Emotion Regulation in Adolescents:
Influences of Social Cognition and Object Relations –
An ERP study.

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Thesis declaration form

I 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.

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Overview

An ability to regulate one's emotions is considered an important developmental achievement. Failures in emotion regulation are associated with multiple psychopathologies and may be responsible for multiple unfavourable outcomes during a person's life. While this emphasis on emotion has given rise to the "emotion revolution" in empirical research over the last decades, there are still many gaps left in the literature, especially in studying emotion regulation in children and adolescents.

Part 1 of this dissertation is a systematic literature review, which summarises and critically assesses the studies examining the associations between emotion regulation and psychopathologies in middle childhood. It confirms the central role of emotion regulation in various psychopathologies and underlines significant conceptual and methodological difficulties in the field of emotion regulation research.

Part 2 is an empirical research paper that examines the neural-correlates of emotion regulation in adolescents. It also explores whether the individual differences in internal representations of relationships contribute to emotion regulation. The results show that emotion regulation changes the Late Positive Potential in adolescents and that this change is partially associated with age. The results also indicate that the quality of mental representations of relationships is significantly associated with the neural-correlates of emotion regulation. Possible reasons for the findings are suggested, as well as their implications for further research.

Part 3 offers a critical appraisal of this thesis. It describes the challenges of working with an adolescent sample and suggests possible ways of optimising this. It then discusses possible methodological improvements and directions for future research and finally reflects on the potential implications of this thesis for clinical practice.

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Part 1: Literature Review

**Emotion Regulation in Child Psychopathology:
A Review of the Literature**

Abstract

Aims: While rapidly growing evidence indicates that emotion regulation plays a significant and often underlying role in many psychopathologies, there are relatively few studies examining emotion regulation in diagnosed children. This review assesses the studies investigating various facets of emotion regulation in school aged children diagnosed with various psychopathologies. *Method:* A systematic review was conducted to identify studies published in peer-reviewed journals, measuring at least one aspect of emotion regulation in a diagnosed sample. *Results:* 1,588 papers were identified, out of which 24 met the inclusion criteria. *Conclusions:* All the studies reviewed confirmed that emotion regulation is associated with a wide variety of psychopathologies in middle childhood. Several methodological and conceptual difficulties in the literature were identified and discussed, alongside recommendations for future research in the field.

Introduction

One of the crucial elements for children's psychological adjustment and social functioning is emotional competence (Cicchetti, Ackerman & Izard, 1995; Hubbard & Coie, 1994); i.e. the ability to efficaciously function in emotionally arousing situations. Adaptive emotion regulation is considered to be a core feature of emotionally competent, functioning (Campos et al., 1994). Recent years have seen an increased interest in research on emotion regulation in children. This has been a relatively recent phenomenon in experimental psychology, stemming from the last two decades, known as the "affect revolution" (Fischer & Tangney, 1995). As part of the same trend, in the last decade emotion regulation has increasingly become incorporated into various models of adult psychopathology (e.g. Campbell-Sills & Barlow, 2007; Mennin & Farach, 2007; Mennin, Holaway, Fresco, Moore, & Heimberg, 2007). This systematic review focuses on recent findings from studies in this relatively new field, investigating the association between childhood psychopathology and emotion regulation capacity.

Emotion Regulation

Gross's (2007, 1998) influential model of emotion regulation conceptualises emotions as biologically-based reactions, which are brief and malleable, that result in changes in expressive behaviour, subjective experience and physiology. Emotions provide individuals with important information about themselves and their environment.

Emotion regulation can be defined as "extrinsic and intrinsic processes are responsible for monitoring, evaluating and modifying emotional reactions, especially their intensive and temporal features to accomplish one's goals" (Thompson, 1994, pp. 27-28). In other words, emotion regulation represents the variety of strategies an individual may employ to manipulate or modify the physiological, subjective and behavioural aspects of an emotional response. These collectively form the means "by

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which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (Gross 1998, pp. 275). These definitions demonstrate that the notion of emotion regulation involves a broad network of processes, including "all the conscious and unconscious strategies used to increase, maintain, or decrease one or more components of an emotional response" (Gross, 1998a).

Emotion Regulation and Development

There is widespread recognition in the literature that competent emotion regulation is a developmental achievement. It is continuously influenced by the immediate social environment of the child (Sroufe 1979, 1997), and emerges through reciprocal interaction with this environment (Saarni, 1999). The child's ability to regulate his or her emotions is thought to be influenced by the experience of previous interactions with his/her social environment, such as the relationship with parents and in later life with peers (Sroufe, Egeland & Carlson, 1996). Therefore, caregivers play a central role in the development of emotion regulation capacities, especially in the first years of life (Thompson, 2008). In the course of development children become more competent and confident in emotional self-control and gradually develop a widening variety of self-initiated emotion regulation strategies, which they then use in order to meet an increasingly complex set of social and personal goals (Thompson, Lewis, & Calkins, 2008).

Emotion regulation is thought to start developing in infancy (Bridges & Grolnik, 1995). Human infants express emotions from birth and the coherence of these expressions to their environment develops rapidly. During the first years of life adults are the primary agents helping the infant, and then the toddler, to regulate their emotional states. Relational influences, therefore, play an important and central role in

the development of emotion regulation in the first years of life; it is considerably influenced by attachment quality as well as parental psychopathology (Calkins, 1994; Cassidy, 1994; Field, 1994). During this developmental phase the socialisation of emotional displays begins (DeHart, Sroufe & Cooper, 2004). At the same time, development of language and the ability to label emotional experiences allow the toddler to further develop rudimentary self-regulation.

These new skills set in motion the development of a continuously increasing repertoire of cognitive and behavioural strategies used to manage emotions. At preschool age children begin to understand and use display rules: the cultural rules guiding the appropriate or inappropriate expression of emotional states depending on social context (for example, appearing to enjoy a meal and thanking someone for it, even if you did not actually enjoy it). Following increasingly sophisticated display rules, as well as acquiring emotion-regulation skills, helps the child to develop an understanding that the emotions expressed do not necessarily correspond to emotions experienced (Zeman et al., 2006).

These developments continue throughout middle childhood as more sophisticated display rules are explored and more varied and flexible emotion regulation strategies are developed and adjusted to meet the requirements of increasingly complex and demanding social environments. From middle childhood and throughout adolescence the ability to regulate one's emotions continues to increase. Mc Rae and colligues (2012) argue that these developments are related to neural changes in the prefrontal cortex (PFC) occurring in adolescence, as well as with an improved social cognition. These improvements in regulatory capacities indeed continue into adulthood (Zeiman, Cassano, Perry- Parish, 2006).

Difficulties with adaptive emotion regulation skills are generally associated with adverse outcomes, such as difficulties in social competence and in school adjustment (Eisenberg & Fabes, 2006). Developmental deficits in child emotional competence are considered to be closely related to a lack of positive emotional exchange between caregiver and child, failure in appropriate emotional socialisation, as well as other constitutional factors, such as temperament and psychobiological responsiveness (Saarni, 1999). One plausible pathway leading to child behavioural maladjustment and increasing vulnerability to psychopathology is poor emotion-regulation, which may lead to consequent negative feedback from the social environment, resulting in further adaptation failures (Shipman, Zeman, 2001 2001).

Children and adolescents who are able to use emotion regulation strategies flexibly and appropriately tend to have better relationship quality, engage in prosocial behaviour and show higher social competence (Spinrad et al., 2006). Problems with emotion regulation, on the other hand, are thought to be linked to a heightened risk of psychopathology (Cole & Deater-Deckard, 2009; Kring & Sloan, 2010).

Overall, adaptive emotion regulation skills are argued to be a significant protective factor against the development of psychopathology (Beauchaine & Gatzke-Kopp, 2012; Shannon, Beauchaine, Brenner, Neuhaus, & Gatzke-Kopp, 2007). It is also widely accepted that difficulties in the development of adaptive emotion regulation skills are associated with a broad range of forms of childhood psychopathology (Bradley & Lang, 2000; Cicchetti, Ackerman & Izard, 1995). The aim of the present review is to systematically examine the evidence for this association.

Defining Emotion Regulation

As outlined in previous sections of this paper, emotion regulation is a multifaceted phenomenon which stems from the development of a wide variety of behavioural, cognitive and biological systems. It is due to this wide diversity in systems involved in emotion regulation, that it is considered challenging to find a commonly agreed classification of what emotion regulation is and what it is not.

Several terms are used interchangeably with emotion regulation by some authors, and to emphasise a specific aspect of emotion regulation by others. The three most frequently used are: affect regulation, emotional dysregulation and emotional lability. *Affect regulation,* according to Gross & Thompson (2007), is a broader term which includes ER as one of its facets. *Emotional dysregulation* (or *emotional lability*) is sometimes defined as a consequence of failure in emotion regulation (Cole & Hall, 2008). Another way of understanding emotional dysregulation, according to the homeostatic model, is that emotion regulation can be defined as a homeostatic process where emotional arousal is regulated around a temporarily determined setpoint. Emotion dysregulation may reflect a pattern of extreme deviation from this adaptive setpoint (Larsen, 2000). All the above terms were used in the systematic search conducted for the purposes of this review in order to capture the field of emotion regulation research as broadly as possible.

Measuring Emotion Regulation

There are multiple methods by which emotion regulation is measured (Adrian, Zeman, & Veits, 2011). In this section we briefly review these methods.

One group of methods focuses on observation, other report and less frequently self report, aiming to evaluate the overt results of emotion regulation or its failure.

These methods focus on the way, and the frequency, in which emotions are expressed behaviourally. In other words, it is assumed that emotion regulation is based on overt emotion expression. In these studies the term emotion regulation is often used interchangeably with the terms emotion lability or emotion dysregulation.

A further group of methods uses implicit physiological responses thought to be associated with emotion regulation, such as neural activation measured by fMRI or EEG, or changes in sympathetic or parasympathetic activity measured using physiological indicators such as breathing and heart rate changes. These are assumed to indicate whether emotion regulation occurs and at what quality (degree of effort).

Another group of methods is self report through questionnaires or interviews, asking the participants to report on emotion regulation strategies they use in different situations or contexts.

Finally the last group of methods includes experimental protocols attempting to evoke an emotion in laboratory settings and observe or record the ways in which participants regulate those emotions. Sometimes participant receive a specific instruction as to what regulation technique to use in other times they are free to regulate in any way they choose. The studies utilising this protocol use one or more of the measures such as observations, neuroimaging, physiological measures, self report, etc.

While studies using all the above methodologies were included in the present review, there is a significant debate as to which measures are most appropriate in measuring emotion regulation. All the methods discussed are thought to have certain advantages as well as methodological weaknesses (Adrian, Zeman & Veits, 2011): these are presented in more detail in the discussion section of this paper.

Previous Reviews

Recent reviews of developmental emotion regulation research have focused on studies of emotion regulation in childhood aggression (Röll, Koglin, & Petermann, 2012), the normative development of emotion regulation in children and adolescents (Zeman & Cassano, 2006), and issues of measurement and assessment of emotion regulation in children (Adrian, Zeman & Veits, 2011). However, the last comprehensive review focusing on emotion regulation in child psychopathology was published in 2002 by Southam-Gerow and Kendall.

The review emphasised that emotion regulation research in children with diagnosed psychopathology is very scarce, and had mostly relied on research conducted with non-referred at-risk samples. These studies generated preliminary evidence which indicative of the relevance of emotion regulation for psychopathology, but direct evidence was limited. The paper reviewed findings that low emotion regulation in school age children significantly predicted behavioural problems (Eisenberg et al., 1996). Beyond this, it listed evidence that children identified as at high risk for disruptive behaviour disorders, as well as children suffering from maltreatment, appear to have emotion regulation difficulties (Cole at al., 1994; Shields & Cicchetti, 1998).

Other finding reviewed suggested evidence of environmental influences on emotion regulation development and subsequent psychopathology. Listing factors included maternal depression, parental over protectiveness, marital discord and child abuse as predictors of future emotion regulation failure and psychopathology (Zahn-Waxler, Iannotti, Cummings, & Denham, 2008; Gottman & Katz, 1989; Hennessy, Rabideau, Cicchetti, & Cummings, 1994).

The only study reviewed in the Southam-Gerow and Kendall paper that involved a psychopathological sample (Casey et al., 1996) showed that when background anger

was present, children diagnosed with oppositional defiant disorder (ODD) exhibited more negative emotions, while children with attention deficit hyperactivity disorder (ADHD) and major depressive disorder (MDD) exhibited more positive emotions compared to controls. It was suggested that, while emotion regulation appeared to be particularly difficult for ODD children, ADHD and MDD children also exhibited deficits in emotion regulation, but used a different strategy (for example, using some form of expressive suppression to hide their feelings). It was suggested that children with MDD overregulated their emotional expression, while children with ODD struggled with regulating the expression of negative emotions.

The overall conclusion of the review was that while there was substantial evidence suggesting that certain patterns of emotion regulation in children are related to psychological disorder, the very limited number of studies of emotion regulation in populations with diagnosed psychopathology did not allow any firm conclusions to be drawn regarding this relationship. The review also identified a tendency to use narrow conceptual models in the study of emotion regulation, which resulted in missing the heterogeneous nature of emotion regulation development. It called for a further integration of biological, social, cognitive and developmental research as well as further conceptual clarification of the definition of emotion regulation (Southam-Gerow & Kendall, 2002).

Objectives of the Current Review

In the last decade the majority of research on emotion regulation has been conducted using normative samples, and past reviews of the subject inevitably reflect that tendency. The objective of this paper is to review research on emotion regulation in children with psychopathology that has been conducted in the last decade. The key question motivating this review is a) whether emotion regulation is associated with

psychopathology in general, b) whether certain forms of psychopathology are more clearly linked to problems with emotion-regulation and c) whether specific aspects of emotion regulation are most important in children's psychopathology?

This review focuses on children aged five to 12: this age range was chosen as this is the peak age for identification of many internalising and externalising disorders. In this period children meet new demands for emotion regulation associated with socialisation to the school environment, increased peer relationships, examinations, etc. This cut-off also allows to focus on children that are old enough to be expected to self-regulate by their surroundings, whilst avoiding the confounds of adolescence such as puberty, substance abuse, etc. (Musser et al., 2011). It is also worth mentioning that children of preschool age tend to present with quite different profiles of emotional and behavioural disturbance than school-aged children or adolescents. Therefore, while an early diagnosis is often a predictor of psychopathology risk in later childhood (Campbell et al., 2000), it is nevertheless very difficult to compare this age group to school age children based on psychopathology.

Methods

Literature Search

For the purpose of this review, a systematic search of articles published between 2002 and May 2014 was conducted using Embase, Medline and PsycInfo databases. The search included every combination of several keywords related to the age of the participants, emotion regulation and psychopathology across all search fields (title, abstract, keywords): Child* (all iterations of root), youngster, young person, psychopathology, mental health, disorder, emotion regulation, affect regulation, emotional dysregulation and emotional lability. The OvidSP online searching platform was used to collate and de-duplicate the articles identified. Only articles published in the English language were included. The database search was supplemented by searches on Google Scholar using the above search terms, as well as checking the reference sections of key articles published in the field and of the articles shortlisted for the review. See

Figure **1** for details.

Inclusion/Exclusion Criteria for the Review

A study was included if it reported on a sample of children aged 5 to 12 with any form of psychopathology (whether diagnosed or scoring above the clinical threshold on a continuous checklist) and reported at least one relationship to emotion regulation, regardless of the general aim of the study.

The review utilised the following exclusion criteria. Studies were excluded if they were not published in peer-reviewed journals in order to increase the likelihood of reviewing studies of acceptable quality. Studies that reported on pharmacological or psychotherapy outcomes were excluded. Studies were excluded if they reported on children diagnosed with intellectual disabilities, autistic spectrum disorder (ASD) or

physical illness due to the focus here on common childhood mental health problems rather than physical health or neurodevelopmental disorders. Studies that reported on mixed age ranges but included the age range of interests (e.g. 9 to 17) were only included if the results regarding the age range of interest were reported separately.

Applying the above criteria resulted in 24 studies retained for qualitative synthesis in the present review (see Table 1). Emotion regulation was assessed by a variety of measures including self-report, other report, observations, experimental protocols, neuroimaging or physiology. Psychopathology was assessed through self-report, other report or diagnostic interview.

For the purposes of the qualitative synthesis, the studies were grouped based on the main domain of psychopathology reported in the sample. This resulted in: 7 studies on anxiety disorders, 7 studies on attention deficit hyperactivity disorder (ADHD), 4 studies on oppositional defiant and conduct disorders (ODD/CD), 2 studies on depression, 2 studies on eating disorders and finally 2 studies that used psychopathology samples but grouped them based on symptoms rather than diagnostic criteria.

The quality of all the included articles was assessed using the standard quality assessment criteria for evaluating primary research papers (Kmet, Lee, & Cook, 2004), see Table 1 for the quality ratings.

Identification

Papers identified via database search (n=1588)

Papers identified via additional sources (n=18)

Screening

Papers after screening for duplicates, non-English, non peer reviewed, pre-2002 (n=1100)

Papers excluded (n=506)

Papers after abstracts screened (n=67)

Papers excluded (n=1033)

Eligibility

Papers after full text assessed for eligibility (n=55)

Papers excluded (n=12)

Inclusion

Papers retained for qualitative synthesis after detailed eligibility assessment (n=24)

Figure 1. Paper selection and screening process

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Table 1. Characteristics and key results of studies included in the review

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Anastopoulos et al., 2011	ADHD (265), Siblings without ADHD (93) 8.7 years	ADHD	C-DISC-IV, CRS-R, BASC-2	CRS-R	Other report (questionnaire)	15/22	Children diagnosed with ADHD had higher levels of emotional lability. Emotional lability partially mediated association between ADHD and functional impairment, comorbidity, and treatment service utilization.
Beauchaine T.P. Gatzke-Kopp L. Mead H.K., 2007	Boys with Conduct Problems (23), Control (17) 8-12 years	ODD/CD	CBCL	RSA	Physiological (parasympathetic activity)	11/22	Children with ODD/CD display significantly lower vagal tone at baseline compared to controls, while both groups show similar decrease when exposed to emotional stimuli.
Berlin, Bohlin, Nyberg, & Janols, 2010	ADHD boys (21), Control (42) 8.3 and 8.4 years	ADHD	CRS, 5-15	CPT, Parental Rating scale	Experimental, other report (questionnaire)	20/22	Emotion regulation was found to be a significant independent predictor of belonging to the ADHD versus control group.

