I been invited to take part?

The school you go to cares about your wellbeing and decided to be part of the project. We will also talk to other young people, parents/guardians and professionals to hear about their opinion about the app.

Do I have to take part?

It is up to you to decide whether you are willing to join the study. We will describe the study and go through this information sheet with you and your parent or guardian. If you agree to take part, we will ask you and your parent/guardian to sign a consent form. You are free to withdraw at any time, without giving a reason. This will not affect your medical care or legal rights. If, after you have taken part, you decide that you want us to remove your responses, you can contact us and ask us to delete them.

What will happen if I take part?

If you decide to take part, you will be asked to complete a questionnaire in class. You will attend classes as usual and you will be able to use the new app on the tablets provided. You will then be asked to complete a questionnaire again three months later. The questionnaire should take no longer than 10 minutes to complete each time.

What are the possible disadvantages of taking part?

There are no known risks to taking part. If any risks become known during the research, you will be informed straight away.

What are the possible benefits of taking part?

There is no guaranteed benefit in taking part. One advantage is that you will get to help developing an app that will benefit young people in future. Most people find taking part in research rewarding, as they contribute to the development of knowledge that may benefit other people in the future.

After the study has ended, all classes in your school taking part in the project will be able to use it further.

Will my taking part in the study be kept confidential?

We will assign you a unique code, and this will appear on any data we collect from them. Consent forms will be kept in their own locked filing cabinet, and questionnaires will be identified only by the unique code we assign to you.

All information we collect from you in the questionnaires is strictly confidential, though we may have to break confidentiality in the highly unlikely event that you tell us something that puts you or others at risk. In this unlikely event, we will inform you that there is a need for us to discuss the issue with others, for example someone working in the school you go to.

What will happen to the results of the study?

The anonymised results will be published in project reports, scientific journals, presented at conferences and disseminated on the Anna Freud website. The results will be shared once the last person completes the research and the results have been analysed. You will not be mentioned as a person in any report or publication.

What happens if something goes wrong?

If you wish to complain, or have any concerns about any aspect of the way you have been approached or treated by members of staff due to their participation in the research, University College London (UCL) complaints mechanisms are available to you. Please ask the researcher if you would like more information on this. In the unlikely event that you are harmed by taking part in this study, compensation may be available.

After discussing with Ms. Moltrecht or Dr. Edbrooke-Childs, please make a claim in writing to the Prof. Miranda Wolpert who is the Chief Investigator for the research and is based at Evidence Based Practice Unit (EBPU), 4-8 Rodney Street, London, N1 9JH. The Chief Investigator will then pass the claim to the Sponsor's

Insurers, via the Sponsor's office. You may have to bear the costs of the legal action initially, and you should consult a lawyer about this.

Who is organising and funding the research?

This research is being carried out by researchers at Anna Freud National Centre for Children and Families and University College London. It is funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 722561.

Who has reviewed the study?

All research is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This research has been reviewed and given a favourable outcome by University College London Research Ethics Committee.

Contact details:

If you have any questions about research in general, this research in particular, your child's rights as a participant, or would like to report any problem or complaint arising from this research, please contact any of the following:

- Prof. Miranda Wolpert, Chief Investigator.
  - o Tel.: 020 7794 2205. Email: Miranda.Wolpert@annafreud.org

- Dr. Julian Edbrooke-Childs, Senior Research Fellow.
  - o Tel.: 020 7794 2275. Email:Julian.Edbrooke-Childs@annafreud.org
- Ms. Bettina Moltrecht, PhD candidate:
  - o Tel.: 020 7794 2313. Email: bettina.moltrecht@annafreud.org.

This research is insured by University College London

Participant Number:

Assent Form (10-12)

Eda

Thank you for your interest in taking part in this research study. Please complete this form after you have read the Information Sheet (or it has been read to you) and someone has explained the project to you.

You are agreeing that:
- You are happy to complete a questionnaire now and in three months
- Take part in classes that may be using Eda
- We will write up your views in a report which will be read by people outside of this study but your name or any information that could identify you will not be mentioned

We are agreeing that these consent forms with any personal details (such as your name) on them will be kept in a locked drawer for the time of the project. They will be securely destroyed after the project.

We will also keep your questionnaire responses separately from any personal details.

