Theoretical Underpinnings of Overgeneral Autobiographical Memory and the Relationship Between Rumination and Executive Control in Adolescence

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Author's Declaration

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

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Date

Previously published work

Three papers, from Chapter 2, 3 and 4 have been submitted for publication:

Chapter 2: Stewart, T., Hunter, C. S., Rhodes, S. (2015). A narrative synthesis of the applicability of the CaR-FA-X model in child and adolescent populations: A systematic review. *Memory* (under review).

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Table of contents

List of tables

Chapter 2:

Chapter 3:

Chapter 4:

List of figures

Chapter 1:

Chapter 2:

Chapter 3:

Chapter 4:

List of abbreviations

AM	Autobiographical Memory
AMI	Autobiographical memory interview
AMT	Autobiographical Memory Test
AMT-PV	Autobiographical Memory Test for pre-school children
BR	Brooding rumination
CaR	Capture and Rumination
CAPS-CA	Clinician Administered PTSD Scale for Children
CaR-FA-X	Capture and Rumination, Functional Avoidance and impaired eXecutive control model
CAQ	Cognitive Avoidance Questionnaire
CBT	Cognitive Behavioural Therapy
CDI-S	The Child Depression Inventory—Short Form
CRSS	the Children's Response Style Scale
CRSQ	the Children's Response Styles Questionnaire
CSA	Childhood Sexual Abuse
BDI-II	the Beck Depression Inventory Second Edition
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, Fifth Forth Edition
DHS	Department of Human Services
DMS-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
E	Emotion
EC	Executive Control

EF	Executive Function
ESRC	the Economic and Social Research Council
FA	Functional Avoidance
FDQ	Family Disagreements Questionnaire
GL	Grey Literature
HD	High Discrepant
IDH	the Impaired Disengagement Theory
IST	Internal Switch Task
IQ	Intelligence Quotient
KDEF	Karolinska Directed Emotional Faces
LD	Low Discrepant
MASC-II	The Multidimensional Anxiety Scale for Children Second Edition
MCAR	Missing Completely at Random
MI	Multiple imputation
MDD	Major Depressive Disorder
Mi-AMT	Minimal instruction Autobiographical Memory Test
N.d	Unpublished manuscript
NE	Non-Emotion
Neg	Negative
NK	Not known
No.	Number of
NOS	Newcastle-Ottawa Scale
ns	Non-significant

OGM	Overgeneral Autobiographical Memory
PR	Partially Remitted
PRISMA	the Preferred Reporting Items for Systematic reviews and Meta Analyses
Prop.	Proportion
PRP	Peer-Reviewed Papers
PSY	Psychiatric sample
PTSD	Post-Traumatic Stress Disorder
PVG	Protecting Vulnerable Groups Scheme
R	Rumination
RAH	the Resource Allocation Hypothesis
rAMS	Reduced Autobiographical Memory Specificity
RRS	the Ruminative Response Scale
SAMT	Semantic Autobiographical Memory Test
SD	Standard Deviation
TE	Trauma Exposure
UK	United Kingdom
WHO	World Health Organisation
WISC	Wechsler Intelligence Scale for Children
WM	Working Memory
WMC	Working Memory Capacity
X	Impaired executive control

Abstract

Introduction: This thesis examined the theoretical underpinnings of overgeneral autobiographical memory (OGM) and the directional relationship between rumination and executive control at a time associated with heightened risk of depression. Specific attention was given to the subcomponents of rumination (brooding rumination and reflective pondering) and executive control when processing emotional and non-emotional information in an attempt to explain inconsistent findings in the literature. Providing insight into the developmental processes involved in autobiographical memory may help explain how OGM develops and is maintained. **Method**: Three studies entailing a mixed methods design formulated the methodology in this thesis and included: a systematic review of the CaR-FA-X model specific to child and adolescent populations and quantitative prospective research studies with school based adolescent samples. **Results**: Partial support was found for the CaR-FA-X model through the systematic review: strong support was found for capture errors and trauma exposure as well as interactive effects between rumination and executive control. Importantly, the mechanisms of the model manifest themselves differently depending on the clinical status of populations. The quantitative studies conducted with adolescents in community settings revealed that high levels of reflective pondering moderated the relationship between executive control for emotional information and OGM. Lower executive control when processing emotional material (reflected by larger switch costs) predicted *less* OGM, but only when reflective pondering levels were high. Lastly, findings indicated that rumination preceded executive control and demonstrated that reflective pondering was predictive of greater executive control (reflected by lower

switch costs) for emotional information over time. Results were independent of age, gender and symptoms of anxiety and depression. **Conclusions**: Partial support for the CaR-FA-X model was found for child and adolescent populations, and findings highlighted important moderating factors. Reflective pondering may serve as a protective factor against OGM and lower levels of executive control when processing emotional information. Recommendations, refinements to theoretical models, implications and limitations are discussed.

Chapter 1: Introduction

1.1 Overview

Mental illness is a leading cause of distress and suffering as well as a heightened source of socioeconomic cost. In developed countries, mental illness accounts for over 15% of the disease weighting overtaking cancer related illnesses (Prince et al., 2007). In the UK alone, an estimated 16.7 million people suffer from illness related to mental health (Wittchen & Jacobi, 2005) and major depressive disorder (MDD) is one of the most prevalent (Judd & Akiskal, 2000) and debilitating of these disorders (Chaudhury, Deka, & Chetia, 2006). Depression is a clinically heterogeneous disorder which makes understanding the pathogenesis of the illness challenging. There has been significant progress in establishing prevalence rates for both clinical and subclinical levels of depression in adults and adolescents as well as preliminary advancements to its aetiology. However, there appears to be a 'ceiling effect' of how much is understood about depression and there is an inability to be able to thoroughly predict who will become depressed, at what time and for what reasons. One possible reason for this is that much of the research conducted to better understand depression tends to focus exclusively on single vulnerability factors and it is inherent that several risk factors interact to increase the risk of depression (Hankin, 2012; Thapar, Collishaw, Pine, & Thapar, 2012).

There are many potential vulnerability factors to depression, including genetic, biological, cognitive, environmental contributions, and emotion regulation factors (Alloy, Abramson, Walshaw, & Neeren, 2006; Dunn et al., 2011; Jacobs, Orr, Gowins, Forbes, & Langenecker, 2015; Joormann, 2010; Lohoff, 2011). Genetic studies show that 30-40% of the variance in depression can be attributed to

hereditary factors (see Sullivan, Neale, & Kendler, 2000 for a review) and while research has suggested that 60 to 80% of first onsets of depression result following an adverse life event, only 20% of people will develop depression following a negative life event (Monroe & Harkness, 2005). It therefore appears that when faced with a stressful negative life event, some individuals show reduced functionality (e.g. symptoms of depression) while others show resilience. Given that the majority of individuals do not develop depression when exposed to high levels of stress, this suggests that depression is not a normative outcome following a stressor but that other influences are involved.

Research spanning over 50 years has focused on cognitive functioning in depression (see Gotlib & Joormann, 2010) and more recently the link between cognitive processing and emotion regulation strategies such as rumination (Koster, De Lissnyder, Derakshan, De Raedt, 2011). One such cognitive factor is overgeneral autobiographical memory (OGM; Williams and Broadbent, 1986). OGM occurs when an individual demonstrates impaired ability to retrieve a specific memory, defined as an event at a specific time and place (e.g. last Saturday night at the cinema), instead categories of events (e.g. every Saturday night) or, memories for events that last over an extended time frame (e.g. my summer holiday in Florida) are retrieved. OGM in an important phenomenon as it has been shown to predict the onset and course of depression in adults (Sumner, Griffith, & Mineka, 2010; Williams et al., 2007), and adolescents (Rawal & Rice, 2012a). OGM has been associated with longer recovery from depression, and has also been found in individuals in remission from depression (Williams et al., 2007).

Given the clinical significance of OGM, researchers have begun to focus attention towards the theoretical underpinnings of OGM. The CaR-FA-X model (Williams et al., 2007) is the most prominent and comprehensive model of OGM. Developed as a framework to enhance understanding of OGM predominately in adults, the model suggests that rumination, impaired executive control and/or functional avoidance are prerequisites to OGM. However, little is known about how these mechanisms manifest and give rise to OGM in childhood and adolescence. A greater understanding of the mechanisms that underlie OGM, particularly with child and adolescent populations could be imperative in gaining insight into the developmental processes involved in autobiographical memory and help to provide an explanation to how OGM develops and is maintained.

There is also separate, but converging evidence to suggest that executive control (i.e. the ability to inhibit information, switching between and update information in working memory) is related to the tendency to ruminate (i.e. a repetitive and passive focus of attention on the causes and consequences of distress and emotional mood states). While research has demonstrated a link between executive control and rumination (Koster et al., 2011), the directional relationship between the two variables is not well understood. Two opposing models have been offered as theoretical frameworks for the relationship between rumination and executive control: The Resource Allocation Hypothesis (RAH; Ellis & Ashbrook, 1988) and the Impaired Disengagement Hypothesis (IDH; Koster et al., 2011). The IDH suggests that impaired executive control places individuals at risk of increased levels of rumination, particularly brooding rumination, whereas the RAH posit that there is a limit on cognitive resources and that engaging in ruminative or depressive

thinking reduces these resources. Developmentally, it is important to investigate the directional association between executive control and rumination in adolescence as this time period is associated with increased rumination (Hyde, Mezulis, & Abramson, 2008), and marks a time frame for increased emotional reactivity (Casey, Jones & Hare, 2008) and of heightened maturation of the prefrontal cortex which is associated with executive control abilities (Paus, 2005; Rubia et al. 2000; Rubia et al. 2006; Yurgelun-Todd, 2007). Therefore enhancing knowledge of the rumination and executive control relationship may be may be influential in understanding of this development.

The research reported in this thesis aimed to explore the theoretical underpinnings of OGM, and investigate the directional relationship between executive control and rumination. This was conducted through a systematic review of past and current literature specific to child and adolescent populations, and two prospective empirical studies with adolescent populations. First, a background to the depression literature is presented, including a summary denoting to adolescence and the development of depression. This section situates the current research in the context of the problem with high prevalence and relapse rates of depression, the socioeconomic cost of depression and the suffering to the individual. Next, subsequent sections explore vulnerability factors to depression and highlight OGM, executive control and rumination as key factors. This is followed by a summary of the literature denoting to the relationships between these three factors through an examination of theoretical models.

1.2 Depression

According to the Diagnostic and Statistical Manual of Mental Disorders (5th ed; American Psychiatric Association, 2013), depression is a heterogeneous disorder, defined by the presence of at least one major depressive episode, with the absence of hypomania and mania. To meet the criteria of a major depressive episode, five of nine symptoms must be present within the same two week period and represent a change from typical functioning. These symptoms include, 1) depressed mood, 2) loss of interest or pleasure, 3) change in weight or appetite, 4) insomnia or hypersomnia, 5) psychomotor retardation or agitation, 6) loss of energy or fatigue, 7) worthlessness or guilt, 8) impaired concentration or indecisiveness, and 9) recurrent suicidal ideation or attempt or thoughts of death (American Psychiatric Association, 2013). For diagnosis, one of the core symptoms must be depressed mood or a loss of interest and/or pleasure. Generally, the frequency and pervasiveness of symptoms have to occur nearly every day and be present for the same two week period, although this does vary depending on the individual's symptoms. A depressive episode will cause significant stress or impairment and will not be caused by a substance or medical condition or be better explained by a psychotic disorder. Diagnosis of MDD is similar for adults as it is for child and adolescent populations, with the exception of one criterion. Irritability, a core diagnostic symptom, is part of the criteria for depression in childhood and adolescence within the DSM-IV and DSM-5.

1.2.1 Epidemiology

MDD is experienced by 8-12% of the adult population and characterized by a constellation of behavioural, cognitive and emotional symptomology (Ustun, Ayuso–

Mateos, Chatterji, Mathers, & Murray, 2004). According to the Wold Health Organisation (WHO, 2015) an estimated 350 million people worldwide suffer from depressive disorders. It is thought that MDD will affect one in four women and one in six men across the lifetime (Kessler et al., 1994) and has been ranked by the WHO as the 4th leading cause of disability worldwide and predicted 2nd by 2020 (Murray & Lopez, 1996) as well as the leading cause of disease burden globally by 2030 (WHO, 2012). Depression is frequently comorbid with other mental health disorders, most often anxiety related disorders (Hirschfeld, 2001). It has also been associated with several chronic diseases including, although not exhaustive of, coronary heart disease (Lichtman et al., 2008), multiple sclerosis (Siegert & Abernethy, 2005) and cancer (Reiche, Nunes, & Morimoto, 2004). There is also direct link to suicidal thoughts and behaviours with an estimated 90% of people who died by suicide having a psychiatric diagnosis such as MDD at the time of death (Bertolote & Fleischmann, 2002). The socioeconomic cost of depression is burdensome. Figures show that self-reported depression is the main cause for absences in the workplace in the UK (Almond & Healey, 2003) costing £8.4 billion and a further £15.1 billion when accounting for reduced productivity in the workplace.

A closer look at socio-demographic correlates of MDD show that within 23 countries in Europe, females are two times more likely than males to be at risk of depression (Van de Velde, Bracke, Levecque, 2010). A cross national study of epidemiology of depression demonstrated similar results. Bromet et al. (2011) showed that twice as many females than males were classified as having MDD. This was reported across 15 of the 18 countries included in the study, and although the remaining three countries did not find significant differences in MDD between males

and females, there was a trend for higher reported rates of depression in females than in males. A recent review of the literature by Kessler and Bromet (2013) found lifetime prevalence estimates of depression differed widely across countries. Kessler and Bromet (2013) highlighted prevalence rates to be generally higher in wealthier countries than low or middle income countries. MDD is known by some authors as 'an illness of affluence' (Koplewicz, Gurian, & Williams, 2009).

Depression is highly recurrent. It is characterised by high relapse rates with 50-80% of people recovered from depression having a further depressive episodes (Judd, 1997). Once a first episode has occurred, it is estimated that within five years recurrent episodes will follow (Belsher & Costello, 1988; Lewinsohn, Clarke, Seeley, & Rohde, 1994). Typically, adults with a history of MDD will experience an additional five (Kessler & Walters, 1998) to nine (Kessler, Zhao, Blazer, & Swartz, 1997) depressive episodes across their life span. Such figures emphasise the importance of preventative research to inform interventions which aim to stop first onsets occurring as well as interventions which can disrupt patterns of relapse to enable sustained recovery.

1.2.2 Depression in adolescence

Recent psychological research has shown adolescence to be one of the greatest risk periods for the development of depression (Rao, Hammen & Poland, 2010). In a follow-back analysis with adults, 75% had an onset of depression during childhood or adolescence (Kim-Cohen et al., 2003). Some research suggests that depression in adolescence is an early onset version of adult depression given its robust association with recurrent depression in adulthood (van Lang, Ferdinand & Verhulst, 2007). It is estimated that one in 13 adolescents worldwide has depression

(Richardson & Katzenellenbogen, 2005) and approximately 20% of adolescents will experience a clinically significant depressive episode by 18 years old (Davey, Yucel & Allen, 2008; Hankin et al., 1998). In pre-pubertal children, depression is relatively uncommon (1-2%) although prevalence rates begin to rise in early adolescence to around 4-5% by mid to late adolescence (Costello, Erkanli, & Angold, 2006). Further research suggests rates of depression hasten considerably from early to late adolescence, suggesting this age group as vulnerable to depression (Hankin & Abela, 2005).

Gender differences in adolescence, specifically a female dominance (2:1) of the disorder is reportedly similar to that found in adult depression (Thapar et al., 2012), whereas in pre-pubertal children depression is gender neutral (Egger & Angold, 2006). This increase for females tends to occur around mid-puberty and research does tend to link adolescent depression in females with hormonal changes at puberty (Goodyer, Herbert, Tamplin, & Altham, 2000). However, it is unlikely that hormonal changes in isolation would be enough to exert such dramatic changes in behavioural aspects of depression. Such gender differences have been attributed to a wide variety of factors such as greater ruminative coping found in females (Nolen-Hoeksema & Girgus, 1994), genetic disposition (Kendler, Gardner, Neale, & Prescott, 2001), cognitive vulnerability (Hankin & Abramson, 2001), and gender roles (Aube, Fichman, Saltaris, & Koestner, 2000) to name a few.

Depression in adolescence is thought to be more severe than in adulthood as signified by increased length of depressive episodes, increased hospitalisation, and suicidal thoughts and behaviours (Kolchak & Goldstein, 2009; Van Noorden et al., 2011). Few longitudinal studies have followed adolescent cohorts into adulthood, but

those which have report robust continuity between adolescent depression and adult psychiatric disorders, alcohol abuse, impaired functioning in work, social, and family life as well as increased suicidality (Colman, Wadsworth, Croudace, & Jones, 2007; Weissman et al., 1999). Adolescents, similar to adults, are burdened with high relapse rates with research showing in 60-70% of cases, depressive episodes remit within one year (Dunn & Goodyer, 2006). Moreover, depression in adolescence has a 60-70% chance of persisting into adulthood (Weller & Weller, 2000).

It is important to recognise the significance of subclinical levels of depression across adolescence. Subclinical depression refers to clinically significant symptoms which do not meet full criteria to be diagnosed with MDD (Gotlib, Lewinsohn, Seeley, 1999). There is little agreement on how many or what symptoms are needed to classify as subclinical depression (Chen, Eaton, Gallo, Nestadt, & Crum, 2000) and although the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V) addresses some of these issues, there is research to suggest that there is a range of depressive type symptoms and disorders that do not exist within particular 'depressive' categories (Cuijpers, de Graaf, & van Dorsselaer, 2004; Lewinsohn, Solomon, Seeley, & Zeiss, 2000). Notwithstanding the issues surrounding terminology and depression categories, it has been found that over 50% of adolescent's self-report mild to moderate symptoms of depression, with 29% reporting moderate to severe symptoms (Lipps et al., 2012) between the ages of 14-16 years old. In a follow up study, Fergusson Horwood, Ridder and Beautrais (2005) reported that adolescents with subclinical levels of depression were at elevated risk of developing depression in adulthood as well as at risk of suicidal behaviours. Moreover, adolescence marks a period in time that is associated with the maturation

and development of social skills (Roisman, Masten, Coatsworth, & Tellegen, 2004) and experiencing symptoms of depression in adolescence has been found to cause impairment in social and emotional skills that are necessary for social development (Gayman, Lloyd, & Ueno, 2011). Symptoms of depression have also been shown to affect school performance, result in reduced concentration, as well as leading to difficulties with reading and writing and perceiving school work as overly difficult (Fröjd et al., 2008).

Clinical depression and symptoms of depression are highly prevalent, characterised by high relapse rates and result in many adverse consequences. Adolescence seems to signify a unique period within development that is critical to the aetiology and onset of subclinical symptoms of depression as well as clinically diagnosed depression (Hankin et al., 1998; Thapar et al., 2012). Research has demonstrated that preventing or delaying depression onset can alter the developmental trajectory and debilitating suffering of depression (Andrews, Szabo, & Burns, 2002). Therefore, future advances in understanding depression are likely to rely upon a clearer understanding of the psychological variables implicated in vulnerability to depression and the theoretical underpinnings of these vulnerability factors.

1.3 Vulnerability factors associated with depression

As noted, there are many potential vulnerability factors to depression, including genetic, biological, cognitive, environmental contributions, and emotion regulation factors (Alloy et al., 2006; Dunn et al., 2011; Jacobs et al., 2015; Joormann, 2010; Lohoff, 2011). While genetic factors such as having a depressed parent account for a large amount of the variability in depression (Goodman et al.,

2010; Sullivan et al., 2000), the identification of specific candidate genes accounting for a direct link with depression has had little success (Jenness, Hankin, Young, & Smolen, 2015). This is likely due to the difficulty with identifying and linking specific genetic markers to the heterogeneous nature and complex aetiology of depression (see Caspi, Hariri, Holmes, Uher, & Moffitt, 2010). Environmental researchers argue that environmental influences such as stress are implicated in depression (Kendler, Hettema, Butera, Gardner, & Prescott, 2003; Kendler, Karkowski, & Prescott, 1999) and while there is support for this theory it does not explain how some individuals are able to show resilience in response to specific risk factors (e.g. stressful events). It seems as though those who are resilient are able to action a set of skills that regulate thoughts and emotions and engage in behaviours that overrides a depressed response to a risk. This suggests that cognitive abilities such as executive control and emotion regulation factors may be instrumental in understanding why someone becomes depressed. Interestingly, geneticists have also turned their attention to cognitive processing in depression to better understand the genetic influences in the disorder. For example, researchers have highlighted difficulties in the processing of emotional information (i.e. executive control) as a possible endophenotype (a measurable component between disease and genotype) as a way of signifying genetic underpinnings of depression (Gibb, Benas, Grassia, & McGeary, 2009). Taken together, these findings suggest that gaining a greater and more comprehensive understanding of the development and nature of cognitive functioning that is associated with emotion regulation strategies such as rumination may be influential in providing an enhanced knowledge of the emotional difficulties

and negative affect which are hallmark features of and fundamental prerequisites to depression.

Recent cognitive research draws on the importance of understanding underlying cognitive processes that may be responsible for the persistent negative affect and negative cognition reported in depression (De Lissnyder, Koster, Everaert, et al., 2012). For example, several researchers have emphasised impaired executive control (Kaiser et al., 2003; Joormann 2005) and OGM (Williams et al., 2007) as important factors in understanding depression. Moreover, these cognitive processes have been linked to rumination (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Hilt, Leitzke, & Pollak, 2014), a key emotion regulation factor implicated in the onset, maintenance and severity of depression (Abela, Brozina, & Haigh, 2002; Abela & Hankin, 2011; Abela, Vanderbilt, & Rochon, 2004; Broderick & Korteland, 2004; Kuyken, Watkins, Holden, & Cook, 2006, & Dalgleish, 2006; McMurrich & Johnson, 2008; Nolen-Hoeksema, 2000; Nolen-Hoeksema & Morrow, 1991; Schwartz & Koenig, 1996; Smith & Alloy, 2009; Verstraeten, Vasey, Raes, & Bijtterbeir, 2010). The following subsections aim to define OGM, executive control and rumination and demonstrate how these factors are implicated in depression.

1.3.1 Overgeneral autobiographical memory

Overgeneral autobiographical memory (OGM), sometimes referred to as reduced autobiographical memory specificity (rAMS[1]) refers to the phenomenon that in response to cue words (e.g., happy, sad) an individual is less specific and more overgeneral in their recall than others. For example, OGM occurs when an individual

[1] Across studies, the terms overgeneral memory and reduced memory specificity are used interchangeably. OGM refers to memories that no not contain specific details (e.g., categorical or extended), and rAMS refers to memories with limited amount of specific detail. See Griffith et al. (2012) for a review on methodological issues with the measurement of OGM (and rAMS).

demonstrates an inability in recalling a specific memory, defined as an event at a specific time and place (e.g. last Saturday night at the cinema), instead categories of events (e.g. every Saturday night) or, memories for events that last over an extended time frame (e.g. my summer holiday in Florida) are recalled. The OGM phenomenon was first described by Williams and Broadbent (1986), who reported that a group of suicidal adults were more overgeneral in their memory retrieval that a control group who were not suicidal. Since their seminal paper, links between OGM and depressive disorder (Sumner et al., 2010), PTSD (Williams et al., 2007), acute stress disorder (Moore & Zoellner, 2007), suicidality (Kaviani, Rahimi-Darabad, & Naghavi, 2005) as well as subclinical levels of depression (Ramponi, Barnard, & Nimmo-Smith, 2004) have been robustly reported in adult samples.

OGM has been found represent a stable characteristic in individuals with depression, those recovered as well as in those at risk of depression (Brittlebank, Scott, Williams, & Ferrier, 1993; Mackinger, Pachinger, Leibetseder, & Fartacek, 2000). In a recent meta-analysis of the adult literature (review of 15 studies), Sumner et al. (2010) found that greater OGM was associated with greater symptoms of depression and predicted elevated symptoms of depression over and above initial symptoms. Fewer studies have investigated the phenomenon with child and adolescent populations. However, in the few that do investigate the OGM and depression relationship, OGM has been associated with clinical depression (Hitchcock, Nixon, & Weber, 2014a; Park, Goodyer & Teasdale, 2002; Swales, Williams & Wood, 2001), and has been shown to predict increases in symptoms of depression in adolescents at familial risk of depression (Rawal & Rice, 2012a) and adolescents with a past history of depression (Kuyken & Dalgleish, 2011). These

findings led to the proposal that the tendency to retrieve AM's in an overgeneral way represents a stable trait-like vulnerability to depression rather than merely a correlate of depressed mood.

1.3.2 Rumination

Rumination, another candidate variable with robust associations with depression, is defined by Nolen-Hoeksema (1991) as a response strategy that consists of a repetitive and passive focus of attention on the causes and consequences of distress and emotional mood states. It is widely accepted that individuals acutely respond to their emotions and are able to modify them (Joormann & D'Avanzato, 2010), thereby regulating their emotions. Emotion regulation is defined as the process in which influence is exerted over which emotion is processed, when and in what way they are expressed (Gross, 2002). Theorists suggest that rumination is the most common maladaptive emotion regulation strategy in depressed populations (Compare, Zarbo, Shonin, Van Gordon, & Marconi, 2014) and that individuals engage in rumination as a misguided belief that such a strategy will improve mood, problem solve or eliminate discrepancies between current and ideal self-views (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Papageorgiou & Wells, 2001). Instead, research consistently shows that rumination does not aid problem solving but ruminating leads to a fixation on problems and their consequences without taking action (Nolen-Hoeksema et al., 2008). This type of ruminatory response in turn makes it difficult to activate adaptive strategies to repair mood (Donaldson & Lam, 2004).

Rumination is a trait like style of response, which remains stable across differing mood states. Research has shown that rumination increases from late

childhood and into adolescence (Hampel & Petermann, 2005; Rood, Roelofs, Bogels, Nolen-Hoeksema and Schouten, 2009) with a female dominance becoming apparent in early adolescence (Rood et al., 2009). This is around the same age when gender differences (i.e. a female dominance) in depression have been noted (Nolen-Hoeksema & Girgus, 1994). Rumination has been linked to negative outcomes throughout the literature (McMurrich & Johnson, 2008; Nolen-Hoeksema 1991; Nolen-Hoeksema, 2000; Nolen-Hoeksema, et al., 2008; Nolen-Hoeksema, Morrow, & Fredrickson, 1993; Smith & Alloy, 2009). For example, the persistent, negative and judgmental focus of attention on the causes of consequences of distress exacerbates negative mood resulting in increased symptoms of depression (Rood, Roelofs, Bogels, Nolen-Hoeksema, & Schouten, 2009) as well as the onset of clinical depression (Nolen-Hoeksema, 2000) in adults. Rumination is not only correlated with symptoms of depression but has been linked to the onset, maintenance and severity of depression both cross-sectionally in adults (Just & Alloy 1997; McMurrich & Johnson, 2008) and children and adolescents (Abela et al., 2002; Kuyken, Watkins, et al., 2006) as well as prospectively in adults (Nolen-Hoeksema & Morrow, 1991; Nolen-Hoeksema, 2000) and children and adolescents (Abela & Hankin, 2011; Schwartz & Koenig, 1996; Verstraeten et al., 2010). Prospective longitudinal studies have shown rumination to predict new onsets of depression and increased symptoms of depression in adults (Just and Alloy, 1997; Nolen-Hoeksema, 2000), children (Abela et al., 2002) and adolescents (Abela & Hankin, 2011; Hankin, 2008; Nolen-Hoeksema, Stice, Wade & Bohon, 2007). These findings suggest that the tendency to ruminate represents a vulnerability to depression. It is therefore

important to provide an enhanced understanding of the theoretical underpinnings of rumination.