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Czaja, Rief, & Hilbert, 2009	Binge eating (60) Control (60) 10.6 and 10.9 years	Loss of Control (LOC) eating	ChEDE	FEEL-KJ	Self report (questionnaire)	18/22	Children with LOC used dysfunctional emotion regulation strategies more often than controls, especially for regulation of anxiety.
Duncombe, Havighurst, Holland, & Frankling, 2012	Boys (276), Girls (97) 7.02 years	Disruptive behavior	SDQ, ECBI	ERC,SCST	Other report (questionnaire)	19/22	Inconsistent discipline, negative parental emotional expressiveness, and parents' mental health were strongly related to problems of emotion regulation.
M. Duncombe, Havighurst, Holland, & Frankling, 2013	Boys (137), Girls (54) 7.81 years	Disruptive behavior	SDQ, ECBI	ERC, KAIR	Other report (questionnaire), Structured interview	19/22	Deficits in emotion regulation and cognitive flexibility are related to symptoms of disruptive behavioral according to parental report.

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Goldschmidt, Tanofsky-Kraff, & Wilfley, 2011	Obese females with binge eating (23), no binge eating (23), 10.5 years	Binge eating	ChEDE	Buffet meal task	Experiment	18/22	Girls in the binge eating group consumed more energy from fat in the set condition. Their baseline mood predicted the likelihood of loss of control eating during the sad condition meal.
Hulvershorn et al., 2014	ADHD high emotional lability (18) 9.9 years, ADHD low emotional lability (19) 9.5 years, Controls (19) 10.5 years	ADHD	K-SADS	CPRS-R-L EL (J) scale	Parent report (questionnaire), Neuroimaging (fMRI)	17/22	In children with ADHD, deficits in emotion regulation were associated with altered amygdala-cortical intrinsic functional connectivity. These differences appeared to be due to emotional lability and not the ADHD diagnosis.
Hum, Manassis, & Lewis, 2013	Clinically anxious (29) 10.31 years, Control (34) 10.14 years	Axis 1 anxiety disorders	MASC, STAIC-S	Experimental go no-go task	Neuroimaging (EEG)	18/22	Anxious children showed increased cortical activation for both emotional and go no-go stimuli.

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Jacob et al., 2012	OCD (26) 10 years, Other anxiety disorders (31) 9.84 years	OCD	Diagnostic interview by based on DSM IV.	ERC	Self report (questionnaire)	15/22	Children diagnosed with OCD had poorer emotion regulation skills compared to the children with GAD, SoP and SAD diagnoses.
Keenan, Hipwell, Hinze, & Babinski, 2009	Girls with one or more depression symptoms (148), Girls with no symptoms (84) 9 years	Depression	K-SADS-PL,	CSMS/CAMS, EESC, observed family problem-solving task	Self report (questionnaire), observation	16/22	Differences in inhibited expression of negative emotions explained more variance in the depressive symptoms then the disinhibited expression.
Legerstee, Garnefski, Jellesma, Verhulst, & Utens, 2010	Anxiety disorders (131) 9.91 years, Control (452) 9.66 years	Anxiety disorders	ADIS-C	CERQ-k	Self report (Questionnaire)	20/22	Children with an anxiety disorder reported using more catastrophizing and rumination, and less positive reappraisal and refocus on planning, than the non-anxious children.

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Musser E.D. Galloway-Long H.S. Frick P.J. Nigg J.T., 2013	ADHD low prosocial (21) 8.13 years, ADHD (54) 8.10 years, Control (75) 8.11 years	ADHD	KSAD-S-E	Emotion induction and suppression task, RSA, PEP	Experimental / Physiological (parasympathetic/ sympathetic activity)	20/22	The ADHD group displayed atypically higher emotion dysregulation during positive induction of emotion. ADHD low prosocial displayed atypically lower emotion dysregulation across all conditions.
Musser et al., 2011	ADHD (32) 7.9 years, Control (34) 8.12 years	ADHD	KSAD-S-E	Emotion induction and suppression task, RSA, PEP	Experimental / Physiological (parasympathetic/ sympathetic activity)	19/22	Typically developing children showed a systematic variation in parasympathetic activity depending on the valence and emotion regulation condition. ADHD children displayed stable elevated activity across all conditions and tasks.
Pagliaccio et al., 2012	PO MDD (24) 9.8 years, Control (31) 9.7 years	Pre-school onset of major depressive disorder	PAPA/CAPA	Emotion induction task	Experimental (neuroimaging fMRI)	20/22	History of preschool depression associated with decreased prefrontal cortex activity during induction and regulation.

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Pang & Beauchaine, 2013	Conduct disorder (30), Depression (28), Comorbid (80), Control (69) 9.9 years	Conduct disorder, depression, comorbid CD and depression	DISC	Emotion inducing video, RSA	Physiological (parasympathetic activity)	14/22	CD and depression comorbidity significantly predicted reduced parasympathetic activity when exposed to sad stimuli.
Posner et al., 2013	ADHD (22) 10 years, Control (20) 10.5 years	ADHD	K-SADS	Resting state scans, Conners parents ADHD rating scale	Neuroimaging (fMRI) / other report (questionnaire)	20/22	Children with ADHD had a reduced connectivity in neural circuits underlying emotional regulation.
Raval, Martini, & Raval, 2010	Externalising (32), Internalising (31), Somatic complaints (25), Control (32). (Indian sample) 6-8 years	Externalising, internalising, somatic.	CBCL-GA	Child emotion vignettes	Self-report (structured interview)	15/22	Internalising children reported expression of sadness and externalising expression of anger as uncontrollable. The somatic group reported use of withdrawal more than others.

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Rosen, Epstein, & Van Orden., 2013	ADHD (11) 9.45 years	ADHD	Previous diagnosis	ERC/EMA protocol	Other report	14/22	Higher mood variability was associated with increased emotion dysregulation.
Roy et al., 2013	Impairing temper tantrums (51) 6.59 years, Control (24) 6.71 years	Impairing temper tantrums	OMS	Balloons Game	Experimental (facial expression coding)	20/22	Children with outbursts exhibited fewer positive expressions in response to success and exhibited deficits in their ability to regulate negative expressivity.
Suveg et al., 2008	Anxiety disorder (28) 10.1 years, Control (28) 10.04 years	Anxiety disorder	ADIS-IV-C/P	Emotion discussion task	Observation	19/22	Children with anxiety disorder used less problem-solving emotion regulation strategies when discussing feeling anxious or angry.

Author	Sample / N / Mean Age	Symptom / Pathology	Measures Psychopathology	Measures ER	Measure Type	Quality Rating	Results Summary
Suveg & Zeman, 2004	Anxiety disorder (26) 10.45 years, Control (26) 10.54 years	Anxiety disorder	ADIS-IV/RCMA/	CEMS/ERC/ERI	Self-report / other report (Questionnaire and interview)	20/22	Children with anxiety disorders had difficulty managing worry, sadness and anger, reporting experiencing these emotions of high-intensity and little confidence in their ability to regulate them.
Tan et al., 2012	Anxiety disorders (65) 10.9 years, Control (65) 10.41 years	Anxiety disorders	K-SADS-PL	EMA	Self-report (interview)	20/22	Anxious children felt more upset than controls after using rumination and were less able to use emotion regulation to down regulate negative emotions.
Trosper & Ehrenreich May, 2010	Anxiety disorder (112 including adolescents) 8-12 years	Anxiety disorders	ADIS-C/P/MASC	EESC	Self-report (questionnaire)	15/22	Negative emotional response to frustration and threat predicted more severe anxiety in anxious children compared to anxious adolescents.

Notes: ''5–15'': Parent and Teacher Rating of ADHD Symptoms; ADIS-C: Anxiety Disorders Interview Schedule for Children; BASC-2: The Behavior Assessment System for Children–Second Edition; CAPA: Childhood and Adolescent Psychiatric Assessment; *CBCL: Child Behavior Checklist;* CBCL-GA: Child Behavior Checklist-Gujarati Adaptation; C-DISC-IV: Computerized Diagnostic Interview Schedule for Children, Fourth Edition; CEMS: Children's Emotion Management Scales; CERQ-k: Cognitive Emotion Regulation Questionnaire; ChEDE: Eating Disorder Examination adapted for Children; CPT: Continuous Performance Task; CPRSR:L: Conners' Parent Rating Scale–Revised, Long Version. Emotional Lability (J Scale); CSMS/CAMS: Children's Sadness/Anger Management Scale; CRS: Conners Rating Scale; DISC: Diagnostic Interview Schedule for Children; DuPaul Barkley ADHD rating scale; ECBI: Eyberg Child Behavior Inventory; EESC Emotion Expression Scale for Children; EMA: Ecological Momentary Assessment; ERC: The Emotion Regulation Checklist; ERI: Emotion Regulation Interview; FEEL-KJ: German Questionnaire Assessing Children's and Adolescents' Emotion Regulation Strategies; K-SADS-PL: Schedule for Affective Disorders and Schizophrenia for School- Age Children-Present and Lifetime Version; KAIR: Kusche Affective Interview–Revised; MASC: Multidimensional Anxiety Scale for Children; OMS: Outburst Monitoring Scale; PAPA Preschool-Age Psychiatric Assessment; PEP: Cardiac Pre-ejection Period; *RCMA: Revised Children's Manifest Anxiety Scale;* RSA: Respiratory Sinus Arrhythmia; SDQ: Strengths and Difficulties Questionnaire; SCST: The Social Competence Scale—Teacher Version; STAIC-S: State-Trait Anxiety Inventory for Children.

Results

Anxiety (7 studies)

Adult studies have demonstrated that individuals diagnosed with anxiety have disrupted emotional processing, such as difficulty in using effective emotion regulation strategies, heightened negative emotional reactivity and frequent use of avoidant behaviour (Salters-Pedneault, Roemer, Tull, Rucker, & Mennin, 2006). A similar tendency in anxious children is often explained by a positive bias towards signs of danger: i.e. interpreting ambiguous stimuli negatively. In terms of emotion regulation, this response may be viewed as an excessive reliance on unhelpful regulation strategies, or on poor attentional disengagement to threat cues, that may make these children susceptible to social and cognitive avoidant behaviours when exposed to emotion-inducing situations (Perez-Edgar et al., 2010; White, McDermott, Degnan, Henderson, & Fox, 2011). Therefore emotion regulation has become the focus of increased attention in childhood anxiety research (Hannesdottir & Ollendick, 2007).

Suveg and Zeman (2004) examined emotion regulation among anxious children and healthy controls, particularly in relation to managing experiences of worry, sadness and anger using self and other repot. Children with anxiety disorders were found to report significantly more dysregulated expression across all emotional states compared to controls. They also reported more inhibition of worry. Children with anxiety disorders were also found to use less adaptive emotion regulation strategies then controls across all the negative emotions studied. Convergent evidence for those findings came from reports by the children's mothers. Mothers of children with anxiety disorders perceived their children as more inflexible, emotionally negative and less capable of appropriate emotion expression. It was also found that children with anxiety disorders had a lower sense of self efficacy in managing all emotional states explored. It

was suggested that a lower sense of self efficacy may be associated with difficulties in emotion regulation, as children with low self efficacy tend to be less likely to try various emotion regulation strategies flexibly when in arousing situations (Bradley, 2000). It is possible that these deficits in self efficacy form part of the explanation for why anxious children tend to avoid or withdraw from emotionally arousing situations (Barrett, Rapee, Dadds, & Ryan, 1996).

Another self-report study by Legerstee and colligues, (2010) found that children with anxiety disorders tended to use strategies of catastrophizing and rumination significantly more often than the non-anxious children. They reported using positive reappraisal and refocus on planning significantly less often than the non-anxious group. Most of the variance between the groups was explained by rumination and positive reappraisal. These results seem to suggest that children with anxiety disorders spend more time thinking about negative life events and tend to be more focused on the negative aspects of their experiences, which may suggest difficulties with the disengagement of attention of negative emotional stimuli and experiences (Derryberry & Reed, 2002) They are also less likely to use cognitive reappraisal, attributing positive meanings to negative life events in terms of personal growth, or think about what steps they can take to handle negative events.

Similar findings by Suveg and colligues (2008), in a study observing family interactions while performing an emotion discussion task (coded for emotion regulation), showed that children with anxiety disorders were significantly more likely to use maladaptive emotion regulation strategies in response to situations evoking anxiety and anger. The study also showed that parents of children with anxiety disorders were not as effective in emotionally socialising their children compared to parent of non-anxious children. It is suggested that if parents are not providing sufficient

emotional facilitation, children are less likely to learn to use adaptive emotion regulation strategies. The authors speculate that child emotion dysregulation might mediate the relationship between insufficient emotion socialising parenting and child anxiety. This is consistent with the argument that parents influence children's emotional development through discussing and expressing emotions within the family context and by directly responding the child's emotions, thus explicitly and implicitly teaching the child to express and regulate his or her emotions (Eisenberg, Cumberland, & Spinrad, 1998). A study with a larger sample of children can attempt to substantiate this hypothesis.

Further addressing the use of emotion regulation strategies in a study using ecological momentary assessment, Tan and colligues (2012) asked the anxious children and controls to identify their reactions to negative events that occurred within the last hour, using a brief structured interview (sampled across five days on 14 separate occasions). The researchers asked the children to choose between six emotion regulation strategies: distraction, cognitive restructuring, problem-solving, acceptance, avoidance and rumination (Connor-Smith et al., 2000; Silk, Steinberg, & Morris, 2003). The anxious children reported experiencing more frequent physiological reactions in response to negative events. The use of rumination predicted higher levels of feeling upset in anxious children, who also found the use of acceptance significantly less effective in down regulating negative emotions. This suggests that anxious children were less able to effectively use emotion regulation strategies to down regulate negative emotions. Anxious children reported a more intense peak in negative emotions, but did not differ from the control group in their report of the frequency of momentary negative emotions. This suggests that, contrary to what is assumed, anxious children do not experience more frequent or more intense momentary negative emotions in their day-to-day lives. The authors suggest that the more intense peak reaction amongst anxious

children can be explained by differences in physiological responding: confronted with a negative situation, anxious children did not report higher levels of negative emotion, but did report more frequent physiological responses. This interpretation is consistent with previous findings, indicating a heightened anxiety sensitivity (excessive sensitivity to anxiety related sensations and the subsequent fear of anxiety) frequently found in children with anxiety disorders (Kashdan, Zvolensky, & McLeish, 2008). This study provided a novel and possibly more ecologically valid way of measuring emotion regulation, but unfortunately it did not use any of the other more established emotion regulation measures to enable examining the findings in the context of the existing body of research.

In a similar vein, the self-report study by Trosper and Ehrenreich May (2010) found that for anxious children more negative emotional responses to frustration and threat were associated with more severe anxiety compared to an anxious adolescent group (13-17) in the same study. While the authors suggested the findings to be indicative of emotion regulation processes, it was not clear how the association was established. It is also difficult to contextualise the findings of the study as it used no control group and the differences between the child and adolescent groups were not clearly outlined.

In a study utilising neuroimaging techniques (EEG) Hum, Manassis and Lewis (2013) examined the difference in neuro-correlates of emotion regulation between anxious children and controls. Previous studies determined that several event-related potential (ERP) components are associated with different phases of emotion regulation (Dennis, 2010). The P1 component indicates visual perception, attention and arousal, while the frontal N2 component is considered an indicator of response inhibition, reflecting regulatory processing. When performing a go/no-go task, which involved

looking at human faces with different emotional expressions, clinically anxious children had significantly higher P1 amplitudes compared to the control group. The fact that there was no effect of emotion type on this suggested heightened attention to facial stimuli regardless of the emotion expressed. Conversely, children in the control group showed higher activation in response to angry faces compared to calm and happy faces. The authors suggested that anxious children had a greater N2 amplitude which also was not differentiated between different emotions, suggesting that the anxious children devoted more resources to emotion regulation. These findings also suggest that while the control group was able to differentially allocate cortical resources depending on the stimulus type, anxious children were equally aroused by all facial stimuli regardless of their valence. The authors argue that anxious children use an emotion regulation style which is indiscriminate and over-generalised, requiring excessive self-monitoring with little sensitivity to the demands of the situation. Alternatively, it is possible that the anxious group was more sensitive to the experimental condition and displayed elevated anxiety associated with the demands of the task. While the findings of this study appear to be relevant to emotion regulation, it is unclear to what extent the results indicated difference in emotional experience, general level of anxiety or, indeed, differences in emotion regulation. The methodological issue associated with the use of physiological indicators as equivalents of emotion regulation/generation is common to most studies which use EEG, fMRI, RSA and PEP reviewed by the present paper. This issue is discussed in more detail in the discussion section.