Please initial each box below if you agree with the sentences below:

Please initial each box

1. Somebody has explained this project to you
2. You understand what this project is about
3. You have asked all the questions you want
4. Your questions were answered in a way you understand
5. You understand that it is OK to stop taking part at any time
6. You are happy to take part

If you **don't** want to take part, don't sign your name! If you **do** want to take part, please write your name below:

My name   Date

Name of researcher   Date   Signature

EDA Young Person Interview Schedule

Things to remember:

- No interview can begin without a signed parental consent form
- Be flexible with interview or focus group format, depends what YP wants
- Make sure to narrate when showing YP EDA or when YP is drawing responses
- Prizing detail of response not praising responses
- Mention note-taking at beginning of interview
- "I don't know"= could mean that they don't understand question, try rephrasing, or if repeated could mean that they don't want to answer, try checking in about whether they want to carry on with the interview

INTRODUCTION:

"Thank you so much for doing this interview with me. I have a few questions I'd like to ask about your experiences using EDA, there are no right or wrong answers I'm just interested in what you think. If you don't want to answer a question or if it's unclear then just tell me and we can skip it, or I can explain it. We will write up what we find from all of our interviews with young people your age using the EDA app and if you would like a copy of our findings please let your teacher know. Everything that we talk about today is private and confidential unless I'm worried that any harm is going to come to you or to anyone else. In which case I would need to speak to your teacher and my supervisor, whose name is Julian, but I would tell you if I was worried in this way first. You are welcome to stop the interview at any time"

ICE BREAKER

Tell me about pet/favourite football player/last weekend/your class

QUESTIONS

- What do you think about the EDA app?
  - Interesting?
  - Easy/difficult to use?
- What is your favourite thing to do in the Eda app?
  - What is it that you like about this?
  - Can you tell me about a time you used this part of the app?

- What part of Eda do you find most helpful?
  - What is it about this part that helps you?

- How has it helped you? [Feelings or changed behaviour]
- Can you tell me about a time when it has helped you?
- What would you have done if you did not have the app to help?

- What parts of the EDA app do you not like/find unhelpful?
    - How would they change this section/like this section to be different?
    - Is there anything teachers could be doing to help?

- How often have you used the EDA app in school?
    - Didn't use it, one or twice, weekly, daily?
    - Tell me about a time when you used the app in school?
    - Do you know why you and your class used it or didn't use it?

- How often have you used the EDA app at home?
    - Tell me about a time when you used the app in school? What happened?
- How do you feel when you are using the EDA app?

- Can you think of situations in which you would like to access EDA outside of school? i.e. at home, on weekends, while doing your homework, spending time with friends
    - What would be different if you had EDA in these situations?
- Have you ever noticed times where you thought your friends should know about the EDA app?
- Do you think it would help your friends? – If so why or why not?
- Would you recommend EDA to your friends?
- Would you recommend EDA to your family?

CLOSING QUESTIONS:

"Thank you very much again for doing this interview with me today; it's been so helpful to speak to you. Do you have any questions for me now that we've finished the interview? We are going to use these interviews to help us understand how EDA helps young people. Would you like to choose a pseudonym for when we write up our findings? This is another name that we will use for you in our write-up to help ensure that other people don't recognise you"

END INTERVIEW

EDA Teacher Interview Schedule

Confirm that teacher is happy to take part in interview (recorded)

"Thank you so much for doing this interview with me. I have a few questions I'd like to ask about your experiences using EDA, there are no right or wrong answers I'm just interested in what you think. If you don't want to answer a question or if it's unclear then just tell me and we can skip it, or I can explain it. We will write up what we find from all of our interviews with people using EDA and if you would like a copy of our findings please let me know. Everything that we talk about today is private and confidential unless I'm worried that any harm is going to come to you or to anyone else. In which case I would need to speak to my supervisor. You are welcome to stop the interview at any time"

QUESTIONS:

- What do you think about the EDA app?
  - Interesting?
  - Easy/difficult to use?
- What is your favourite part in the EDA app?
  - What is it that you like about this?
  - Can you tell me about a time you used this part of the app?
- What part of EDA do you find most helpful as a teacher/for the children?
  - What is it about this part that seems helpful?
  - Can you tell me about a time when it was helpful to you/the children?
- What parts of the EDA app do you not like/find unhelpful?
  - How would we change this section?
  - Is there anything that we could do to support teachers with using the app?
- How often have you used the EDA app in school?
  - Didn't use it, one or twice, weekly, daily?
  - Can you tell me why you and your class used it or didn't use it? [Remember there is no right or wrong answer]
  - Tell me about a time when you used the app in school?
- Would you recommend using EDA outside of school? i.e. at home, on weekends, while doing your homework, spending time with friends
- Would you recommend EDA to your family/colleagues?

CLOSING QUESTIONS:

"Thank you very much again for doing this interview with me today; it's been so helpful to speak to you. Do you have any questions for me now that we've finished the interview?"

END INTERVIEW