Despite a wealth of research examining rumination as a single construct, Treynor, Gonzalez and Nolen-Hoeksema (2003) found support for a two factor model of rumination, brooding rumination and reflective pondering. The subtypes of rumination are thought to differ in terms of their adaptiveness. For example, Treynor et al. (2003) demonstrated that brooding rumination was a maladaptive strategy associated with heightened levels of depression whereas reflective pondering was an adaptive strategy of rumination associated less with depression and a more positive focus on problem solving. Their study highlighted the importance of differentiating between the subtypes of rumination, yet few studies acknowledge this distinction. The studies which have acknowledged the distinction tend to support the theory that brooding rumination is maladaptive and associated with symptoms of depression and depressive disorder in adults (Joormann, Dkane, & Gotlib, 2006; Watkins, 2009) and adolescents (Burwell & Shirk, 2007).

The literature on reflective pondering however is limited and has produced mixed findings. For example, some research has suggested that reflective pondering is protective against symptoms of depression in adulthood (Treynor et al., 2003; Arditte & Joormann, 2011) and increased coping in adolescent females (Burwell and Shirk, 2007), whereas others have reported a relationship between depression and increased reflective pondering in adults (Verhaeghen, Joormann, & Khan, 2005). Verstraeten et al. (2010) found that greater reflective pondering was protective against symptoms of depression in older children (11 years and older) at a one year follow up session but greater reflective pondering was associated with greater levels

of depression in younger children (9.9 years or younger). Across all ages, lower levels of reflective pondering were predictive of greater levels of symptoms of depression in boys at follow up, whereas in girls, there was no relationship between reflective pondering and symptoms of depression. Such findings highlight the potential protective nature of reflective pondering in older children and warrant further study.

A recent study by Whitmer and Gotlib (2011) added further disparity to the literature. While they found support for the distinction between brooding rumination and reflective pondering, this distinction was only reported in their participants who were never depressed or who were remitted, but the distinction was not found in adults who were currently depressed. It is possible that in non-clinical adult populations, reflective pondering is adaptive but becomes maladaptive (like brooding rumination) in the occurrence of depression. In support of this theory, Joormann et al. (2006) found that while brooding rumination and reflective pondering were separate variables in non-clinical groups, in clinical samples, reflection and brooding perpetuate each other, concealing any distinction between them. These findings suggest that, for adults, reflective pondering may only be adaptive in non-clinical populations.

1.3.3 Executive control

Executive control has been proposed as an underlying factor in rumination (Koster et al., 2011). Executive control refers to the ability to coordinate multiple cognitive processes efficiently and flexibility towards a specific goal requires the brain to integrate and organise multiple cognitive processes (Roberts, 1998; Shah & Miyake, 1999). There is great debate within the literature towards the cognitive

substructures and processes involved in executive control. For example, Sumner, Griffith and Mineka (2011) define executive control as a set of internal processes that permit goal directed action, including the planning and inhibitory processing of information. Executive control has also been discussed as a central system, with a focus on the control over inhibitory processing and working memory (Williams et al., 2007). It is evident that the specific processes involved in this action remain unclear and vary across theoretical and experimental research. Although there is a limited consensus as to what cognitive processes are involved in executive control, there is a general agreement that executive control refers broadly to the control of a set of cognitive processes accountable for the planning, initiation and monitoring of complex goal directed behaviour, particularly when distracting information is present (Dalgleish et al., 2007).

Impaired executive control has been defined within the literature as an umbrella term referring to "reduced executive resources" (Williams et al., 2007, p. 137). Williams and colleagues suggest that impaired executive control refers to difficulty in holding information in working memory, difficulty in inhibiting negative material and switching between different mental sets. The authors further use the term "reduced executive control" when referring to the same difficulties and have previously used term "executive control dysfunction" (Williams, 2006, p. 548; Williams et al., 2007, p. 143). The disparity between terms may give reason to the array of definitions which are presented across the literature. For example, Sumner (2012) describes impaired executive control as "deficits in executive resources", but goes on to use the terms "impaired executive control", "executive control deficits" and "difficulties in executive control" interchangeably throughout their paper.

Similarly, Hitchcock et al. (2014a) use the term “impairment in executive control” interchangeably with the term “reduced executive control”. Given the broad and inconsistent definition of executive control across the literature, it is not surprising that difficulties in executive control are challenging to define.

The way in which impaired executive control is operationalised within the literature varies across studies. For example, Hitchcock et al. (2014b) discuss impaired executive control and reduced executive control interchangeably to refer to a reduced ability to update information in working memory, reduced working memory capacity or the difficulty in limiting the inhibition of irrelevant information. While these terms may suggest cut off scores (e.g. impairment), or change scores (e.g. reduced executive control), the authors state that executive control refers to as ‘a score’ on a measure of executive control (i.e. a range of scores on the measure). Similarly, De Lissnyder, Koster, Goubert, et al. (2012) refer to impaired executive control to reflect larger switch costs from a range of scores on the internal switch task in a non-clinical student population. Rawal and Rice (2012b) on the other hand define low executive control as scores falling below one standard deviation of the mean on a block design task. Within the current literature ‘impaired’ does not seem to reflect, in all studies, a particular cut off of score. It is evident that greater consistency in the definition and consistency of meaning of ‘impaired’ ‘reduced’ or even ‘low’ executive control is needed. In the empirical studies conducted within the current thesis, executive control is operationalised as the range of reaction time scores on a switching task. Higher reaction times (i.e. greater switch costs) reflect lower levels of executive control and lower reaction times (i.e. lower switch costs)

reflect greater levels of executive control. There were no cut off scores to reflect a high and low impairment group, instead the range of scores across the task was used.

To add further disparity, executive control is synonymous with the term cognitive control. Miller and Cohen (2001) suggested that cognitive control refers to top down processing that exercises supervisory control over other cognitive processes. Similarly, Gotlib and Joormann (2010) discuss the term cognitive control as a set of processes involved in goal directed behaviour. Cognitive control is thought to involve the ability to inhibit irrelevant information, override prepotent responses and to switch between and update material held in working memory (De lissynder et al., 2012). Like executive control, this allows individuals to regulate emotional responses and to respond flexibly to varying situations (Joormann & D'Avanzato, 2010). Typically, authors researching autobiographical memory use the term executive control (Dalgleish et al., 2007; Sumner, 2012; Williams et al., 2007) whereas authors within in the depression literature favour the term cognitive control (De lissynder et al., 2012; Gotlib & Joormann, 2010; Joormann & D'Avanzato, 2010). Executive control and cognitive control seem to refer to the same concept, a set of cognitive processes responsible for the efficient and flexible organisation towards goal directed action and for the purpose of clarity throughout this thesis I will refer to the term executive control.

Executive control is directly related to executive functions (EF). Funahashi and Andreau (2013) suggest that EF is a product of executive control. For example, the efficient and flexible coordination of multiple cognitive processes needed for goal directed action (i.e. to exert executive control) requires the ability to tap into multiple EFs, such as working memory. Although denoted to as one of the

"unresolved mysteries of the mind" (Monsell, 1996) EF is an umbrella term which refers to a collection of related underling processes necessary for cognitive functioning (Miyake et al., 2000). There is a continuing effort to clarify the nature, components and definition of EF, however the concept and theory is still somewhat elusive. Some researchers have gone as far as to state that that the way in which specific EFs are coordinated and controlled during cognitive tasks is an "embarrassing zone of almost total ignorance" (Monsell, 1996). However, research in recent years has made important steps forward in characterising the nature of EFs, and their underlying processes and it is generally accepted that EF broadly refers to a set of top-down processes required for concentration and attention at a time when relying on automatic instinctual intuition would be inappropriate (Burgess & Simons 2005, Diamond, 2013; Espy, 2004; Miller & Cohen, 2001).

Despite developments within the EF literature, there are two predominant challenges that still impact EF research and researchers alike and should be highlighted: the unity and diversity issue and the task impurity problem. There is a lack of consensus concerning whether EF is a unitary factor or a diverse set of independent factors (Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001; Brocki & Bohlin, 2004; Miyake et al., 2000). This is known as the unity and diversity issue. Theoretical advancements of the unity and diversity issue have proposed that, for adults populations, there are three main separable, but related EFs: inhibition, working memory updating and switching (Miyake et al., 2000).

Inhibition (also known as inhibitory control or inhibitory processing) involves the control of attention, behaviour, thought processes and/or emotions to override prepotent responses (Diamond, 2013). Some authors argue that inhibition is not a

unitary construct (Nigg, 2000). For example, aspects of inhibition include behavioural inhibition (also known as response inhibition), and cognitive inhibition. Behavioural inhibition involves the ability to resist acting impulsively whereas cognitive inhibition refers to inhibiting prepotent mental representation (including thoughts and memories) and allows selective attention to specific information with the suppression of attention to other stimuli (sometimes known as interference control or selective attention; see Diamond, 2013 for a review). The second main EF is working memory updating. Working memory is a limited-capacity system (Baddeley, 1986) that allows momentary maintenance and manipulation (e.g. updating) of information. Updating consists of holding, monitoring and updating information held in working memory by adding new relevant and deleting previously relevant information over a short period of time (Gathercole & Alloway, 2008; Smith & Jonides, 1999). Switching, the third main EF, refers to the mental ability to switch between different task sets, rules and/or mental operations (Monsell, 2003). Switching is also known as set-shifting, cognitive flexibility, task switching, and attentional switching (Diamond, 2013; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003; Miyake et al., 2000). Switching ability is closely related to category and verbal fluency (Diamond, 2013) as category and verbal fluency require the ability to switch between different mental sets (e.g. category of words).

The unity and diversity issue is less clear with child and adolescent populations. For example, a single unitary construct of EF (i.e. switching, inhibition and working memory updating are indistinguishable) has been reported in child samples up to the age of 9 years old (Brydges, Reid, Fox, & Anderson, 2012), whereas Lehto et al. (2003) found diversity (i.e. separable factors) in support of

Miyake's three-factor model for children aged 8 to 13. In a recent study with children grouped as 7-9 year olds, 10-12 year olds and 13-15 years olds, Xu et al. (2013) found that a one factor unity model best explained EF in the 7-9 year old and 10-12 year old groups, and a three factor diversity model similar to Miyake et al. (2000) was found for adolescents aged 13-15 years. It appears that EF may be a unitary construct in childhood, whereas in adolescence a three factor model emerges, in which inhibition, switching and working memory updating are related, but separable constructs. However, not all research supports this theory. For example, Huizinga, Dolan, and Van der Molen (2006) examined the unity and diversity of EFs in 7, 11, 15 and 21 year olds and found EF diversity across all ages. However, while they found that memory and switching were separable but related constructs, inhibition was not related to these factors providing only partial support for Miyake et al.'s (2000) three factor model. Huizinga et al. (2006) also found that this diversity across EFs was stable across all age groups (7-21 year olds), which would suggest that EFs in their sample were diverse in childhood, contrary to previous research (Brydges et al., 2012; Xu et al., 2013). Task (e.g. variations in measurement) and sample (e.g. low group numbers) differences are likely to have contributed to these dissimilar findings as the consensus within the literature demonstrates that EFs are unified in childhood, becoming diverse (i.e. separable but related) in adolescence.

If EF's are separable entities, particularly for adults and arguably for adolescents, then measurement tasks of EF should be able to separate these functions at task level. However, while researchers frequently classify tasks as measures of a single construct, often tasks that are meant to measure specific EFs often tap into multiple components of EFs. This leads to the second challenge of EF research; the

task impurity problem. Given that EFs tend not to operate in isolation but instead with other cognitive processes, a proportion of the variance in an EF task is not necessarily measuring only the specific EF that the task intended to measure. For example, the Wisconsin Card Sorting Test (WCST; Grant, & Berg, 1948) is one of the most widely used measures of EF in the literature. The WCST is predominantly known as a switching task as participants are asked to sort cards in colour, shape or by the number of items on a set of cards and are required to switch sets when the experimenter changes the sorting rule (e.g. colour to shape – which is unbeknownst to the participant). This task not only taps into switching ability but also inhibition as participants are required to inhibit past rule sets when sorting new sets. Perceptual, motor and other cognitive processes are also needed to sort new rules. This task impurity problem confounds the interpretation of studies as it is difficult to state with confidence what precise EF the task is measuring when tasks tap into multiple cognitive processes.

It is not only the interpretation of EF results which cause confusion, but there is a lack of clarity between researchers when defining an EF task. Researchers often employ the same task but adopt a different label to the measurement. For example, when employing the WCST (or the DCCS, a child version) some authors describe the tasks as a measure of inhibition and others as a measure of switching ability (see Garon, Bryson, & Smith, 2008, for a review). This issue is not only specific to the WCST but to other measurement tasks. Best and Miller (2010) reviewed theoretical and methodological issues of EF in child and adolescent population studies and reported that many authors using the same measurement tasks often define EF tasks as measuring different EFs. For example, various versions of Tower Of Hanoi task

has been described as measuring inhibition, working memory or planning (Best & Miller, 2010). Furthermore, tasks are often not constant across different age ranges (i.e. different tasks employed for children than adults) which make comparisons from different age groups increasingly difficult. These measurement issues, in turn, may be a contributing factor to the discrepant findings within the EF literature.

The factors discussed above (e.g. task impurity, unity and diversity issue, processes involved in EFs) pose a challenge to providing a detailed understanding of the developmental trajectories of EF. Whilst being mindful to these limitations, researchers have attempted to theorise a broad developmental framework of EF (see Best & Miller, 2010). For example, in using the three factor model (Miyake et al., 2000) to address the developmental trajectories of EF research has shown that inhibition abilities (thought to be the foundation for EF, Miyake et al., 2000) first appear in preschool with rapid improvement between ages 5 to 8 (Romine & Reynolds, 2005) and increasing in linearity (although modestly) into adolescence (Best & Miller, 2010). Similarly, working memory is thought to emerge in preschool, developing and progressing into adolescence (Gathercole, Pickering, Ambridge, & Wearing, 2004). However, for complex working memory tasks such as those that require the ability to manipulate and update information, these are thought to mature in adolescence and show continued improvement into adulthood (Best & Miller, 2010). While simple switching ability has been reported in young children (Hughes, 1998), switching between complex task sets shows an advanced development and maturation in adolescence, continuing to develop into adulthood (Huizinga et al., 2006). This is likely due to complex nature of switching ability that involves the use of other cognitive processes. For example, although executive functions have been

shown to be separable (Miyake et al., 2000), research suggests that switching ability relies and builds on other executive functions such as working memory and inhibition (Diamond, 2013).

It is evident that despite notable progresses in EF research, there is still much debate in the field (e.g., with regard to terminology, unitary vs. diversity, processes involved, measurement issues & developmental underpinnings of EF). Despite the issues highlighted within the literature, it is agreed that reduced or impaired functioning of EF and executive control can lead to significant adverse changes in thoughts, emotions and behaviour (Diamond, 2013; Joormann, & D'Avanzato, 2010).

Impairment in executive control has been reported in depressed samples. For example, difficulties in inhibition have been reported across tasks such as the Stroop test (Markela-Lerenc, Kaiser, Fiedler, Weisbrod, & Mund, 2009), the Prose Distraction Task, and the Hayling Sentence Task (Gohier et al., 2009) with adult populations. Likewise, switching difficulties have been found when applying the WCST and the Trail Making Test (Austin et al., 1999; Beats, Sahakian, & Levy, 1996; Harvey et al., 2004; Merriam et al., 1999; Purcell, Maruff, Kyrios, & Pantelis, 1997). Difficulties in switching, inhibition and working memory have also been associated with depression in childhood and adolescence (Baune, Czira, Smith, Mitchell, & Sinnamon, 2012; Gunther, Konrad, De Brito, Herpertz- Dahlmann, & Vloet, 2011; Micco et al., 2009; Matthews, Coghill, & Rhodes, 2008; Wilkinson and Goodyer 2006), although some null findings have also been found (Favre et al., 2009; Gunther, Holtkamp, Jolles, Herpertz-Dahlmann, & Konrad, 2004; Kyte, Goodyer, & Sahakian, 2005).

While the above mentioned studies employed executive control tasks with neutral stimuli, it has been argued that lower levels of executive control may be more pronounced when processing emotional information (Joormann, Yoon, et al., 2007) and that executive control deficits when processing neutral stimuli may be restricted to populations who are severely depressed (Kaiser et al., 2003). When emotional tasks have been applied results show that depressed adults have a greater difficulty in ignoring emotional task irrelevant stimuli (Goeleven, De Raedt, Baert, & Koster, 2006) and subclinical and clinically depressed children and adolescents show memory biases for negative information (Bishop, Dalgleish, & Yule, 2004; Drummond, Dritschel, Astell, O'Carroll, & Dalgleish, 2006; Neshat-Doost, Moradi, Taghavi, Yule, & Dalgleish, 2000). Research has also shown depressed adults have greater problems in removing irrelevant emotional information from working memory than control groups (Yoon, Le Moult, & Joormann, 2014) and greater difficulty with updating emotional information in working memory (Joormann & Gotlib, 2008). Impairment in executive control for emotional information has also been found to be a prerequisite to later symptoms of depression in adults (Zetsche & Joormann, 2011) and female children of depressed mothers demonstrated heightened attention to emotional stimuli (Joormann, Talbot & Gotlib, 2007). Gotlib and Joormann (2010) proposed that difficulties in processing emotional information, particularly inhibiting negative material, might explain why some people react to negative events and mood with repeated, uncontrollable negative thoughts. Clarifying the nature of emotional processing difficulties in clinical disorders is important, especially for the development of treatments. However, studies with depressed populations cannot explain any trait-like executive control profile that may

be present in non-clinical populations which could represent a risk factor to the aetiology of the disorder.

1.4 Theoretical underpinnings of vulnerability factors

The above subsections demonstrated that there are multiple factors implicated in the onset and maintenance of depression and that cognitive and emotional factors may be instrumental in providing an enhanced understanding of the emotional difficulties and negative affect which are hallmark features of depression. OGM, rumination and executive control were identified as key factors that are implicated in depression and the aforementioned research provided a background to these factors and demonstrated the importance that each individual factor has on the development and maintenance of depression, in child, adolescent and adult populations. Despite marked progression in the understanding of the affective consequences of OGM, rumination and executive control, there is less clarity on the theoretical underpinnings of such vulnerability factors. Little is known about their developmental trajectories, how they relate to each other and how they manifest themselves in non-clinical populations. Given the clinical significance of OGM, rumination and executive control, gaining a greater insight into the developmental processes of such factors and their relationships to each other will provide a basis for improved theories and may allow for targeted interventions to prevent the development of vulnerability factors.

Providing a greater understanding of the processes that underlie OGM, particularly in adolescence (at a time of heightened risk of depression) may identify ways to refine models of OGM specific to this population. The CaR-FA-X model (Williams et al., 2007) of OGM provides a theoretical background within which it is

possible to identify such processes. The CaR-FA-X model (Williams et al., 2007) posits that impaired executive control and ruminative thinking can account for OGM, yet few studies have investigated this theory in child and adolescent populations. This is surprising as OGM has been demonstrated as a cognitive marker for depression (Sumner, 2012; Williams et al., 2007) and adolescence marks a period in development for increased symptoms of depression (Dekker et al., 2007) and depressive disorder onset (Kessler et al., 2005). Gaining an improved understanding of the mechanisms underlying OGM could be imperative in providing insight into the developmental processes involved in autobiographical memory in adolescence and will help to explain to how OGM develops and is maintained.

It is equally important to gain a greater understanding of the directional relationship between rumination and executive control. For example, if rumination is maintained by executive control then this would have implications for clinical interventions. Koster et al. (2011) argued that it might be unrealistic to assume that interventions aimed at reducing rumination can change this habitual way of thinking if impairment in executive control is an underlying prerequisite and is not improved first. They also suggest that this could be a reason for the high relapse rates reported in depression. The Resource Allocation Hypothesis (RAH; Ellis & Ashbrook, 1988) and the Impaired Disengagement Hypothesis (IDH; Koster et al., 2011), provide theoretical frameworks for the relationship between impaired executive control and rumination. The IDH posits that impaired executive control places individuals at risk for increased levels of rumination, particularly brooding rumination, whereas the RAH posit that there is a limit on cognitive resources and that engaging in ruminative or depressive thinking reduces these resources. The CaR-FA-X model

(Williams et al., 2007), the RAH (Ellis & Ashbrook, 1988) and the IDH (Koster et al., 2011) are explained in more detail below.

1.5 The CaR-FA-X model (Williams et al., 2007)

The CaR-FA-X model (Williams et al., 2007) is the most prominent and comprehensive theory of OGM. Developed as a framework to enhance understanding of OGM predominately in adults, the CaR-FA-X model (see Figure 1) is based on the foundations of Conway and Pleydell-Pearce's (2000) self-memory model. The self-memory model of AM (Conway & Pleydell-Pearce, 2000) posits that the search for a specific memory requires a hierarchical search through the autobiographical memory knowledge store which has three levels of memory representations (or descriptions as it is also referred to). The top, broadest level holds memories for events of prolonged time periods (e.g. my time at high school) to general memories for repeated or single events (e.g. every day on the train to work or my summer holiday in Spain) to event specific knowledge primarily consisting of a summary record of sensory-perceptual processing which occurred during the event (e.g. my 30th birthday party last Saturday). A memory for an event can be recalled in two ways, 1) through a generative process or 2) by direct retrieval. Generative retrieval refers to top-down processing which spreads down the AM knowledge base, in turn activating broad memory representations, to general representations and lastly to event specific memories. When an environmental cue activates immediate event specific knowledge, this is known as direct retrieval.

The CaR-FA-X model is a framework for generative retrieval, which posits that due to difficulties in three specific mechanisms, the generative search through the hierarchy is disrupted early, truncating the search, in turn resulting in OGM

(Williams et al., 2007). These mechanisms are capture and rumination (CaR), functional avoidance (FA) and impaired executive control (X). These mechanisms can work in isolation or in interaction.

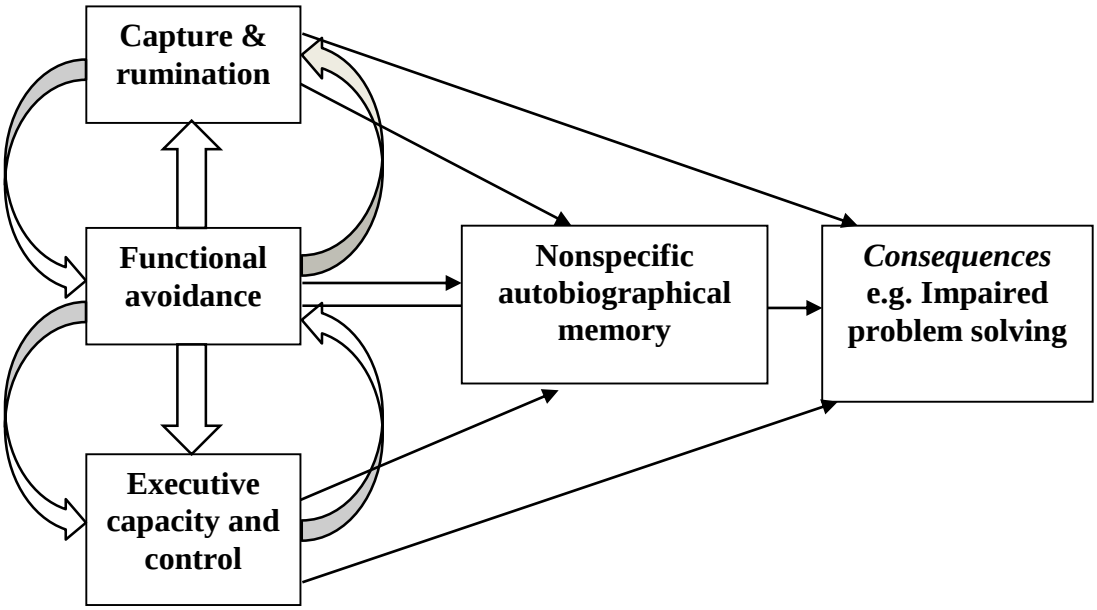

Figure 1: The CaR-FA-X model: Three processes contributing to overgeneral memory capture and rumination (CaR), functional avoidance (FA), and impaired executive capacity and control (X)—can each have effects on cognition and behaviour (e.g. problem solving), either independently or through their individual or combined effect on autobiographical memory (permission granted for reproduction of image from Professor J Mark G Williams).

1.5.1 Capture and rumination

The CaR mechanism can disrupt the retrieval process in two ways, through capture errors and/or rumination. Conceptual processing based on self-representations such as personal semantic memoires (e.g. names of friends, teachers, places etc.) is predominant in the early stages of retrieval (Conway, Singer, & Tagini, 2004; Williams et al., 2007). The early activation of these conceptual, abstract, self-representations can cause attention to become captured at this early state of retrieval. This, in turn, leads to capture errors. Once an individual's attention becomes captured at this stage, instead of moving down the hierarchy, they move across the

knowledge base which can result in retrieval of an overgeneral memory. If each time a search results in moving across the hierarchy, in turn activating conceptual abstract, self- representations, this information will be strengthened and more likely to be retrieved in future searches (referred to as the mnemonic interlock, Williams, 1996).

There are two main routes to which capture errors can occur. Firstly, some individuals have exceedingly active or elaborate access to emotion related self-representations which can result in becoming captured at an early stage of retrieval (Sumner, 2012; Williams et al., 2007). Therefore, rather than early general memories aiding the search for a specific memory, individuals are likely to become captured at this stage. Secondly, individuals who tend to ruminate are more likely to become captured and remain at an early stage of retrieval, thus resulting in the retrieval of an OGM. Rumination disrupts the retrieval process due to the elaboration (i.e. ruminating) on the conceptual, abstract information which was activated in the early search. This results in the search for a specific memory becoming terminated, resulting in OGM.

While support for capture errors have been reported (Crane, Barnhofer, & Williams, 2007; Williams et al., 2007) in depressed and previously depressed populations, the literature on the association between rumination and OGM is mixed. In depressed populations, rumination has shown associations with OGM in adults (Watkins & Teasdale, 2001, 2004; Watkins, Teasdale, & Williams, 2000) and adolescents (Park, Goodyer & Teasdale, 2004). Given that OGM is thought to be an underlying vulnerability factor for the development of depression (Williamson, Birmaher, Axelson, Ryan, & Dahl, 2004), it would be expected that rumination would be associated with OGM in non-clinical populations who may be at

heightened risk for depression (e.g. adolescents, university students etc.). However, some researchers report an association between rumination and OGM in non-clinical adult populations (Sumner et al., 2011) and others report null findings in adolescent (Hitchcock, Nixon & Weber, 2014b) and adult studies (Kao, Dritschel, & Astell, 2006). There are two possibilities for null findings.

The first possibility is that the null findings could be due to measurement differences, particularly the task used to measure OGM. Kao et al. (2006) did not use the AMT but instead asked participants to recall memories that came to mind during a problem solving task. This AM task may not have tapped into the same processes as the AMT. Similarly, Hitchcock et al. (2014b) employed the original gold standard AMT (Williams & Broadbent, 1986) which has been argued is not sensitive enough to detect OGM in non-clinical populations (Debeer, Raes, & Hermans, 2009). The AMT asks participants to retrieve specific memories in response to a set of cue words (e.g. happy, sad), with emphasis given on the need to recall a *specific* memory. It is possible that some non-clinical participants who generally recall memories in an overgeneral way are able to overcome this when explicitly asked to recall a specific memory. Therefore, populations who might be at risk of depression would not be identified when using the standard AMT. To account for this limitation, Debeer et al. (2009) devised the minimal instruction autobiographical memory test (Mi-AMT), which omits asking participants for a specific memory. This task instead asks participants to retrieve a memory without stating it should be specific. When the Mi-AMT has been used, it has increased detection of OGM in non-clinical populations (Debeer et al., 2009). This measurement difference could serve as an explanation to the null findings reported in non-clinical populations. The second possibility for null

findings for a relationship between rumination and OGM reported within the literature is that rumination may not exert any effect on OGM in non-clinical samples. However, given adolescence marks a period of increased rumination and risk of depression, examining the rumination and OGM relationship with more sensitive tests of OGM, along with additional vulnerability factors (e.g. executive control) will enable a greater understanding of vulnerability to OGM.