Jacob et al. (2012), in the only study that focused on a specific anxiety disorder as opposed to a more general grouping, using self report, found that children diagnosed with obsessive compulsive disorder (OCD) reported significantly poorer emotion regulation compared to children diagnosed with other anxiety disorders. The study suggests that alongside oppositionality, cognitive problems and parent disability, also

examined as part of the research, emotion regulation appears to be one of the key features differentiating OCD from other anxiety disorders in childhood. The findings are consistent with adult studies suggesting that people diagnosed with OCD frequently use ineffective regulation strategies in dealing with emotions, for example self punishment or thought suppression (Abramowitz, Whiteside, Kalsy, & Tolin, 2003). It is suggested that children with OCD would be less tolerant to emotional experiences due to the intrusive nature of the obsessions and compulsions, and thus be more likely to engage in maladaptive emotion regulation strategies. The study did not use a control group of children with no anxiety disorders and had a relatively small sample size, thus making the picture somewhat incomplete.

Overall, the findings suggest that anxious children tend to use more maladaptive and less adaptive regulation strategies in response to negative life events. These findings seem to replicate a similar trend seen in anxious adults and adolescents (Garnefski et al.,2002) . It also appears that they are more likely to experience greater levels of sensitivity to negative affect but also to affective states in general and as a result, even when they do use adaptive regulation strategies, they are possibly using them ineffectively. Most of the studies reviewed in this section grouped anxiety disorders into one cluster and therefore only explored emotion regulation deficits common to the entire cluster. The findings of Jacob et al., (2012) indicate the need to study more diagnostically specific emotion regulation deficits, which require larger samples and possibly more sensitive research methodologies.

ADHD (7 studies)

Deficit in one's ability to effectively regulate emotional arousal impedes children's ability to flexibly adapt behaviour to environmental demands and act in situationally appropriate ways in situations evoking negative emotions (Denham, 1998).

In Gross's (1998) model of emotion regulation, attention control plays an important role in the ability to regulate one's emotions. Therefore individual differences in attention may have a significant impact on the ability to use emotion regulation techniques (Denham, 1998).

Children with ADHD are vulnerable to developing significant impairments in various domains of daily functioning (Barkley, 2006) and are predisposed to internalising (Biederman, Mick, & Faraone, 1998; Tannock, 2000) and externalising difficulties (Angold, Costello, & Erkanli, 1999; Cunningham & Boyle, 2002; Jensen, Martin, & Cantwell, 1997). Previous findings show that children with ADHD have difficulties in regulating their emotions (Braaten & Rosén, 2000; Cole, Martin, & Dennis, 1994; Martel, 2009). Nigg (2006) argued that emotion regulation difficulties are central to understanding the development of ADHD from early childhood.

Difficulties with emotion regulation are considered to be one of the key features associated with this disorder (Faraone, Biederman, Weber, & Russell, 1998; Nigg & Casey 2005). In the ADHD literature, the symptoms of temper outbursts, irritability, decreased frustration tolerance, etc, are interchangeably referred to as deficient emotion regulation, emotion impulsivity, emotional lability, emotional dysregulation, etc. It is also argued that deficits in regulation associated with the functioning of the prefrontal regions of the brain are responsible for the behavioural, cognitive and emotional symptoms of ADHD (Arnsten, 2009).

In line with the above, Berlin, and colligues (2010) found, that emotion regulation (alongside interference control and time reproduction) appeared to be a significant independent predictor of ADHD diagnosis. The study was conducted using a continuous performance task to evaluate the child's ability to adjust arousal and parent report of the child's emotion regulation, comparing children diagnosed with ADHD and

controls. Even when parental report was excluded from the analysis, discrimination between the two groups in terms of emotion regulation capacity was still evident.

Using ecological momentary assessment, Rosen, Epstein and Van Orden (2013), confirmed that in childern with ADHD more intense arousal and variable moods were associated with higher emotion regulation difficulties. These findings can only be used as a confirmation of an establish association due to the lack of a control group and a small sample size.

In another study Anastopoulos and colligues (2011) used parent report to compare childeren with ADHD with their undiagnosed siblings in their ability to self-regulate emotions. It was found that in both groups high levels of emotional lability were significantly associated with both functional impairment and psychopathology comorbidity (e.g. anxiety, depression, aggression and conduct disorder). Children with ADHD showed higher levels of emotional lability and functional impairments, as well as various comorbidity outcomes compared to non-diagnosed siblings. Furthermore, emotional lability mediated the association between ADHD and all adverse outcomes. The findings also suggested that some of the difference in adverse outcomes between the various ADHD subtypes (combined, inattentive, hyperactive impulsive) are partially accounted for by differences in emotional lability. Children with the combined type had greater emotional lability than the other two subtypes. In addition, increases in emotional lability were associated with multiple treatment utilisation including medication, parent training and individual therapy. This suggests that children with greater emotional lability required significantly more professional support and clinical input. As this study used non-diagnosed siblings as a control group the generalizability of the result is somewhat questionable, as the interplay between shared environment and emotional lability is not clear.

It is suggested that emotion regulation and social affiliation are closely related to parasympathetic activity, specifically the functioning of the vagal network, which facilitates the deployment of higher order behaviours that are considered more beneficial in facilitating complex social behaviour. Multiple studies have suggested that deficiencies in the functioning of the vagal network are associated with an increased risk of psychopathology in children and adults (Beauchaine, 2001; Crowell et al., 2006.; Rottenberg, Wilhelm, Gross, & Gotlib, 2003; Schmidt, Fox, Schulkin, & Gold, 1999). Respiratory sinus arrhythmia (RSA) is used as an index of parasympathetic control of the heart through the innovations of the vagus nerve (Berntson, Cacioppo & Quigley, 1993). The RSA is frequently associated with emotion regulation (Beauchaine, 2001; Berntson et al., 1997).

In a study which used RSA as a measure of emotion regulation, Musser and colligues (2011) compared children with ADHD to controls: both were required to perform emotion regulation tasks while watching video clips. The four conditions included, induction and suppression of both positive and negative emotional responses. Children with ADHD showed higher parasympathetic activity compared to controls across all emotion regulation conditions. Children from the control group showed a differentiated parasympathetic activity depending on both emotion valence and emotion regulation strategy used, showing higher activation for negative emotions and for suppression. There were no differences in PEP between the two groups, as indicated by cardiac pre-ejection period (PEP) (Beauchaine, 2001; Berntson et al., 1997). As autonomic functioning did not differ between the groups during baseline and emotional neutral conditions, these findings seemed to show that children with ADHD tend to display an inflexible and inefficient parasympathetic response, not only when suppressing emotions but also when regulating emotions in general. The findings are in line with the suggestion that externalising behaviour in children with ADHD is related

to inflexible parasympathetic responding at times of negative emotion induction (Beauchaine et al., 2001; Calkins, 1997). They are also consistent with clinical observations that children with ADHD often fail to adapt their emotional reactivity to contextual demands. Unfortunately the sample size of the study did not allow differentiating between ADHD subtypes, which are often considered to differ in their profile of emotion regulation difficulties (Sonuga-Barke, 2002).

Using the same paradigm, Musser and colligues (2013) compared children with ADHD and ADHD with callous unemotional (CU) traits to a group of typically developing controls. Consistent with the previous study, children with ADHD had an elevated parasympathetic activity (RSA) which is thought to be associated with emotion dysregulation, during positive induction, suggesting that additional regulatory efforts were required for dealing with positive emotions. As opposed to the previous study, they also displayed an increased sympathetic activity (PEP) indicating elevated arousal across all emotion regulation conditions. Children with ADHD and CU, on the other hand, had dampened parasympathetic and sympathetic activity at baseline and across all the emotion regulation conditions. Overall the study suggests that differences in emotion regulation serve an important role in understanding the heterogeneous nature of ADHD.

Neurological studies to date seem to indicate that emotion regulation capacity is dependent on an interaction between multiple cortical and subcortical systems, each of which has a unique developmental trajectory. Each of these systems become effective during different stages of development, forming a unique interactive matrix that supplies children with a range of habits of emotional expression, appraisal and regulation, which in some cases can make them vulnerable to developing

psychopathology (Thompson et al., 2008). The neural mechanisms of ADHD specifically involved in emotional symptoms are relatively unstudied.

A neuroimaging (fMRI) and parent report study by Hulvershorn and colligues (2014) comparing children with ADHD to controls, found that intrinsic functional connectivity (iFC) of a cortico-amygdalar network was associated with emotional lability. In children with ADHD, high emotional lability was associated with increased positive iFC between amygdala and bilateral insula, suggesting a disruption in the neural network associated with emotional control in the subset of children diagnosed with ADHD and displaying high emotional lability. The amygdala iFC in children with ADHD and low emotional lability was the same as that of a control group, supporting the suggested relationship between amygdala iFC and emotional lability. The study accounted for both inattention and hyperactivity and seems to suggest that the patterns reported were specific to emotional lability and not to other symptoms of ADHD. Overall the study suggests that elevated positive amygdala-PFC (prefrontal cortex) connectivity (iFC) is associated with emotion regulation difficulties. This study did not examine children without a diagnosis of ADHD and high emotional lability; therefore it is unclear to which extent the neurological differences between the groups are specific to children diagnosed with ADHD or are possibly transdiagnostic and related to emotional lability across disorders. Furthermore, the study relied exclusively on parental report, not detailing whether an emotion regulation task was performed in the scanner.

Elaborating on this, a different neuroimaging (fMRI) and parent report study by Posner and colligues (2013) also found that children with the ADHD had abnormal functional connectivity in emotion regulation circuits. It was found that emotional lability increased as the connectivity between the ventral striatum and orbitofrontal

cortex decreased. This reduced connectivity was significantly associated with measures of emotional lability, but was not associated with abnormalities in the executive attention circuits reported in the same study. It may be argued that this reduced connectivity underlies the difficulty children with ADHD have regulating emotions, leading to an increased emotional lability. The authors also suggest that this reduced connectivity may not be unique to ADHD and may underlie emotion regulation difficulty across various diagnoses.

The dual pathway model of ADHD (Sonuga-Barke, 2002) suggests that the key deficits in children with ADHD are not only associated with executive attention, but for some children are predominantly to do with neurocognitive deficits in motivation and emotion regulation. The affected emotion regulation system described in this model is subserved by frontolimbic circuits which consists of subgenual and orbitofrontal cortices, the amygdala, hippocampus and ventral striatum (Cardinal, Parkinson, Hall, & Everitt, 2002). This model is further supported by structural MRI studies confirming that people with ADHD display abnormalities in regions associated with emotion regulation networks (Plessen et al., 2006).

The results of the neuroimaging studies reviewed above seem to support the dual pathway model by showing that the anomalies in the emotion regulation system in ADHD may be distinctive and independent from the executive attention system. All the studies reviewed in this section seem to confirm that emotion regulation is significantly implicated in ADHD. More generally the pattern of the findings seems to underline the heterogeneous nature of ADHD and suggests that one key element differentiating various ADHD subtypes, as well possible comorbidities, could be emotion regulation capacity. As the studies reviewed did not compare participants with ADHD to children

with other psychopathologies it is hard to establish which of the findings are unique to ADHD and which are valid transdiagnostically.

Disruptive Behaviour (CD/ODD) (4 studies)

There is evidence to indicate that difficulties with emotion regulation put children at risk of developing behavioural problems (Gilliom, Shaw, Beck, Schonberg, & Lukon, 2002.; Trentacosta & Shaw, 2009).

A study of children with disruptive behaviour disorders by Duncombe and colligues (2013), which utilised parent and teacher report alongside a structured child interview, showed that both cognitive flexibility and emotion regulation were associated with disruptive behaviour independently of each other, even when taking into account IQ and symptoms of ADHD. Factors such as emotional identification and emotion understanding, both clearly related to emotion regulation, failed to predict disruptive behaviour, suggesting a unique role of emotion regulation in this disorder. These findings fall in line with the suggestion by Lemerise & Arsenio (2000) that emotion regulation is more critical than the ability to identify feelings of others when faced with an emotionally challenging situation.

Another parent and teacher report study by Duncombe and colligues (2012), using the same sample, found that inconsistent parenting, negative emotional expressiveness and parental mental health significantly predict parent rated destructive behaviour, as well as problems with emotion regulation. Furthermore, the quality of the child's emotion regulation mediated the relationship between parenting practices (specifically inconsistent discipline and corporal punishment) and disruptive behaviour problems. It was suggested that these parental practices negatively affect the child's emotion regulatory capacity, leading to an increase in behavioural difficulties. The study also showed that emotion coaching was associated with greater emotion

regulation capacity in children, and was associated with reduced destructive behaviour. Finally, emotion regulation mediated the relationship between parental positive emotional expressiveness and destructive behaviour when positive expressiveness contributed to better emotion regulation, which seemed to reduce behavioural difficulties. These findings are in line with the commonly made statement that child emotional development is influenced, and to a significant degree formed, by processes of parental socialisation of emotion. These include emotional expressivity modelling, emotion labelling, coaching as to what methods and forms are appropriate and inappropriate to express (Denham, 2007; Dunn, Brown, & Maguire, 1995; Garner, 2006).

In both studies these links were only found through parents reports of children's emotion regulation, and not through teacher report. While one of the reasons for this might be the fact that different measures were used for parent and teacher reports, the authors suggest it is possible that children with disruptive problems experienced more difficulties of emotional regulation and cognitive flexibility at home compared to school.

While the findings of both studies are generally consistent with existing research, they have several methodological issues. Both were exclusively based on reports by parents and teachers, the gender distribution of the sample was very skewed to male participants, and finally the study did not use a control group. All these make the findings somewhat incomplete, putting to question their generalizability.

In a study utilising RSA as a measure of parasympathetic activity associated with emotion regulation, Beauchaine, Gatzke-Kopp and Mead (2007) compared childen with oppositional defiant disorder and conduct disorder (ODD/CD) to contols. It was found that while watching a video clip aimed at evoking feelings of sadness and empathy, both

the ODD/CD and control children showed a decrease in RSA; the baseline RSA was significantly lower in the ODD/CD group compared to controls. The authors suggest that the significantly lower RSA in the ODD/CD group at baseline indicates that this group was significantly closer to the threshold associated with fight or flight behaviour and therefore a normative decrease of the RSA might be significantly more detrimental for this group. Following on from this, the authors suggest that as these children have already been operating within a compromised system, it made emotion regulation significantly more challenging.

This study was part of a larger one comparing differences in RSA between pre-schoolers, school-age children and adolescents with ODD/CD. While similar patterns were reported for school-age children and adolescents there were no differences in baseline RSA in the pre-schooler group, suggesting that vagal tone might become a significant marker of emotion regulation in children with ODD/CD relatively late in development. This might be related to the fact that both emotion regulation and vagal tone are significantly affected by socialisation within one's family (Calkins, 1997; Stifter & Fox, 1990) and hence the differences become more evident as children become increasingly exposed to extra-familial socialisation. Each of the three sub-studies had a relatively small sample and a great deal of gender variability, therefore the conclusions should be treated with caution.

In a later study also using RSA as a measure of emotion regulation, Pang and Beauchaine (2013) explored the effect of depressive comorbidity in CD on emotion regulation using children with CD, CD and depression, and controls who were asked to watch an emotion inducing video. Depression, conduct disorder and the interaction between the two was associated with lowered parasympathetic activity at baseline and in sadness evoking conditions. The interaction between conduct disorder and depression

was the most significant in predicting reduced parasympathetic activity. In addition to confirming previous findings suggesting altered emotion regulation in internalising and externalising disorders, the discovered association between CD and depression comorbidity with emotion regulation suggests that the combination of internalising and externalising symptoms may be particularly associated with compromised emotions regulation. The nature of the study does not allow inferences of causality, nor does it explain the direction of the effect psychopathology and emotion regulation have on one another when measured through parasympathetic activity.

Overall, the studies reviewed in this section indicate that children with behavioural difficulties experience significant deficits in emotion regulation. Unfortunately, the studies only used a limited number of emotion regulation measures, thus leaving an incomplete picture of the ways in which emotion regulation is implicated in this type of psychopathology.

Depression (2 studies)

It has been suggested that emotion regulation is rooted in the interaction between limbic and prefrontal neural circuitry and may be especially vulnerable to disturbances, such as internalising and externalising problems during childhood (Andersen & Teicher, 2008; Guyer et al., 2008). It has been argued that deficits in emotion regulation are prevalent in people with depression, which can partially explain the development of depression from childhood to adolescence (Kate Keenan & Hipwell, 2005).

Pagliaccio and colligues (2012) conducted a neuroimaging (fMRI) study examining differences in emotion regulation between children who were diagnosed with a preschool onset of major depressive disorder (MDD) before the age of five and controls. The participants watched a sad video followed by emotion inducing instructions. The study was undertaken when the children were between nine and ten

some of them were still depressed but others had no current symptoms of depression. Children who had experienced the preschool onsets of depression showed decreased activity in the left dorsolateral PFC and the right superior frontal gyrus during a sad mood elaboration, compared to the control group. This group difference was not attributable to current internalising or externalising psychopathology. The findings are consistent with the adult and adolescent studies demonstrating dysfunctional emotion regulation in people with depression, related to altered activity in the prefrontal cortex and the limbic regions (Brody, Barsom, Bota, & Saxena, 2001). It also suggests that early episodes of depression alter the connectivity in the brain circuitry involved in emotion regulation, preventing the children with history of the disorder from effectively regulating their emotions, regardless of whether they had depression or other psychopathology at the time of the study. Current depression severity in the sample was associated with decreased activity in the medial and inferior PFC regions and increased amygdala activation during the sad mood elaboration. These associations could possibly reflect dysfunctions in regions associated with mood and emotion regulation associated with depression.

In a study comparing emotion regulation in depressed and non-depressed girls, Keenan and colligues (2009) found that while both the inhibited and disinhibited expression of emotions were associated with depressive symptomatology, inhibition of expression not only accounted for the majority of the variance but was also associated with the level of functional impairment linked to depressive symptoms. The study used self report and observation of mother and daughter emotion expression during a family problem solving task. The authors suggest that inhibition of emotional expression plays a key role in emotion regulation deficits associated with the development of depression and associated impairment in girls.

These findings are interesting as most emotion regulation and psychopathology research tends to focus on disinhibited expression (emotion dysregulation), which is also thought to be associated with symptoms of depression (Shipman et al., 2004) and disruptive behaviour (Keenan, 2000). Less is known about the implications of excessive inhibition of emotion in child psychopathology. It has been argued that inhibiting the expression of negative emotions can make an effective communication of one's emotional states very challenging, which in turn results in less appropriate support from individuals in the social environment for learning to manage and regulate negative emotions (Cole, Michel, & Teti, 1994).

As this research only used a female sample it leaves a significant gap in understanding how specific the findings are to gender or to childhood depression in general. Also, as the self and other reports of emotion regulation and depression were not significantly associated, a methodological question is raised of whether the measures used were tapping into different aspects of regulation and depressive symptomatology, or had different degrees of reliability or construct validity.

It is surprising, given the established implication of emotion regulation in internalising disorders, that only two studies have examined emotion regulation in childhood depression. Both studies hint at an interesting interdependence between emotion regulation and depression, but the limited number and the narrow focus of the studies leaves much scope for future research.

Eating Disorders (Binge Eating) (2 studies)

Emotion regulation is assumed to play a central role in binge eating in adults (Hilbert & Tuschen-Caffier, 2007; Kenardy, Arnow, & Agras, 1996). Negative mood is suggested as the most common trigger to binge eating in both children and adults (Stein et al., 2006; Tanofsky-Kraff & Goossens, 2007), with previous studies showing that

children with binge eating symptoms engage in emotional eating as a response to anxiety, anger or depression much more frequently than controls, thus suggesting that binge eating might be a dysfunctional emotion regulation strategy (Goossens, Braet, & Decaluwé, 2007; Tanofsky-Kraff & Goossens, 2007).

In line with the above , the self-report study by Czaja, Rief and Hilbert, (2009) found that children with loss of control (LOC) eating reported using maladaptive strategies to regulate all the three emotions assessed (anger, anxiety, sadness) compared to children with no LOC eating. Interestingly however, no differences in using adaptive strategies were found between the two groups. Children suffering from LOC eating used significantly more maladaptive strategies (giving up, aggressive action, withdrawal, self-evaluation) to regulate feelings of anxiety and anger. The authors suggested that children with LOC eating might react similarly to anger and anxiety. Similarly to adults, anxiety was the most frequently experienced emotion prior to a binge eating episode (Masheb & Grilo, 2006).

A study of obese girls with and without binge eating (BE) symptoms by Goldschmidt, Tanofsky-Kraff and Wilfley (2011) showed that the negative affect the BE girls reported before watching a film predicted loss of control eating after watching the film, but not the valence of the film watched (sad or neutral). Girls with BE also had a greater percentage of energy intake from fats while exposed to the sad condition relative to the neutral condition. This could possibly be associated with the tendency to seek comfort from high-fat foods when experiencing negative emotions.

Most of the effects found in the study appeared to be attributable to the negative mood of the participants *before* the sad mood induction. It is possible that this indicates that the sad mood experimental condition failed to sufficiently alter the mood of the participants. Overall, the findings seem to indicate that girls predisposed to negative

emotions are more vulnerable to binge eating problems as a response to a negative mood trigger. The study only included obese females, it would seem important to examine if the overall trends reported in the study are specific to obese females with binge eating or have traits in common with non-obese females or obese and non-obese males with emotion regulation deficits.

In the above study, eating as a process is described as an emotion regulation strategy. This suggests that physical activities such as eating, running, lying in bed, etc. can be considered as basic non-cognitive emotion regulation strategies. (Tanofsky-Kraff et al., 2007).

Both studies seem to support the view that emotion regulation problems are associated with binge eating, there were no studies comparing binge eating disorder to other eating disorders, the reason for this is most likely is that a very small number of children will present with other eating disorders before adolescence. More studies using larger and more heterogeneous samples can help to advance the understanding of the more subtle differences in emotion regulation between children with eating disorders and children with other psychopathologies.

Other Studies (2 studies)

This section reviews two studies of emotion regulation, which while using a sample diagnosed with various psychopathologies, chose to group the participants by specific symptoms as opposed to a diagnostic category.

The first study by Roy and colligues (2013) compared emotion regulation of children referred for impairing temper outburst to healthy controls. The children in the temper outburst group presented with ODD, ADHD, anxiety disorders and the non-MDD depressive disorders. This study used an emotion suppression task that was

developed for children as young as five years old (Bar-Haim, Bar-Av, & Sadeh, 2011) and facial expression coding was used to measure emotion regulation. Children with temper outbursts showed significantly less positive expressivity in response to success and found it significantly more difficult to regulate negative expressivity in response to frustration. Moreover they appeared to show an increase in negative emotional expressivity during the emotion regulation condition compared to controls. More specifically within the temper outburst group, children with diagnoses of anxiety disorders demonstrated less positive expressivity than the non-anxious children with outbursts. Children with temper outbursts and depressive disorders were found to have poorer regulation of negative expressivity than non-depressed children with outbursts. These findings seem to suggest that children with severe outbursts do not necessarily have more negative emotions as a response to frustrating experiences, but do exhibit deficits in regulating these emotions once they occur. These findings might suggest that temper outbursts can be viewed as one of the transdiagnostic symptoms closely associated with failures in emotion regulation.

In a differnet study Raval, Martini and Raval (2010) used self report to compare emotion regulation in middle-class Indian Gujarati children grouping them by internalising, externalising and somatic symptoms. The externalising children reported their reason for expressing anger to be uncontrollability, while internalising children provided the same explanation as a reason for expressing sadness. Children presenting with somatic complaints reported using what the authors referred to as "regulatory withdrawal" to control anger and sadness more frequently than the control group. Children in the control group reported significantly higher use of expressive suppression strategies (facial and verbal concealment). The authors argue that the study shows that Indian children report strict control of their emotions informed by display rules of their culture and suggest cultural differences in emotion regulation across psychopathologies.

While the study provides an interesting perspective of emotion regulation in the cohort of Indian Gujarati children it is difficult to draw any direct cross-cultural comparisons due to the use of a non-standardised measure and the lack of a comparison group from a different culture. It is argued that the appropriate expression and control of emotions and the way emotions are communicated can significantly vary across cultures (Saarni et al., 2006) and that culturally inappropriate expression and communication of emotional states are associated with both externalising and internalising difficulties (Salovey & Rothman, 2000). Therefore, this study does raise an interesting question for future research suggesting the possibility of culturally determined impacts of emotion regulation on child psychopathology.

Both studies demonstrate that research into the impact of specific symptoms (as opposed to diagnostic categories) on emotion regulation is a valid way of researching the phenomenon, providing a different angle on the issue. This methodology is of a particular interest given the assumed transdiagnostic nature of emotion regulation deficits.

Discussion

This review found broad support for the important role of emotion regulation in child psychopathology. While all the studies reviewed differed in methodology, sample and measures of emotion regulation, all found that some evidence that emotion regulation was implicated in this, in one form or another, either in the development or in the symptomatology of the disorder. The overall quality of the papers included in this review was relatively high, scoring the average of 17.58 out of 22 (79.9%) with no studies scoring below 50% on the quality assessment scale for evaluating primary research papers (Kmet et al., 2004).

This review also demonstrates significant gaps in research on emotion regulation in childhood. While some disorders have received greater attention from the research community (anxiety disorders and ADHD) than others (depression, eating disorders), the total number of studies in the field is relatively low and the research is fragmented, allowing only very preliminary and incomplete conclusions to be drawn. This following section of the paper attempts to describe some of the key methodological and conceptual issues that had emerged through the review of the articles.

Methodology and Measurement Issues

A key issue with the studies examining emotion regulation based on observation or report of emotion expression (dysregulation or lability) rather than emotion regulation, is the assumption that what is measured is indeed a failure or success in regulating one's emotions. While it is suggested that all emotions are regulated in one way or another (Gross & Thompson, 2007), there is little evidence to suggest that any expression of "many emotions" (dysregulation) is always a consequence of a failure in emotion regulation. Even if this assumption is correct there seems to be no way of

knowing what regulatory strategy was used. A similar issue arises in studies using implicit physiological responses, when neural or physiological markers associated with emotion regulation (such as RSA, PEP, fMRI and EEG) are assumed to be equivalent to emotion regulation itself, even when no request to regulate is made to the participant. While these neuro-physiological markers are known to be associated with emotion regulation, it is hard to know whether the changes between groups are directly associated with emotion regulation or other mediating phenomena.

Another significant limitation of both the methodologies mentioned above is the difficulty they pose in distinguishing between the emotion itself (experienced or expressed) and emotion regulation. Measures that focus on specific regulatory strategies (e.g., suppression, re-appraisal) may be more useful in this regard than measures which focus on emotional dysregulation or lability.

It therefore seems that the use of self report directly inquiring about the use of specific emotion regulation strategies, or the use of experimental protocols requiring the participant to use specific regulation technique are the most effective ways of addressing these difficulties. However, these introduce further measurement complications.

While one of the most convenient and common measures of emotion regulation is self-report, it also has distinct disadvantages. It is questionable whether individuals can accurately self-report on the emotion regulation strategies they use (Robinson & Clore, 2002). One of the most significant criticisms of using self-report for the study of emotion regulation is the frequently co-occurring deficits in emotional awareness, which can prevent participants with lower emotion regulation capacity from accurately evaluating themselves (Lane, Sechrest, & Riedel, 1998). Self-report also most likely

suffers from the difficulty participants may experience in distinguishing between emotion, and its *regulation*.

Another difficulty with the use of self-report in the study of emotion regulation is that retrospective reporting is susceptible to response biases and does not allow capturing emotion regulation as it occurs (Stone & Schwartz, 1998). While the ecological momentary assessment methodology attempts to address this problem (in this review Rosen, Epstein, & Van Orden., 2013), this methodology is still relatively novel and its validity remains unclear.

Observational methods on the other hand are allowing for a non delayed representation of emotion regulation but, they only capture the overt component of emotion regulation and provide no insight into the internal unobservable processes. Observational methods are also frequently critiqued for only providing information about the short-term effects of emotion regulation strategies.

Experimental assessments of emotion regulation pose questions as to the ecological validity, as well as to whether the stimuli used are successful in eliciting the emotion and the instructions provided are indeed making the participants use the emotion regulation strategy in question.

Another significant difficulty with many emotion regulation measures is that they enquire about ways in which people cope with emotions in general, without specifying the specific emotion or emotion regulation strategy. This is particularly problematic, as there is evidence to suggest people tend to use different emotion regulation strategies to regulate different emotional states in different psychopathologies (reviewed by, Aldao, Nolen-Hoeksema, & Schweizer, 2010).

The only way to overcome the individual weaknesses of each measure is the use of a multi-method approach with several measures of emotion regulation.

In a recent review examining measurement and assessment of emotion regulation in children over the last two decades, a multimethod approach was used in only 23% of the published research reviewed. This is despite evidence suggesting that a multimethod approach is not only appropriate for researching emotion regulation in children, but also necessary to determine the biological, cognitive and behavioural mechanisms involved in emotional regulation development and their interplay (Adrian et al., 2011). Even fewer studies (four), as reviewed for this paper, used more than one format of emotion regulation measure, and only six used an experimental protocol requesting participants to regulate.

Conceptual Issues

While emotion regulation is becoming an increasingly popular construct in the study of psychopathology, the field is still far from a consensus on the definition of emotion regulation and its various facets (Gross & Thompson, 2007). As Berking and Wupperman (2012) accurately pointed out, everything seems to be emotion regulation these days.

This review found that various researchers tend to use different terminology to refer to emotion regulation (e.g. emotion regulation, affect regulation, emotional lability, cognitive control, emotion dysregulation etc.). While some researchers seem to use this terminology interchangeably, others refer to the specific aspect of each related construct. This terminological confusion also contributes to the difficulties in comparing different studies, even within the same domain of psychopathology.

As emotion regulation is a very broad and inclusive construct, not only the definitions but also its empirical operationalisation are relatively poorly defined (Cole, Martin & Dennis, 2004). As evident from this review different measures and experimental designs were used for each psychopathology.

Given the current discrepancy in definitions, measures and operationalisations of emotion regulation, it is difficult to examine commonalties and differences in emotion regulation across different psychopathologies, age groups, countries etc. This creates a tremendous challenge for the field. While the overall trend of the findings clearly indicates the transdiagnostic nature of emotion regulation, it cannot be sufficiently explored and understood due to these discrepancies.

A further key issue in the study of emotion regulation is that of causality. Most models linking psychopathology to emotion regulation rely on the assumption that emotion regulation is a causal factor in the development of psychopathology rather, than a result of such. Due to the cross-sectional nature of most studies in the field, including the ones outlined in the present review, the question of causality strongly presents itself as a central consideration. This highlights the need for further longitudinal studies in the field which would address this important issue.

Limitations

There were several limitations to this review, which warrant a degree of caution in drawing conclusions about the state of the research into emotion regulation in child psychopathology. These limitations are related to several factors. Firstly, it only reviewed studies in the English language, possibly missing relevant studies published in peer-reviewed journals in other languages. Secondly, it is also possible that relevant studies published in the "grey literature" (specifically unpublished masters and doctoral dissertations) were overlooked. Thirdly, it is possible that due to a significant

terminological variation in the field of emotion regulation, some studies using different

keywords but describing relations between emotion regulation and child

psychopathology were missed.

Conclusion

This review attempted to bring together findings from the last 12 years of emotion regulation research in child psychopathology. This period was characterised by a significant change in neuroimaging and physiological measures which became widespread and available, alongside an increased interest in emotion regulation as a further elaboration of the "affect revolution". This review supports the view that emotion regulation is a transdiagnostic phenomenon that has a significant influence across multiple disorders. It emphasises the need for studies utilising multimethod designs enabling the study of the multiple facets of emotion regulation and of the wide variety of its associated processes and mechanisms. Finally, it had emphasised the importance of using clear and unambiguous terminology to refer to different facets of emotion regulation, as well as developing unified measures of emotion regulation for each methodology, minimising the conceptual confusion, which places the "affect revolution" at risk of turning into a Tower of Babel.

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Part 2: Empirical Paper

**Emotion Regulation in Adolescents:
Influences of Social Cognition and Object Relations –
An ERP study.**

Abstract

Aims: The use of emotion regulation strategies can reduce the intensity of negative experiences; event related potentials (ERP) specifically the late positive potential (LPP) is known to be sensitive to this reduction in adults. It is argued that individual differences play an important role in one's ability to regulate emotions. The current study aimed to explore neural correlates of emotion regulation in adolescents. The study aimed to replicate previous findings from studies on adult populations, to show that emotion regulation is associated with changes in the amplitude of the late positive potential (LPP) in adolescents. It also aimed to examine neural changes associated with emotion regulation as a function of age and explore age-related differences in the scalp localisation of emotion regulation in adolescents. The study also aimed to explore whether individual differences, specifically the quality of internal representations of relationships, can predict neural activity associated with emotion regulation. *Method:* Event related potentials (ERP) of 53 adolescents (12 to 17 years old) performing an emotion regulation task were recorded. The social cognition and object relations scale (SCORS; Westen, 1995) was utilised in a narrative interview to obtain data about the quality of mental representations of relationships. *Results:* The study confirmed that the use of emotion regulation modulated the LPP in adolescence early in the emotion generation process. A relationship between the changes in the LPP and the age of the participants has been established, indicating that emotion regulation became more effortless with age. The study found that the quality of mental representations of relationships was able to significantly predict LPP amplitude related to emotion regulation. *Conclusions***:** The findings suggest that emotion regulation becomes more effortless with age, and that internal representations of relationships are closely implicated in the ability to regulate emotions.

Introduction

The ability to regulate one's emotions is believed to be essential for mental health (Gross & Muñoz, 1995); difficulties in emotion regulation are a key feature in multiple psychopathologies across the lifespan (American Psychiatric Association, 1994). Developmentally, emotion regulation is thought to reflect an interaction between developing cognitive and affective abilities (Lewis, Lamm, Segalowitz, Stieben, & Zelazo, 2006) and it is relatively widely researched in adults (Campbell-Sills & Barlow, 2007; Campos & Mumme, 1994; Gross & Thompson, 2007; Gross, 1998b; Mennin & Farach, 2007; Mennin, Holaway, Fresco, Moore, & Heimberg, 2007; Tangney & Fischer, 1995; Thompson, 1994; Zeman & Cassano, 2006) and to a lesser extent in children, (Cicchetti, 1995; Hubbard & Coie, 1994; Saarni, 1999; Sroufe, 1997; Thompson, Lewis, & Calkins, 2008; Thompson, 2008). Adolescence is a developmental phase which presents with increased demand to regulate one's emotions and behaviour at a time characterised by multiple neurological, physiological, social and individual changes (Blakemore & Choudhury, 2006; Pfeifer & Blakemore, 2012; Steinberg, 2005). Despite this, only a few studies using self-report methodologies have explored emotion regulation in adolescence (Phillips & Power, 2007) its association with attachment (Cooper, Shaver, & Collins, 1998; Spangler & Zimmermann, 1999; Spangler & Zimmermann, 2006; Zimmermann,1999) and psychopathology (Garnefski, Kraaij,van Etten., 2005; Silk, Steinberg, & Morris, 2003). Thus, the empirical study of the emotion regulation processes in adolescents remains scarce.

Emotion Generation and Regulation

Emotions arise when an individual interprets the situation he/she is faced with as relevant to his goals (Gross, 1998). While the changes in behaviour and affect associated with emotions are usually not obligatory, they might be experienced by an

individual as an imperative, interrupting what the individual is doing and forcing themselves on to his/her's awareness (Frijda, 1986). Thus these experiences compete with other responses, as well as with environmental and physiological demands. In order to deal with those conflicting demands in an adaptive and situationally appropriate way, one needs to exercise the ability to regulate emotions.