1.5.2 Functional avoidance

Functional avoidance is the second mechanism thought to contribute to OGM. The self-memory model (Conway & Pleydell-Pearce, 2000) posits that OGM results from the recollection of general descriptions as these descriptions result in less affect in comparison to the retrieval of specific memories. Williams et al. (2007) call this functional avoidance. The activation of specific emotional memories can result in numerous strategies using top-down control processes in an attempt to avoid emotional responses from these specific memories. For example, individuals who have experienced a form of trauma are more probable to retrieve an OGM, even to neutrally valenced events as they have likely discovered that the retrieval of specific memories result can result in negative consequences (e.g. negative affect).

As the recollection of specific memories can result in negative affect this forms the basis for passive avoidance (Williams et al., 2007). For example, if thinking about summer resulted in a negative emotional response, the next time the summer is thought about, the individual will likely choose to remain at a general level of description (i.e. resulting in an OGM). Williams et al. (2007) suggests that such a strategy to avoid negative affect can become habitual overtime as it is negatively reinforced. This results in avoidance, the idea that if the search is not

truncated it will lead to negative affect. It has been proposed that functional avoidance can take time to develop (Williams et al., 2007) and in some individuals, such a strategy may be flexible or helpful in some situations but for others it can become inflexible, and a habitual response.

Truncating a search due to avoiding negative affect has been investigated in two key ways within the literature, through the effects of trauma exposure (typically early life trauma), and more specifically through the direct link between avoidance and OGM. The direct examination of avoidance is however limited and has produced mixed results. For example higher scores on the avoidance subscale has been associated with increased levels of OGM in adult (Lemogne et al., 2009; Wessel, Merckelbach, & Dekkers, 2002) and child and adolescent populations (Stokes, Dritschel, & Berkerian, 2004), although not in all child and adolescent studies (Kuyken, Howell, et al., 2006). In separate methodologies, OGM in adults has been associated with more general levels of avoidance such as avoidance in dealing with problems or situations (Hermans, Defranc, Raes, Williams, & Eelen, 2005). While the CaR-FA-X model suggests that functional avoidance is a pathway to OGM, a majority of the literature investigates the effect of trauma exposure on OGM but again the literature is mixed. Research with adult samples that have experienced trauma in childhood has found that having a trauma history in childhood is associated with increased levels of OGM (Crane & Duggan, 2009; Hauer, Wessel, Geraerts, Merckelbach, & Dalgleish, 2008) but there are a number of studies that do not show associations between trauma history and greater levels of OGM (Moore & Zoellner, 2007). Similarly, research with adolescent populations has found mixed results. While some studies demonstrate a relationship between trauma exposure and

increased OGM (Arie, Apter, Orbach, Yefet, & Zalzman, 2008; Brennen et al., 2010; Crane et al., 2014), others have not found any association (Hitchcock et al., 2014b; Kuyken, Howell, & Dalgleish, 2006). However, rather than refuting the model, it is possible that mixed findings are reflective of the heterogeneous literature with child and adolescent populations which makes it increasingly difficult to draw strong conclusions for the support of the CaR-FA-X model. It may be that other variables (e.g. the measurement of AM, nature and age of trauma, population differences) have a moderating effect on the functional avoidance and OGM relationship. For example, it may be that certain traumas are more likely to result in OGM than others, or that the trauma and OGM relationship is only found in particular populations (e.g. clinical samples). Some studies with adolescent populations have shown that OGM is present in adolescent samples that have not been exposed to trauma (e.g. Kuyken, Howell, et al., 2006). This suggests that OGM is not only attributable to functional avoidance but other factors are involved in OGM and further research is needed to better understand this relationship, particularly in child and adolescent populations.

1.5.3 Impaired executive control

The third mechanism of the CaR-FA-X model is impaired executive control. Williams et al. (2007) defines impaired executive control as a 'reduction of executive resources'. The impaired executive control mechanism has also been referred to within the literature as reduced executive control (Hitchcock et al., 2014a), low executive control (Rawal & Rice, 2012a) and as difficulties in executive control in others (Sumner, 2012). While these terms are used interchangeably within this literature base, Williams et al. (2007) suggests that in relation to OGM, the generative search for a specific memory relies on executive resources (Conway &

Pleydell-Pearce, 2000) and the CaR-FA-X model proposes that difficulties in executive control can hamper a search strategy at different levels of retrieval (Williams et al., 2007). For example, difficulties in working memory can reduce the ability to hold and update retrieved information in working memory, while impaired inhibitory processing may allow irrelevant autobiographical material to enter the search, in turn capturing attention (i.e. capture errors) and truncating the search (Conway & Pleydell-Pearce, 2000; Williams et al., 2007). Furthermore, difficulties in verbal fluency can impact the search process by disrupting the ability to organise retrieval, initiate and maintain a search as well as impairing the ability to inhibit irrelevant responses (Swan & Carmelli, 2002). Although AM retrieval can be disrupted at many executive processing levels, research has demonstrated that OGM is not the result of a more general cognitive deficit. To account for the possibility that OGM may result from a general deficit in processing speed, Williams and Broadbent (1986) examined the time taken to answer true or false on a number of sentences (e.g. pork chops are meat). The results demonstrated that OGM was not associated with general difficulties in processing speed.

A number of studies have since been interested in investigating which aspects of executive control are associated with OGM. Typically, research with adults support the CaR-FA-X model and has shown difficulties in working memory capacity, updating and monitoring, inhibition, and verbal fluency to be related to OGM across a variety of tasks and populations (Dalgleish et al., 2007; Sumner, 2012). These studies help to provide a greater understanding of the processes involved within a generative search that are related to the phenomenon of OGM and provide support for the CaR-FA-X model over and above any effects attributable to

mood. However, executive control is a complex process and limited studies have been conducted with child and adolescent samples and the role of executive control when processing emotional information on OGM is not well understood.

Furthermore, the depression literature highlights that difficulty in executive control is particularly prevalent when processing emotional material (De Lissnyder, Koster, & De Raedt, 2012) yet the majority of studies investigating the relations between executive control and OGM employ neutrally valenced tests of executive control. As OGM is an underlying vulnerability factor to later depression it is therefore questioned whether neutral valenced tasks are the best way to elicit any relationship between executive control and OGM. This however would not explain the results that did find an association between executive control and OGM when neutral stimuli were used. It is possible that in some populations, impaired executive control alone is not enough to result in OGM and that multiple factors such as impairment in executive control and rumination may interact to predict OGM (Williams et al., 2007). In support of this view, Rawal and Rice (2012b) investigated the prospective relationship between rumination and executive control on OGM with an adolescent population at familial risk of depression. Executive control in isolation (or rumination) did not predict OGM. Despite these findings seemingly refuting the CaR-FA-X model, Rawal and Rice (2012b) found that low executive control (operationalised as 1 SD below the mean on a block design task) in the context of a heightened ruminative response style was predicative of later OGM. This suggests that multiple mechanisms of the model may better able to explain OGM than mechanisms in isolation.

1.5.4 Multiple mechanisms

The Car-FA-X model (Williams et al., 2007) posits that the three mechanisms (capture and rumination, functional avoidance and impaired executive control) can work in isolation or in interaction to predict OGM. For example, impairment in executive control can hamper the search strategy and cause a person to become 'captured' at this early stage of retrieval. Furthermore, the ability to inhibit irrelevant information will be particularly difficult if a person has a tendency to ruminate. Trauma exposure may also result in OGM indirectly due to impaired executive control. Through the constant attempts to avoid negative affect (functional avoidance), this can reduce the amount of cognitive resources available for other tasks, such as the recall of specific memories. Therefore an overgeneral memory may result from impaired executive control rather than the trauma per se. It is evident that there is great overlap between mechanisms yet there is a great predominance within the literature to investigate only one mechanism of the CaR-FA-X model. For example, in a recent review of the literature, Sumner (2012) reported that only two adult studies (from a total of 38 studies) investigated the interacting effects of the mechanisms on OGM (Barnhofer, Crane, Spinhoven, & Williams, 2007; Raes et al., 2006). Research is limited and mixed within the child and adolescent literature. While Rawal and Rice (2012b) found rumination interacted with low executive control to predict OGM in adolescents at familial risk of depression, Hitchcock et al. (2014b) reported null findings in a sample of trauma exposed children. The disparity in findings could be due to the age differences in the samples or the different populations used. It is currently not clear whether the CaR-FA-X model can account for OGM in non-clinical adolescent populations (e.g. who are not at familial risk of

depression) or whether the mechanisms are simply associated with OGM or act as a vulnerability to later OGM, over and above any effects due to depressed mood. The inconsistency of results between the studies points toward the need for further investigation in this area.

In separate literature from OGM research, there is emerging evidence linking the tendency to ruminate with executive control in adult samples (Altamirano, Miyake, & Whitmer, 2010; Davis & Nolen-Hoeksema, 2000; Koster et al., 2011; Whitmer & Banich, 2007). In a study with a remitted adult population, Demeyer, De Lissnyder, Koster, and De Raedt (2012) found that impaired executive control (operationalised by larger switch costs) when processing emotional information predicted symptoms of depression one year later, an effect that was fully mediated by rumination. This finding suggests that executive control may underlie rumination as a vulnerability to depressive episodes in adults. A promising line of research draws on the integration of theories of rumination with theories of executive control, particularly when processing emotional information. Two opposing models have been offered as theoretical frameworks for the relationship between rumination and executive control and each will be discussed in turn.

1.6 The Impaired Disengagement Hypothesis (IDH; Koster et al., 2011)

The impaired disengagement theory (Koster et al., 2011) posits that despite progress within the rumination literature, the underlying mechanisms of rumination are not clear. The authors argue that information processing factors (i.e. executive control) are instrumental in understanding rumination. Koster et al. (2011) suggested that engaging in rumination is a normal response to stress, negative mood or life events. For example, a job loss, an argument with a friend or spouse, or receiving

criticism will typically result in a self-critical view of oneself and their contribution to the situation. Self-critical thoughts are not typically in line with the positive self-views that individual's hold about themselves. After some time, these negative self-thoughts will cause a cognitive conflict, resulting in the disengagement of attention from the negative thoughts. Typically this occurs once a solution is found or emotion regulation strategies are enlisted. Once disengaged, attention is given to adaptive strategies to repair mood such as the focus on positive distractors. The IDH posits that it is the difficulty in disengaging attention (e.g. exerting executive control[2]) that places individuals at heightened risk of rumination.

There are two ways that disengagement from negative thoughts can be disrupted.

1. Impairment in conflict signalling, or
2. Intact conflict signalling but low executive control

First, impairment in conflict signalling results when an individual has negative self-schemas as this will result in less conflict between self-views and self-critical thoughts. In turn, there will be an absence of conflict signalling which will result in an increased attentional focus to negative information and subsequently rumination. Secondly, low executive control can result in a sustained attentional focus towards negative information. This difficulty in the ability to disengage attention (i.e. the inability to exert executive control), leads to a prolonged inward focus on negative thought (i.e. rumination). This will result in impaired problem solving, difficulties in completing tasks and greater levels of negative affect. In contrast, greater executive control will allow the disengagement of attention away

[2] The authors refer to the term 'attention control' as the ability to attend to relevant information and inhibit distracting irrelevant information. This is synonymous with the term executive control and thereby I will use the term executive control.

from negative information, in turn activating reappraisal, distraction and repair of mood. Importantly the impaired disengagement hypothesis posits that lower executive control is a prerequisite for heightened levels of rumination.

There is converging evidence that shows greater levels of rumination are negatively correlated with executive control in adult populations (Whitmer & Banich, 2007), even after controlling for symptoms of depression (Donaldson, Lam, & Mathews, 2007). Moreover, cross-sectional data has shown that cognitive inflexibility (i.e. difficulty in switching ability) is a contributing factor in the tendency to ruminate (Altamirano et al., 2010; Davis & Nolen-Hoeksema, 2000) and that difficulty in the ability to inhibit previously relevant tasks is an important factor contributing to ruminative thinking (Whitmer & Banich, 2007). However, to be able to causally demonstrate that executive control leads to increase in rumination, prospective studies are needed.

In a six month prospective study with adults, Zetsche and Joormann (2011) used an emotional version of the negative priming task to show that lower levels of interference control[3] prospectively predicted increases in rumination, providing support for the IDH. De Lissnyder, Koster, Goubert, et al. (2012) further provided support for the IDH. In a multi-wave (4 time points) prospective study, De Lissnyder, Koster, Goubert, et al. (2012) examined stress, executive control and rumination. They demonstrated that impaired executive control (reflected by larger switch costs) at baseline moderated the association between stress and brooding rumination at follow-up. Specifically, greater difficulties in exerting executive

[3] The authors refer to the term 'interference control' and define this as the ability to limit the access of irrelevant information to working memory. The tasks the author employed also require the ability to inhibit distracting information and selectively attend to other stimuli.

control when processing emotional material was associated with increased brooding rumination in response to stress. Similarly, Joormann (2006) reported that the tendency to rumination was specifically attributed to an increased difficulty when inhibiting negative words. Taken together, these findings discussed above provide support for the IDH in adult populations and highlight the importance of using emotional stimuli in executive control tasks, particularly when targeting its relationship with rumination.

1.7 The Resource Allocation Hypothesis (RAH; Ellis & Ashbrook, 1988)

The RAH posits that the amount of cognitive resources an individual has available to them is limited and that engaging in ruminative or depressive thinking diminishes these resources. As cognitive resources are allocated to ruminative and depressive thought, this in turn leads to deficits in other cognitive processes such as executive control. This theory has been investigated in a number of ways within the literature, mainly with depressed populations. It has been demonstrated that depressed populations show heightened focus towards task-irrelevant processing of emotion material (e.g. negative thoughts about mood) and this reduces the amount of resources to allocate elsewhere (Ellis & Ashbrook, 1988). Recently, researchers have begun to focus on ruminative thinking. The allocation of cognitive resources to persistent ruminating thinking has been shown to deplete other cognitive resources such as executive control. For example, Hertel (1998) demonstrated that rumination weakened cognitive performance by capturing attention and cognitive resources, which in turn resulted in a limited amount of resources being available for effortful tasks. Importantly, the RAH and subsequent research posits that ruminative thinking

precedes executive control by taking up available recourses that could otherwise be allocated elsewhere.

In one study with an adult population, Watkins and Brown (2002) found that inducing rumination resulted in impaired performance on tests of executive control. They demonstrated that rumination resulted in a reduction in switching ability due to an overload of resources used for ruminative thinking. Philippot and Brutox (2008) reported similar findings in which induced rumination led to difficulties in inhibition in an adult population. These studies suggest that rumination may precede executive control, providing support for the RAH. However, to examine this hypothesis prospective studies examining rumination as a predictor of executive control are required. To date, there are no prospective studies with adult populations that examine rumination as a predictor of executive control. Only one study has examined the directional relationship between executive control and rumination in an adolescent population, while employing neutrally valenced cognitive tasks. Connolly et al. (2014) examined an array of cognitive processes (e.g. selective attention, sustained attention, attentional switching, divided attention and working memory) and rumination over time. Connolly et al. (2014) noted that while none of the cognitive tasks were predictive of later rumination, greater rumination at baseline predicted decreased attentional switching (also known as switching; set-shifting; cognitive flexibility) at follow up. These findings were able to show the directional nature of rumination and executive control and refute the IDH, while providing support for the RAH as rumination preceded executive control. While this finding is promising, it is not clear if the relationship between rumination and executive control

differs with the subcomponents of rumination or when emotional stimuli in applied in cognitive tasks

Preliminary research with adults has shown that brooding rumination and reflective pondering have different effects on executive control. De Lissnyder, Koster, Goubert, et al. (2012) found an association between brooding rumination and impaired executive control when processing emotional information in a sample of adults, but there was no association between reflective pondering and executive control. With a depressed adolescent sample, Wilkinson and Goodyer (2006) reported that although switching difficulties were associated with depression, there was no relationship between executive control and rumination in their sample of depressed adolescents. One possible explanation for this finding however could be due to the lack of emotional stimuli used in the executive control task. When emotional tasks have been used, research has found impaired executive control has been linked to the tendency to ruminate in adults (De Lissnyder, Koster, Derakshan et al., 2010) and adolescents (Hilt et al., 2014). Taken together, these findings suggest that rumination and executive control are associated, particularly when processing emotional information. However, prospective studies with adolescent samples are needed to examine the directional relationship between these two variables while accounting for the differing effects of rumination.

1.8 Statement of the problem

Overall, it appears that adolescence is a critical time period for the development of depression. It has been shown that depression at this time results in more unfavourable consequences than in adulthood, and that over half of adolescents will experience symptoms of depression during this time. Adolescence marks a

developmental time frame for not only increases in depressive symptoms, but also increases in vulnerabilities linked to the onset of depressive disorders such as greater rumination, overgeneral autobiographical memory as well as maturation of the prefrontal cortex associated with cognitive factors. Thus, adolescence presents a unique age point to investigate the relationship between vulnerability factors, yet few studies have been conducted particularly with non-clinical adolescents. There has been a specific focus within the literature on clinically depressed populations and individuals at heightened risk (i.e. familial risk) of depression. Although these studies are valuable, applying findings from clinical and at risk samples to non-clinical community adolescents would be erroneous as these methods of research cannot fully inform us of how OGM develops in adolescents who are not yet depressed or do not have a depressed parent. Given the unfavourable consequences linked to theses vulnerability factors (e.g. depression) a greater understanding of how these factors develop and relate to each other in adolescence is critical.

It is important to recognise that much of the research examining such effects has been limited by a number of methodological constraints such as cross-sectional designs, with the result that cause and effect have often been difficult to disentangle. Prospective longitudinal studies will provide a unique design which will be informative for identifying mechanisms and moderator factors that may be helpful for providing a thorough understanding of the development of OGM, and the direction of the relationship between rumination and executive control. Further measurement issues have been discussed such as the examination of rumination as a whole construct, despite notable research emphasising the different functions of brooding rumination and reflective pondering and there are a lack of studies

investigating executive control for emotional and non-emotional information. There has also been an over-reliance on traditional versions of the AMT in non-clinical populations.

There is also great heterogeneity in the type of memory analysed when examining autobiographical memories, which has theoretical implications. For example, Griffith et al. (2012) argues that the choice of memory type used in analysis has theoretical consequences. If specific memories are used as the memory type for analysis then effectively extended, categoric and semantic memories recalled are grouped together as overgeneral. Likewise, if overgeneral memories are used (e.g. categoric and/or extended), then sematic memories are grouped together with specific memories. There is also great debate whether omissions reflect an overgeneral memory or whether an individual recalled a specific memory but for whatever reason did not want to tell the examiner (see Griffith et al., 2012, for a review). It is not clear within the literature as to which scoring method works best he extensive methodological disparity across studies also hampers the progression of OGM research as this inconsistency in examining OGM creates a difficulty for comparing results with incongruent findings. For now, it would be beneficial for the field if researchers were to provide information of the number and proportion of specific and overgeneral memories.

It has been shown that executive control is associated with depression, particularly when processing emotional information (Joormann, 2004; Joormann & Gotlib, 2010) and that impairment when processing emotional information has also been reported in daughters of mothers who have recurrent depressive episodes but are not depressed themselves (Joormann, Talbot, et al., 2007). Similarly, the link

between executive control and rumination was heightened when emotional stimuli are used in cognitive tasks (Hilt et al., 2014). Taken together, these findings highlight the importance of the processing of emotional material in understanding depression and rumination, yet very few studies employ emotional tests of executive control. There is no study that investigates the directional relationship between executive control and rumination over time with an adolescent sample, and no research investigating executive control and rumination as underlying vulnerability factors to later OGM when employing emotional and non-emotional tasks of executive control. Gaining a greater understanding of the relationship between emotional and non-emotional processing of information with rumination and OGM may be influential in providing a better understanding of the emotional difficulties and negative affect that are hallmark features of depression.

Furthermore, as highlighted throughout this overview of the literature, rumination is typically investigated as a single construct, despite previous research showing rumination as a two factor structure (Treynor et al., 2003). It is important that future research examines these factors separately as it is possible that adverse consequences of rumination may be specific to brooding rumination acts and reflective pondering may serve as a protective factor. Prospective research is needed to clarify the relationships between rumination, executive control and overgeneral memory in adolescence, while accounting for previous methodological shortfalls within the literature.

1.9 PhD thesis objective

It is evident from research studies with children, adolescent and adults that while OGM is implicated in depression (Williams et al., 2007) and an underlying

vulnerability to the development of depression (Sumner et al., 2010), little is known about the underlying mechanisms give rise to OGM. A greater understanding of these mechanisms, how they relate to each other and the directional relationship between these mechanisms will enhance and refine our understanding of the theoretical models specific to child and adolescent populations. It may also help to explain how OGM, rumination and executive control lead to such an unfavourable course, and identify any protective factors. Such research may help inform preventative research and intervention. Investigating these relationships in adolescence, a time of risk for depression as well as a time associated with increases in rumination and the maturation of cognitions will provide documented evidence of these relationships across the adolescent developmental trajectory, and not specific to particular samples (e.g. those at familial risk of depression).

1.10 The present research

The present thesis reports the findings from three studies aimed at exploring the theoretical underpinnings and relationships between three key vulnerability factors that have previously been demonstrated as important factors in the development of depression. Given that it is currently not clear whether the CaR-FA-X model can account for OGM in child and adolescent populations, the present thesis will systematically review child and adolescent studies, while accounting for multiple moderating factors that have been demonstrated to affect research findings (e.g. AM measurement). The systematic review will examine whether the mechanisms of the CaR-FA-X model are associated with OGM or constitute an underlying vulnerability to OGM, investigate whether these factors independently or in interaction with each other predict OGM and whether the mechanisms manifest

themselves differently in clinical and non-clinical populations. Providing answers to these questions may improve our understanding of the aetiology of OGM.

As previous research, particularly with adults, has suggested that rumination an executive control may be underlying vulnerabilities to OGM, the present thesis will examine this relationship with an adolescent population and investigate whether this relationship impacts OGM differently depending on the subcomponents of rumination or the emotional stimuli used in the cognitive task. Given that reflective pondering has been associated with reduced symptoms of depression and more coping in adolescence, it could be that reflective pondering may serve as a protective factor against the development of OGM. Gaining a greater understanding of the theoretical underpinnings of the development of OGM may provide opportunity for refinement to models of OGM, with specific attention given to adolescent populations.

If rumination and executive control are important in understanding the development of OGM in adolescence, it is important to question how these factors also develop, and to understand their directional nature. It may be that difficulty in switching attention away from emotional information in working memory could result in increases of ruminative thinking or that rumination perpetuates executive control processes. A greater understanding of the direction of this relationship, particularly in adolescence will enhance our understanding of the link between and development of cognitive and emotional vulnerability factors. The exploration of this issue in the present thesis may also lead to findings that will have implications for preventative interventions for depression. These issues will be explored in the present thesis.

1.11 Research questions

Given the issues identified throughout the literature, the thesis aims to address several research questions:

Questions 1 – 4 addressed in Chapter 2

1. Is the CaR-FA-X model applicable to child and adolescent populations?
2. Are the CaR-FA-X mechanisms better able to explain OGM in isolation or in interaction in child and adolescent populations?
3. Does the CaR-FA-X model account for OGM in a different way in clinical and non-clinical populations?
4. Do the CaR-FA-X mechanisms represent a vulnerability to the development of OGM?

Questions 5 – 8 addressed in Chapter 3

5. Is executive control for emotional information better able to explain OGM than executive control when processing non-emotional information?
6. Is brooding rumination better able to account for OGM than reflective pondering?
7. Does brooding rumination, reflective pondering or executive control for emotional and non-emotional information predict OGM over time in a community sample of adolescents?
8. Does brooding rumination, reflective pondering or executive control for emotional and non-emotional information interact to predict OGM over time in a community sample of adolescents?

Questions 9 – 11 addressed in Chapter 4

9. Does rumination precede the development of executive control or does executive control lead to rumination?
10. Is the directional relationship between rumination and executive control dependent on different aspects of rumination?
11. Does the directional relationship between rumination and executive control produce different findings when difficulties are specific to emotional or non-emotional information processing?

1.12 Organisation of the thesis

In order to address these research questions a series of three studies will be presented. To address gaps in the literature, the first study is a systematic review of the applicability of the CaR-FA-X model (Williams et al., 2007) specific to children and adolescents. This was conducted in order to investigate whether functional avoidance, rumination and executive control independently or in interaction are associated with or predict OGM in these populations. In the review, findings were discussed in relation to multiple factors previously shown to affect OGM. The results from this systematic review are presented in Chapter 2.

Building on findings from previous literature, the second study in the thesis involved a large prospective study with a school based sample of adolescents. This study aimed to assess whether rumination (both brooding and reflective) and executive control (for emotional and non-emotional information) in isolation or in interaction predicated OGM at follow up, over and above baseline OGM and symptoms of depression and anxiety. Moderating factors were examined and discussed. These results are presented in Chapter 3.

In addition, the directional relationship between executive control and rumination was examined in the third study. This novel study applied a prospective design and investigated the directional relationship between rumination and executive control by employing emotional and non-emotional measures of executive control for internally represented information as well as investigating rumination by its subcomponents, brooding and reflective pondering within adolescent development. Findings from this study can be found in Chapter 4.

An overall discussion of the research findings pertaining to each study as well as collectively are addressed in Chapter 5, as are limitations of the present thesis and recommendations for future research.

Chapter 2 (study 1): A narrative synthesis of the applicability of the CaR-FA-X model in child and adolescent populations: A systematic review

This chapter is under review in Memory. As such, the chapter is presented in the format of a manuscript following the guidelines of the journal.

Contribution to this chapter:

My Role: I designed the study, conducted literature searches and the statistical analysis. My first supervisor reviewed each stage of the review (as noted within the chapter). I wrote the first draft of the chapter without other co-authors and discussed drafts with both of my supervisors. My first supervisor is corresponding author on the paper as my university email address will not be valid after completion of the PhD.

Signed:

Date:

A narrative synthesis of the applicability of the CaR-FA-X model in child and adolescent populations: A systematic review

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2.1 Abstract

Background: The CaR-FA-X model (Williams et al., 2007) is the most prominent and comprehensive model of overgeneral autobiographical memory (OGM) and provides a framework as to how OGM occurs. The model comprises of three mechanisms, capture and rumination, functional avoidance, and impaired executive control. These can independently, or in interaction, account for OGM. This systematic review aims to evaluate the existing research on the CaR-FA-X model, specific to child and adolescent populations. **Methods**: The following databases were searched: 'PsychInfo', 'PsychArticles', 'PubMed', 'Web of Science', 'Medline', 'SCOPUS' and 'Embase' for English-language, peer-reviewed papers with samples < M = 18 years, published since 1986. To account for the possibility of grey literature, six online journal databases 'OpenGrey', 'ProQuest', 'Web of Science Conference Proceedings', 'Copac', 'The British Library' 'Zetoc' and the 'Centre for Autobiographical Memory Research Conference proceedings' were also searched. **Results**: Strong support was reported for capture errors and trauma exposure as well as interactive effects between rumination and executive control. Limited support was found for rumination, avoidance and executive control in isolation. **Conclusions**: Partial support for the CaR-FA-X model was found for child and adolescent populations. Recommendations, refinements to the model, and plausible explanations for the mixed findings are discussed.