Emotion regulation can increase, maintain or alter the emotion depending on the goal of the individual. Gross and Thompson, (2007) propose to view emotion regulation as a continuum moving from conscious, effortful and controlled to unconscious, effortless and automatic regulation.

In his process model of emotion regulation Gross (1998a) argues that the generation of emotions is a complex dynamic process that unfolds over time. Gross and Thompson (2007) suggest that emotion generation is a constantly on-going process consisting of multiple cycles each influenced by the previous one. These influences consist of the ways other people react to our emotions, the way emotions and the behaviours they evoke modify the situation we are in, as well as the ways people in our surroundings help us to regulate our emotions. Moreover, emotion regulation is also associated with both quality and intensity of the emotion (Zimmermann & Iwanski, 2014).

Overall   the process of emotion generation and regulation appears to include a wide variety of emotion regulation processes which differ based on the time, interpersonal context and environmental feedback in which the emotion generation and its regulation occurs.

Emotion Regulation Strategies

Gross (1998a) describes five groups of emotional regulation processes: situation selection, situation modification, attentional deployment, cognitive change, and

response modulation. Each of these processes is thought to differ in relation to the point in time at which they can be deployed and in the primary impact they have on the emotion generation process. The first four are considered to be antecedent focused i.e. occurring before the fully expressed emotional response. Response modulation is considered to be response focused occurring once the other responses had been generated (Gross & Muñoz, 1995).

There is no a priori assumption about a particular form of emotion regulation being "good" or "bad" (Thompson & Calkins, 2009). Earlier studies tended to make the distinction between cognitive change (reappraisal) as an adaptive response and response modulation (suppression) as a maladaptive one (Gross, 1998a, 1998b). However, recent studies tend to show that whether an emotion regulation strategy is effective or adaptive is almost entirely context dependent (Paul, Simon, Kniesche, Kathmann, & Endrass, 2013; Zimmermann & Iwanski, 2014). One might say that an excessive reliance on any emotion regulation strategy, when disregarding the situational demands and context, may lead to adverse consequences. For example, situation selection and modification may give rise to avoidance and social anxiety, while attentional deployment may lead to missing important situational and social cues (Campbell-Sills & Barlow, 2007; Werner & Gross, 2010)

Emotion Regulation and Development

Emotion regulation is thought to change with development under the influence of social, genetic and neurological factors (Thomson, 1994), thus resulting in significant individual differences in emotion regulation observed in adulthood (Thompson & Meyer, 2007).

Mc Rae and colligues (2012) research of emotion regulation in adolescents suggests that emotion regulation ability improves with development. They argue that

this improvement is associated with activity in the ventrolateral prefrontal cortex (PFC) which was shown to linearly increase with age. It was suggested that this change in emotion regulation capacity may be related to the improved social cognitive processing observed in adolescents.

Earlier studies argued that the nature and quality of the emotions people might try to regulate may significantly differ depending on the developmental stage. Specifically, there is evidence to suggest that due to the increased value young adults attribute to social interactions, the negative emotions they tend to down regulate are predominantly social in nature (Gross, Richards, & John, 2006).

Overall it would appear that from infancy to adulthood executive functions, emotion understanding, and cognitive capacity, all of which are involved in emotional reactions, become more complex (Thompson, 2011; Thompson, 2008; Zeman & Cassano, 2006) and the choice of emotion regulation strategies becomes more flexible (Zimmermann, 1999). There is evidence that emotion regulation becomes more selective and effective with age, as adults seem to adapt the way in which they manage emotions based on experiences and the demands of the situation (Carstensen, Fung, & Charles, 2003).

Individual Differences in Emotional Regulation

Several studies have suggested that individual differences also play a significant part in one's ability to emotionally regulate. It has been suggested that emotion regulation may be influenced by personality and genetic predispositions (Gross & John, 2003; John & Gross, 2004); gender and age (Nolen-Hoeksema & Aldao, 2011); individual psychopathology (Aldao, Nolen-Hoeksema, & Schweizer, 2010).

Neurological studies to date seem to support the proposition that emotion regulation is a multifaceted phenomenon significantly influenced by a variety of

idiosyncratic developments which form the basis for individual differences in regulation style and capacity. Emotion regulation capacity is dependent on an interaction between multiple cortical and subcortical systems, each of which has a unique developmental trajectory, forming a unique interactive matrix that supplies children with a range of habits for emotional expression, appraisal and regulation (Thompson, Lewis & Calkins, 2008).

The development of emotion regulation begins in infancy. In these first years of life caregivers are the primary agents helping the child to regulate his or her emotional states. Therefore, relational influences, fulfil a key role in the development of emotion regulation in the first years of life (Cassidy, 1994; Field, 1994)

Following on from this, the significant role of attachment in one's capacity to emotionally regulate has been suggested by several studies (Spangler & Zimmermann, 2006; Zimmermann, Mohr, & Spangler, 2009). For example, in an important study of early development, it was found that emotional coping of toddlers in stressful situations was aided by the specific intervention of the care giver, as well as by the existence of a secure attachment between them (Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996).

It is argued that at first all emotions are regulated extrinsically i.e. being regulated by the other. Gradually this capacity becomes more intrinsic i.e. most emotions regulated by self (Gross & Thompson, 2007). Attachment (Bowlby, 1980) and object relations (Kernberg, 1982; Winnicott, 1965) theorists state that repeated patterns of interpersonal relationships form a template for managing affective states.

This idea is elaborated upon in one of the key assumptions of attachment theory, which claims that internal working models (IWM - emotional, motivation and cognitive knowledge and schemas of interpersonal relationships) have a trans-situational,

longitudinal effect on individual development and his/her functioning in interpersonal relationships with others (Bowlby, 1969). Taking this argument further, Spangler and Zimmermann (2006) suggest that internal working models control not only attachment behaviour, but also have an impact on the way emotions are regulated.

Fonagy, Gergely & Jurist (2003) argue that the helpful response of a caregiver, which successfully manages distress, may be internalised and subsequently used as a higher order strategy of affect regulation.

Westen (1991) also suggests that these internalised mental representations of relationships significantly influence multiple cognitive and emotional processes, and in fact mediate multiple domains of interpersonal functioning including emotion regulation. He argues that the various aspects of those internalised representations are best understood through the integration of theories of social cognition and object relations. In order to measure the quality of these representations, Westen (1995) developed the social cognition and object relations scale utilised in the present study.

Neurological Correlates of Emotion Generation

As described above, emotions are multifaceted events involving changes in central and peripheral physiology, neural activation, behaviour and subjective experience (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). Consequently, neuroimaging studies provide a vital perspective in studying emotions and emotion regulation.

While the neuroscientific investigation of emotion often uses functional magnetic resonance imaging (fMRI), it is also argued that the use of electroencephalogram (EEG) is essential to study the phenomenon. EEG time locked to a specific event is known as event related potentials (ERPs) reflecting the synchronous activity of populations of neurons (Luck, 2005). Unlike the fMRI, ERPs directly reflect

scalp recorded neural activity. The recording and the neural activity occur almost simultaneously allowing for an exceptional temporal resolution, crucial for studying temporal characteristics of emotion generation and regulation (Moser, Hajcak, Bukay, & Simons, 2006).

Most ERP studies looking at emotional processing and emotion regulation have focused on the late positive potential (LPP), which is a midline ERP observable around 300 ms after stimulus onset and may last for several hundred milliseconds and sometimes even after stimulus offset (Hajcak & Olvet, 2008). The LPP is significantly enhanced by motivationally relevant stimuli, both pleasant and unpleasant (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Dillon, Cooper, Grent-'t-Jong, Woldorff, & LaBar, 2006; Foti & Hajcak, 2008a; Moser et al., 2006). Previous studies have shown that all emotions generate motivated attention, In other words all emotional stimuli (pleasant and unpleasant) are automatically perceived as motivationally relevant when compared to neutral stimuli and therefore enhance the LPP presented (Bradley et al., 2003; Sabatinelli, Bradley, Fitzsimmons, & Lang, 2005).

Consistent with that, the LPP has been shown to be highly sensitive to emotional versus neutral images; emotional images significantly enhanced the LPP. However, several studies have shown that the LPP was not sensitive to the valence (positive vs negative) of the presented images (Cuthbert et al., 2000; Hajcak, MacNamara, & Olvet, 2010; Hajcak & Nieuwenhuis, 2006; Keil et al., 2003)

The modulation of the LPP by emotional stimuli is most visible in occipital to central recording zones on the scalp (Foti, Hajcak, & Dien, 2009). LPP enhancement observed when emotional stimuli are presented is thought to reflect the downstream effects of amygdala activation in the visual cortical structures (de Rover et al., 2012).

Neurological Correlates of Emotion Regulation

In addition to being sensitive to emotional stimuli in general, it is suggested that the time course of the LPP is an index of emotion regulation. Several studies have shown the sensitivity of the LPP to participants employing various emotion regulation strategies such as reappraisal, distraction and suppression (Foti & Hajcak, 2008b; Hajcak & Nieuwenhuis, 2006; Moser et al., 2006; Paul et al., 2013; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011).

Hajcak & Nieuwenhuis (2006) demonstrated that reappraisal reduced the magnitude of the LPP in participants looking at unpleasant stimuli. This reduction also correlated with the reduction of self-reported emotional intensity. Moser and colleagues (2006) found that suppressing negative emotions in response to unpleasant stimuli also reduced the magnitude of the LPP. Both these findings were amongst the first to indicate that different emotion regulation strategies can be used to successfully reduce the LPP.

It was also shown that different emotion regulation strategies seem to affect the LPP modulations at different time points. While distraction, expressive suppression (Paul et al., 2013) and cognitive suppression (Moser et.al 2006) seem to affect the earlier time windows of the LPP starting around 300 ms, cognitive reappraisal seems to affect the later time windows from around 700 ms (Thiruchselvam et al., 2011). It has been suggested that the earlier positivity recorded in these studies is possibly associated with attending to the stimulus, while the later positivity reflects the semantic elaboration of the stimulus (Schupp, Flaisch, Stockburger, & Junghöfer, 2006). Interestingly all of the above strategies were effective in reducing the self-reported emotion, but distraction and reappraisal did differ when individuals were repeatedly exposed to the stimuli. The stimulus that was presented during the distraction condition elicited a greater emotional

response than the one presented during reappraisal, suggesting that the short term benefits of distraction may come at a price. (Thiruchselvam et al., 2011).

While cognitive reappraisal appears to be a beneficial regulation strategy, it would appear that it is necessary to know the contexts before a situation or stimulus can be successfully reappraised. Therefore it seems that other more "pre-emptive" regulation strategies may be more beneficial and adaptive in times of uncertainty. As reappraisal requires more cognitive resources, using distraction or suppression can also be more beneficial when performing a concurrent task (e.g. giving a talk). All the three emotion regulation strategies affecting the earlier parts of the LPP (distraction, cognitive suppression and expressive suppression) seemed to be used to alter the initial perception of the emotion evoking stimulus and are used pre-emptively. For expressive suppression this explanation is supported by the fMRI study by Vanderhasselt and colleagues (2013) demonstrating preparatory activity during anticipation of the expressive suppression condition.

Neurological Correlates of Emotion Generation and Regulation in Children and Adolescents:

While less research had focused on the neural correlates of emotion regulation in children, some studies have explored the issue using developmentally appropriate stimuli. Hajcak and Dennis (2009) used the age appropriate images from the international affective picture system (IAPS; Lang, Bradley, & Cuthbert, 2008) (an image set used most frequently in studying emotion and emotion regulation in adults), found that similarly to adults, children (5-8 years old) produced increased LPP amplitudes in response to emotional images compared with neutral ones. However, in this age group the associated neural activity seemed to be localised in a more occipital recording zone. Furthermore, Kujawa and colleagues (2013) showed a relative two-year

stability of the LPP in childhood and early to mid-adolescence (8 to 13 years old at first measurement, 10 to 15 during the second) in response to pleasant, unpleasant and neutral images.

Dennis and Hajcak (2009) also demonstrated that emotion regulation strategies modulated the LPP in children (5 to 10-year-olds) with the LPP being significantly lower following neutral compared to negative interpretations of the images observed. This was only the case for the middle LPP time window (600 to 1000 ms), showing that similarly to adults, cognitive reappraisal in children has an impact relatively late in the emotion generation process. This study also found individual differences affecting the LPP, as children with reduced anxious depressive symptoms showed greater modulation of the LPP by neutral interpretations, suggesting that that the LPP can have clinically relevant correlates to individual differences in children. DeCicco and colleagues (2012) on the other hand showed that while the LPP amplitudes were indeed larger in response to unpleasant versus neutral pictures in children aged 5 to 7, but the LPP was not sensitive to reappraisal. The authors explained this discrepancy with the previous findings by suggesting that the use of reappraisal is still developing between the ages of 5 to 7, and that younger children are less able to use this strategy to regulate their emotions. This discrepancy also introduced an important methodological issue regarding measuring processes specific to emotion regulation, while avoiding the bias associated with the varying cognitive capacities resulting from developmental changes. It may be suggested that research protocols utilising complex regulation instructions (e.g. reappraisal, complex distraction etc.) may be especially susceptible to this bias. The same study had also found links between LPP and anxiety symptoms, further suggesting that the LPP is sensitive to clinically relevant individual differences.

In contrast with adult and child studies, the number of LPP studies of emotion processing in adolescence seems to be very limited. Zhang and colleagues (2012) demonstrated that in adolescents (aged 11 to 17) the LPP is modulated by emotional images from the Chinese affective picture system when affective pictures elicit larger LPP than neutral ones, overall showing the same trend as the adult findings. In a different study, Zhang and colleagues (2013) found that individual differences in harm avoidance in adolescents (aged 11 to 19) predicted LPP for positive and negative images, but not for neutral ones.

Aims of the Present Study

Part one

While general developmental research tends to suggest that emotion regulation is undergoing significant development during adolescence (Zimmermann & Iwanski 2014), little is known about the development and activity of the neural systems supporting emotion regulation in adolescents. In light of this it is surprising that to our knowledge there are no neuroimaging studies of emotion regulation in adolescence.

The first part of the current study had three aims. Firstly, we expected to replicate previous adult findings, to show that emotion regulation reduces LPP amplitude in adolescents. Second, we expected to see evidence in the brain data indicative of improvement in emotion regulation associated with age, thus filling the gap in research between child and adult emotion regulation literature. Third, we were interested in exploring the scalp distribution of emotion regulation in this age group, examining the neural activity across the occipital and parietal midline recording sites, where emotional processing and regulation related LPP was reported in the child and adult populations (Hajcak & Dennis 2009; Hajcak & Nieuwenhuis, 2006).

Part two

Previous adolescent studies have shown a relationship between the neural responses emotion processing elicits and individual differences in development (Forbes et al., 2010; Pfeifer et al., 2011; Yang et al., 2007) and suggested that the LPP can be used as a marker of attachment in adults (Zilber, Goldstein, & Mikulincer, 2007). However, to our knowledge there have been no studies examining the relationship between individual differences and neural correlates of emotional regulation in adolescent populations.

Previous studies that had shown individual differences in one's ability to regulate emotions, and demonstrated links between the emotion regulation capacity and mental representation of relationships, relying on one's internal working model (Spangler & Zimmermann, 1999). Following on from these, we were interested in exploring more specifically whether the quality of these internal representations of relationships can predict one's neural activity associated with emotion regulation. To measure this, we have used a well-established coding system: Social Cognition and Object Relations Scale SCORS (Ackerman, Hilsenroth, Clemence, Weatherill, & Fowler, 2001; Eshel, Nelson, Blair, Pine, & Ernst, 2007; Hilsenroth, Stein, & Pinsker, 2007; Peters, Hilsenroth, Eudell-Simmons, Blagys, & Handler, 2006; Porcerelli et al., 2006; Westen, 1995) alongside the Early Memory Protocol (Fowler, Hilsenroth, & Handler, 1995). In combination, these tools are considered to provide an in-depth, narrative based, quantitative measure, which allows the exploration of both social cognition and relational representations. We hypothesised that individual differences in social cognition and affective representation of relationships would predict the LPP modulation.

Due to the relatively broad age range (12-17) we wanted to study, it was important for us to use a protocol that would be as simple as possible so that the

measured response would be more specific to emotion regulation and not cognitive capacity. We therefore chose to use expressive suppression as the regulation condition. This protocol is widely used in adult populations; it has been shown to be equally effective in attenuating the LPP at the earlier time windows as other "pre-emptive" strategies such as distraction and cognitive suppression (Paul et al., 2013). Importantly, it has the benefit of clear and unambiguous instructions.

Method

Participants

Participants were fifty-three 12 to 17 year old adolescents (M = 14.43 years, SD = 1.74); 29 females and 24 males. There were seventeen 12 to 13 year olds, twenty 14 to 15 year olds and sixteen 16 to 17 year olds. The participants were recruited from a diverse community in North West London all were fluent in speaking and reading in English for at least five years. All were right handed with no chronic illnesses, with normal or corrected to normal vision and no history of drug or alcohol dependency or diagnosed psychopathology. The participants were paid 20GBP for their participation in the experiment.

Ethical Considerations

The parents of all participants who were younger than 16 years old and adolescents aged 16 and older were required to sign an informed consent form that detailed the study rationale and all the procedures. Both the parents and the participants were clearly informed that they may withdraw from any part of the study at any point. The study has been granted ethical approval by UCL Research Ethics Committee (UCL Ethics Project ID Number: 1908/001).

Assessment Measures

Early memory protocol (Fowler et al., 1995) consists of eight queries including: earliest memory; second earliest memory; earliest memory of mother; earliest memory of father; earliest memory of the first day at school; earliest memory of feeling warm and snug; earliest memory of a special object. It is suggested that enquiring into multiple early memories allows for a broader and more representative sample of the participants' relational experiences and object representations.

Social cognition and object relations scale - global rating (SCORS-G)

(Hilsenroth et al., 2007; Stein & Hilsenroth, 2011; Westen, 1995) is a rating system used in the current study for rating the early memory narratives. The SCORS-G was designed to evaluate self and significant other representations on eight parameters stemming from the social condition and object relational theories. The scale consists of eight variables, each scored on a seven point scale in which the low scores (1-3) indicate the more pathological representations, while the higher scores (4-7) indicate the more normative responses. The eight variables are as follows. (1) Complexity of representations (COM) evaluates how well the participants can see internal states in self and other and assesses the relational boundaries and the ability to integrate both positive and negative aspects of self and others. (2) Affective quality of representations (AFF) assesses the expectations from others within a relationship and the description of significant relationships in the past. (3) Emotional investment in relationships (EIR) assesses the ability for intimacy and emotional sharing. (4) Emotional investment in moral standards (EIM) evaluates the extent to which the participant is emotionally invested in adhering to moral standards, as well as using abstract thought in relation to morality and compassion towards others. (5) Understanding of social causality (SC) assesses the degree to which the participant is able to understand the logic, motivation and causality of human behaviour. (6) Experience and management of aggressive impulses (AGG) evaluates the ability to appropriately manage aggression in self and others. (7) Self-esteem (SE) assesses self-concept. (8) Identity and coherence of self (ICS) evaluates the degree to which the participant sees him/herself as an integrated person with a stable sense of self.

The SCORS has shown good to excellent reliability (Ackerman, Clemence, Weatherill, & Hilsenroth, 1999; Fowler, Hilsenroth, & Handler, 1998; Fowler et al.,

2004) and convergent validity (Ackerman & Hilsenroth, 2001; Stein, Pinsker-Aspen, & Hilsenroth, 2007; Conklin & Westen, 2005).

Rating

All the raters in the current study were trained in the SCORS-G rating system using the narratives provided in the training manual (Stein et al., 2011) and all achieved a good (>.60) to excellent (>0.75) inter-rater reliability (ICC 1; Shrout & Fleiss, 1979). For detailed psychometric descriptions of the SCORS-G rating used in the current study, see (Desatnik et al., In preparation). As the data from the SCORS variables was not normally distributed, for the purpose of the present study the eight variables were divided into two groups of low (indicating the more pathological responses) and high (indicate the more normative responses) in line with the suggestions by Stein et al., 2010.The scores were based on a median split.

The Stimuli

The stimuli were presented on a black background of a 15 inch computer monitor using Eprime 2.0 software. 60 unpleasant and 30 neutral developmentally appropriate images were selected from the international affective picture system (IAPS; Lang, Bradley, & Cuthbert, 2008). The 9 x 7 cm images were presented at the centre of the screen at a 65cm viewing distance. Each image covered the horizontal visual angle of 7.9° and vertical visual angle of 6.1°.

The Procedure

After the parents signed all the consent documents, and the children gave verbal consent to the procedure, the participants received brief information about EEG and were invited to ask questions about the procedure. Then the electroencephalographic sensors were applied and the participants were given detailed instructions. The experiment consisted of two blocks: in the first block (passive view) the participants

were instructed to view 30 unpleasant and 30 neutral randomly presented images in order to establish the effect the emotional valence had on the LPP. This was followed by the expressive suppression instructions: participants were required not to show their feelings, so that the person watching them would have no idea what they were feeling. The participants were shown the cameras at the bottom of the computer screen and informed that the experimenters would be watching their responses. The participants were then asked to repeat to the experimenter what was required of them in the task. Prior to the EEG recording, the participants completed three trials which they were allowed to repeat if they wished to, in order to become more comfortable with the task. Once the participants confirmed they were happy to proceed, they were presented with the second expressive suppression block consisting of 30 unpleasant images. Block one and two were not counterbalanced as it is suggested that putting suppression prior to passive viewing may reduce the suppression challenge as well as produce a carryover effect (e.g. Musser et al., 2011).

Following the completion of the task, the participants were shown 30 random positive images from the IAPS in order to improve their mood in case it was affected by the images they had seen; this last block was not recorded. After the last block the EEG sensor net was removed and the participants were allowed to rest. During that time, the participants were asked what they were doing in the task and all the participants confirmed that they had tried to make sure the experimenters could not see what they felt on their face. After 10 to 15 minutes the participants were led to another room where a different researcher conducted the interview based on the early memories protocol. The interviews lasted between 20 and 40 minutes depending on the individual pace of the participants, and the amount of detail they had volunteered. At the end of the interview the participants were paid and debriefed.

The Task

Each trial in the passive view block began with a white fixation cross that appeared at the centre of the screen for 500 ms, it was followed by a 500 ms blank screen after which the neutral and/or unpleasant IAPS image was presented for the duration of 2000 ms which was then followed by another 500 ms blank screen. The total number of trials in that block was 60, with 30 in neutral and 30 in unpleasant conditions.

Each trial in the expressive suppression block began with a white fixation cross appearing at the centre of the screen or 500 ms. This was followed by a 2000 ms ("regulate") window during which the words "don't show" appeared on the screen in white on a black background accompanied by a male or female voice (alternating) saying "don't show". This was followed by the presentation of the unpleasant image for 2000 ms which was then followed by a 500 ms blank screen. The total number of trials in the block was 30.

EEG Recording and Data Reductions

The EEG was acquired with 128-channel HydroCel Geodesic (Tucker, 1993) sensor nets and recorded and analysed with Net Station 4.3 software (Electrical Geodesics, Eugene, OR). Eye movements were recorded using electrodes placed approximately 1 cm below the participants' right and left eyes.

The EEG was filtered with a 30 Hz low-pass and a 0.03 Hz high-pass filter. The EEG was then segmented for each trial beginning 200 ms before the stimulus onset and continuing for 1500 ms. Artefact detection was set up to exclude files with amplitudes changes above 150 μV across an entire segment, performing a moving average of 10 ms and eye blinks. Standard bad channel replacement was then performed. The EEG

epochs were then averaged to create the stimulus locked ERP. The ERPs were then

montaged using PARE128 operation and baseline corrected (-200 to 0 ms).

Based on previous studies (Moser et al., 2006; Hajcak & Dennis, 2009; Dennis &

Hajcak, 2009), the LPP was defined as the mean amplitude in three time windows

following stimulus onset: the early 350 to 600 ms, middle 600 to 1000 ms and late 1000

to 1500 ms time windows. Recordings were taken from three locations along the

midline: central parietal (Cpz), parietal (Pz) and occipital (Oz), where previous studies

reported the emotion regulation related LPP activity.

Results

ERP Result

At 3 (recording site: Cpz, Pz, Oz) x 3 (Time window: early, middle, late) x 3 (Condition: neutral view, unpleasant view, unpleasant supress) repeated measures analysis of variance (ANOVA) (see Table 2) identified significant main effects of: recording site $F_{(2, 51)} = 31.4$, $p<0.001$; Time window $F_{(2, 51)} = 84.32$, p,0.001; and condition $F_{(2, 51)} = 14.58$, $P<0.001$. Significant interactions of: condition and time window $F_{(4, 49)}=27.12$, $p<0.001$; condition and recording site $F_{(4, 49)} = 22.15$, $p<0.001$; and condition, time window and recording site $F_{(8, 45)} = 10.27$, $p<0.001$. The above results confirm the impression gathered from Figure 2 and

Figure **3** that the three experimental conditions clearly differ between each other across all three recording sites and time windows.
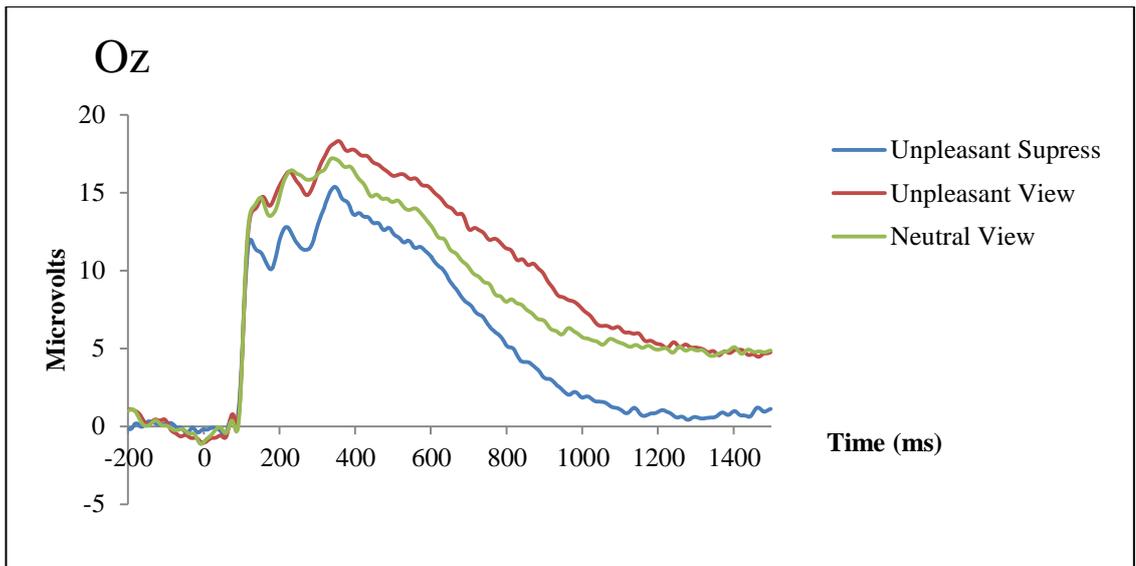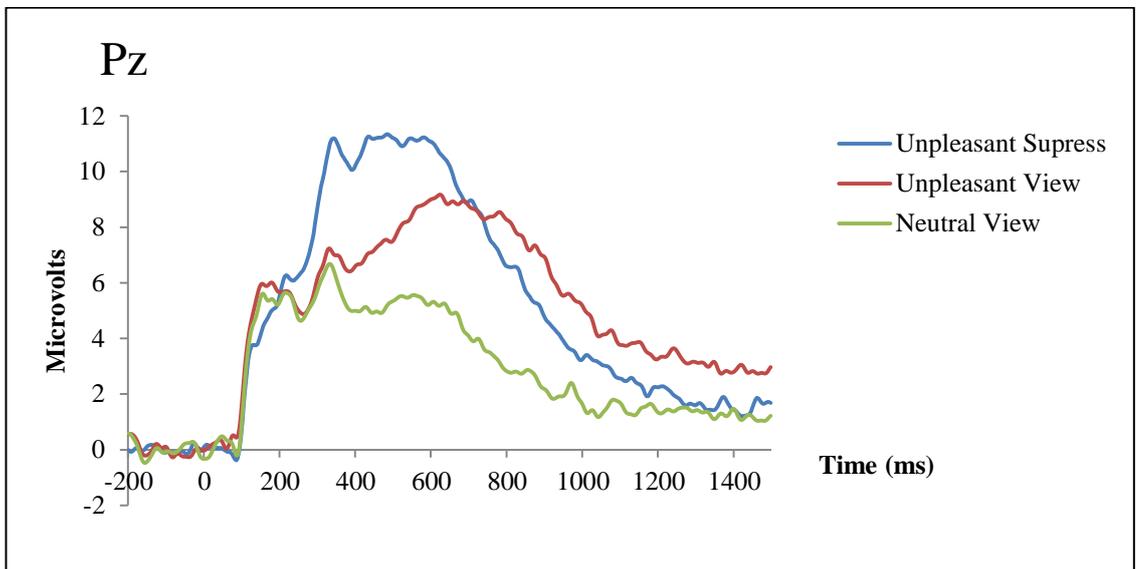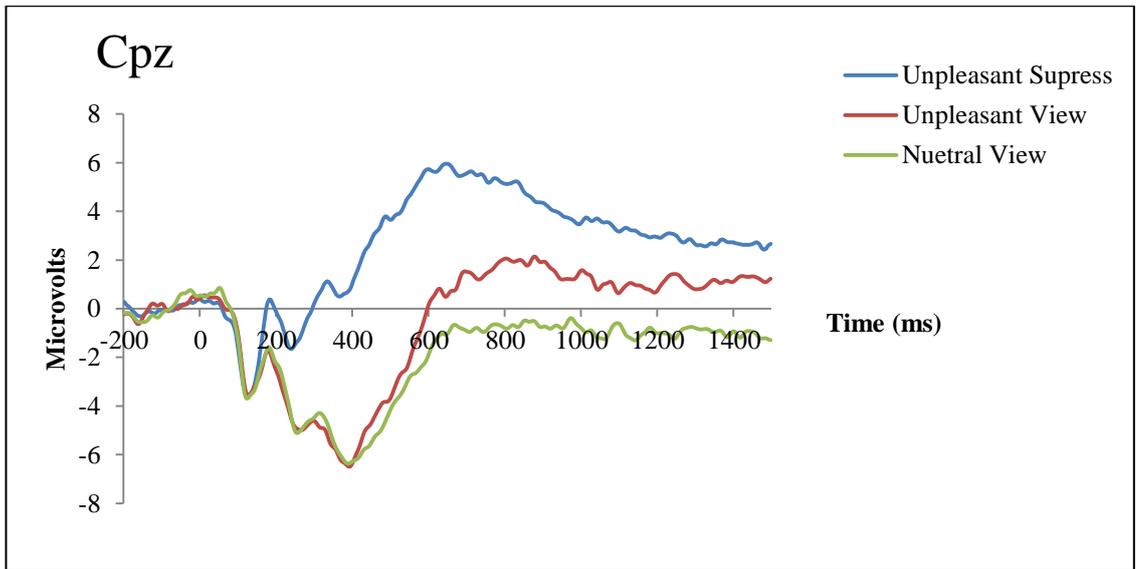
Figure 2. Stimulus-locked ERPs at Cpz, Pz and Oz recording sites for Unpleasant Supress, Unpleasant View, and Neutral View conditions

Time: 475 ms

Unpleasant View   Neutral View   Unpleasant Supress

Time: 800 ms

Unpleasant View   Neutral View   Unpleasant Supress

Time: 1250 ms

Unpleasant View   Neutral View   Unpleasant Supress
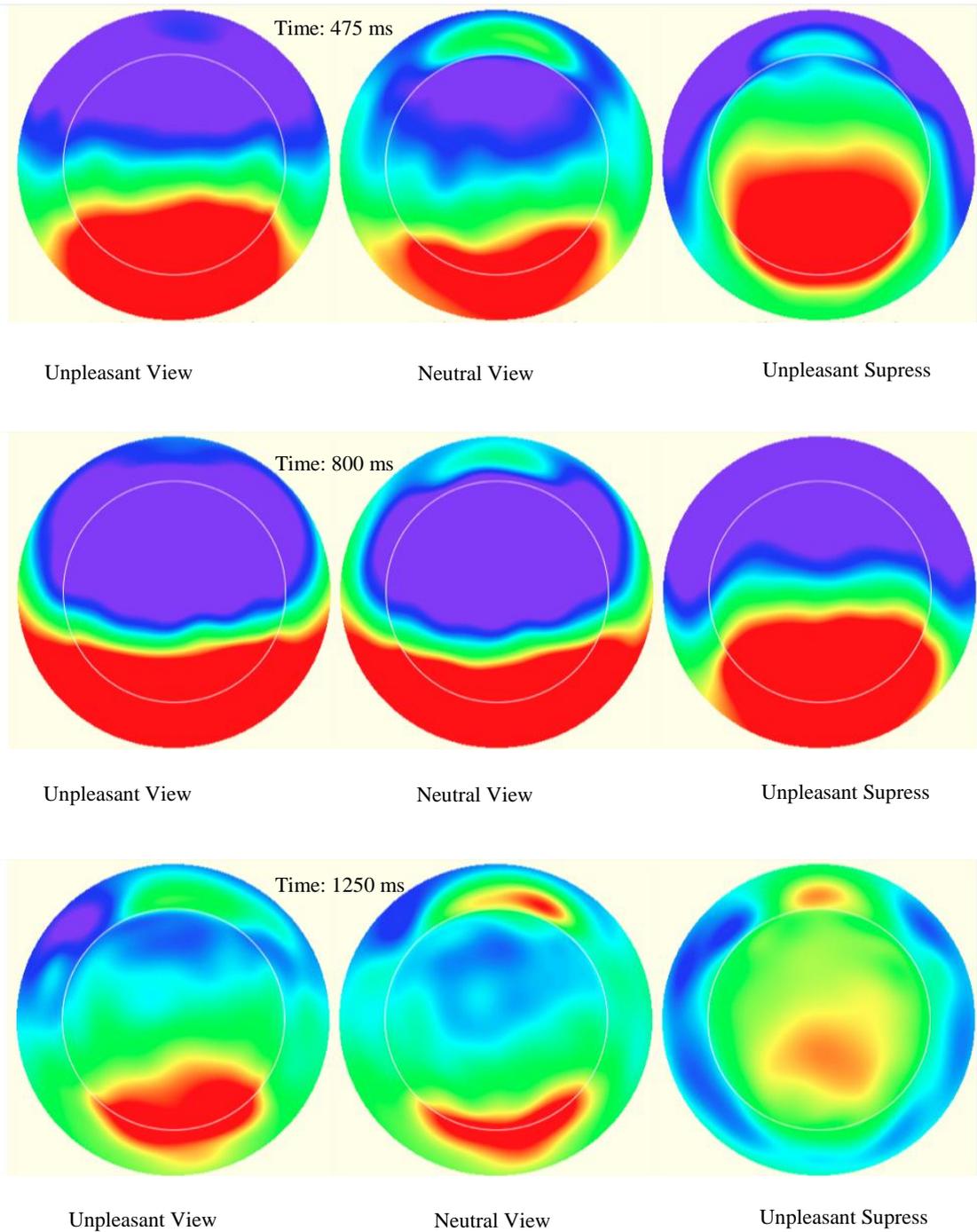
Figure 3. Scalp topography for the three conditions at time window midpoints

Table 2 presents the results of the post hoc paired tests conducted for each condition, at all time windows, across all recording sites.