Keywords: Overgeneral autobiographical memory; Autobiographical memory specificity, CaR-FA-X model; Capture and rumination, Functional avoidance; Executive control

2.2 Introduction

Autobiographical memory (AM) is a memory storage system responsible for past episodic memories and self-related semantic information (Conway & Pleydell-Pearce, 2000). In an attempt to recall a specific autobiographical memory, referred to as a memory for an event at a specific time and place, sometimes a group of memories or abstract thoughts come to mind or no memory at all. When a non-specific memory is recalled in the search for a specific memory, this is referred to as overgeneral autobiographical memory (OGM) or reduced autobiographical memory specificity (rAMS[4]) (Smets, Wessel, & Raes, 2014; Sumner, 2012; Williams et al., 2007).

The phenomenon of OGM has been widely investigated since first observed in a sample of suicidal adults (Williams & Broadbent, 1986). Since then, OGM has been associated with major depressive disorder (MDD; Sumner, Griffith, & Mineka, 2010; Williams et al., 2007) and post-traumatic stress disorder (PTSD; Kleim & Ehlers, 2008; Sutherland & Bryant, 2008). OGM is also indicative of a stable characteristic in adults recovered from depression (Mackinger, Pachinger, Leibetseder, & Fartacek, 2000). Given the clinical significance of OGM, researchers have begun to focus attention towards greater understand of the theoretical underpinnings of OGM. The CaR-FA-X model was developed as a framework to enhance understanding of OGM in adults (Williams et al., 2007). This model (see Figure 1) proposes three mechanisms that can disrupt the retrieval processes, in isolation or in interaction with each other. These mechanisms are; *c*apture and

[4] Across studies, the terms overgeneral memory and reduced memory specificity are used interchangeably. OGM refers to memories that no not contain specific details (e.g., categorical or extended), and rAMS refers to memories with limited amount of specific detail. See Griffith et al. (2012) for a review on methodological issues with the measurement of OGM (and rAMS).

*r*umination (CaR), *f*unctional *a*voidance (FA) and impaired e*x*ecutive control (X).

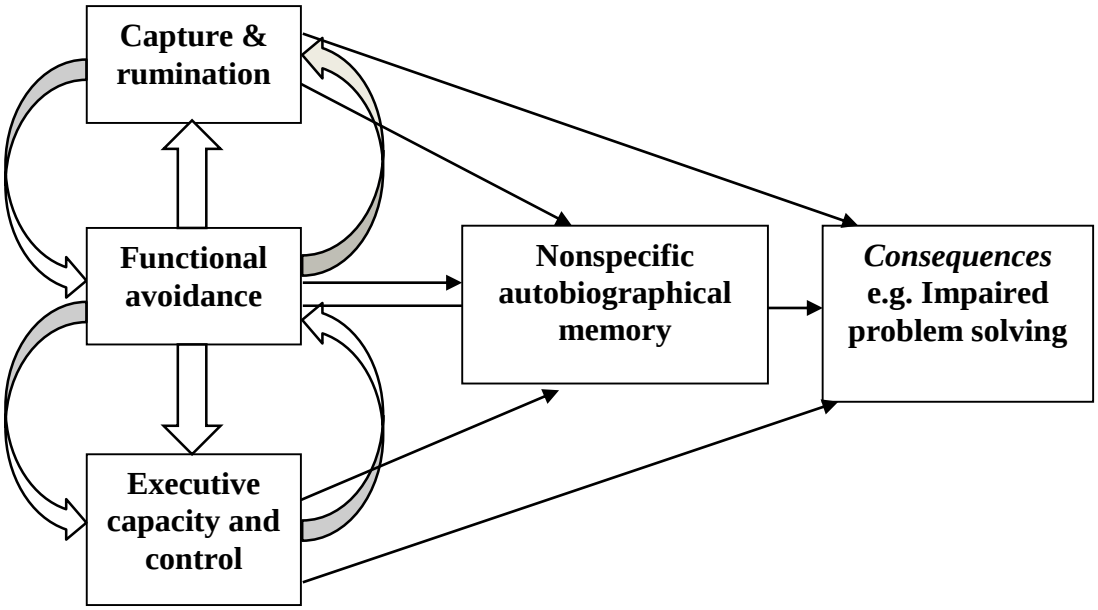

Figure 1: The CaR-FA-X model. Three processes contributing to overgeneral memory—capture and rumination (CaR), functional avoidance (FA), and impaired executive capacity and control (X)—can each have effects on cognition and behaviour (e.g., problem solving), either independently or through their individual or combined effect on autobiographical memory (permission granted for reproduction of image from Professor J Mark G Williams).

2.3 The CaR-FA-X model (Williams et al., 2007)

The CaR-FA-X model is built on the foundations of Conway and Pleydell-Pearce's (2000) self-memory model. This is a hierarchical autobiographical memory knowledge store with three levels of memory representations. The highest, broadest level holds memories including prolonged time periods (e.g. my time at university), to general memories for repeated or single events (e.g. driving home from work each day or my summer holiday in Spain), and event specific knowledge primarily consisting of a summary record of sensory-perceptual processing which occurred during the event (e.g. my birthday party last Saturday). A specific memory can be retrieved by either generative processing or by spontaneous, direct retrieval. Generative retrieval refers to top-down processing spreading down through the autobiographical memory knowledge base, activating broad, to general and then to

event specific memories in the hierarchy. Direct retrieval occurs when an environmental cue activates an immediate event specific knowledge. The CaR-FA-X model is a framework for generative retrieval, which proposes that the generative search through the hierarchy of AM's is disrupted early in the process due to one or more of the proposed mechanisms of the CaR-FA-X model, resulting in the retrieval of an overgeneral memory.

2.3.1 Capture and rumination

The capture and rumination mechanism of the CaR-FA-X model posits that capture errors can result from a disruption of the retrieval process if conceptual, abstract information activated at an early stage is self-relevant or related to self-representations. Conceptual processing based on self-representations is predominant in the early stages of retrieval (Conway, Singer, & Tagini, 2004; Williams et al., 2007) and subsequently the search for a memory can become captured at this stage and pass across the knowledge base rather than down the hierarchy. The search then becomes aborted, resulting in OGM. If continued attempts are terminated at this general stage, these 'intermediate descriptions' will become elaborated and future attempts will likely activate conceptual information, which activates other intermediate self-representations rather than specific memories. This process is referred to as mnemonic interlock (Williams et al., 2007). Such capture errors are particularly prevalent in people who are prone to have elaborate and highly activated self-representations, for instance those diagnosed with depression or individuals who have a tendency to ruminate (Sumner, 2012; Williams et al., 2007). Nolen-Hoeksema (1991) refers to rumination as the perpetual and persistent focus of attention towards negative thoughts, depressive affect and their consequences. Ruminative thinking can

elaborate the conceptual, abstract information which is activated in the early search for a specific memory. This focus on general representations at this early stage of retrieval increases the probability of attention becoming captured, in turn the search becomes truncated subsequently resulting in OGM.

Although the CaR-FA-X model does not differentiate between the different aspects of rumination, there are differing functions of the subcomponents of rumination. As an adaptive form of rumination, reflective pondering refers to a non-judgemental attentional focus on problem solving (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Reflective pondering has been associated with reductions in symptoms of depression (Arditte & Joormann, 2011), and coping in adolescence (Burwell & Shrik, 2007). Brooding rumination is a maladaptive form of rumination, which refers to a passive focus on negative and self-blaming thoughts (Treynor et al., 2003). Conversely, brooding rumination has shown associations with depressive disorders as well as sub-clinical symptoms of depression in adolescence (Burwell & Shirk, 2007; Gibb, Grassia, Stone, Uhrlass, & McGreary, 2012). In the adult literature, brooding (not reflection) has been shown to mediate the relationship between symptoms of depression and OGM (Debeer, Raes, & Hermans, 2009).

2.3.2 Functional avoidance

Functional avoidance, which refers to the ability to remain at a general level of retrieval as a way of affect control, is the second mechanism of the CaR-FA-X model. Specific memory recall of traumatic events can result in greater emotional disturbance. General recollections typically result in less emotional distress than specific memories (Conway & Pleydell-Pearce, 2000; Williams et al., 2007) and therefore remaining at a general level of retrieval can act as a strategy to avoid

negative affect. This strategy forms the basis of passive avoidance (Williams et al., 2007). For example, if the recollection of a memory in response to a cue word "holiday" resulted in a negative emotional response, the next time the person thinks about holidays they will likely choose to remain at a general level of retrieval, which in turn will result in an OGM. This strategy is not specific only to memories for traumatic events but can also occur for memories of other events.

2.3.3 Impaired executive control

The third mechanism of the CaR-FA-X model is impaired executive control (sometimes referred to as cognitive control). Executive control is a broad term referring to the ability to flexibly and efficiently coordinate one or more executive functions and processes (Roberts, 1998; Shah & Miyake, 1999; Williams et al., 2007). Despite much debate around what specific cognitive processes are involved in executive control (Diamond et al., 2013; Miyake et al., 2000) there is a general agreement that executive control refers to a set of cognitive processes responsible for the planning, initiation and monitoring of complex goal directed behaviour (Dalgleish et al., 2007). The search for a specific memory relies on executive resources and deficits in executive control can hamper a search strategy at different levels of retrieval, resulting in OGM. For example, difficulties in working memory capacity can reduce the ability to hold and update retrieved information in working memory, while impaired inhibitory processing may allow irrelevant autobiographical material to enter the search, in turn capturing attention and truncating the search (Conway & Pleydell-Pearce, 2000; Williams et al., 2007).

Research with adult populations does tend to support the CaR-FA-X model (see Sumner, 2012) however it is still unclear whether the model can account for

OGM in childhood and adolescence and whether the mechanisms of the CaR-FA-X model account for OGM differently in clinical and non-clinical youth populations. Gaining a greater understanding of the factors underlying OGM in childhood and adolescence is an important research objective for a number of reasons. Firstly, despite advances in intervention research, rates of depression are increasing (Compton, Conway, Stinson, & Grant, 2006). It is estimated that approximately 20% of adolescents will experience a clinically significant depressive episode by the age of 18 years (Davey, Yucel, & Allen, 2008). Moreover, relapse rates are as high as 60-90% in some cases (Dunn & Goodyer, 2006). In adolescence, depressive episodes last longer, are thought to be more severe than in adulthood and result in increased hospitalisation and suicidal thoughts and behaviours (Korczak & Goldstein, 2009; Van Noordenetal et al., 2011). Given the high relevance and relapse rates, as well as severity of symptoms, it is clear that a greater understanding of vulnerability factors that give rise to depression may be beneficial in informing preventative interventions.

OGM is one such vulnerability factor for depression. OGM is prevalent in children and adolescents diagnosed with depression (Kuyken, Howell, & Dalgleish, 2006; Park, Goodyer, & Teasdale, 2002), young people experiencing symptoms of depression (Drummond, Dritschel, Astell, O'Carroll, & Dalgleish, 2006), and in those who have experienced trauma (Crane et al., 2014). Recent evidence suggests that OGM is predictive of later depressive symptoms and MDD in adolescence, independent of age, IQ and current symptoms of depression (Rawal & Rice, 2012a) and, like adult populations, OGM has been found in adolescents recovered from depression (Kuyken & Dalgleish, 2011). This suggests that OGM is not only a by-

product of depression but serves as a cognitive vulnerability marker for future symptoms of depression and depressive disorders in child and adolescent populations. To date, the CaR-FA-X model is the most prominent and comprehensive theory of OGM.

2.4 Previous vs. current review

Previous reviews on OGM primarily focus on studies which include few child and adolescent populations (Sumner, 2012; Williams et al., 2007). Drawing conclusions about the strength of evidence of the applicability of the CaR-FA-X model in children and adolescence based on adult populations may be misleading. However, two reviews with child and adolescent populations have been published, though each has certain limitations. Valentino (2011) focused on developmental aspects of memory specificity, rather than specifically reviewing the CaR-FA-X model. Hitchcock, Nixon, and Weber (2014a) investigated OGM in child psychopathology, with a sub-section (8 studies) on the applicability of the CaR-FA-X model and ten studies separately investigating trauma exposure and OGM. Hitchcock et al's review examined studies which investigated the CaR-FA-X mechanisms in isolation, considered the applicability of the CaR-FA-X model on child and adolescent samples as a collective whole and did not examine whether the mechanisms were an underlying vulnerability for later OGM. More evidence is now available that can allow a more nuanced, complex understanding of the model in young people.

2.5 Aims and objectives

This review aims to systematically evaluate the three mechanisms of the CaR-FA-X model by assessing studies that have examined one or more of the

mechanisms in child and adolescent, clinical and non-clinical populations. We add nuance to the most recent review in this area by including research studies from the 'grey literature (GL)', longitudinal studies, and studies investigating interactive effects between mechanisms. Across 26 studies, we examine 10 findings for the CaR mechanism (5 capture, 9 rumination), 17 for the FA mechanism (17 trauma exposure, 3 avoidance) and 13 findings for the executive control mechanism. In this way, the review will provide a greater understanding of the associations and vulnerability to OGM, across different populations (e.g., clinical vs. non-clinical), while accounting for measurement differences and symptoms of depression.

2.6 Methodology

2.6.1 Summary of search strategy

Literature search strategies were developed using medical subject headings (MeSH) and text words related to autobiographical memory in childhood and adolescence. Seven online journal databases 'PsychInfo', 'PsychArticles', 'PubMed', 'Web of Science', 'Medline', 'SCOPUS' and 'Embase' were searched for English-language, peer-reviewed papers (PRP), published since Williams and Broadbent's (1986) seminal paper, which investigated, or commented upon, the relationship between one or more of the functions of the CaR-FA-X model and autobiographical memory in childhood or adolescence (mean age <18 years old). We considered studies with some participants above the age of 18 years only when the mean age of the whole sample was 18 years or less. The key words and terms included: ('autobiographical memory' OR 'episodic memory' OR 'retrospective memory') AND ('specific' OR 'overgeneral' OR 'over general' OR 'over-general' OR 'categoric' OR 'extended) AND ('child' OR 'adolescent' OR 'youth' OR 'minor'

OR ‘girl’ OR ‘boy’ OR ‘teen’). The last date searched was January 2016. To account for the possibility of grey literature, six online journal databases ‘OpenGrey’, ‘ProQuest’, ‘Web of Science Conference Proceedings’, ‘Copac’, ‘The British Library’ ‘Zetoc’ and the ‘Centre for Autobiographical Memory Research Conference proceedings’ were likewise searched. Requests were made to authors of the 26 included studies (71% response rate) for any possible unpublished data and reference lists of included studies were also examined for any additional relevant studies. The results of the search are summarised in Figure 2.

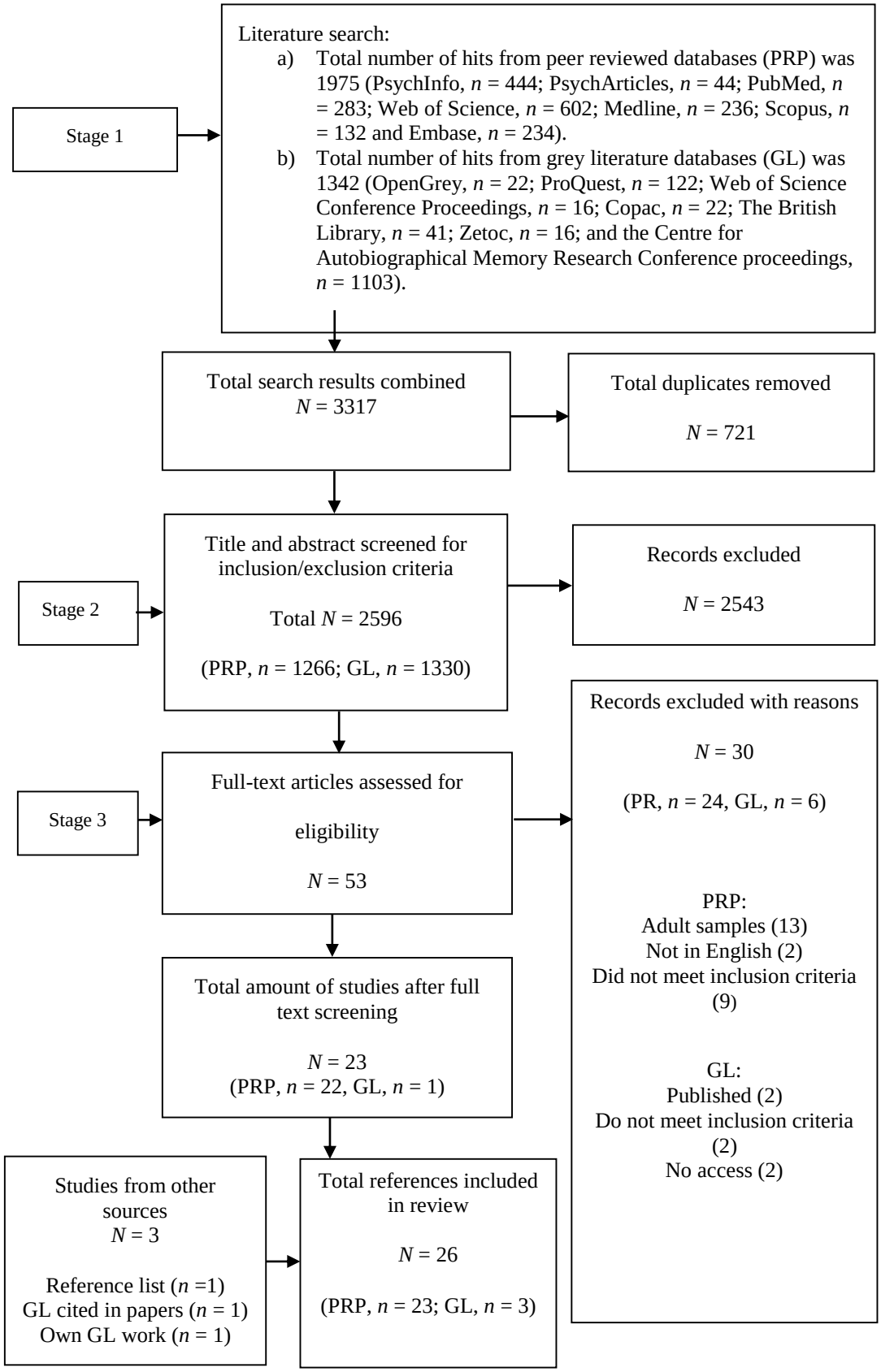

Figure 2. Summary of database search

2.6.2 Selection, inclusion and exclusion

At stage 1, the initial search returned a total of 3317 results (see Figure 2). We identified 1975 results from peer reviewed journals and a further 1342 results from a grey literature database search. From the original search results, 21% were duplicates and thus removed. Titles and abstracts were screened at stage 2 (*n* = 2596). Studies that examined one of more of the mechanisms of the CaR-FA-X model in children or adolescents (mean age < 18 years old) were retained. Studies were also retained if they investigated one or more of the mechanisms but did not specify the CaR-FA-X model. For example, a paper investigating the effects of trauma on overgeneral memory was retained, even though it did not refer to the model. Clinical and non-clinical samples were included. A sub-sample of 10% of titles and abstracts were independently reviewed at stage 2 (97% agreement). Any discrepancies were resolved through discussion. A majority of these studies (*n* = 2543) were removed from further analysis as they did not meet criteria. At stage 3, a total of 53 studies (46 peer-reviewed studies and 7 from the grey literature) full-text articles were assessed for eligibility. The papers were read in their entirety and scrutinised for relevance. A sub-sample of 10% of full-text papers were independently reviewed at stage 3 (100% agreement). In total, 30 papers were removed from the analysis and the justification for this removal is detailed in Figure 2. Twenty three articles (peer-reviewed, *n* = 22, grey literature, *n* = 1) were identified through this search strategy and deemed eligible for inclusion in the review. Three further studies were located and included. One study was located in reference list checks, one unpublished study was cited in a peer-reviewed paper and one unpublished study was included from the review authors. Requests from included

study authors for unpublished work unveiled one unpublished manuscript (already located through the grey literature). The total number of studies in the current review was 26, of which 23 were peer-reviewed studies and 3 were unpublished studies.

2.6.3 Data extraction and quality assessment

Retained studies were reviewed and relevant data was extracted using an adapted version of data extraction forms based on information from the Cochrane Handbook (Higgins & Green, 2011, see Appendix 1). To ensure consistency across reviewers, a calibration exercise was conducted whereby two reviewers independently screened 10% of papers with the data extraction from and guidelines (93% agreement). Data abstracted included study eligibility, population and setting details, participants and method details, and all reported results and outcomes. Any conflicts were resolved through a subsequent team discussion. To reduce potential errors on data extraction we extracted information as reported, any modification to data was done after extraction (e.g. changing % male to number of males).

An adapted version of the Newcastle-Ottawa scale (NOS) was used to assess of the quality of studies (see Appendix 2). The Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011) suggests that the items on the NOS may still need to be customized to the review question of interest. Modified versions of the NOS scale have been used by several other researchers to appropriately assess the quality of cross-sectional studies (Herzog et al., 2013; Patra et al., 2015). The NOS has demonstrated content validity and inter-rater reliability (Wells et al., 2015). A maximum of nine points can be awarded on quality assessment for cohort and case control studies. A search of the literature highlighted a score of seven or more as a cut off to be considered a good quality study (see McPheeters et

al. 2012; Patra et al., 2015). A maximum of seven points can be awarded on quality assessment on cross-sectional studies and therefore a score of five or above is considered a good quality study. Due to the heterogeneous nature of the included studies, individual studies were not quality assessed against each other but instead a quality score is provided for descriptive purposes only. Quality assessments were undertaken by the first author and 10% and were screened by an additional reviewer (92% agreement). Conflicts were resolved through a subsequent team discussion.

2.6.4 Reporting

To ensure appropriate reporting and transparency throughout, the Preferred Reporting Items for Systematic reviews and Meta Analyses (PRISMA) statement and guidelines were used to guide the current review (Liberati et al., 2009). An updated version became available during the review (Shamseer et al., 2015) and the review met these guidelines.

2.6.5 Data analysis

The studies identified varied substantially in terms of their study design, tasks used, and scoring procedures applied to outcome measures. Therefore, the summary of data was carried out using narrative synthesis. To ensure a robust and transparent synthesis of the evidence, the narrative synthesis explored the relationship and findings both within and between the included studies, in line with the guidance from the Economic and Social Research Council (ESRC) Methods Programme (Popay et al., 2006). The guidance offers four elements along with several tools and techniques that can be applied to the synthesis process. These elements include: developing a theory, developing a preliminary synthesis, exploring relationships within and between studies, and assessing the robustness of the synthesis (see Figure 3).

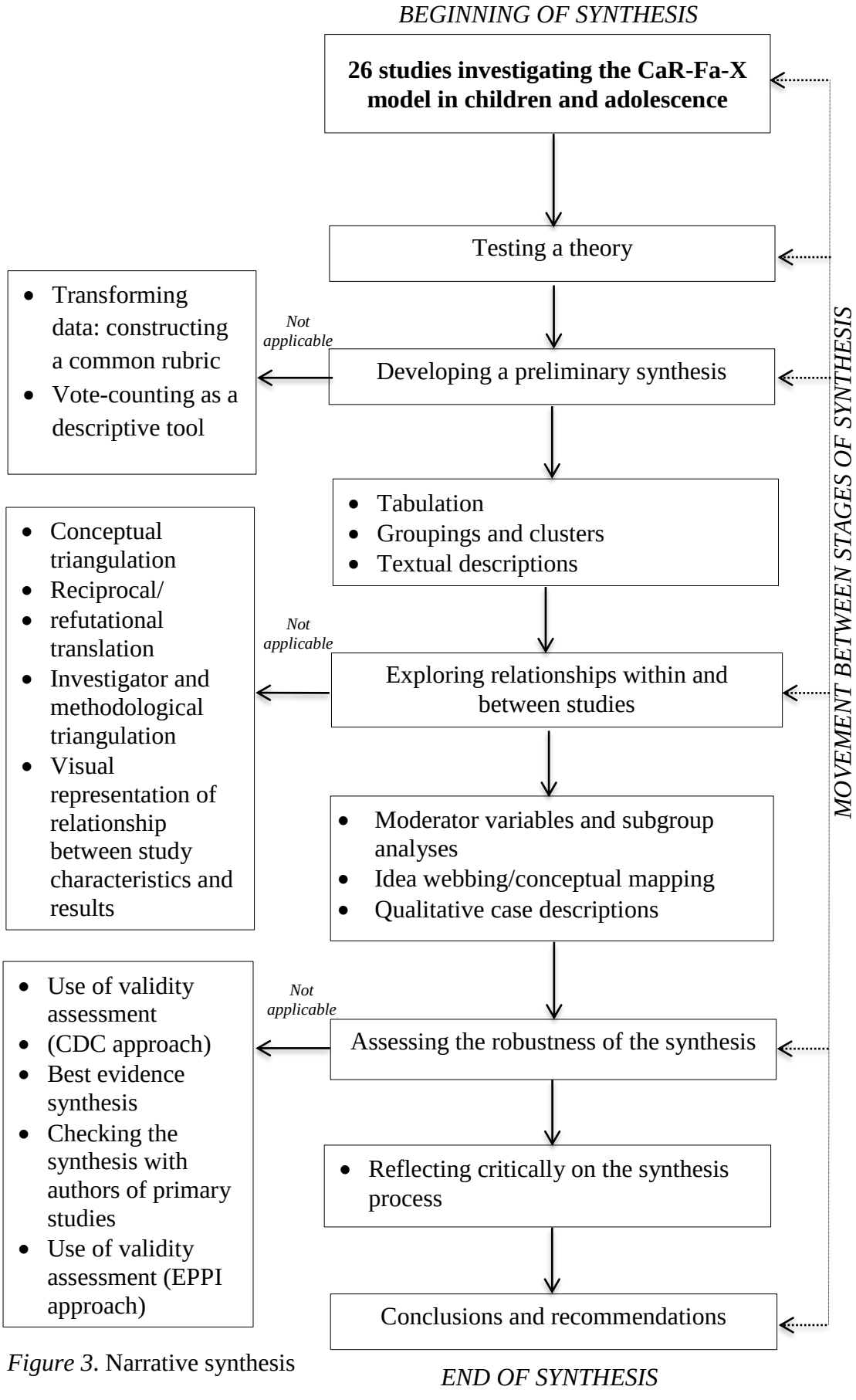

Figure 3. Narrative synthesis

2.7 Results

2.7.1 Description of studies included

Twenty six studies were included in the review (three unpublished). Of the 23 peer-reviewed studies, the median number of participants per study was 89 (range 24 – 5792). The age of the participants was 4 to 20 years with a median age of 14.35 years. Twenty two of the peer reviewed studies provided gender information and 43% of the participants were male. Thirteen studies examined one mechanism of the CaR-FA-X model in isolation, nine examined two mechanisms and one examined all three mechanisms of the CaR-FA-X model. Of the 3 unpublished studies, the median number of participants per study was 196 (range 149 – 246). The age of the participants ranged from 12 to 17 years (age range not available for one study) with a median age of 14.18 years. All three studies provided gender information, 41% were male. One study examined one mechanism of the CaR-FA-X model in isolation, one examined two mechanisms and one examined all three mechanisms.

Across all 26 included studies, 14 examined one mechanism in isolation, 10 examined two mechanisms and 2 studies examined all three mechanisms of the CaR-FA-X model. Quality assessment was conducted on 25 studies (see Table 1), and grouped into three categories: cohort, case-control and cross-sectional. Due to a lack of information, one study was not quality assessed (Smets et al., N.d as cited in Smets et al., 2013) but remained included. Eight were cohort studies (two unpublished), ten studies were case control and the remaining eight were cross-sectional (one unpublished).

Table 1. *Quality Assessment*

Cohort studies[1]	Selection			Comparability		Outcome			Total
Author(s)	Representativeness of the exposed cohort	Selection of the non-exposed cohort	Ascertainment of exposure	Demonstration that the outcome of interest was not present at start of the study	Comparability of cohorts on the basis of design or analysis	Assessment of outcome	Was follow-up long enough for the outcome to occur?	Adequacy of follow up of cohorts	
Crane et al. (2014)	*	*	*		**	*	*	*	8
Hitchcock et al. (2014b)	*	*	*	*	**	*	*	*	9
Hitchcock et al. (N.d)	*	*	*	*	**	*	*	*	9
Johnson et al. (2005)	*	*	*		**	*	*	*	8
Nixon et al. (2013) study 1	*	*	*	*	**	*	*	*	9
Rawal & Rice (2012b)	*	*	*	*	**	*	*	*	9
Stewart et al. (N.d)	*	*	*	*	**	*	*	*	9
Orbach et al. (2001)	*	*	*		*	*	*	*	7

Cross-sectional studies[2]	Selection			Comparability	Outcome		Total
Author(s)	Representativeness of the exposed sample	Non-respondents	Ascertainment of exposure	Comparability of outcome groups on the basis of design or analysis	Assessment of outcome	Statistical test is appropriate	
de decker et al. (2003)	*		*	**		*	5
Nuttall et al. (2014)	*	*	*	*	*	*	6
Park et al. (2004)	*	*	*	**	*	*	7
Raes et al. (2010)	*	*	*		*	*	5
Schoofs et al. (2012) study 1	*	*	*	*		*	5
Schoofs et al. (2012) study 2	*	*	*	*		*	5
Smets et al. (2013)	*		*	*	*	*	5
Smets et al. (N.d)	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	N/A

Case-control studies[3]	selection				Comparability	Exposure			Total
Author(s)	Is the case definition adequate?	Representativeness of the cases	Selection of controls	Definition of controls	Comparability of cases and controls on the basis of design or analysis	Ascertainment of exposure	Same method of ascertainment for cases and controls	Non-response rate	
Arie et al. (2008) [4]	*	*	*	*	*	*	*	*	8
Brennen et al. (2010) study 1	*	*			**	*		*	6
Kuyken et al. (2006)	*	*	*	*	**	*	*	*	9

Case-control studies[3]	selection				Comparability		Exposure		Total
Author(s)	Is the case definition adequate?	Representativeness of the cases	Selection of controls	Definition of controls	Comparability of cases and controls on the basis of design or analysis	Ascertainment of exposure	Same method of ascertainment for cases and controls	Non-response rate	
Meesters et al. (2000)		*	*	*	**		*	*	7
Neshat Doost et al. (2014)	*	*	*	*	**	*	*	*	9
Nixon et al. (2013) study 2	*	*		*	*	*	*	*	7
Ogle et al. (2014)	*		*	*	**	*		*	7
Valentino et al. (2012)		*	*	*	*	*	*	*	7
Valentino et al. (2009)	*	*	*	*	**	*	*	*	9
Stokes et al. (2004)	*			*	**		*	*	6

[1]Possible 9 stars, [2]Possible 7 stars (adapted measure), [3]Possible 9 stars

[4]Arie et al. (2008) was quality assessed as a case control study however the case definition applies here to clinical status (i.e. suicidal psychiatric group, psychiatric non suicidal control group and community control) rather than the case definition of a trauma group. The authors reported correlational (cross-sectional) data for the whole (mixed) sample when assessing the negative life events and OGM.

2.7.2 Clinical status and participant selection

Of the 26 published studies, six studies reported a sample with a clinically diagnosed mental health disorder. Two of these studies included diagnosis of depression (Kuyken et al., 2006; Park, Goodyer, & Teasdale, 2004), one sample with clinical PTSD (Nixon, Ball, Sterk, Best, & Betty, 2013, study 2) and three studies employed a sample with a diverse range of clinical disorders, including borderline personality disorder, anorexia nervosa conduct disorder, PTSD and mood disorders (Arie, Apter, Orbach, Yefet, & Zalzman, 2008; de Decker, Hermans, Raes, & Eelen, 2003; Valentino, Bridgett, Hayden, & Nuttall, 2012). Of the remaining non-clinical studies, six included school community samples (Brennen et al., 2010; Neshat Doost et al., 2014; Raes, Verstraeten, Bijttebier, Vasey, & Dalgleish, 2010; Schoofs, Hermans, & Raes, 2012, study 1 & 2; Smets, Griffith, Wessel, Walschaerts, & Raes, 2013), four from ongoing larger studies (Crane et al., 2014; Johnson, Greenhoot, Glisky, & McCloskey, 2005; Orbach, Lamb, Sternberg, Williams, & Dawud-Noursi, 2001; Rawal & Rice, 2012b), two from hospitals (Hitchcock, Nixon, & Weber, 2014b; Nixon et al., 2013, study 1), two from a range of community sources (Nuttall, Valentino, Comas, McNeill, & Stey, 2014; Stokes, Dritschel, & Berkerian, 2004) and the remaining three studies recruited participants from either a child maltreatment diagnostic and treatment centre (Ogle et al., 2013), participants referred to local Department of Human Services (DHS) due to concern of child maltreatment (Valentino, Toth, & Cicchetti, 2009) and participants living in youth care (Meesters, Merckelbach, Muris, & Wessel, 2000). All three unpublished studies included non-clinical community adolescents from a range of secondary schools (Hitchcock, Nixon & Weber, N.d; Smets et al., N.d cited in Smets et al., 2013; Stewart, Hunter, &

Rhodes, N.d).

2.7.3 Outcome measurement

Outcome measures and variations in measurement task and scoring can be found in Table 2. Research with adults has suggested that the original ATM (Williams & Broadbent, 1986) may not be sensitive enough to assess memory specificity in non-clinical samples (Debeer et al., 2009). The minimal instruction autobiographical memory test (Mi-AMT; Debeer et al., 2009) omits asking participants for a specific memory and instead asks participants to recall a memory without stating it should be specific and no examples are given. The Mi-AMT has been shown to increase detection of reduced memory specificity in non-clinical populations (Debeer et al., 2009). While the measurement issue of autobiographical memory in children and adolescents is not the main focus of the current review, information on AM measures within the included studies will be discussed. A separate review of AM measurement specifically in child and adolescent populations would add a significant contribution to the literature.

Table 2. *Summary Table of Outcome Measurement Variations*

	Assessment of OGM							
Study (year)	Measure (author)	Time limit	Cue words	Cue delivery	Practice set	Memory type	Unit of measurement	Omissions
Arie et al. (2008)	AMT (no author but based on Williams & Broadbent, 1986)	60 seconds	10 words: Five words with positive connotations (happy, proud, calm, successful, surprised) and 5 words with negative connotations (sorry, angry, guilty, heart, lonely)	Not stated	No (they were given 2 additional chances, each with a 60-second limit if no specific memory was given within 60s)	OGM (all memories except specific and omission)	Number	Recorded
Brennen et al. (2010) study 1	AMT: (Williams & Broadbent, 1986). Norwegian and Bosnian translations	2 minutes	12: 5 positive (happy, safe, interested, successful, and surprised). 5 negative (sad, angry, clumsy, hurt, and lonely). 2 more positive words were included (optimistic and victory)	Oral	Yes	Specific, categoric, extended and no responses	Proportion	Recorded
Crane et al. (2014)	AMT: Williams & Broadbent, 1986). Written version	None	10: 5 positive (excited, happy, lucky, relaxed, relieved). 5 negative (bored, failure, hopeless, lonely, sad)	Written	No (examples were given)	Binary score used: lowest quartile (providing at most one specific memory response) versus the remainder.	Number	Included as a non-specific memory

Study (year)	Measure (author)	Time limit	Cue words	Cue delivery	Practice set	Memory type	Unit of measurement	Omissions
De decker et al. (2003)	AMT Dutch version (de Decker, 2001) of the AMT (Williams & Broadbent, 1986)	30 seconds	10: 5 positive (happy, safe, interested, successful, surprised), 5 negative (sad, angry, clumsy, emotionally hurt, lonely)	Oral	No	Specific	Number	Not stated
Hitchcock et al. (N.d)	AMT (Williams & Broadbent, 1986) Written version	60 seconds	10: Time 1 (happy, sad, easy, lonely, proud, scared, brave, angry, successful, broken) and Time 2 (happy, sad, friend, stupid, surprised, tears, smart, mad, playing, afraid)	Written and oral	Not stated	Specific	Number	Recorded
Hitchcock et al. (2014b)	AMT (Williams & Broadbent, 1986)	60 seconds	Three word sets (5 positive & 5 negative in each) Word set 1: Happy, sad, easy, lonely, proud, scared, brave, angry, successful, broken. Word set 2: Happy, sad, friend, stupid, surprised, tears, smart, mad, playing, afraid. Word set 3: Happy, sad, beautiful, hurt, safe, sorry, lucky, upset, interested, alone	Written and oral	Yes	OGM (categoric and extended)	Number	Recorded
Johnson et al. (2005)	AMT (Crovitz et al.,1980)	3 minutes	Not stated: three types of cue words: positive (e.g., “present,” “playing”), neutral (e.g., “car,” “shopping”), negative (e.g., “punishment,” “arguing”).	Not stated	Not stated	Specific	Generate as many specific as possible from before age 9 in time limit	Not stated
Kuyken et al. (2006)	AMT (Williams, 2000).	30 seconds	10: 5 positive (happy, hopeful, excited, proud and loved) and 5 negative (lonely, frightened, sad, angry and ashamed)	Flashcards	Yes	OGM (categoric and extended)	Number	Recorded

Study (year)	Measure (author)	Time limit	Cue words	Cue delivery	Practice set	Memory type	Unit of measurement	Omissions
Meesters et al. (2000)	SAMT (Meesters at al., 2000)	Not stated	No cue words Sentences (e.g. the name of the street lived on)	Not stated	Not stated	No. of correct responses / by total no. of items - the number of non-relevant items	Number	Not stated
Neshat Doost et al. (2014)	AMT (Williams & Broadbent, 1986)	30 seconds	18: 6 positive (park, play, praise, party, celebration, holiday), 6 negative (accident, loneliness, argument, death break-up, illness), 6 neutral (year, book, class, clothes house, desk).	Written	Yes	Specific, categoric, extended, and semantic associates	Proportion (total of each memory type was divided by total no. of memories provided)	Recorded
Nixon et al. (2013) study 1	AMT: constrained and unconstrained[1] (Williams & Broadbent, 1986)	60 seconds	10: Ten affect words were presented on 5 positive (happy, brave, safe, strong, interested), 5 negative words (lonely, doubt, hurt, strange, clumsy)	Flashcards	Yes	Specific	Number	Recorded
Nixon et al. (2013) study 2	AMT (Williams & Broadbent, 1986)	60 seconds	10: Ten affect words were presented on 5 positive (happy, brave, safe, strong, interested) 5 negative words (lonely, doubt, hurt, strange, clumsy)	Flashcards	Yes	Specific	Number	Recorded
Nuttall et al. (2014)	AMT-PV[2] (Nuttall et al., 2014)	60 seconds	10: 5 positive (happy, surprised, lucky, strong, smart), 5 negative (mad, sad, scared, tired, hungry)	Oral and visually	Not stated	Specific (coded 1 for specific and 0 for all other memories)	Number	Coded as OGM

Study (year)	Measure (author)	Time limit	Cue words	Cue delivery	Practice set	Memory type	Unit of measurement	Omissions
Ogle et al. (2013)	The AMI[3] (Kopelman et al., 1989)	None	No cue words: recalled an incident that occurred in elementary school (Grades 1–5; aged 5–10), and an incident that occurred during sixth grade (aged 12)	Not stated	No (examples were given)	Specific	Number	Recorded
Orbach et al. (2001)	The FDQ[4] (Salzinger, Feldman, Hammer, & Rosario, 1992)	Not stated	No cue words: Questions asked the child to describe issues, incidence, and characteristics of child-parent and interparental disagreements, arguments, disputes, parental punishment, and parental physical violence	N/A	No	Categoric	Proportion	Recorded
Park et al. (2004)	AMT (Williams & Broadbent, 1986)	60 seconds	4 word sets were used (6 positive & 6 negative in each set) Word set 1: happy, relieved, proud, eager, glorious, sunny, guilty, hopeless, grave, ugly, worse, failure; Word set 2: interested, hopeful, amazed, pleased, calm, bright, grief, rejected, lonely, blame, awful, mistake; Word set 3: joy, smile, loyal, lively, cheer, lucky, sad, misery, ashamed, weakness, angry, tired; Word set 4: safe, excited, friendly, peaceful, successful, pleasant, tragic, upset, hurt, bad, bored, fault	Flashcards	Yes	Categoric	Proportion	Recorded

Study (year)	Measure (author)	Time limit	Cue words	Cue delivery	Practice set	Memory type	Unit of measurement	Omissions
Raes et al. (2010)	AMT: Written version (Williams & Broadbent, 1986)	Not stated	10: 5 positive (happy, relaxed, successful, brave, proud), 5 Negative (scared, lonely, angry, sad, guilty)	Written	Not stated	Categoric	Number	Recorded
Rawal and Rice (2012b)	AMT (Williams & Broadbent, 1986)	30 seconds	Two word sets consisting of 12 emotional: 6 positive (Word-set 1: loyal, joy, smile, achieve, loved, ambitious; Word-set 2: friendly, happy, respect, caring, sunny, perfect) 6 negative (Word-set 1: mistake, rejected, weakness, needy, angry, tired; Word-set 2: failure, disliked, ugly, useless, worse, lonely).	Read aloud	Yes	Specific	Number	Not stated
Schoofs et al. (2012) study 1& 2	Mi-AMT: written version (Williams & Broadbent, 1986) (Written; Debeer et al., 2009)	60 seconds	20 words: Only positive 10 high discrepant (example - optimistic, successful, and satisfied); 10 low discrepant (example - sensitive, grateful, and polite)	Not stated	No	Specific and Categoric	Proportion (no. of specific memories / by no. of total responses (10 - no. of no responses)	Excluded in proportion calculations
Smet et al. (2013)	Mi-AMT: written version (Williams & Broadbent, 1986) (Written; Debeer et al., 2009)	60 seconds	20 words: Only positive 10 high discrepant (example - optimistic, successful, and satisfied); 10 low discrepant (example - sensitive, grateful, and polite)	Read aloud	No	Specific and categoric	Number	Recorded

Study (year)	Measure (author)	Time limit	Cue words	Cue delivery	Practice set	Memory type	Unit of measurement	Omissions
Smets et al. (N.d as cited in Smets et al., 2013)	Mi-AMT: written version (Williams & Broadbent, 1986) (Written; Debeer et al., 2009)	60 seconds	10 words: 10 high discrepant cues (these are positive, emotional words which may bring discrepancies between a current state and desired, ideal goals into prominence).	NK	NK	Categoric	Number	NK
Stewart et al. (N.d)	Mi-AMT: written version (Williams & Broadbent, 1986) (Written; Debeer et al., 2009)	60 seconds	Two word sets consisting of 12 emotional: 6 positive (Word-set 1: loyal, joy, smile, achieve, loved, ambitious; Word-set 2: friendly, happy, respect, caring, sunny, perfect) 6 negative (Word-set 1: mistake, rejected, weakness, needy, angry, tired; Word-set 2: failure, disliked, ugly, useless, worse, lonely).	Oral and Visual	No (examples were given)	OGM (categoric and extended)	Number	Recorded
Stokes et al. (2004)	Cued recall task (no author)	60 seconds	10 emotional cue words. 5 positive cue words (Happy, Safe, Interested, Successful, Surprised) 5 negative words (Sorry, Angry, Clumsy, Hurt, Lonely)	Not stated	No (examples were given)	Specific, extended, categoric and omissions	Number	Recorded
Valentino et al. (2012)	AMT (Williams & Broadbent, 1986)	60 seconds	10 cue words: 5 positive and 5 negative (example - happy, sorry)	Oral and visual	Not stated	OGMs defined as memories that did not contain at least one specific detail	Number	Not stated

Study (year)	Measure (author)	Time limit	Cue words	Cue delivery	Practice set	Memory type	Unit of measurement	Omissions
Valentino et al. (2009)	AMT (Williams & Broadbent, 1986)	60 seconds	10: 5 positive cue words (Happy, Safe, Interested, Successful, Surprised), 5 negative words (Sorry, Angry, Clumsy, Hurt, Lonely)	Oral and visual	Not stated	OGMs defined as memories that did not contain at least one specific detail	Number	Not stated

[1] Unconstrained condition = recall a specific event from any time period of their life, prior to the recent trauma/hospital admission. Constrained condition = recall a specific event from the time of trauma, up to 24 hours following the event in response to the cue words.
[2] The AMT-PV is an adaptation of the original AMT (Williams & Broadbent, 1986) that was designed to be developmentally appropriate for pre-school children.
[3]AMI = Autobiographical memory interview (Kopelman et al., 1989)
[4]FDQ = Family Disagreements Questionnaire (FDQ: Salzinger, Feldman, Hammer, & Rosario, 1992)
AMT = autobiographical memory test; Mi-AMT = minimal instruction autobiographical memory test
N.d = Unpublished manuscript; NK = Not known.

Results have been summarised according to four broad categories: 1) capture and rumination, 2) functional avoidance, 3) impaired executive control and 4) interactions between mechanisms. Within each category, a) the role of symptoms of depression, b) clinical status of the participants, c) methodology, d) outcome measures and e) whether the findings constitute a vulnerability to OGM was considered. A summary of findings for the 26 included studies is presented in Table 3.

Table 3. *Summary of Studies Examining the Mechanisms of the CaR-FA-X Model*

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
Capture and Rumination							
Park et al. (2004)	134 (Full MDD = 30%; PR-MDD = 26%; Non-MDD PSY = 38%; Control = 38%)	Clinical: (Full MDD = 44; PR MDD = 31; Non-MDD PSY = 26; Control = 33)	12-17 years: (Full MDD, M = 14.90, SD = 1.3; PR-MDD, M = 15.00, SD = 1.4; Non-MDD PSY, M = 13.70, SD = 1.4; Control, M = 14.60, SD = 1.3)	AMT: (Prop. of categoric)	R: (Rumination vs. distraction induction)	Greater increase in OGM after rumination induction than with distraction in the MDD (collapsed with partially remitted) group only. This effect was specific to negative cue words.	R: Yes
Schoofs et al. (2012) study 1	126 (21%)	Non-clinical: Community sample	17-20 years (M = 17.57, SD = 0.66)	AMT: minimal instruction, written (Prop. of specific and categoric)	C: (high & low discrepant words) R: (brooding and reflective)	A greater proportion of specific memories were retrieved in response to LD cues compared to HD cues. A greater proportion of categoric memories were retrieved in response to HD cues compared to LD cues. BR and RP not associated with OGM.	C: Yes R: No
Schoofs et al. (2012) study 2	146 (45%)	Non-clinical: Community sample	16-19 years (M = 16.82, SD = 0.72)	AMT: minimal instruction, written (Prop. of specific and categoric)	C: (high low discrepant words) R: (brooding and reflective)	A greater proportion of specific memories were retrieved in response to LD cues compared to HD cues. A greater proportion of categoric memories were retrieved in response to HD cues compared to LD cues.BR and RP not associated with OGM.	C: Yes R: No
Smets et al. (2013)	123 (45%)	Non clinical: Community sample	16-19 years (M = 17.30, SD = 0.50)	AMT: minimal instruction, written (No. of specific and categoric)	C: (self-discrepancy induction) R: (RRS; Dutch version)	Rumination was not associated with OGM before or after self-discrepant induction.	C: No R: No

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
Capture and rumination							
Smets et al. (N.d as cited in Smets et al., 2013)	246 (39%)	Non clinical: Community sample	Unknown (M = 17.30)	AMT: minimal instruction, written (No. of categoric)	C: (high low discrepant words)	Self-discrepancies did not result in greater OGM.	C: No
Functional Avoidance							
Arie et al. (2008)	75 (Suicide attempt group = 35%; psychiatric control = 40%; community control = 48%)	Clinical: psychiatric inpatient (Suicide attempt group = 25; psychiatric control = 25; community control = 25)	12 – 19 years (Suicide attempt group, M = 16.50 ± 2.5 years; psychiatric control, M = 16.50 ± 2.5 years; community control, M = 16.6 ± 2.3 years)	AMT: no author (No. of OGM – defined as non-specific responses)	TE: (life events questionnaire)	In comparison to the psychiatric and community control group, negative life events were correlated with OGM in the suicide psychiatric group.	TE: Yes
Brennen et al. (2010) study 1[1]	89 (Trauma group = 50%; control group = 46%)	Non-clinical: (Trauma group = 40; control group = 49)	17-19 years (Trauma group, M = 17.90, SD = 0.70; control group, M = 18.00, SD = 0.50)	AMT (Prop. of specific and categoric)	TE: War trauma questionnaire (verified by clinical)	The Bosnian group (war exposure) recalled significantly fewer specific memoires and significantly more categoric memories than the Norwegian group (non- war exposure group).	TE: Yes
Crane et al. (2014)	5,792 (43%)	Non-clinical: Children from ongoing population study	13 years (95% between 13 years, 1 month & 13 years, 3 months)	AMT written: (No. of specific lowest quartile, binary)	TE: Life events measures	60% increase in the odds of low memory specificity at aged 13 for children who had experienced severe trauma in middle childhood.	TE: Yes

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
Functional Avoidance							
Neshat Doost et al. (2014)	103 (Bereaved = 50%; non-bereaved = 58%)	Non-clinical: (Bereaved = 70; non-bereaved = 33)	12-18 years (bereaved, M = 14.89, SD = 1.83; non-bereaved (M = 14.91, SD = 2.05)	AMT: (Prop. of specific, categoric & extended)	TE: School records and brief interview	The bereaved group retrieved a lower proportion of specific memories and a higher proportion of categoric and extended memories than the non-bereaved group.	TE: Yes
Ogle et al. (2013)	85: 49 adolescents	Non-clinical: Childhood sexual abuse = 25; control = 24)	14-17 years (M = 15.12, SD = 0.95)	The AMI[2]: (No. of specific)	TE: CSA history	Adolescents without CSA histories reported more specific memories than adolescents with CSA histories	TE: Yes
Orbach et al. (2001)	50 (not stated)	Non-clinical: (Family violence = 34; control = 16)	8 – 12 years (M = 10.61, SD = 1.31)	The FDQ[3]: (Prop. of categoric)	TE: Family Violence (Assessed by social workers, cross-validated using parents and children's reports)	No group differences in OGM in between children in the Family Violence (Victims of Abuse, Witnesses of Abuse, and Victims and Witnesses) and Comparison groups	TE: No
Stokes et al. (2004)	24 (0%)	Non-clinical: Burns group = 12; orthodontic controls = 12)	11-16 years (M = 14 years)	Cued recall task: (no. of specific, categoric, extended)	TE: Burns between 6 weeks old & 14 years (parental reports) A: Impact event scale	The burn group recalled significantly fewer specific memories and more extended memories In the burn group, reduced specificity was correlated with higher avoidance	TE: Yes A: Yes

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
Impaired executive control							
Nuttall et al. (2014)	227 (4 year olds = 52%; 5 year olds = 51%; 6 year olds = 48%)	Non-clinical: preschool sample (4 year olds = 79; 5 year olds = 63; 6 year olds =65)	4-6 years (4 year olds, M = 4.52, SD = 0.27; 5 year olds, M = 5.49, SD = 0.29; 6 year olds, M = 6.52, SD = 0.28)	AMT-PV[4]: (No. of specific)	X: Behavioural inhibition	Behavioural inhibition not association with OGM in the preschool sample	X : No
Raes et al. (2010)	135 (47%)	Non clinical: Community school sample	9-13 years (M = 10.53, SD = .66)	AMT Written: (no. of categoric)	X: Inhibition	Lower levels of inhibitory control were associated with greater recall of categoric memories.	X :Yes
2 mechanisms							
de Decker et al. (2003)	27 (63%)	Clinical: Psychiatric inpatient	14-20 years (M = 16.40, SD = 1.5)	AMT: (No. of specific)	TE: Trauma questionnaire X: WM capacity	Greater trauma was associated with less specificity. This effect was specific to positive cue words. Working memory capacity not associated with memory specificity.	TE: Yes X : No
Johnson et al. (2005)	134 (46%)	Non-clinical: Exposure to family violence and sexual abuse	Year 1: 6 – 12 years (M = 9.00, SD = 1.98; Year 6 : 12 – 18 years (M = 15.00, SD = 1.97)	AMT: Crovitz et al.,1980 (Generate as many specific within time limit)	TE: Conflict questionnaire and interview questions X: WM capacity	Family violence or sexual abuse not related to specific memories or OGM at year 1 or 6. WM capacity was not associated with OGM or memory specificity.	TE: No X : No

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
2 mechanisms							
Kuyken et al. (2006)	62 (Never depressed = 25%; depressed no trauma = 25%; depressed and trauma = 9%)	Clinical: (Never depressed = 28; depressed no trauma = 12; depressed + trauma = 22)	12–18 (Never depressed, M=15.68, SD= 1.59; depressed no trauma, M=15.92, SD=1.51; depressed and trauma, M=16.23, SD = 1.38)	AMT: (No. of OGM, categoric and extended combined)	TE: Trauma Questionnaire plus a clinical interview A: The Children's Impact of Event Scale X: Verbal fluency	Adolescents with MDD and a history of trauma were *less* overgeneral than adolescents with MDD with no trauma. In the trauma plus MDD group, higher levels of avoidance was associated with *less* OGM Across the whole sample, verbal fluency was not associated with OGM.	TE: No A: No X : No
Meesters et al. (2000)	27 (trauma group = 30%; no trauma group = 29%)	Non clinical: Adolescents in youth care (Trauma = 10; no-trauma =17)	14-19 years (Trauma group, M = 16.50, SD = 1.3; no trauma group, M = 16.10, SD = 2.8)	SAMT: (No. of correct responses divided by the total number of items minus the number of non-relevant items)	TE: Children's case records of physical maltreatment, sexual abuse & neglect X: WM capacity	Adolescents with a history of trauma have greater difficulty reporting autobiographical facts than adolescents without a history of trauma X: WM capacity not associated with AM	TE: Yes X : No

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
2 mechanisms							
Nixon et al. (2013) study 1[5]	67 (High acute PTSD stress = 36%; low acute PTSD stress = 71%; control = 66%)	Non-clinical: Children attending hospital for a single-incident trauma and hospitalised control for non-trauma related illnesses (High acute stress = 11; low acute stress = 24; control = 32)	8-17 years (High acute PTSD stress, M = 13.27, SD = 2.72; low acute PTSD stress, M = 12.33, SD = 2.90; control, M = 12.78, SD = 3.01)	AMT: Constrained vs unconstrained[6] (no. of specific)	TE: Trauma interview and PTSD questionnaire X : WM capacity	When constrained to retrieve memories from the 24-hour period following trauma, children with higher levels of acute PTSD stress symptoms retrieved a *greater* number of specific memories. However, no differences were reported when memories were retrieved from a period that predated their trauma (unconstrained). Greater WMC was associated with greater memory specificity	TE: No X: Yes (partial)
Nixon et al. (2013) study 2	67 PTSD (58%) Control (59%)	Clinical5: Trauma exposed children with PTSD receiving CBT treatment vs trauma-exposed but non-PTSD children recruited from the community (PTSD = 33; control = 34)	7-16 years (PTSD, M= 11.12, SD = 3.12; control, M = 11.06 , SD = 2.10)	AMT (No. of Specific)	TE: Clinical interview for PTSD X: WM capacity	Trauma exposed children with PTSD retrieved fewer specific memories compared to trauma exposed non-PTSD controls. WMC was not associated with memory specificity.	TE: Yes X : No