At the Cpz electrode site, the expressive suppression instruction appeared to modulate the LPP in all the three time windows, generating increased amplitude compared to the other two conditions, in all the three time windows. The difference between the neutral and unpleasant view conditions appeared only the middle and late windows. The unpleasant view condition in the early time window and the neutral condition across all time windows did not generate an LPP.

At the Pz, the three conditions appeared to differ at the early time window; contrary to our predictions, the expressive suppression generated a higher amplitude than both neutral and unpleasant views. The unpleasant view amplitude at this time window appeared to be higher than the neutral view amplitude. In line with our predictions, the amplitude associated with expressive suppression in the middle window was lower than that for the unpleasant view, although the difference between the two was not significant, but higher than that for the neutral view. During the late LPP there was no difference between the neutral view and expressive suppression amplitudes, while the unpleasant view amplitude was still significantly higher than that of the neutral view.

At the Oz, the three conditions differed from one another in both early and middle time windows, with expressive suppression amplitude attenuated compared to both unpleasant and neutral views. The neutral view showed a lower amplitude than the unpleasant view in these two time windows. In the late time window there was no difference in mean amplitude between the neutral and unpleasant view conditions, while the expressive suppression condition amplitude remained lower than the other conditions.

Table 2. Mean values and standard deviations (SD) and corresponding differences of post-hoc paired tests (* = significant), between Neutral View, Unpleasant View, and Unpleasant Suppression trials, for every time epoch at each recording site

Time epoch (ms)	Cpz				Pz			Oz	
	Neutral View	*Unpleasant View*	*Unpleasant Supress*	*Neutral View*	*Unpleasant View*	*Unpleasant Supress*	*Neutral View*	*Unpleasant View*	*Unpleasant Supress*
350 – 600	-4.51 (6.3 SD)	-3.82 (6.02 SD)	3.16* (4.42 SD)	5.14* (5.5 SD)	7.57* (6.83 SD)	10.96* (5.55 SD)	14.84* (8.89 SD)	16.64* (10.96 SD)	12.72* (9.07 SD)
600 – 1000	-0.78* (4.59 SD)	1.44* (4.26 SD)	4.92* (3.70 SD)	3.24* (4.27 SD)	7.64 (5.88 SD)	6.84 (4.97 SD)	8.49* (6.76 SD)	11.25* (8.45 SD)	5.57* (6.11 SD)
1000 – 1500	-0.99* (4.41 SD)	1.07* (3.66 SD)	2.96* (3.58 SD)	1.35*[†] (3.56 SD)	3.41 (4.25 SD)	2.06 (3.80 SD)	5.02 (5.58 SD)	5.41 (6.43 SD)	0.93* (4.52 SD)

Relationship Between LPP and Age and Gender

In order to examine how the changes in LPP relate to the age and gender of the participants, Pearson correlations between the mean LPP amplitudes were calculated for each condition and time window at the Pz and Oz recording sites. The Cpz data was not included in any of the following analyses as two of the conditions in this recording site did not generate an LPP, which was the focus of study. Significant negative correlations with age were found for all expressive suppression conditions across all time windows at the occipital (OZ) recording site: Time window 350-600 ($r = -.44$, $p < 0.001$); Time window 600-1000 ($r = -.45$ $p < 0.001$); Time window 1000-1500 ($r = -.42$ $p < 0.002$). All the correlations were significant at $p < 0.05$ following Bonferroni's adjustment for multiple comparisons. These results suggest a relationship between a decrease in the reported amplitudes associated with suppression at the occipital recording site and the participants' age. The direction of the relationship indicates that the older the participants were, the lower the expressive suppression LPP amplitudes became. Furthermore, Hotelling's t analysis showed that the correlations between age and the expressive suppression LPP at the early time window (350-600) were significantly higher compared to those with an unpleasant view LPP, $t = 1.9$, $p < .05$. This confirms the hypothesis that the amplitude decrease associated with age was related to the suppression condition and not just the valence of the stimulus. Finally, there were no significant correlations between age and the "suppression effect" variable that was used in the following section (subtracted standard effect (unpleasant view) from the target (expressive suppression)) in either the OZ or the PZ recording sites. No significant relationship with gender was found in any of the LPPs.

Can the SCORS Variables Predict the LPP?

In order to examine the relationship between expressive suppression and the SCORS variables, we have subtracted the standard effect (unpleasant view) from the

target (expressive suppression) mean amplitude across all the recording sites and time windows. In order to determine whether the SCORS variables predicted the LPP a series of stepwise multiple regression tests was conducted, with the amplitudes across the Pz and Oz recording areas as dependent variables. This was done while controlling for age and gender, given the significant correlation with age that was found for the recording location and time windows of interest. The results of the multiple stepwise regressions identified one significant final model for the Oz in the early time window (R=.69, R Square =.48, F = 3.148, p = 0.001) (while keeping age and gender constant) which accounted for 49% of the variance predicting the LPP with the following beta weights: EIR (.39, p = 0.008) indicating a positive relationship; EIM (-.37, p = 0.016) and ICS (-.45, p = 0.004) indicated a negative relationship (see Table 3). The other variables were not significantly associated with the LPP amplitude. A higher emotional investment in relationships (EIR) predicted a higher LPP associated with the regulation instructions, while higher emotional investment in moral standards (EIM) and greater identity and coherence of self (ICS) predicted lower LPP.

Table 3. Stepwise multiple linear regression predicting the amplitude of the occipital recording site in the early time window, based on SCORS variables.

Variable	Oz 350 – 600 ms		
	Beta	*t*	*p*
Age	.069	.508	
Gender	-.122	-.923	
COM	-.119	-.660	
AFF	.071	.445	
EIR	.483	2.800	$\leq.01$
EIM	-.367	-2.533	$\leq.05$
SC	-.088	-.562	
AGG	-.040	-.257	
SE	-.046	-.354	
ICS	-.463	-3.102	$\leq.005$

Discussion

The aim of the present study was to extend previous findings regarding the neural correlates of emotion regulation to an adolescent sample, as well as to explore the contribution of individual differences to this process. This study provides further evidence that emotion regulation can alter emotional responses to unpleasant stimuli in adolescents, and that individual differences are significantly involved in this process.

We have first confirmed that, in line with previous studies (Cuthbert et al., 2000; Dillon et al., 2006; Foti & Hajcak, 2008a; Moser et al., 2006), unpleasant images successfully increased the amplitude of the LPP compared to neutral stimuli across all the recording sites. This result supports the assumption that the LPP is a valid tool to explore emotion related processes in adolescence, similarly to adult studies. Further, we successfully replicated findings from adult studies, confirming that emotion regulation instruction in adolescents successfully changed the LPP amplitude, as has been shown with adults. This provides an indication that the LPP is sensitive to regulation instructions and can be used to explore emotion regulation processes in adolescent. The overall effect of emotion regulation was also consistent with adult studies (Paul et al, 2013).

The experimental instructions of expressive suppression significantly reduced the LPP in both the parietal and occipital recording sites. At the parietal site the suppression condition first increased the LPP in the earlier window before returning to a reduction consistent with previous studies. Similarly to adult studies (Foti & Hajcak, 2008), unpleasant images preceded by emotion regulation instructions had the same LPP (at the parietal site) as neutral images in the late time window, while unpleasant images that were attended to continued showing a higher amplitude than those under the

other two conditions. This suggest that similarly to adults, adolescents can successfully use emotion regulation strategies to down regulate emotional arousal.

It is possible that the spike in the parietal LPP in the early time window is the neural correlate of the anticipatory respiratory activity, indicating an increase in autonomic responding. This is thought to be associated with the physiological suppression effect, as reported by Dan-Glauser and Gross (2011), occurring at the same time window (0 to 0.5 seconds) during a similar expressive suppression task. While middle aged individuals use emotion regulation strategy based on experience (Zimmermann & Iwanski, 2014) and therefore more effortlessly, adolescents may be less prepared for the variety of emotionally evocative situations with which they are faced. It is therefore plausible that the same anticipatory activity is more effortful and corresponds with additional neural activation in adolescents compared to adults, thus providing a possible explanation to the difference in amplitude between the two age groups.

While adult studies did not report on changes at the occipital site, in the present study the effect of expressive suppression instruction on the LPP at this site was so pronounced, that the LPP amplitude was lower than the one for the neutral view (suggesting extreme down regulation). Interestingly, in the late time window the difference between unpleasant and neutral condition disappeared, whereas the effects of emotion regulation were marked through all the three time windows. This suggests that the occipital LPP in this age group may correspond with a somewhat different mechanism, more specific for emotion regulation and not as sensitive to the emotional valance of the stimulus. It is possible that this trend is more evident in the adolescent population as previous studies have shown that the neural correlates of emotion

regulation tend to be located more occipitally in younger participants (Hajcak & Dennis, 2009).

In the central parietal site the unpleasant view condition did not produce an LPP in the early time window, but the emotion regulation instruction resulted in a positive activation. The overall amplitude trend is similar to the one reported by Moser et al (2006) at the same recording site. It is possible that the effects observed on this recording site are tapping into a different, more frontal process (also sensitive to emotion regulation instructions) to that described in the literature.

It is likely that the posterior reduction in the LPP observed in the regulation condition of the present study is related to attenuated amygdala activation during emotion suppressive tasks as shown by an fMRI study by Hayes and colleagues (2010). Further support for this assumption is provided by the fact that the reduced facial feedback that was required from participants as part of the expressive suppression instruction is also known to be accompanied by attenuated amygdala activation (Hennenlotter et al., 2009).

While earlier theories suggested that response modulation tends to occur late in the emotion generation process (Gross, 1998), later research has shown that the effects of both expressive and physiological suppression can be detected relatively early on in the emotion process at the peripheral level (Dan-Glauser and Gross, 2011). As far as the temporal features of emotion regulation are concerned, the findings of the present study seem to confirm that some forms of response modulation, specifically expressive suppression, are not always deployed after the emotion is generated but can be used as a preventative regulatory strategy. This is consistent with the findings of Paul and colleagues (2013) and Vanderhasselt and colleagues (2013), suggesting that preparatory

use of expressive suppression can be used when the content of the stimulus cannot be anticipated and therefore an effective reappraisal is not possible.

As predicted, the current study found a significant relationship between the reduction in the LPP in the regulation condition and the age of the participants. Overall the correlation with age is consistent with previous findings that reported change in neuro-correlates of emotion regulation with development (McRae el al., 2012). More specifically, the results are consistent with Kisley and colleagues (2007) findings that the change in LPP in response to unpleasant images was shown to be reduced with age.

This could suggest that this relationship in part reflects a specific process of improved emotion regulation. This may indicate that the capacity to regulate also becomes less effortful with age, during the age span covered by this study. A greater capacity for cognitive control in affective conditions (Pfeifer & Blakemore, 2012) could explain the decrease of the LPP.

Relevant to the present results are the findings of Zimmerman and Iwanski (2014) who showed that emotion regulation develops in an emotion specific manner, demonstrating an increased use of expressive suppression for fear from early adolescence to adulthood, but not for other emotions such as anger and sadness. Due to the nature of the IAPS that consist of images that could possibly evoke fear, it is possible that the LPP decrease associated with age is associated with more habitual use of expressive suppression in the older age group. It might be argued that the use of expressive suppression to deal with fear is adaptive and the ability to use it improves with age.

More generally, it is interesting to consider the possible effects that may be unique to expressive suppression as a pre-emptive regulation strategy in adolescents. Given the continuous cyclical nature of emotion generation (Gross and Thompson,

2007), modulating the response (e.g. through expressive suppression) early in the cycle can be used to modify situations changing the overall emotional "pulse" of an interaction.

An individual may need to regulate the expression of one's emotions for a multitude of reasons, such as: to comply to social norm of a situation, adhering to display rules (not laughing at the teacher); avoid others knowing what one actually feels (not showing a bully you are afraid); helping someone else to regulate his/her emotion (not showing one's anxiety to a younger sibling in a potentially dangerous situation), etc. Generally, it is fair to say that the degree of adaptive expression of one's emotions varies greatly across different situations, relationships and cultures (Cole, Bruschi, & Tamang, 2002).

In adolescents expressive behaviour may often be under significant social scrutiny by peers, hence not showing one's emotions (for instance not showing one is upset by a hurtful remark or afraid when bullied) may often be an adaptive and beneficial behaviour. This is in line with the hypothesis that suppression of fear and dysregulation may become more adaptive with increasing age, autonomy and responsibility (Zimmermann & Iwanski, 2014).

One might also suggest that adolescents' relative lack of experience means there are more situations and emotions which would be novel and highly arousing to them. Hence the use of pre-emptive, less context dependent and more generalised emotion regulation strategies would be used more frequently and would generally be more beneficial for this age group.

This is consistent with Paul and colleagues' (2013) suggestion that being prepared to suppress emotional behaviour facilitates down regulation; hence suppression can operate by targeting emotional responses early, prior to a full expressed

emotional response. Hence adolescents may use expressive suppression more often as it seems to be an effective strategy of emotion regulation when faced with uncertainty. The findings of the present study seem to support the view that expressive suppression in adolescents can successfully modify emotions relatively early the emotion generation process.

Emotion Regulation Predicted by Individual Differences

To our knowledge, this is the first study to demonstrate predictable associations between individual difference measures and the capacity to regulate one's emotions in adolescents. The current findings support our initial hypothesis that the quality of internal representations of relationships may be associated with one's ability to regulate emotions.

Interestingly, the aspect of these internal representations that were predictive of emotion regulation measured through the LPP modulation at the occipital recording site, were: the emotional investment in relationships (EIR), emotional investment in moral standards (EIM) and identity and coherence of self (ICS). The first is associated with the ability of the participants for intimacy, emotional sharing and overall reliance on significant others. The emotional investment in abiding to moral standards and the ability to use abstract thought in relation to morality and compassion towards others is mostly associated with firmly internalised aspects of significant others, who's representations serve as a benign and sufficiently flexible "moral compass". Finally, identity and coherence of self is related to the extent to which the participants were able to perceive themselves as wholesome and integrated individuals with an agentive sense of self.

Gross and Thompson (2007) argue that emotion regulation can occur extrinsically, through the other (a parent helping the child to regulate his/her emotion

when upset) or intrinsically, in oneself. It is suggested that developmentally the ability to regulate emotions starts from extrinsic regulation "regulating myself through you" (Cole, Martin, & Dennis, 2004). Through the course of development, it is gradually internalised through an internal mental representations of the relationship with the other, which forms the capacity to regulate intrinsically. In this way the quality of the mental representation of the relationships with a significant other may modulate the ability to regulate emotions.

It can also be argued that a similar pathway of internalisation occurs in the acquisition of moral standards. A parent would at first tell the child right from wrong; gradually the child would internalise this distinction forming the basis of one's individual sense of morality (Kochanska, 2002). It is possible that the association of the emotional investment in moral standards with emotion regulation may be partially due to the similarity between these processes.

During adolescence there is an enhanced transition from extrinsic to intrinsic emotion regulation: a continuous increase in self-regulation parallel with the gradual decrease in reliance on social and external regulation (Sameroff, 2010).

Due to this gradual shift from extrinsic to intrinsic emotion regulation, it may be argued that the finding which shows emotional investment in relationships (EIR) predicting an increase in the LPP, i.e. more effortful regulation, results from greater reliance on others in regulating one's emotions. The more an individual relies on extrinsic regulation perhaps the more challenging intrinsic regulation becomes. It is possible that a greater investment in relationships results in more habitual use of others to facilitate self-regulation. As the present study explored the effects of expressive suppression, which is considered to be an intrinsic self-regulation strategy, (EIR) predicted more effortful suppression. The variables associated with more internalised

processes (emotional investment in moral standards (EIM) and identity and coherence of self (ICS) appear to be more closely linked with one's ability to regulate using intrinsic regulation more effortlessly. Therefore these variables predicted the reduction in the LPP associated with the regulation instructions. In addition, it may be suggested that identity and coherence of self (ICS), which is associated with one's sense of agency, is predicting the reduction in the LPP due to an increased sense of own efficacy. There may be a perception of oneself as a mindful agent able to, and therefore more used to regulating one's own emotions more effortlessly.

Previous studies using the SCORS have reported the same variables identified as predictors in the present study to be associated with attachment quality (EIR in Stein et al. (2011)) and predicting therapeutic alliance (EIR and ICS in Pinsker, Stein & Hilsenroth (2007)). Both these findings provide evidence that these variables are implicated in mental representations of relationships and in the quality of functioning within intimate and social relationships. Another study has shown attachment anxiety resulting in a higher LPP in response to negative stimuli (Zilber et al., 2007). Similar patterns have been demonstrated by the present study, where attachment related variables have predicted changes in LPP. It is therefore plausible that less benign representations of relationships can make it harder not only to perceive but also to regulate one's negative emotions.

The SCORS variables seemed to predict modulation of the LPP only in the early time window. Following from the argument that the early LPP is related to attending to the emotion and the later LPP is related to semantic elaboration of the emotion (Schupp et al., 2006), it would appear that internal representation of relationships predicts the ability to regulate emotion perception rather than semantic elaboration. This can also explain why, contrary to our prediction, the SCORS variables associated with social

cognition failed to predict the changes in the LPP. It is possible that social cognition would be implicated more in semantic elaboration of the emotion and as such related to later regulation strategies, such as reappraisal.