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
2 mechanisms							
Rawal and Rice (2012b)	230 (42%)	Non-clinical: At familial risk of depression	10-18 years (M = 13.64, SD = 1.98)	AMT: (No. of specific)	R: The Children's Response Styles Questionnaire X: Visuo-constructional ability R&X: Rumination x executive control	Rumination in isolation not associated with OGM. Executive control not association with OGM in isolation. Interaction: rumination in the context of low executive control predicts OGM at follow up	R: No X: No R&X: Yes
Stewart et al. (N.d)	149 (37%)	Non-clinical: Community school sample	13-16 years (M = 13.85, SD = 0.78)	AMT: (No. of OGM, categoric and extended combined)	R: RRS scale X: Executive control R&X: Rumination x executive control	Rumination in isolation is not associated with OGM. Executive control not associated with OGM in isolation. Interaction: lower executive control for emotional information, with increased levels of reflective pondering predicted less OGM	R: No X: No R&X: Yes

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
2 mechanisms							

Valentino et al. (2012)	49 (67%)	Clinical: Psychiatric inpatient (Physical and sexual abuse = 30; no abuse = 19)	7 -17 years (Total, M = 14.10, SD = 2.3; Abuse, M = 13.49, SD = 2.3; No abuse, M = 15.28, SD = 1.6)	AMT (No. of OGM, not containing at least one specific detail)	TE: Child records & classification system X:Shifting, inhibition, verbal fluency (letter & category fluency)	Abuse is not associated with OGM (but is in interaction with depression) Switching, letter fluency and inhibition not correlated with OGM Category fluency associated with OGM	TE: No X: Yes (only for category fluency)
Valentino et al. (2009)	192 (Sexual and physical abuse = 67%; neglected = 56%; non-maltreated = 47%)	Non-clinical: (Sexual and physical abuse = 36; neglected = 34; non-maltreated = 115)	7 -13 years (total, M = 10.61, SD = 1.55; Sexual and physical abuse = M = 10.69, SD = 1.6; neglected = M = 10.78, SD = 1.7; non-maltreated = M = 10.51, SD = 1.5)	AMT (No. of OGM, not containing at least one specific detail)	C: Child and maternal self-representations TE: Child records & classification system	Negative self-representations positively associated with OGM (in abused and non-maltreated groups combined). Abused children recall more OGMs than did the neglected children and the non-maltreated children.	C: Yes TE: Yes

Studies (year)	No. of participants (% male)	Sample (no. in group)	Age (mean and SD)	Assessment of OGM (unit of measurement)	CaR-FA-X mechanism (task)	Finding(s)	Support CaR-FA-X model
3 mechanisms							

Hitchcock et al. (N.d)	196 (47%)	Non-Clinical: Community school sample	12- 17 years (M = 14.18, SD = 1.58)	AMT Written (No. of specific)	R: CRSS TE: PTSD Scale for trauma history A: Cognitive avoidance X: Inhibition R,X& TE: Trauma history x rumination; inhibition x trauma	Rumination, inhibition, avoidance nor trauma exposure was independently or in interaction associated with memory specificity.	R: No TE: No A: No X: No R,X&TE: No
Hitchcock et al. (2014b)	50 (75%)	Non-clinical: Children attending hospital for a single incident accidental injury	7 – 17 years (M = 11.90, SD = 3.31)	AMT (No. of. OGM, categoric & extended combined)	R: CRSS TE: trauma questionnaire X: WM capacity, WM updating, verbal fluency & inhibition R&X: Rumination x executive control	Rumination not associated with OGM. Trauma history not associated with OGM. WM updating, verbal fluency and inhibition not associated with OGM. Greater WM capacity was associated with reductions in OGM (in older children) but greater WM in younger children was associated with greater OGM. Greater WM capacity and high levels of inhibition positively associated with OGM. No interactive effects between executive control and rumination.	R: No TE: No X: Yes (partial & only for WM capacity & older children) R&X: No

A = Avoidance; AMT = Autobiographical Memory Test; BR = Brooding Rumination; C = Capture; CBT = Cognitive Behavioural Therapy; CRSS = The Children's Response Style Scale; CSA = Childhood Sexual Abuse; EC = Executive Control; FA = Functional Avoidance; HD = High Discrepant; LD = Low Discrepant; MDD = Major Depressive Disorder; N.d = Unpublished Manuscript; Neg = Negative; No. = Number of; ns = Non-significant; PR = Partially Remitted; PSY = Psychiatric Sample; Prop. = Proportion; PTSD = Post Traumatic Stress Disorder; RRS = Ruminative Response Scale; R = Rumination; SAMT = Semantic Autobiographical Memory Test; TE = Trauma Exposure; WM = Working Memory; WMC = Working Memory Capacity; X = Executive control.

[1]Follow up study 2 not included as mean age above 18 years old.

[2] Autobiographical memory interview (Kopelman et al., 1989)

[3] FDQ = Family Disagreements Questionnaire (FDQ: Salzinger, Feldman, Hammer, & Rosario, 1992)

[4] The AMT-PV is an adaptation of the original AMT (Williams & Broadbent, 1986) that was designed to be developmentally appropriate for pre-school children

[5]39% of sample failed to meet to full criteria for 1 of the 3 symptom clusters
[6]Unconstrained condition = recall a specific event from any time period of their life, prior to the recent trauma/hospital admission. Constrained condition = recall a specific event from the time of trauma, up to 24 hours following the event in response to the cue words.

2.7.4 The capture and rumination mechanism

Ten studies in total investigated the capture and rumination mechanism (three unpublished). Of the seven peer-reviewed studies, the number of participants tested was 858 and the median number of participants per study was 123 (range 49 – 230). The age of the participants ranged from 7 to 20 years with a median age of 13.70 years. All seven studies provided gender information and 46% of the participants were male. Of the seven studies, one examined the capture aspect without rumination (Valentino et al., 2009), three examined rumination without the capture aspect (Hitchcock et al., 2014b; Park et al., 2004; Rawal & Rice, 2012b) and three studies investigated both capture and rumination (Schoofs et al., 2012, study 1 & 2; Smets et al., 2013). Capture was assessed by various methods including the use of high and low discrepant cue words (Schoofs et al., 2012, study 1 & 2), a self-discrepancy induction (Smets et al., 2013) and by examining negative self-representations (Valentino et al., 2009). Rumination was assessed by the ruminative response scale (RRS; Treynor et al., 2003) in three studies (Schoofs et al., 2012, study 1 & 2; Smets et al., 2013), the children's response styles questionnaire (CRSQ; Abela, Vanderbilt, & Rochon, 2004) in one study (Rawal & Rice, 2012b) and the children's response style scale (Ziegert & Kistner, 2002) in another (Hitchcock et al., 2014b). Only two of the published studies examined rumination by its subcomponents of brooding rumination and reflective pondering (Schoofs et al., 2012, study 1 & 2).

All three unpublished studies investigated the CaR mechanism. One study investigated the capture phenomenon (Smets et al., N.d as cited in Smets et al., 2013) and two studies investigated rumination (Hitchcock et al., N.d; Stewart et al., N.d). The number of participants tested was 591 and the median number of participants per

study was 196 (range 149-246). The age of the participants ranged from 12 to 17 years (one study did not provide this information) with a median age of 14.18 years across the three studies. All three studies provided gender information and 41% of the participants were male. Capture was assessed by the use of high discrepant cue words. Rumination was assessed by the RRS (Treynor et al., 2003) in one study (Stewart et al., N.d) and the Children's Response Style Scale (CRSS; Ziegert & Kistner, 2002) in one study (Hitchcock et al., N.d). One of the unpublished studies examined rumination by its subcomponents of brooding rumination and reflective pondering (Stewart et al., N.d).

The capture aspect was supported in three of the five (one unpublished) studies (Schoofs et al., 2012, study 1 & 2; Valentino et al., 2009). Schoofs et al. (2012, study 1 & 2) examined the capture aspect with non-clinical community adolescents. High and low discrepant cue words were used in the AMT (discrepancy between attributes of the actual and the ideal self) as a method of assessing the capture aspect. A greater proportion of categoric and a reduced proportion of specific memories were retrieved in response to high discrepant cues, in comparison to low discrepant words. Thus, when cues were not consistent with the adolescents' self-image this resulted in capture errors and reduced specificity and greater OGM. To account for the possibility that the findings were reflective of the importance of the cue to the adolescent, rather than the discrepancy per se, Schoofs et al.'s (2012) second study controlled for the effects of cue word importance and confirmed that the results could not be due to the importance of the cue to self-image. In a subsample of participants (abused and control adolescents), Valentino et al. (2009) found negative self-representations were related to OGM, providing support for the capture aspect of the

capture and rumination mechanism of the CaR-FA-X model.

The rumination aspect was supported in one of eight (two unpublished) studies (Park et al., 2004). The authors examined OGM pre and post an experimental rumination and distraction manipulation task. In a sample of adolescents diagnosed with MDD, partially remitted MDD, a psychiatric control and a community control group it was found that rumination (but not distraction) increased OGM, but only within the MDD group (full and partially remitted). The increase in OGM due to rumination was specific to negative cue words and was independent of mood, age, gender or IQ.

2.7.4.1 Controlling for depressive symptoms

Of the four studies demonstrating significant effects (Park et al., 2004; Schoofs et al., 2012, study 1 & 2; Valentino et al., 2009), all accounted for symptoms of depression and/or mood. These finding suggest the capture and rumination mechanism contribution to OGM is not due to symptoms of depression or mood.

2.7.4.2 Clinical status comparisons

Capture errors were reported in non-clinical community adolescents (Schoofs et al., 2012, study 1 & 2) and non-clinical adolescents with a history of abuse (Valentino et al., 2009). This suggests that capture errors are not simply a function of clinical severity but are present in adolescents free of clinical disorder. The only study to find an association between rumination and OGM comprised a clinically depressed sample (Park et al., 2004). This suggests that the association between rumination, in isolation, and memory specificity may be specific to clinical MDD. Future research is needed to verify this finding.

2.7.4.3 Vulnerability to OGM

To determine if the capture and rumination mechanism is an underlying vulnerability factor for OGM, longitudinal studies are needed. From the seven studies that investigated this mechanism in childhood and adolescence, four studies (two unpublished) made use of such a design. No study found rumination, in isolation, to predict OGM over time. Two studies did however report interactive effects between rumination and other mechanisms of the CaR-FA-X model (discussed later in the review).

2.7.4.4 AMT variations

The unit of measurement, number and volume of cue words, cue presentation and measurement type (specific vs OGM) impacts on AMT performance (Griffith et al., 2012; van Vreeswijk & de Wilde, 2004). This varied across all studies (see Table 2) and may explain conflicting results. Smets et al. (2013) and Smets et al. (N.d as cited in Smets et al., 2013) are the only studies to report non-significant effects. The authors employed the Mi-AMT written version, similar to Schoofs et al. (2012), and therefore it is unlikely the null findings are due to the version of AMT. Smets et al. (2013) used a different scoring algorithm (number, not proportions), however they noted in their paper that the results did not alter when proportions were used instead of the number of memories, suggesting that the null findings are not due to the scoring of the AMT. As rumination was non-significant (with the exception of Park et al., 2004) across different versions of the AMT (original AMT, written AMT and Mi-AMT), it is unlikely that null findings of a relationship between rumination and OGM are due to the measurement of AM.

2.7.5 Functional avoidance mechanism

Seventeen (one unpublished) of the studies investigated the functional avoidance mechanism of the CaR-FA-X model. Truncating a search due to functional avoidance has predominately been investigated in two key ways within the literature: indirectly through the effect of trauma exposure on OGM, or via the direct link between avoidance and OGM. The former is categorised here as 'trauma exposure' and the latter as 'avoidance'. Of the published studies, the number of participants tested was 6857 and the median number of participants per study was 65 (range 24 – 5792). The age of the participants ranged from 6 to 20 years with a median age of 14.10 years across the 16 studies. Of the 16 studies, 15 provided information on gender. Male participants accounted for 45% of the sample. The one unpublished study investigated FA, via avoidance and trauma exposure (Hitchcock et al., N.d).

Of the FA studies, 14 investigated the relationship between trauma exposure alone and OGM (Arie et al., 2008; Brennen et al., 2010; Crane et al., 2014; de Decker et al., 2003; Hitchcock et al., 2014b; Johnson et al., 2005; Ogle et al., 2013; Orbach et al., 2001; Meesters et al., 2000; Neshat Doost et al., 2014; Nixon et al., 2013, study 1 & 2; Valentino et al., 2009; Valentino et al., 2012) and 3 investigated trauma exposure and avoidance on OGM (Hitchcock et al., N.d; Kuyken et al., 2006; Stokes et al., 2004).

Of the 17 studies, all except one (Arie et al., 2008) included a Criterion A stressor event required for the DSM–V for posttraumatic stress disorder (American Psychiatric Association, 2013). A Criterion A event is defined as exposure to actual or threatened death, serious injury, or sexual violence. This can include direct experience or witness to an event, learning about the event (e.g. occurred to family

member or friend) or repeated or extreme exposure to aversive details of events (e.g. police officers repeatedly exposed to details of child abuse). Trauma was operationalised as war exposure (Brennen et al., 2010), paternal death (10 + years ago) related to war (Neshat Doost et al., 2014), childhood sexual abuse (Ogle et al., 2013), physical and sexual abuse (Johnson et al., 2005; Valentino et al., 2012), witnessed and/or actual family violence (Orbach et al., 2001), burn incidents requiring treatment at hospital (Stokes et al., 2004), neglect, physical and sexual abuse (Meesters et al., 2000; Valentino et al., 2009), a single incident accidental injury which met conditions for a Criterion A event (Nixon et al., 2013, study 1) and participants receiving therapy for trauma (Nixon et al., 2013, study 2). Hitchcock et al. (2014b) recruited children who had experienced a single incident accidental injury requiring medical treatment at hospital with the exclusion of physical or sexual abuse and loss of consciousness or brain injury due to trauma, while measuring trauma exposure for adverse life events. Three studies measured various events including but not exclusive of emotional neglect and abuse, physical abuse and sexual approach and abuse (de Decker et al., 2003), trauma related to serious car accidents, physical assault, sexual abuse, being a witness to a death, accidents, and severe violence (Kuyken et al., 2006) and death of a family member, physical or sexual abuse, and the removal of a child from home such as being taken into the care system (Crane et al., 2014). Hitchcock et al.'s (N.d) sample were exposed to sexual or physical assault/abuse or war exposure. One study investigated the effects of life events including events at school, parents, family and health (Arie et al., 2008).

2.7.5.1 Trauma exposure

Trauma exposure was positively associated with OGM in 10 studies (Arie et

al., 2008; Brennen et al., 2010; Crane et al., 2014; Neshat Doost et al., 2014; Ogle et al., 2013; Stokes et al., 2004; de Decker et al., 2003; Nixon et al., 2013, study 2; Meesters et al., 2000; Valentino et al., 2009), providing support for the CaR-FA-X mechanism. It should be noted that although Nixon et al. (2013, study 2) found an association between trauma exposure and rAMS, this was specific to the group with PTSD (and subthreshold PTSD). One study reported a negative effect, such that adolescents with MDD and a history of trauma were less overgeneral than adolescents with MDD and no trauma (Kuyken et al., 2006). Six studies (one unpublished) found no relationship between trauma exposure and autobiographical memory (Hitchcock et al., 2014b; Hitchcock et al., N.d; Johnson et al., 2005; Nixon et al., 2013, study 1; Orbach et al., 2001; Valentino et al., 2012). Although Nixon et al. (2013, study 1) reported that trauma exposure was not correlated with autobiographical memory they did however find that when constrained to recall memories within 24 hours post trauma, children were more specific. This was only found when the children displayed high levels of acute stress symptoms (as measured via the Child PTSD Symptom Scale; CPSS; Foa, Johnson, Feeny, & Treadwell, 2001) in comparison to children scoring low or the control group. When the children were not constrained (i.e. could provide memories for anytime, in line with typical AM tasks) there were no group differences.

2.7.5.2 Controlling for depressive symptoms

Of the 10 studies supporting the CaR-FA-X model, nine accounted for the role of depressive symptoms. Five studies controlled for symptoms of depression in their analysis (Crane et al., 2014; de Decker et al., 2003; Meesters et al., 2000; Ogle et al., 2013; Valentino et al., 2009) and four studies reported no difference between

groups in symptoms of depression or confirmed that OGM was not associated symptoms of depression (Brennen et al., 2010; Neshat Doost et al., 2014; Nixon et al., study 2; Stokes et al., 2004). It should be noted that when Crane and colleagues excluded children with probable depression at ages 7.5 and 10.5 years this did not alter results; however, after controlling for symptoms of depression at aged 12.10 years, results became non-significant (although remained significant when data imputation was used). Arie et al. (2008) did not control for symptoms of depression but the suicide measure in their study included items that correlated with depression. Given that the suicidal group scored higher on this measure the possibility that the symptoms of depression may have accounted for the association between negative life events and greater overgeneral memory recall in the suicidal group cannot be ruled out. As 9 of the 10 studies with significant results controlled for symptoms of depression, it is unlikely that the relationship between trauma exposure and memory specificity is due to symptoms of depression.

2.7.5.3 Clinical status comparisons

Of the studies reporting a relationship between trauma exposure and increased OGM, three included clinical populations (Arie et al., 2008; de Decker et al., 2003; Nixon et al., 2013, study 2). Participants in these studies were diagnosed with a range of clinical diagnoses including borderline personality disorder, anorexia nervosa, conduct disorder and mood disorders and in one group a suicide attempt (Arie et al., 2008), inpatient adolescents who had not yet received formal diagnosis (de Decker et al., 2003), and one study which determined PTSD diagnosis based on a clinical interview (Nixon et al., 2013, study 2). The remaining were non-clinical populations (Brennen et al., 2010; Crane et al., 2014 ; Neshat Doost et al., 2014;

Ogle et al., 2013; Stokes et al., 2004; Meesters et al., 2000; Valentino et al., 2009) recruited from a diverse range of sources (e.g. from ongoing population studies, hospital patients, recruited from social services, youth care and community schools) but without a diagnosis of clinical disorder or not stated. Stokes et al. (2004) noted one participant scored above the clinical cut off for depression, six for the anxiety scale and four for PTSD scale (although there were no group differences on these measures). Taken together, these findings suggest that the effect of trauma on autobiographical memory recall is not an artefact of clinical disorder as it is reported in both clinical and non-clinical samples.

2.7.5.4 Explained by heightened symptoms of PTSD?

Of the 10 studies that show a relationship between trauma exposure and increased OGM, 3 demonstrated that symptoms of PTSD were not related to OGM (Brennen et al., 2010; de Decker et al., 2003; Neshat Doost et al., 2014) and one study indicated no group differences in PTSD symptoms overall (Stokes et al., 2004). Crane et al. (2014) assessed probable PTSD and, as only one participant scored above a clinical cut off, they did not further consider the role of PTSD. Overall, five studies showed that symptoms of PTSD do not account for the relationship between trauma exposure and autobiographical memory. Two studies however refute this view and suggest that PTSD could account for the relationship between trauma exposure and OGM. Nixon et al. (2013, study 2) reported that trauma exposed children with PTSD retrieved fewer specific memories in comparison to a trauma exposed non-PTSD control group. This suggests that it is PTSD which is associated with OGM and not trauma exposure per se. In another study, heightened levels of PTSD were reported in the trauma exposed group in comparison to the non-exposed

group (Ogle et al., 2013). The authors however did report that across the whole sample (adults and adolescents) symptoms of PTSD were associated with greater specificity. Similarly, Kuyken et al. (2006) found adolescents with probable PTSD reported less OGM than those without a probable diagnosis of PTSD. Taken together, these findings show that trauma history, without probable PTSD, is associated with OGM in some samples. However, PTSD can account for the relationship between trauma history and OGM in some studies. It is evident that further, well controlled studies are needed to better establish the role of symptoms of PTSD in the relationship between trauma exposure and OGM.

2.7.5.5 Type of trauma and trauma measurement

The type of trauma could be a potential moderating factor in the relationship between trauma history and OGM. Valentino et al. (2009) proposed that certain memories such as sexual or physical abuse may elicit more distressing emotions and therefore result in greater OGM. The authors reported that abused children demonstrated greater OGM than neglected children or non-maltreated children. Despite promising results, the literature with child and adolescent populations has produced mixed findings. For example, while war exposure, sexual abuse and neglect, as well as negative life events have been associated with OGM (Arie et al., 2008; Brennen et al., 2010; Ogle et al., 2013; de Decker et al., 2003; Meesters et al., 2000), other studies have found no such support for similar events (Hitchcock et al., 2014b; Hitchcock et al., N.d; Johnson et al., 2005; Valentino et al., 2012). It does not seem as though the type of trauma can account for differing findings in the current review.

The measurement of trauma exposure typically relies on retrospective self-

report or parental reports (Arie et al., 2008; Crane et al., 2014; de Decker et al., 2003; Hitchcock et al., 2014b; Hitchcock et al., N.d) and retrospective reports have been subject to criticism in the literature (see Hardt & Rutter, 2004). However, not all research studies relied on self-report alone, some verified self-reported trauma via neuropsychologists (Brennen et al., 2010), parental reports (Stokes et al., 2004), and information from social workers, parents and children's reports (Orbach et al., 2001). Some authors measured trauma from interviews (Johnson et al., 2005), interviews with parents (Nixon et al., 2013, study 1) or with questionnaires and clinical interviews (Kuyken et al., 2006). Documented cases of trauma from school records (Neshat Doost et al., 2014), youth care records (Meesters et al., 2000), therapy groups (Nixon et al., 2013, study 2), records held in child maltreatment diagnostic and treatment centres (Ogle et al., 2013) and child protective and preventive records (Valentino et al., 2009; Valentino et al., 2012) were used in the remaining studies. The relationship between trauma exposure and OGM does not seem to be an artefact of the trauma measure as the relationship was found across different levels of measurement.

2.7.5.6 Vulnerability to OGM

Little is known developmentally about how, why or when OGM develops after trauma exposure and prospective studies are warranted to highlight when and the way in which exposure leads to OGM. Three studies were able to longitudinally document trauma exposure throughout childhood, allowing for a proximal measure of exposure (Crane et al., 2014, Johnson et al., 2005; Orbach et al., 2001), but only Crane et al. (2014) found an association between rAMS and trauma exposure. Crane et al. followed a cohort of children from toddlers (up to approximately two years nine

months) to middle childhood (from five years up to approximately 11 years, two months). They noted that while there was no difference in memory specificity in toddlers, reduced memory specificity (i.e. OGM) was associated with severe trauma experienced in middle childhood. Adolescents assessed at aged 13 who had experienced a severe trauma (defined as child removed from family, physical or sexual abuse) in middle childhood were at a 60% increased risk of rAMS. These findings suggest that trauma exposure in middle childhood is more strongly associated with OGM than in early life. Although these findings are valuable, the measure of autobiographical memory was not administered at each testing session and therefore it is possible that trauma exposure in early life would have resulted in OGM at the time but any effect was diminished given the time lapse (over 10 years). Future research that examines AMT performance and trauma exposure throughout childhood would be helpful in permitting a greater understanding of the developmental aspect of functional avoidance.

2.7.5.7 AMT variations

AM measurement across studies can be found in Table 2. The relationship between trauma exposure and OGM was reported across various tests of AM. For example, Meesters et al. (2000) applied the semantic autobiographical memory task (SAMT). Questions on the SAMT focussed on self-referent semantic information personal facts such as previous addresses or names of childhood friends. Despite not directly examining AM in typical format, Meesters and colleagues found adolescents with a history of trauma experienced greater difficulty in recalling autobiographical facts than the adolescents without such a history. It is possible that the traditional AMT was not sensitive enough to detect a relationship in non-clinical populations

(Debeer et al., 2009) and could serve as an explanation for some null findings. While this may form a reason for null findings in some studies (Hitchcock et al., 2014b) it does not explain null findings (and reverse effects) in the clinical studies (e.g. Kuyken et al., 2006; Valentino et al., 2012). Nonetheless, the findings show that trauma exposure is predominantly related to OGM across different types of measurement and therefore it is unlikely that the relationship is due to the AMT measure.

2.7.5.8 Functional avoidance

Avoidance was measured in three (one unpublished) studies (Hitchcock et al., N.d; Kuyken et al., 2006; Stokes et al., 2004) using the avoidance subscale of the impact event scale (Horowitz, Wilner, & Alvarez, 1979), the avoidance subscale of the children's Impact of Event Scale (Smith et al., 2003; Yule et al., 1994) and the Cognitive Avoidance Questionnaire (CAQ; Sexton & Dugas, 2008) scale. One of the three studies supported an association between avoidance and OGM (Stokes et al., 2004). The authors compared a group of non-clinical adolescents who had been admitted to hospital due to a burn injury between the ages of 6 weeks and 14 years old with a control group of adolescents who had received orthodontic dental work. In the burn group, reduced specificity was correlated with higher avoidance, supporting the FA mechanism of the CaR-FA-X model. However, Kuyken et al. (2006) found avoidance was associated with reduced levels of OGM, contradicting the CaR-FA-X model. Hitchcock et al (N.d) did not find any support for an association between avoidance and OGM in a non-clinical community sample. As only three studies (one unpublished) have examined functional avoidance in children and adolescents it would be erroneous to draw conclusions on the contribution of

clinical status, design, vulnerability to OGM or AMT methodology. It is evident that more research is needed to directly test functional avoidance and its relationship with OGM.

2.7.6 Impaired executive control

Thirteen (two unpublished) of the included studies produced results for the impaired executive control mechanism of the CaR-FA-X model. Of the 11 published studies, the number of participants tested was 1075 and the median number of participants per study was 67 (range 27 – 230). The age of the participants ranged from 4 to 20 years with a median age of 13.38 years across the studies. Of the 11 studies, all provided information on gender. Male participants accounted for 47% of the sample. Of the two unpublished studies, the number of participants tested was 345 (range 149-196). The age of the participants ranged from 12 to 17 years with a mean age of 14.02 years across the two studies. Both studies provided gender information and 42% of the participants were male.

In the current review, inhibition was investigated in five studies (Hitchcock et al., 2014b; Hitchcock et al., N.d; Nuttall et al., 2014; Raes et al., 2010; Valentino et al., 2012), switching ability in one (Valentino et al., 2012), working memory capacity in six (de Decker et al., 2003; Hitchcock et al., 2014b; Johnson et al., 2005; Meesters et al., 2001; Nixon et al., 2013; study 1 & 2) and working memory monitoring and updating in one (Hitchcock et al., 2014). Verbal fluency was investigated in three studies (Kuyken et al., 2006; Hitchcock et al., 2014b; Valentino et al., 2012) and impaired executive control with more holistic measures of executive control was examined in two (Rawal & Rice, 2012b; Stewart et al., N.d).

2.7.6.1 Inhibition

Only one of the five studies that investigated links between inhibitory control and OGM reported significant results (Raes et al., 2010). Employing the revised early adolescent temperament questionnaire (Ellis & Rothbart, 2001, as cited in Raes et al., 2010) to a sample of school children, Raes et al. (2010) found a relationship between greater OGM and difficulties in inhibition. Furthermore, Raes and colleagues indicated that difficulties in inhibitory control partially mediated the link between symptoms of depression and OGM. This suggests that the link between depression and OGM, at least in part, is due to difficulties in inhibitory processing. However, behavioural inhibition as measured using the colour-word interference task and the day/night task were not associated with OGM in other studies (Nuttall et al., 2014; Valentino et al., 2012). However, inhibition as measured by the "walk, don't walk" subtest of the test of Everyday Attention for Children (Manly et al., 2001) was not associated with OGM (Hitchcock et al., 2014b; Hitchcock et al., N.d). It is clear that further research is warranted.

2.7.6.2 Working memory capacity

Of the six studies that investigated working memory capacity and OGM, only two demonstrated a link between working memory capacity and rAMS (Nixon et al., 2013; study 1) or OGM (Hitchcock et al., 2014b). Digit span scores (not errors) on the subtest of the Wechsler Intelligence Scale for Children - 4th Edition (Wechsler, 2003) were positively associated with greater memory specificity (Nixon et al., 2013, study 1). Similarly, Hitchcock et al. (2014b) found that working memory capacity predicted OGM, although this effect was moderated by age. In older children, greater working memory capacity was associated with *less* OGM (as expected) whereas in

younger children greater working memory capacity was associated with *greater* OGM recall (not expected). Although deficits in working memory capacity were not associated with increased OGM (as proposed by the model), greater WMC was associated with greater memory specificity and less overgenerality, providing support for the CaR-FA-X model. The finding that in younger children greater working memory capacity was associated with *greater* OGM recall refutes the CaR-FA-X model. Hitchcock et al. (2014) further reported that high working memory capacity and high levels of inhibition resulted in greater OGM (contrary to the CaR-FA-X model).

2.7.6.3 Working memory updating

Only one study investigated the relationship between working memory updating and OGM but found no support for the mechanism (Hitchcock et al., 2014b). Employing a computerised *n*-back task in a trauma exposed sample of children, working memory updating was not found to be associated with OGM.

2.7.6.4 Verbal fluency

Verbal fluency was assessed in three studies (Hitchcock et al., 2014b; Kuyken et al., 2006; Valentino et al., 2012). Only one study found verbal fluency to be associated with OGM. Valentino et al. (2012) recruited 49 adolescent inpatients who were tested on measures of OGM, executive function and were grouped by the presence or absence of previous sexual or physical abuse (findings for trauma reported above). Across the whole sample, category fluency (closely related to switching), but not letter fluency, was significantly correlated with OGM. It should be noted that Valentino and colleagues refer to this fluency task as a measure of updating and monitoring of information in working memory.

2.7.6.5 Switching

Switching ability was examined in one study. Valentino et al. (2012) employed the Wisconsin Card Sorting Test (Heaton, Chelune, Talley, & Kay, 1993) and reported no associations between switching ability and OGM in their psychiatric inpatient adolescent sample.

2.7.6.6 Holistic executive control

Two studies employed holistic measures of executive control. Rawal and Rice (2012b) employed the Block Design test of the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2004). This is a measure of visuo-constructional ability and performance on such visuo-constructional tasks require working memory capacity and updating, as well as switching ability. The authors examined rAMS in a sample of adolescents at familial risk of depression. They found that low executive control was not independently associated with rAMS. Following on from this, Stewart et al. (N.d) examined executive control for emotional and non-emotional information employing the Internal Switch Task (IST; De Lissnyder, Koster, Everaert, et al., 2012). The task, a general measure of executive control, involves the ability to inhibit and over-ride previous previously relevant information, and to switch between internal information and update working memory. Stewart et al. (N.d) examined OGM in a community sample of adolescents, and executive control, in isolation, was not associated to OGM. Interestingly, both Rawal and Rice (2012b) and Stewart et al. (N.d) report interactions between executive control and other mechanisms of the CaR-FA-X model (reported below).

2.7.6.7 Controlling for depression

Of the four studies that reported associations between executive control and

OGM only Valentino et al. (2012) controlled for depression in their analyses. Hitchcock et al.'s (2014b) participants had no previous diagnoses of depression and, although three of their participant sample scored above clinical cut off on the child depression inventory (CDI-S), the authors noted that symptoms of depression were not associated with OGM. Nixon et al. (2013, study 1) reported correlational effects of working memory capacity and rAMS but they did report that symptoms of depression were not correlated with memory specificity. Raes et al. (2010) did not control for symptoms of depression, and reported categoric memories were correlated with OGM. However, mediation analyses suggest that in their sample, inhibition mediated the relationship between OGM and depressed mood. This suggests that inhibition may be a key variable in better understanding the developmental trajectories of OGM to depression, although prospective studies are warranted.

2.7.6.8 Clinical status comparisons

Of the studies showing a relationship between OGM and executive control, one included a clinical sample (Valentino et al., 2012) and three included non-clinical samples (Hitchcock et al., 2014b; Nixon et al., 2013, study 1; Raes et al., 2010). Non-clinical status was as follows: two studies employed trauma exposed participants (Hitchcock et al., 2014; Nixon et al., 2013, study 1) and one study a community sample of children (Raes et al., 2010). The relationship between executive control and AM was found in clinical and non-clinical samples, suggesting that the relationship is not due to population differences.

2.7.6.9 Vulnerability to OGM

To determine whether impaired executive control is an underlying

vulnerability factor for OGM, longitudinal studies are needed. From the 13 studies that investigated this mechanism in childhood and adolescence, six studies made use of such a design (Hitchcock et al., 2014b; Hitchcock et al., N.d; Johnson et al., 2005; Nixon et al., 2013, study 1; Rawal & Rice, 2012b; Stewart et al., N.d). While Johnson et al. (2005) followed children over time, the authors only tested working memory capacity at the final testing session, providing cross-sectional data for this result. Similarly, Nixon et al. (2013) tested whether memory specificity predicted later symptoms of PTSD and did not examine working memory capacity over time. Of the studies reporting significant effects, only Hitchcock et al. (2014) found a relationship between working memory capacity and OGM over time. Although the authors reported that older children's greater working memory was associated with less OGM, there is a clear need for longitudinal studies to examine whether executive control underlie the development of overgeneral memory.

2.7.6.10 AMT variations

All four studies which found an association between EC and OGM employed the AMT, although there were variations in task design across studies (see Table 2). Nixon et al. (2013, study 2) employed the same unit of measurement (number and volume of cue words, cue presentation) and measurement type as their first study (Nixon et al., 2013, study 1). However, both studies resulted in different findings which suggest the effects are not due to the outcome task design but instead attributed to other factors such as measurement of EC discussed above.

2.7.7 Interactions between mechanisms

Four (two unpublished) of the 26 studies have investigated interactions between the mechanisms of the CaR-FA-X model in child and adolescent

populations (Hitchcock et al., 2014b; Hitchcock et al., N.d; Rawal & Rice, 2012b; Stewart et al., N.d). Two studies support interactions between mechanisms on OGM (Rawal & Rice, 2012b; Stewart et al., N.d), and two found no interactive effects between rumination and various aspects of executive control (working memory capacity, updating and inhibition) and no interactive effects between trauma exposure, rumination and inhibition (Hitchcock et al., 2014b; Hitchcock et al., N.d). Rawal and Rice (2012b) assessed adolescents at familial risk of depression and reported that high levels of rumination, in the context of low executive control, predicted rAMS. In a follow up study with a community sample of adolescents, Stewart et al. (N.d) found that high levels of reflective pondering in the context of lower executive control for emotional information predict less OGM. This suggests that reflective pondering can act as a protective factor between lower executive control and OGM, particularly when processing emotional information.

2.7.7.1 Controlling for depression and clinical status

Rawal and Rice (2012b) and Stewart et al. (N.d) controlled for symptoms of depression in their analyses suggesting that the effects reported are not due to depression symptoms. All four studies investigating interactive effects employed non-clinical populations. Rawal and Rice (2012b) recruited non-clinical adolescents though their sample was at familial risk to depression. Two studies employed community adolescents recruited from a range of schools (Hitchcock et al., N.d; Stewart et al., N.d) while Hitchcock et al. (2014b) recruited participants from hospital who had experienced a single accident trauma. Interestingly, while Rawal and Rice (2012b) found increased rumination to interact with low executive control to predict OGM, Stewart et al. (N.d) did not find brooding rumination (the

maladaptive form) to interact with executive control to predict OGM. In contrast, Stewart et al. (N.d) found that reflective pondering acted as a protective factor between executive control and OGM. There are two possible explanations for this finding. First, Rawal and Rice (2012b) did not examine rumination by its subcomponents and therefore it is possible that had they tested reflective pondering they may have found the same protective nature. However, it is also possible that the difference comes from the clinical status of the participants. While Rawal and Rice (2012b) assessed non-clinical adolescents, the children had a parent with a history of depression. Previous research suggests that children with a depressed parent (whether currently or previously), are less specific in their autobiographical memory recall in contrast to children of non-depressed parents (Woody, Burkhouse, & Gibb, 2015). Therefore, it could be argued that the interaction between high levels of rumination and low executive control is more pronounced on OGM in at risk samples.

2.7.7.2 Vulnerability to OGM

A limitation in the AM research, particularly in evaluating whether the mechanisms of the CaR-FA-X model are underlying vulnerability factors for OGM, is that the majority of studies are cross-sectional. Such studies cannot determine causality. While limited, each research study investigating interactive effects between mechanisms of the model on OGM with child and adolescent populations examine the relationships over time. Rawal and Rice (2012b) and Hitchcock et al. (2014b) investigated the impaired executive control mechanism and their interaction with other mechanisms on OGM over 6 and 12 months. Stewart et al. (N.d) had a follow up of 6 months and Hitchcock et al. (N.d) at the beginning and end of an academic year (estimated 10 months). Given that Stewart et al. (N.d) reported

interactions after 6 months, in a non-clinical community population, the follow up time is not suggested as a reason for null findings in other studies (Hitchcock et al., 2014b; Hitchcock et al., N.d). Although drawing conclusions from limited data is difficult, two studies do support interaction effects between executive control and rumination on OGM over time. These studies suggest that rumination in the context of executive control acts as underlying vulnerability for OGM.

3.6.7.3. AMT variations

Only one study employed the minimal instruction version (Stewart et al., N.d) which, it has been argued, has greater sensitivity in detecting OGM in non-clinical populations (Debeer et al., 2009). This could explain the null findings in other studies (Hitchcock et al., N.d; Hitchcock et al., 2014b). Although Rawal and Rice (2012b) employed the traditional AMT, the task may have been sensitive enough to detect OGM in the at risk sample. Like most AM research, the studies differed on the unit of measurement number and volume of cue words, cue presentation and measurement type (specific vs OGM). Stewart et al. (N.d) and Hitchcock et al. (2014b) however both reported effects for memory specificity and OGM, which did not affect original findings. This suggests that the type of memory as an outcome does not affect findings in the reviewed studies.

2.8 Discussion

The CaR-FA-X model (Williams et al., 2007) posits that capture and rumination, functional avoidance and impaired executive control in isolation or in interaction are key contributing factors that explain OGM and a growing body of research has examined these mechanisms in child and adolescent populations. The current review aimed to systematically appraise and synthesise the current published

and unpublished data in such populations. Emerging trends within the review highlight the detrimental role of capture errors, trauma exposure and to a lesser extent rumination, avoidance and impaired executive control on OGM in child and adolescent populations. There is considerable heterogeneity between studies in regard to participant sample, age, measures and variables controlled in analyses, making it difficult to confidently draw conclusions. Similarly, few studies investigating the CaR mechanism reported statistical power thus increasing the difficulty in understanding whether null findings within the studies are due to problems with low statistical power. Given this variability, the review conclusions must be taken with caution.

2.8.1 Capture and rumination mechanism

Three of five studies supported the capture mechanism of the CaR-FA-X model. Capture errors, measured by various methods, were found in non-clinical community samples and in a mixed sample of adolescents with and without a history of abuse. These findings suggest that capture errors are related to OGM. Only one in eight studies found rumination to be independently associated with OGM, in a sample of clinically diagnosed adolescents. No effect of rumination on OGM was found with non-clinical populations. Although Smets et al. (2013) did not find an association between rumination and OGM they did report that greater symptoms of depression were related to increases in OGM and decreases in memory specificity following a state rumination induction. This suggests that symptoms of depression moderate the effect of rumination on OGM. It could be that rumination in isolation is not associated with OGM in non-clinical populations but may be associated with OGM, in the context of greater symptoms of depression. Such findings provide a

fruitful avenue for future research on the CaR mechanism. Given the different effects of brooding and reflective pondering in the literature (Arditte & Joormann, 2011; Burwell & Shirk, 2007; Gibb et al, 2012) future research is needed to better establish the roles of the subcomponents of rumination on OGM. To establish whether the CaR mechanism is an underlying vulnerability factor to later OGM, prospective studies are warranted. Such research may help to resolve the mixed findings in the literature.

2.8.2 Functional avoidance

Ten of 17 studies support an association between trauma history and increased OGM. The relationship was found across clinical and non-clinical studies, which suggests that the effect of trauma on autobiographical memory recall is not an artefact of a clinical disorder. Symptoms of depression were accounted for in nine of the 10 studies which reported significant effects, which suggest that it is unlikely that the relationship between trauma exposure and memory specificity is due to symptoms of depression. The role of PTSD accounting for the effect of trauma on OGM was considered. While PTSD (clinical and subthreshold) can account for the relationship between trauma history and OGM in some studies, others suggest this is not the case. It is clear from the evidence that further research is needed to gain a better understanding of the role of PTSD on the relationship between trauma exposure and OGM.

It is concluded that the nature of trauma cannot account for variations in findings within this review as certain types of events were associated with OGM (e.g. war exposure, sexual abuse), yet others did not find a relationship with similar types of traumas. The relationship between trauma exposure and OGM does not seem to be

an artefact of the trauma measure as the relationship was found in self-reported cases of trauma, parental reports and documented cases as well as longitudinal follow up studies from childhood. The relationship between trauma exposure and OGM was found across variations of the AMT and therefore it is unlikely that variations in results are due to different scoring techniques, although this is not impossible. It is clear from the current review, and that of previous reviews, more research is needed to determine whether contradictory research findings can be accounted for by outcome measure variations.

A central tenant of the FA mechanism is that it is avoidance that drives the FA mechanism rather than trauma exposure, yet few studies have investigated avoidance. Three studies in the child and adolescent literature examined the role of avoidance on OGM. While one supported this role, one found a negative relationship in that greater avoidance was associated with more specific memories and one study found no relationship between avoidance and OGM. All three studies differed in AMT measurement, participant sample (i.e. one clinical, one trauma and one community sample) and on measures of avoidance. Given the few studies to investigate avoidance and OGM and the differences in study design, it is impossible to draw conclusions concerning this relationship. Further research is needed to assess functional avoidance directly in child and adolescent populations.

Although the majority of studies supported the role of trauma exposure on OGM, seven studies did not. As noted in previous reviews (Sumner, 2012), this suggests that trauma exposure alone is not sufficient for the development of OGM. It could be that trauma in interaction with other mechanisms are better able to explain OGM in childhood and adolescence. Williams et al. (2007) suggests that trauma can

result in OGM indirectly through impaired executive control. The authors posit that effortful attempts to control intrusive thoughts relating to the trauma, as well as overriding processing, can result in reduced capacity of executive control.

It is also possible that avoidance tendencies can result in OGM in the absence of exposure to trauma. Each possibility provides opportunity for future research. It is clear that there are many pathways in which FA can lead to OGM, both directly and indirectly, yet little is known under what circumstances the pathways lead to OGM in childhood and adolescence. Developmentally, little is known about how, why or when OGM develops after trauma exposure and whether the age of the child at the time of the trauma has an impact on OGM. While the findings of Crane et al. (2014) were very valuable as they provided a proximal measure of trauma exposure across childhood further research is needed. Future research that examines AMT performance, trauma exposure and avoidance throughout childhood would allow a greater understanding of the developmental aspect of functional avoidance. Furthermore, given that the relationship been trauma exposure and OGM has been documented in non-clinical samples, an important research objective for future research will be to better understand when and if the relationship between trauma exposure and OGM will subsequently lead to clinical disorder.

2.8.3 Impaired xecutive control

Few studies support the impaired executive control mechanism in child and adolescent populations. While two studies supported the relationship between impaired executive control (i.e. inhibition and verbal fluency) and OGM, two studies found greater working memory capacity to be associated with greater specificity and reduced OGM (Hitchcock et al., 2014b; Nixon et al., 2013, study 1) but did not find

difficulties in working memory capacity to lead to less specificity or increased OGM. The majority of studies (nine) reported null findings. From the few studies that support a relationship, it was found across clinical and non-clinical adolescents and trauma exposed populations. This suggests that the relationship, if present, is not simply an artefact of clinical disorder. While Valentino et al. (2012) reported results over and above any contributions due to depression, and Hitchcock et al. (2014b) proclaim depression is not associated with OGM in their sample, there are too few studies supporting the executive control mechanisms of the CaR-FA-X model to confidently comment on the role of depression. Nonetheless, symptoms of depression have been shown to affect cognitive tasks and therefore future studies investigating executive control and OGM should control for symptoms of depression.

There is an array of theoretical issues concerning the measurement of executive control (see Davidson, Amsoa, Cruess, & Diamond, 2006; Diamond, 2013; Miyake et al., 2000) which are beyond the scope of this review but should be considered when examining cognitive functioning in child and adolescent populations. For example, it is debated whether working memory, inhibition and switching are related but separate (Miyake et al., 2000) and whether they rely on and build on each other (Davidson et al., 2006; Diamond, 2013). A review of executive measures in childhood and adolescence further highlighted the changing, complex processes which underlie performance on executive tasks and suggested that results from such tasks can also be affected by a range of factors such as low applicability to real-life functioning (Hughes & Graham, 2002). These findings highlight multiple issues with the measurement and purity of executive control tasks and could serve as reasons for mixed findings within the review. Tasks that relate to real-life

functioning such as processing faces shown as in the internal shift task (De Lissynder et al., 2012) would be advantageous as faces have been shown to be interpersonal and have ecological validity (Joormann & Gotlib, 2006; Raes, Hermans, & Williams, 2006).

The depression literature highlights that difficulty in executive control is heightened when processing emotional material (De Lissnyder, Koster, & De Raedt, 2012). Given that OGM is an underlying vulnerability factor to depression it is therefore questioned whether neutrally valenced cognitive tasks are the best way to target a relationship between executive control and OGM. Given that a search can become aborted due to avoidance of negative affect (FA mechanism) it is possible that difficulty may also arise via the impaired executive control mechanism with difficulty in processing emotional information in turn resulting in truncating the search at a general level of retrieval. Indeed, research with adolescent samples does highlight different pathways of emotional and non-emotional executive control on OGM (Stewart et al., N.d). Future research is needed that accounts for measurement issues within the executive literature as well as examining the different effects of executive control on OGM when processing emotional and non-emotional information.

2.8.4 Interactions between mechanisms

Two of the four studies which investigate interactions between mechanisms of the CaR-FA-X model, found interactive effects. Rawal and Rice (2012b) reported high levels of rumination in the context of low executive control predicted rAMS and Stewart et al. (N.d) reported high levels of reflective pondering in the context of low executive control, for emotional information, predicted reduced OGM. The

prospective nature of these studies suggests rumination and executive control in interaction are an underlying vulnerability factor to later OGM, even after controlling for symptoms of depression and baseline OGM scores. These findings tap into separate, but related, literature. Research with adolescents highlights a relationship between rumination and executive control, particularly when inhibiting emotional material (Hilt, Leitze, & Pollack, 2014). Williams et al. (2007) proposed that ruminative processing can hinder access to specific memories when executive control is impaired, which was supported by Rawal and Rice's (2012b) study with adolescents. Williams et al. (2007) also suggested that highly elaborate representations of the self which are accessed early in the search are generally more difficult to inhibit. A fruitful avenue for future research would be to examine the self-relevance of the cues, rumination, and their interactive effects with low executive control.

Given that reflective pondering was shown to have protective qualities within the executive control and OGM relationship, and that differences were reported between executive control when processing emotional and non-emotional representations, further research examining these factors presents an exciting avenue for future research. Examining these relationships across child development will provide a greater understanding of how the mechanisms of the CaR-FA-X model relate to OGM and further our knowledge of the developmental routes of OGM.

2.9 Final considerations

One of the main themes emerging throughout the current review is the lack of comparable studies and therefore effect estimates cannot be calculated and pooled to produce meaningful combined results. There was also great heterogeneity between

studies on what variables were controlled in analyses. For example, some authors controlled for numerous socioeconomic variables in their analyses, such as social class, household income, parental marital status and home overcrowding (Crane et al., 2014) and others opted for controlling vocabulary scores and gender (Valentino et al., 2009). There were also differences within studies on matching groups. While Arie et al. (2008) reported no significant difference between the psychiatric groups in age, ethnic origin, socioeconomic status, years of schooling, or length of hospital stay, Brennen et al. (2010) did not test trauma exposure in the control group (other than non-war exposure) and the groups differed in terms of language and cultural background. Taken together, these findings highlight the need for well controlled studies that can be compared not only narratively but synthesised meta-analytically.

Preliminary interaction studies are promising, but further research is needed that examines multiple mechanisms of the CaR-FA-X model. Williams et al. (2007) posit that one mechanism alone may not be enough to explain all the OGM data, yet few studies examine multiple components and even less examine interactive effects. The CaR-FA-X model as a whole has been examined twice (when including trauma exposure as a measure of FA) in child and adolescent populations (Hitchcock et al., 2014b; Hitchcock et al., N.d). It is evident that future research should address this issue as such work will allow for a holistic understanding of how the CaR-FA-X model can account for OGM. Future research should examine the role of reflective pondering further and identify any other protective factors which could further our understanding of OGM and refine the CaR-FA-X model. Currently, there are too few studies investigating multiple mechanisms of the CaR-FA-X, and limited studies

investigating the mechanisms of the model over time. However, these findings highlight a rich opportunity for future research.

At this stage, data from the studies reviewed provided adequate support for the CaR-FA-X model in child and adolescent populations. As OGM research has become more sophisticated, to include protective factors and as well as investigations of interactive effects between the CaR-FA-X mechanisms, methodological approaches within OGM research in child and adolescent samples should be advanced. The recommendations for future research presented throughout the review, as well as possible explanations provided for mixed results, will facilitate a greater understanding and refinement of how the CaR-FA-X model can account for OGM in child and adolescent populations.

Chapter 3 (study 2): A prospective investigation of rumination and executive control in predicting overgeneral autobiographical memory in adolescence

This chapter is under review in Child Development. As such, the chapter is presented in the format of a manuscript following the guidelines of the journal.

Contribution to this chapter:

My Role: I designed the study, recruited and test all the participants. I wrote the first draft of the chapter without other co-authors and discussed drafts with both of my supervisors. My first supervisor is corresponding author on the paper as my university email address will not be valid after the PhD.

Signed:

Date:

A prospective investigation of rumination and executive control in predicting overgeneral autobiographical memory in adolescence

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3.1 Abstract

Two mechanisms of the CaR-FA-X model (Williams et al., 2007) were examined in isolation and in interaction to investigate the developmental trajectory of overgeneral autobiographical memory (OGM). Across two time points, 6 months apart, a total of 149 adolescents (13-16 years) completed a minimal instruction autobiographical memory test, a measure of executive control with emotional and non-emotional stimuli, and measures of brooding rumination and reflective pondering. Symptoms of anxiety and depression were also recorded. A significant, negative interaction was found between rumination and executive control on OGM. In the context of high levels of reflective pondering, lower executive control (reflected by larger switch costs scores) led to less OGM at follow-up. This suggests that in the context of lower executive control, reflective pondering can serve as a protective factor against the development of OGM in adolescence.

3.2 Introduction

Autobiographical memory (AM) is a type of episodic memory storage system that relates to the recollection of personal experiences and semantic information about the self (Conway & Pleydell-Pearce, 2000). One aspect of AM consistently associated with emotional disorders is the level of specificity in recalled memories. This overgeneral memory (OGM) response, or reduced memory specificity (rAMS) as it is also known, refers to the difficulty in the retrieval of a specific event from AM that occurred at a particular time and place (Williams & Broadbent, 1986). For example, when asked to retrieve a specific memory to the cue word 'happy' an overgeneral, non-specific response would be 'last weekend' or 'every time I go to the cinema'. A specific response on the other hand would be one that occurred at a particular day and time (e.g. last Friday night when I went to the cinema with my friend).

The relation between OGM and depression is well documented and OGM has been associated with the onset, diagnosis and course of depression in adults (Kaviani, Rahimi, Rahimi-Davabard, & Naghavi, 2011; Sumner, Griffith, & Mineka, 2010; Williams et al., 2007) as well as the onset of depression in adolescence (Kleim & Ehlers, 2008). OGM is predictive of later depressive symptoms and depressive disorder (Hitchcock, Nixon & Weber, 2014a), even after controlling for levels of OGM, depressive symptoms, age, and IQ at baseline (Rawal & Rice, 2012a). There is also evidence to suggest that OGM is indicative of a stable characteristic in adolescents and adults who are recovered from depression (Kuyken & Dalgleish, 2011; Mackinger, Pachinger, Leibetseder, & Fartacek, 2000). Taken together, OGM indexes a cognitive vulnerability marker for future symptoms of depression and

depressive disorders. Given the significance of OGM in understanding psychopathology, an important research objective is to investigate the theoretical underpinnings of OGM particularly within adolescent development, at a time categorised with rises in depression symptoms (Dekker et al., 2007) and depressive disorder onset (Kessler et al., 2005).

The self-memory model of AM (Conway & Pleydell-Pearce, 2000) advises that the successful retrieval of a specific memory relies on a hierarchical, top-down generative search through a database of AM's. This hierarchy forms from general conceptual information down to specific event related information. Based on the self-memory model, Williams et al. (2007) proposed the CaR-FA-X model; *c*apture *a*nd *r*umination (CaR), *f*unctional *a*voidance (FA) and impaired e*x*ecutive control (X), as mechanisms that disrupt the hierarchical search strategy, resulting in OGM recall (see Figure 1). It is proposed that The CaR-FA-X mechanisms can work alone and in interaction. Capture and rumination occur when attention is captured by irrelevant thoughts which activate ruminative thinking, keeping an individual at a general level of retrieval. Rumination refers to the persistent and recurring attentional focus on negative thoughts, depressive affect and their consequences (Nolen-Hoeksema, 1991). Functional avoidance occurs when the retrieval of a specific memory is interrupted as a way of affect regulation, typically in response to avoiding a traumatic memory.

Executive control (sometimes referred to as cognitive control) is a broad term, which although debated, refers to a collection of cognitive processes responsible for the control, coordination and flexibility of executive functions and processes towards goal directed behaviour (Roberts, 1998; Shah & Miyake, 1999;

Williams et al., 2007). It is generally accepted that there are three main separable, but related executive functions; inhibition, updating working memory, and switching (Miyake et al., 2000). Impaired executive control can hamper a person's ability to successfully search and retrieve specific memories. For example, difficulty in the ability to inhibit irrelevant information and switch between, update and hold information in working memory may truncate the search for a specific memory (Sumner et al., 2010; Williams et al., 2007).