It is of particular interest that mental representations of relationships predicted the occipital modulation of the LPP. A possible explanation could be that the amygdala, which is involved in processing emotional visual stimuli (Phillips, Drevets, Rauch, & Lane, 2003; Sabatinelli et al., 2005), projects to the occipital cortex, which was found to be more active in children and early adolescents during emotion regulation tasks (Hajcak & Dennis, 2009). It plays a role in biasing visual information in such a way that emotionally significant information is preferentially processed. As the LPP is thought to index downstream processes resulting from increased activation of the amygdala (Hajcak et al., 2010), current findings might indicate the impact of individual differences on activation in these brain areas during emotion regulation. This could suggest decreased amygdala activation when regulating one's emotions more effortlessly. Earlier, we suggested that the LPP recorded at the occipital site is the neural activation that has more to do with the pre-emptive emotion regulation activity and is less influenced by the valance of the stimulus. Following on from this, it is possible that mental representation of relationships predicting the LPP change in this area could also be associated with a process which is more specific to emotion regulation than to general emotional sensitivity.

Limitations and Possibilities for Future Research

This study had several limitations that should be considered when interpreting the findings.

The images that were used did not allow for clear differentiation between the types of emotional response evoked in participants. Therefore it is difficult to reach

conclusions about any emotion-specific relevance of the regulation strategy used. This is specifically problematic as it has been suggested that emotion regulation may develop in an emotion-specific manner (Zimmerman & Iwanski, 2014). Furthermore, only one emotion regulation strategy was explored as part of the study, not allowing for comparison of how different emotion strategies may be influenced by the age, specific regulated emotion and individual differences. It is important that future studies explore and compare multiple regulation strategies across multiple emotions, examining whether different aspects of social cognition and mental representations of relationships predict ability to exercise different regulation techniques. For instance, it is possible that reappraisal, relying significantly more on cognitive elaboration, could be better predicted by social cognition.

In line with previous research, this study did not use a counterbalanced experimental design in order to avoid the carryover effect of the emotion regulation instruction into the passive view conditions. This choice could have possibly resulted in a degree of desensitisation of the participants to the stimulus and therefore may have skewed the findings. In future studies this limitation could be addressed through arranging two separate visits for the participants or introducing individual ratings of stimulus intensity as part of the task.

A further limitation is related to the age range of participants in this study. The current study focused on the age range between 12 and 17; however, there is evidence of neural development in the brain regions implicated in emotion regulation continuing well into the 20's (Blakemore & Choudhury, 2006). It is therefore important to treat this study with caution. Similarly, caution is advised when examining many other studies of emotion regulation that assume young college students to be representative of a normative adult sample. In order to further our understanding of change in emotion

regulation associated with development, future studies should explore the neural correlates of emotion regulation across the entire life span.

This study had used a narrative based rating system (SCORS): while presenting with significant advantages of an in depth non-self-report measure, it is important to be cautious in making conclusions about the specific nature and causality of mental representations of relationships and emotion regulation.

Further studies are also required in order to investigate the occipital neural activity reported in this study using different regulation strategies. This will aide examining whether the effect reported is unique to expressive suppression, or may be generalised across the earlier pre-emptive regulation strategies. Another issue that requires further exploration is which aspects of social cognition and relationship representations predict emotion regulation in different age groups.

More generally, this study is supporting previous findings suggesting that the LPP can be a clinically relevant marker. The highly significant prediction capacity of the SCORS variables (predicting nearly 50% of the variability) can get us closer to using EEG as a clinically relevant and much more cost efficient marker that can predict clinically relevant constructs. Just one example of this is therapeutic alliance, frequently referred to as one of the core predictors of successful outcome in psychotherapy, which was found to be predicted by the same SCORS variables (EIR and ICS) that predicted the variance in the LPP modulation in emotion regulation (Pinsker, Stein & Hilsenroth, 2007).

Summary

The present study is the first neuro-imaging study to demonstrate the neural correlates of emotion regulation in an adolescent sample. This study had successfully replicated previous adult findings in demonstrating that the LPP in an adolescent population is sensitive to emotion regulation instructions. This study had also replicated previous findings in showing that expressive suppression can be effectively used to significantly modulate emotion generation early in the emotion generation process. Furthermore, the findings of this study indicated an occipital LPP activity that appears to be more specifically associated with the process of emotion regulation rather than influenced by the emotional valence of the stimulus. Finally, this study was able to show that individual differences play an important part in emotion regulation; specifically the differences in mental representations of relationships are very significantly implicated in one's ability to regulate emotions.

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Part 3: Critical appraisal

Introduction

This appraisal provides an opportunity to reflect on some of the important aspects of the research that were out of scope for the empirical paper or the literature review sections. This appraisal will start by reflecting on the issues and challenges the author encountered while conducting research with an adolescent population aged 12 to 18. It will continue with a discussion of ideas for possible improvement of the research conducted, as well as directions for future research in the field. Finally, the clinical implications of the research reported in the empirical paper, as well as those of general research into emotion regulation in children and adolescents will be discussed. It is hoped that these reflections may be of use for future research in the field.

Adolescent Population

Recruitment of young participant is considered to be a difficult and convoluted process (Rice & Broome, 2004; Campbell, 2008), which many researchers try to avoid. Nevertheless, the importance of studying psychological processes across the lifespan (Baltes, 1987; 1998) makes it necessary to stand up to this challenge. This section will reflect on the issues of recruitment, consent and experiment design encountered in this study of emotion regulation in adolescents.

One of the first challenges in conducting this research was the issue of participants' recruitment. There were several difficulties to be addressed.

It was decided that the most appropriate recruitment method would be to work directly with schools in the vicinity of the research lab (Beskow et al., 2004; Elder et al., 2008). The research team phoned multiple schools in the area, asking the schools to advertise the study among the students and their parents. While in some schools the most helpful source of contact was the head teacher, other schools made it very difficult to contact the head teacher directly and the emails sent were never answered. The most useful contacts were the teachers coordinating Personal, Social and Health education in each school. The research team offered the schools talks about issues in psychology research from the postgraduate members of the team in return for the help in recruitment. While most teachers never used the offer many of them appeared to be pleased by the offer and were happy to collaborate.

As recruitment began, it quickly became apparent that the location of the research site, which is based at the Anna Freud Centre, located in one of the most affluent areas of north London causes difficulties. The participants recruited as part of the first recruitment drive were almost exclusively white British from a high

socioeconomic background. It became clear that the team had to contact a wider range of schools. Using the same recruitment channels, schools in different areas of London were contacted allowing for a much more balanced community sample.

Another issue arose during the first weeks of recruitment when the team realised that more that 50% of the participants scheduled did not attend their research appointment. Email reminders did not seem to be successful in ensuring attendance. It was decided to call and text the participants, both the day before the experiment and on the morning of the same day. Implementing this more assertive strategy significantly increased the attendance rate and resulted in much more efficient use of scanning time. While this difficulty was not as significant for the younger participants who were brought in by their parents, it was very noticeable in older adolescents, who appeared to find it difficult to hold the appointments in mind, but were mostly happy to attend once reminded.

Another aspect the research team identified was the need to work with the parents of the participants. While officially children above the age of 16 could sign their own consent forms to participate in the study, the research team preferred communicating with as many parents as possible to ensure they understood the procedure and were happy for their children to participate. It appeared that this attitude to parents allowed us to recruit more participants, as many of the parents we communicated with recommended our study to their friends.

Another important challenge that we encountered was choosing an age-appropriate method of communication for the study objectives and procedures. While the younger participants were not required to sign a consent form, it was important for us that they understood what the study involved and would be able to decide whether they wanted to participate, as well as clearly understand that they can leave the study at

any point. The research team therefore made a specific effort to communicate with each child in an age appropriate way and to make sure they clearly understood all the issues mentioned above. (Broome, 1999; Kodish, 2003)

A further issue associated with the participants' was related to the use of age appropriate measures and instructions for the experiment which accounted for the varied cognitive abilities across this relatively wide age range (12-18) (Shaw et al., 2006; Steinberg, 2005; Yurgelun-Todd, 2007). A further challenge was ensuring that the participants remained sufficiently alert and focused, as well as making sure they were following the study instructions. In order to address these issues, after each set of instructions a participant was asked to repeat back to the researcher what he/she understood he/she needed to do. All the experimental conditions had several trial runs ensuring that the participants were adhering to the tasks. Finally each participant was debriefed at the end of the study and asked what they were trying to do at each point in the experiment.

The study used the early memories protocol (Fowler, Hilsenroth, & Handler, 1995) that asks the participants about their earliest memories of their caregivers and life experiences. While sometimes these narratives report on positive aspects of ones experience at other times the narratives generated may become difficult to listen to and may convey stories of deprived childhood experiences and some painful memories. As most of the participants were still living with their parents, the interviewers always had to be alert to narratives suggesting risk or reporting on possible abuse. While none of the narratives collected were sufficiently suggestive of risk or abuse, it was challenging to remain neutral during the recollection of some very difficult and painful memories, while at the same time providing the participants with sufficient support. This required a

significant degree of sensitivity, as well as being mindful of one's role as a researcher, rather than taking part in a therapeutic encounter.

Overall, the experience of working with an adolescent sample was challenging but rewarding at the same time. It showed that engaging with the broader network around the adolescent makes the recruitment process more straightforward. It also suggests that taking into account the developmental features of this age group during recruitment and the experiment itself, methodologically sound and ethical studies can be conducted with this sample.

Research Improvement and Future Research Directions

In this section ideas about how the research conducted could be improved, as well as directions for future research, will be outlined.

In retrospect, it seems that the study conducted had several limitations stemming from methodological oversights, that are in common to studies in this field (Adrian, Zeman, & Veits, 2011). The most significant of these oversights were that only one emotion regulation strategy was used in the experiment, and that the stimuli did not differentiate the emotion they were meant to evoke. A better study design would have included at least three emotion regulation conditions; for example distraction, cognitive reappraisal and suppression, as well as try and control for what particular emotions were being generated by the stimuli. This would have allowed comparing the use of different regulation strategies for various emotions such as fear, disgust, sadness and other emotional states. A further methodological oversight was that only one measure of emotion regulation was included in the study. It would have also been helpful to include a measure of parasympathetic activity, which is considered to be closely associated with emotion regulation (Porges, Doussard-Roosevelt , Maiti, 1994); the respiratory sinus arrhythmia (RSA) could have been used in conjunction with the EEG.

The findings of this study also invite several possible directions for future research in the field. It would be advantageous if future research would use more than one measure of emotion regulation, in addition to neuroimaging and measures of parasympathetic activity, self and other report measures of emotion regulation, ideally combining both questionnaires and structured interviews to allow for a multifaceted and rich representation of emotion regulation. More specifically it would be important to attempt replicating the present study using functional magnetic resonance imaging (fMRI) to further explore the localisation of the regulatory processes reported.

It would be especially interesting to examine findings from neuroimaging studies of emotion regulation alongside the ecological momentary assessment methodology, which while not being sufficiently validated, holds significant promise of addressing one of the key limitations of self-report i.e. its retrospective nature.

Another interesting research direction is related to the social cognition and object relations scale (SCORS) (Hilsenroth, Stein, & Pinsker, 2007; Stein & Hilsenroth, 2011; Westen, 1995). As far as the author is aware, there is no research using SCORS with pre-adolescents and children. Given the findings of the research reported in this dissertation, suggesting a significant association between the SCORS and emotion regulation, it would be important to try utilising the SCORS in researching younger age groups to examine if the quality of object relations and social cognition is equality pertinent in predicting emotion regulation in these age groups. In order to allow for such research, it would be important to explore whether the coding can be used within age appropriate narrative interviews such as chid attachment interviews (CAI) (Target, Fonagy, & Shmueli-Goetz, 2003) or projective interviews such as the children's apperception test (CAT) (Bellak & Bellak, 1949). As the scale was devised to be used on all narratives describing relational episodes, it should be appropriate for scoring those narrative (Westen, 1995). It would also be interesting to examine how the quality of object relations and social cognition as measured by the SCORS changes with age.

More generally, as shown in the literature review and the empirical paper, there is a very limited body of research utilising neuroimaging and involving active emotion regulation in children and adolescents. The findings of the research reported in this dissertation indicate the feasibility of using this paradigm with younger participants. This creates a potential to replicate this study using several emotion regulation

conditions and more measures of emotion regulation across the age groups as well as various psychopathologies.

Overall a study of normally developing children and adolescents incorporating several validated emotion regulation measures is important in order to establish a baseline for emotion regulation in each age group. This will enable future studies exploring emotion regulation across various psychopathologies to have a meaningful comparison and elucidate emotion regulation difficulties which are specific to each psychopathology (Aldao, Nolen-Hoeksema, & Schweizer, 2010)and differentiate those from other more transdiagnostic emotion regulation difficulties.

Clinical Implications

This research and review also have implications to the design and evaluation of clinical interventions across child and adolescent psychopathology. It appears to be of importance for evaluating clinical intervention aimed at children at risk of developing psychopathology related to emotion regulation to assess the following: 1) Whether the intervention leads to a change in emotion regulation strategies children use; 2) Whether the change in emotion regulation strategy leads to a reduction of the symptoms associated with the psychopathology; 3) Whether the interventions produce a preventative change especially for children vulnerable to developing psychopathology.

While the capacity to regulate ones emptions increases through adolescence (McRae et al., 2012; Pfeifer & Blakemore, 2012), this increase is often not linear. Due to significant challenges associated with this developmental stage, adolescents may differ in their ability to use emotion regulation appropriately, depending on the situation as well as on the overall level of mental strain. This may result in situational regression in the emotion regulation capacity that may lead to the use of more basic or less situation ally appropriate regulation techniques. Clinical interventions aimed at this age groups should take into account this variable capacity and attempt to provide the adolescents with tools to deal with their emotions during these "temporary regressions".

As far as cognitive behavioural therapy is concerned, while the issue of emotion recognition is deeply embedded in clinical practice (e.g. hot cross bun (Padesky & Mooney, 1990)), the specific issue of regulation strategy is sometimes overlooked. Given the significant implication of emotion regulation in most forms of psychopathology (as described in the literature review section), it is likely that experimenting and learning to use various emotion regulation techniques in different situations should be an implicit focus of the interventions. This focus is already being

implemented to a significant extent in CBT manuals for most disorders. Approaches include emphasis on avoiding maladaptive emotion regulation (e.g. stopping rumination in health anxiety or depression) and learning to use adaptive emotion regulation (e.g. the use of cognitive reappraisal or distraction in anxiety disorders), (e.g. Berking et al., 2008; Erk et al., 2010; Goldin et al., 2012). These approaches are good examples of recognising the importance of emotion regulation in therapy, but may require clearer explanation as well as psychoeducation.

In light of the research findings presented in this paper, an interesting claim can be made supporting the use of psychodynamic psychotherapy in working with adolescents with emotion regulation deficits. Given the significant association between the quality of mental representations of relationships and emotion regulation, it would be interesting to examine whether an exploration of the nature of object relations and of the repeating relational patterns can improve emotion regulation capacity and reduce symptoms of psychopathology. Some preliminary findings from adult interventions successfully using Dynamic Interpersonal Therapy (DIT) to treat depression (Lemma, Target, & Fonagy, 2011) indicate this might be a promising intervention. Needless to say, significant research exploring changes in emotion regulation capacity are necessary to confirm this suggestion.

Another intervention that may be specifically useful for adolescents struggling with one of the emotion regulation related psychopathologies is group therapy. It is considered that during adolescence the main emotions young people try to regulate are emotions of social nature, this is probably related to the significant value they attribute to social interactions and the powerful emotions they can therefore generate (Gross, Richard & John, 2006). Group therapy may allow developing, practising and reflecting upon appropriate emotion regulation strategies in the most challenging but also most

relevant context: that of peer relationships. Another possible use of the group setting is the delivery of practical psychoeducation for groups in high risk communities; these may be beneficial as they can provide adolescents at risk the tools necessary to improve their emotion regulation capacity. More generally these strategies can be useful for most adolescents taking into consideration the non-linear development of emotion regulation capacities described previously.

Another clinical area which becomes increasingly popular is parenting interventions for parents of adolescents ((Bateson, Delaney, & Pybus, 2008; Nowak & Heinrichs, 2008). While closely focusing on emotion dysregulation and emotion liability, these approaches do not usually refer to emotion regulation. It might be beneficial to provide parents of adolescents with some parenting strategies which would take into account age specific difficulties with emotion regulation. As many adolescents refuse to engage directly with mental health professionals and associated services the parents are often the most direct access the mental health professional may have to the adolescent (Jarvis, Trevatt, & Drinkwater, 2004). Therefore, it may be helpful to provide parents with relevant information about adaptive and maladaptive regulation strategies and discuss with them possible ideas of how these can be taught to the adolescent. Needless to say, the inclusion of psychoeducation in emotion regulation as well as providing parents with ideas of how to teach their children more effective and adaptive regulation strategies, should not be limited to adolescents. It is evident from the literature review that emotion regulation difficulties appear very early in the course of development, often as a result of parental failures to socialise their children to appropriate emotion expression and regulation. It can be therefore suggested that most parenting interventions should refer to the issue of emotion regulation at least to some extent.

Besides parents, another group, which can benefit from similar interventions is teachers. As teachers often play a central role in socialising children into the school environment, information to allow them to evaluate whether a child is struggling with socialisation due to deficits in emotion regulation can allow the teacher to become aware early on of these difficulties, and help the child by putting in place a helpful support network.

Overall, there seems to be a degree of disconnect between the empirical research into emotion regulation and clinical practice. It would be of great interest to bring the two fields closer together and use the multiple measures of emotion regulation mentioned in the literature review and the empirical paper to further examine the efficacy of the various therapeutic modalities. Further exploration of emotion regulation change as a result of psychotherapy can also shed light onto the mechanisms of change that might be common across different therapeutic interventions. It is the author's hope that the present dissertation stimulates more interest in conducting further research that would be able to bring those clinical and theoretical perspectives of emotion regulation closer together.

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