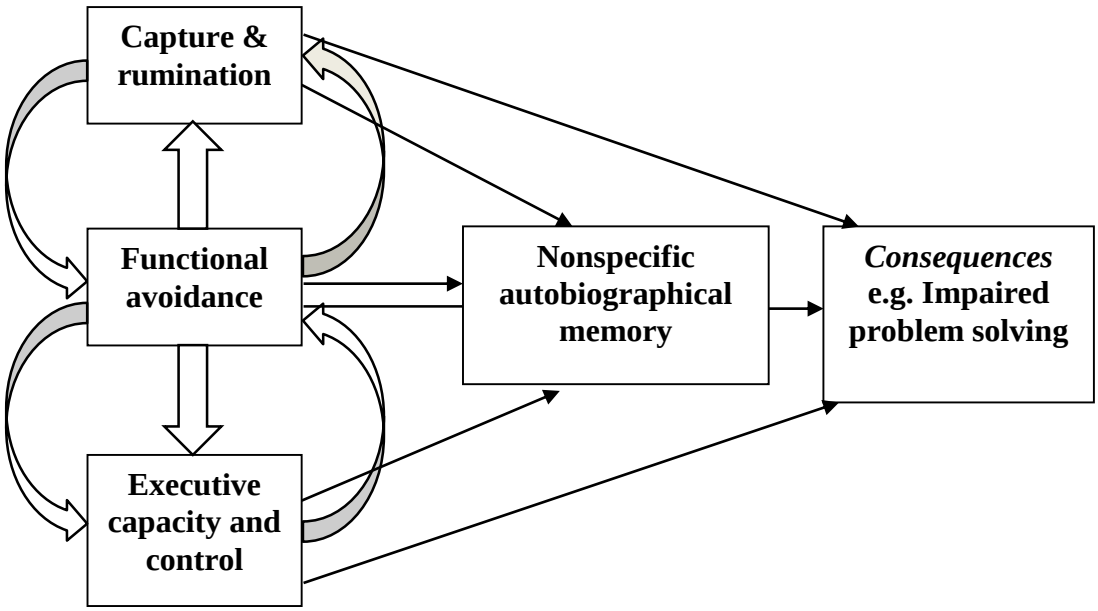

Figure 1: The CaR-FA-X model. Three processes contributing to overgeneral memory—capture and rumination (CaR), functional avoidance (FA), and impaired executive capacity and control (X)—can each have effects on cognition and behaviour (e.g. problem solving), either independently or through their individual or combined effect on autobiographical memory (permission granted for reproduction of image from Professor J Mark G Williams).

The majority of research studies within this area that assess child and adolescent samples have tended to focus on the effects of trauma on OGM (Brennen et al., 2010; Crane et al., 2014; de Decker, Hermans, Raes, & Eelen, 2003). Although research investigating trauma and OGM is valuable, OGM has been reported in individuals without a history of trauma (Kuyken, Howell, & Dalgleish, 2006). This suggests the way in which OGM develops is not purely an artefact of a history of

trauma or functional avoidance. The literature on the relation between executive control and its links with OGM is mixed. For example, although OGM has been associated with difficulties in inhibitory processing (Raes, Verstraeten, Bijttebier, Vasey, & Dalgleish, 2010), working memory (Nixon, Ball, Sterk, Best, & Betty, 2013), and category fluency (Valentino, Bridgett, Hayden, & Nuttall, 2012), other researchers have found no such association between OGM and inhibition, switching, letter fluency (Valentino et al., 2012) or with working memory (de Decker et al., 2003).

There are several possible explanations for the mixed literature. Research investigating OGM varies considerably in design and methodology. Variations such as these can make it difficult to draw conclusions about the cognitive vulnerabilities associated with OGM (see Griffith et al., 2012, for a review). Previous research has suggested that the original autobiographical memory test (AMT; Williams & Broadbent, 1986) may not be sensitive enough to detect OGM in non-clinical populations as high functioning non-clinical individuals who may have an OGM style can retrieve specific memories to cue words when explicitly asked (Debeer, Hermans, & Raes, 2009). This may explain null findings in non-clinical populations. A further explanation for the different findings within the literature could be attributed to the lack of emotional tasks of executive control. None of the aforementioned studies employed emotional tasks of executive control, yet a growing literature shows that the relationship between executive control and OGM is more pronounced when processing emotional information (Joormann & Gotlib, 2010). Given that OGM is a vulnerability factor for future depression (Kleim & Ehlers, 2008), and depression is characterised by emotional difficulties, the relation between

executive control and OGM may be more pronounced when processing emotional material on cognitive tasks.

Turning to the capture and rumination mechanism of the CaR-FA-X model, the literature is again limited. Park, Goodyer and Teasdale, (2004) examined OGM pre and post an experimental rumination and distraction manipulation task, with a sample of depressed adolescents, partially remitted adolescents, a psychiatric control group and a community control sample. In contrast to distraction, rumination resulted in increased OGM in the group diagnosed with depression (full and partially remitted). However, Treynor, Gonzalez and Nolen-Hoeksema (2003) identified two subcomponents of rumination, reflective pondering and brooding rumination. Thus, although valuable, Park et al.'s study only focussed on rumination as a whole construct rather than on its subcomponents and it is unclear which component of rumination was related to OGM recall. Reflective pondering, defined as a non-judgemental attentional focus on problem solving, is thought of as an adaptive form of rumination as it has been associated with decreases in symptoms of depression (Arditte & Joormann, 2011) and coping in adolescence (Burwell & Shrik, 2007). Brooding rumination, defined as a maladaptive component of rumination with as a passive attentional focus on the meaning of negative and self-blaming thoughts (Treynor et al., 2003), has instead consistently been associated with major depressive disorder and depressive symptoms in adolescence (Burwell & Shirk, 2007; Gibb, Grassia, Stone, Uhrlass, & McGreary, 2012).

Despite the differing functions of the subcomponents of rumination, only one paper has investigated OGM and the subcomponents of rumination in adolescence. In two studies with non-clinical adolescent populations, Schoofs, Hermans and Raes

(2012) did not find any associations between brooding rumination or reflective pondering and OGM. One possible explanation for this result could be that rumination alone is not enough to predict OGM in non-clinical adolescent samples. Research with non-clinical adolescents at familial risk of depression showed that rumination in isolation did not predict OGM but rumination in interaction with executive control predicted OGM at a one-year follow-up (Rawal & Rice, 2012b). In support, associations have been reported between rumination and executive control, specifically difficulty in inhibiting emotional information (Hilt, Leitze, & Pollack, 2014). This suggests that rumination in the context of executive control may be more effective at detecting levels of OGM than either mechanism in isolation. Rawal and Rice (2012b) focussed on rumination as a whole construct, and therefore little is known about the differing effects of brooding rumination and reflective pondering as a function of executive control. As psychological benefits are thought to ensue from reflective pondering and negative outcomes following brooding rumination (Arditte & Joormann, 2011; Burwell & Shrik, 2007; Gibb et al., 2012) future research examining the subcomponents of rumination, in interaction with executive control and their relation with OGM over time provides, a fruitful avenue for future research.

In order to gain a greater understanding of the developmental trajectories of OGM, longitudinal studies are needed but very few have been conducted. Two studies have prospectively investigated multiple mechanisms of the CaR-FA-X model in isolation and in interaction with child and adolescent samples. Hitchcock, Nixon and Weber (2014b) investigated rumination and multiple aspects of executive control over a 6 month period. This included a measure of inhibition, working memory capacity, verbal fluency, and a computerised *n*-back task as a measure of

working memory updating. The authors found no associations between rumination and OGM in isolation or in interaction with executive control (Hitchcock et al., 2014b). This finding is in contrast to Rawal and Rice (2012b) who investigated rumination and employed the Block Design test of the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2004) as a measure of executive control. The Block Design test is a measure of visuo-constructional ability and performance on visuo-constructional tasks require the use of working memory capacity and updating, as well as switching ability, representing a holistic measure of executive control. The authors found rumination in the context of low executive control (operationalised as 1 SD below the mean) was predictive of rAMS at a 1 year follow up (Rawal & Rice, 2012b).

There are a few possible explanations for the inconsistent findings. Rawal and Rice (2012b) tested adolescents who had a parent with a history or recurrent depression and research has shown children who have a depressed parent (whether current or previously) are less specific in their autobiographical memory recall in contrast to children of non-depressed parents (Woody, Burkhouse, & Gibb, 2015). This suggests that the contribution of genetics or the modelling influence on OGM could have resulted in greater OGM in the sample. The age of participants could also explain the different findings. Rawal and Rice (2012b) included an adolescent sample (M = 13.64 years), whereas the Hitchcock et al. (2014b) sample were pre-adolescents (M = 11.90). Research suggests that rumination is relatively unstable in childhood (Driscoll, 2004) and does not become a trait like, more stable predictor of depression until adolescence (Rood, Roelofs, Bogels, Nolen-Hoeksema, & Schouten, 2009). Therefore, rumination may not have developed enough or have been severe

enough in the pre-adolescent sample to exert an effect of executive control on OGM. This suggests that to evidence the relation between rumination and executive control in predicting OGM, an adolescent sample over the age of 13 years may be necessary.

The cognitive tasks employed in different studies can also affect findings. Each of these tasks measured executive control for externally represented material, utilising neutral stimuli. Measuring executive control for externally represented information may not be the most beneficial way to measure executive control and target its relation with rumination (De Lissnyder, Koster, Goubert, et al., 2012; De Lissnyder, Koster, & De Raedt, R, 2012). Researchers have distinguished between external and internal attentional processing (Chun, Golomb, & Turk-Browne, 2011). External processing refers to processing information from the external world whereas internal processing refers to the processing of information held in working memory. As rumination is characterised by repetitive, internal negative thoughts, and executive control requires internal processing, a task which taps into this internal process may be more effective in detecting a relation between rumination and executive control and subsequently OGM.

The internal switch task (IST; De Lissnyder, Koster, Everaert, et al., 2012) is a valenced measure of executive control for internally represented information. Importantly, this task measures executive control when processing emotional and non-emotional information and primarily taps into inhibitory processing as well as working memory and switching ability, providing a top-down measure of executive control. Given that rumination, particularly brooding rumination, involves a passive attentional focus on the meaning of negative emotions thoughts (Treynor et al., 2003), the relation between rumination and executive control may be more

prominent when cognitive tasks use emotional stimuli rather than neutral stimuli. No previous study has investigated the interactive relation between rumination and executive control when processing emotional and non-emotional information and their effects on OGM in adolescence to the authors' knowledge.

The current study addressed several gaps in the literature. We examined the prospective relation between two mechanisms of the CaR-FA-X model in an adolescent sample, aged between 13 and 16 years. While basic executive functions and processing develop around 3-5 years old, development progresses throughout childhood and adolescence (Best & Miller, 2010; Diamond, 2013). It is therefore important to better understand the developmental trajectories of OGM during a time of cognitive change and maturation of the prefrontal cortex associated with these abilities (Luna, Padmanabhan, & O'Hearn, 2010). We examined both brooding rumination and reflective pondering subcomponents of rumination and employed emotional and non-emotional tests of executive control. These mechanisms were investigated in isolation and in interaction to predict OGM at follow up. As previous research has suggested that the original AMT (Williams & Broadbent, 1986) is not sufficient enough to detect OGM in non-clinical populations, we used the minimal instruction AMT (MI-AMT; Debeer et al., 2009) to measure OGM. This is the first study to prospectively investigate rumination by its subcomponents and executive control for emotional and non-emotional information, in isolation and in interaction to predict OGM within a community sample of adolescents.

3.3 Method

3.3.1 Participants

The sample consisted of 149 secondary school adolescents (37% male and 64% female) aged between 13 and 16 years old (Wave 1;W1, M = 13.85, SD = 0.78; Wave 2; W2, M = 14.28, SD = 0.88) recruited from four participating schools. Each parent or guardian provided written consent. Written assent was provided by each adolescent at both waves (W1 and W2) of the study. All adolescents with appropriate parental consent and written assent participated. No exclusion criterion was applied at recruitment, similar to other studies (e.g. Gathercole, Pickering, Ambridge, & Wearing, 2004). Participants were assessed at two time points, 6 months apart. Thirteen participants (8.8% attrition) from W1 did not complete the second testing session. Scheduling difficulties, graduation, and personal family issues were the main cause of attrition. The socio-economic status (SES) of each individual participant was not measured, however the uptake of free school meals is frequently used as a factor signifying socio-economic disadvantage and deprivation (Hobbs & Vignoles, 2007). Examining the uptake of free school meals in participating vs. non-participating schools allows a measure of SES at the school level, rather than at an individual level and has been described within the literature as a reasonable measure for SES for an overall area (Halse & Ledger, 2007). The average percentage of uptake of free school means in Scotland is 10% (range = 0% - 42%; School Meals Data set, 2013). In the current sample, the uptake of free school meals was 16% (range = 6% - 20%). From the secondary schools that were asked to take part in the project, there were no differences in the uptake of free school meals (School Meals Data set, 2013) in participating vs. non-participating schools, t (79) = -1.58, p = .12,

which suggests that in regard to SES, at the school level, the included participant cohort was representative of the cohort of pupils from other schools who were contacted but did not take part in the project.

3.3.2 Procedure

Ethical approval for the prospective studies was gained from the School of Psychological Sciences and Heath Ethics Committee, University of Strathclyde, in August 2013. Data were collected during school hours at each participant's school. At both waves of the study, adolescents were individually administered a sequence of tasks which included the minimal instruction autobiographical memory test (AMT), an emotional and non-emotional computerised executive control task, a measure of reflective pondering and brooding rumination and self-report questionnaires of depressive and anxiety symptoms. At both time points, the executive control task and the AMT were counterbalanced in order to control for order effects and fatigue. In order to reduce mood priming effects, rumination, anxiety and depression measures were administered last and also counterbalanced using a random number generator.

3.3.3 Measures

3.3.3.1 Autobiographical memory: The Minimal Instruction Autobiographical Memory Test (MI-AMT; Debeer et al., 2009)

The MI-AMT was employed as a measure of autobiographical memory. The MI-AMT is a cued recall methodology in which individuals are asked to respond with memories in response to valenced cue words within a given time frame. Unlike the traditional AMT, we asked participants to generate memories within 60 seconds in response to cue words without stating that these memories should be specific. Participants were asked "Can you write down an event that the word……..reminds

you of?" Instructions and cue words were read aloud to participants and presented visually (i.e. written on an A4 sheet of paper). Instructions stated memories must be older than 1 week and the same memory should not be given more than once. No examples and no practice words were provided. Two word sets, containing twelve cue words were taken from previous OGM research with adolescents (Rawal & Rice, 2012b; W1 positive word set: loyal, joy, smile, achieve, loved, ambitious; W1 negative word set: mistake, rejected, weakness, needy, angry, tired; W2 positive word set: friendly, happy, respect, caring, sunny, perfect; W2 negative word set: failure, disliked, ugly, useless, worse, lonely). Cue-words were counterbalanced in each set and matched for emotionality, imageability and word frequency.

Responses were coded by the first author (25% double coded by a trained independent researcher) as specific (memory of a particular event that occurred at a particular time and place, within 1 day), categoric (memory of a number or category of events, e.g. the weekends), extended (memory which lasted more than a day, e.g. the school summer holidays), semantic associate (general semantic information which is not a memory, e.g. my mum), omission (no memory provided) and a rest category (incomplete answers, not in line with the instructions). The number of overgeneral memories (categoric and extended) was the dependent variable used in the analysis. Inter-rate reliability was high at both time points. Raters agreed on 96.9% of responses at baseline ($\kappa_{W1} = .92$) and 90.2% of responses at ($\kappa_{W2} = .86$). The AMT showed good internal consistency at ($\alpha_{W1} = .72$) and ($\alpha_{W2} = .76$) as well as modest test-retest reliability ($r = .43$, $p < .001$).

3.3.3.2 Executive control: Internal Switch Task (IST; De Lissnyder, Koster, Everaert, et al., 2012)

The IST is a computer based task, programmed in E-Prime to measure executive control for emotional and non-emotional information. Forty eight (24 angry, 24 neutral) faces taken from the Karolinska Directed Emotional Faces (KDEF; Lundqvist, Flykt, & Öhman, 1998) were presented on a computer screen, one at a time. The task consisted of two counterbalanced conditions (emotion and non-emotion), 24 blocks of trials (12 blocks in each condition) and each block of trials contained 10-14 randomised faces (see Figure 2). Three practice blocks were given before the start of each condition. Faces appeared at an inter-trial interval of 200ms and the order of trials and faces were randomly determined with a replacement procedure. The participant's task was to keep a mental count of the number of faces which appeared on the screen, depending on the task condition (i.e. number of male faces and number of female faces, or number of angry faces and number of neutral faces). Participants were asked to press the spacebar as fast as possible to indicate they had updated their mental count, which measured reaction time in response to switching and updating their mental count. To ensure consistent counting, participants used the number path on the keyboard to indicate how many faces they counted within each block of trials.

Switch costs were calculated as the reaction time difference between switch and no-switch trials and used as the main unit of analysis (switch: male – female, female – male, angry – neutral, neutral – angry; no-switch: male – male; female – female; angry – angry; neutral – neutral). Switch costs reflect the executive control processes that are used when participants switch between multiple mental sets (De

Lissnyder, Koster, & De Raedt, 2012). Thus, executive control is operationalised here as the range of reaction time scores on the task. Higher reaction times (i.e. greater switch costs) reflect lower levels of executive control and lower reaction times (i.e. lower switch costs) reflect greater levels of executive control. No cut off scores were calculated. Instead greater or lower executive control is suggestive of the range of scores within the sample, that refer to the ability to switch between different mental sets. To reduce statistical influence of outliers, median scores were used (De Lissnyder, Koster, Everaert, et al., 2012). In line with previous research, correct and incorrect trials were included in the analysis (De Lissnyder, Koster, Everaert, et al., 2012). Internal consistency was excellent within the emotion condition (α_{W1}= .80; α_{W2} = .80) and non-emotion condition (α_{W1}= .81; α_{W2} = .77). The task displayed modest test re-test reliability in the emotion condition (r = .48, p < .001) and non-emotion condition (r = .38, p < .01) respectively.

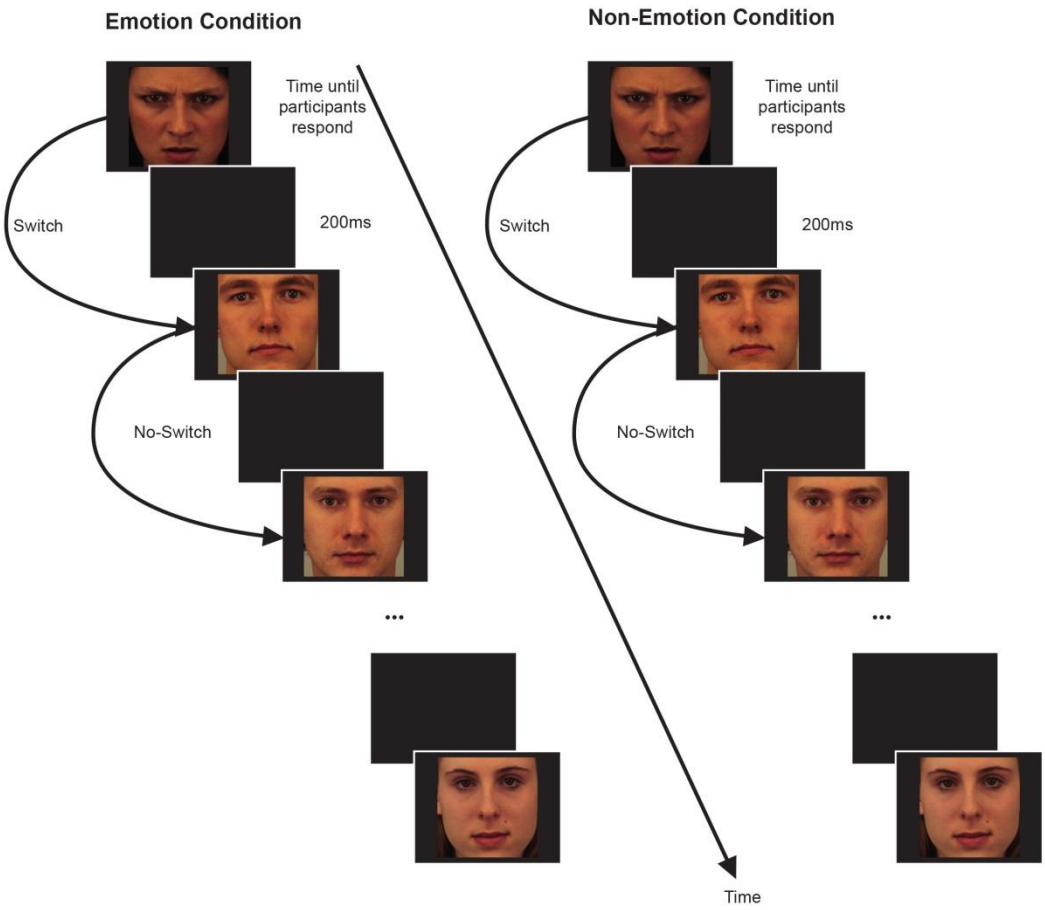

Figure 2. An example of a block of trials within each condition during the Internal Shift Task (constructed by author based on image in De Lissnyder, Koster, Everaert, et al., 2012).

3.3.3.3 Rumination: Ruminative Response Scale of the Response Style Questionnaire Rumination (RRS; Nolen-Hoeksema, 1991)

Based on a 4-point Likert scale (1 = almost never, 2 = sometimes, 3 = often to 4 = almost always) the RRS is a 21 item self-report questionnaire which measures ruminative responses. Higher scores are indicative of a greater ruminative tendency. Brooding rumination and reflective pondering subscales were extracted from the RRS, following the work of Treynor et al. (2003). Internal consistency was excellent for brooding rumination (α_{W1}= .79; α_{W2} = .85) and reflective pondering (α_{W1}= .77; α_{W2} = .80). The task displayed good test re-test reliability for the brooding scale (r = .68, p < .001) and reflective pondering scale (r = .66, p < .001) respectively.

3.3.3.4 Depression: The Beck Depression Inventory-II (BDI-II; Beck, Steer, Ball, & Ranieri, 1996)

The BDI-II is a 21 item, self-report measure of depressive symptom severity (each item ranging from 0-3). Scores are summed to calculate a total BDI–II score, which can range from 0 to 63. As per previous research (Balazs et al., 2013: Basner et al., 2014; Osman, Kooper, Guttierez, Barrios, & Bagge, 2004; Wisco & Nolen-Hoeksema, 2010), we removed the sex and suicidal ideation questions from the scale as these were considered unsuitable for the age of the sample and anonymous due to the prospective study design. Given the omission of two questions, the scale ranged from 0-57 in severity in the current sample. Internal consistency was excellent for (α_{W1}= .94; α_{W2} = .94) as was test-retest reliability (r = .83, p < .001).

3.3.3.5 Anxiety: Multidimensional Anxiety Scale for Children 2nd Edition (MASC-II; March, Parker, Sullivan, Stallings, & Conners, 1997)

The MASC-II is a 50 item (each item ranging from 0-3; never, rarely, sometimes and often true about me) self-report measure of anxiety. Rated on a 4-point Likert-type scale, higher scores are indicative of greater anxiety. Scores are summed from specific subscales and items to calculate a total MASC-II score, which can range from 0 to 150. Excellent Cronbach's alpha was found for the MASC-II scores at (α_{W1}= .94) and (α_{W2} = .94) as well as good test-re-test reliability (r = .82, p <.001).

3.3.4 Analytical strategy:

Data were screened for skew and missing data scores. All measures displayed skewness and kurtosis values between -1.0 and +1.0, suggesting no transformation of data was necessary. Two participants data were highlighted with a Mahalaonbis D^2

value of <.001 and were excluded from all further analyses. At baseline, 82.99% had a complete data set and 74.15% had a complete data set at W2. Missing data were identified on the depression and anxiety questionnaires at both time points (individual items: 0.7% to 2%, n = 1-3). Data was missing completely at random (Little's MCAR; χ^2 = 3584.44, df = 3553, p = .35). Missing data were imputed using Multiple Imputation (MI) in SPSS 22. MI is effective for up to 80% of missing data and provides unbiased estimates when the data is missing completely at random as in the current dataset. Imputed values matched original values (i.e. MASC-II had a score of 0, 1, 2 or 3) and five data sets were imputed. MI allowed for analysis on 100% of the participant data. Pooled estimates were created through SPSS version 22. Estimates were averaged across all five imputed data sets when pooled estimates were not available in SPSS (see Jones, Heim, Hunter, & Ellaway, 2014).

A hierarchical multiple linear regression analysis was applied to the data. To allow the detection of a medium effect size, with a power of .80 and significance of α <.05, an *a priori* power analysis indicated that 113 participants were required (Tabachnick & Fidell, 2007). Step 1 controlled for five covariates; age, gender, depressive symptoms, anxiety symptoms and baseline autobiographical memory. Symptoms of anxiety and depression have previously been shown to impact task performance on cognitive tasks (Altamirano, Miyake, & Whitmer, 2010; Cisler & Koster, 2010). Predictor variables (brooding rumination, reflective pondering and executive control for emotional and non-emotional information) were added at step 2 and interaction effects between the predictor variables were added at step 3. To control for possible multicollinearity when including interactions terms, each predictor variable was mean centred. Finally, follow-up simple slopes analyses based

on Aiken and West (1991) standard procedure were assessed using Hayes (2012) PROCESS macro for SPSS 21. The predictor variable (executive control for emotional information) and control variables (age, gender, depressive symptoms, anxiety symptoms, brooding rumination and baseline autobiographical memory) were standardised prior to moderation analysis.

3.4 Results

All main study variable means and standard deviations are reported in Table 1. Also in Table 1 are reports of whether scores were significantly different at W2 compared to W1. There was no significant difference between W1 and W2 overgeneral memory scores, nor between W1 and W2 executive control scores for non-emotional information, W1 and W2 depression scores, or W1 and W2 anxiety scores. Executive control for emotional information showed significant decreases at W2 in comparison to W1. Rumination, both brooding rumination and reflective pondering, significantly decreased over time.

Table 1. *Mean Scores, Standard Deviations and t-tests (with Effect Sizes) for all W1 and W2 Measures*

		Wave 1		Wave 2			
		M	SD	M	SD	*t*	*d*
Autobiographical memory:	AMT-MI: Overgeneral memory	4.04	2.23	4.16	2.49	-0.56	0.05
Depressive symptoms:	BDI – ii	15.85[1]	11.96[2]	14.84	11.33	1.81[1]	0.30
Anxiety symptoms::	MASC – ii	61.64[1]	24.28[2]	59.69[1]	25.93[2]	1.55[1]	0.26
Executive control:	IST: Switch cost (Emotion)	541.98	310.17	485.43	293.66	2.22*	0.38
Executive control:	IST: Switch cost (Non-Emotion)	530.67	298.98	485.17	287.04	1.63	0.27
Rumination:	RRS: Brooding rumination	11.36	3.57	10.74	3.67	2.58*	0.43
Rumination:	RRS: Reflective pondering	9.54	3.51	8.99	3.41	2.22*	0.38

***$p < .001$, **$p < .01$, *$p < .05$.

[1]*Pooled estimates*

[2]Estimates averaged from results of the five imputed data sets

Note. AMT-MI = Autobiographical Memory Test – Minimal Instruction, BDI-II = Beck Depression Inventory-II, MASC-II = Multidimensional Anxiety Scale for Children, IST = Internal Shift Task, RRS = Ruminative Response Scale.

Bivariate correlations for within and across time points are displayed in Table 2. W1 OGM was not correlated with any other W1 predictor; brooding rumination, reflective pondering or executive control for emotional or non-emotional information. W1 symptoms of anxiety and depression as well as brooding rumination and reflective pondering were correlated with W2 OGM.

Table 2. *Bivariate Correlations*[1]

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. W2 Overgeneral Memory	-	.06	.06	.20**	.14*	.43***	.23**	.20**	-.08	-.07
2. Age		-	-.01	.19**	.00	-.06	.20**	.22**	.07*	-.10*
3. Gender			-	.38***	.31***	-.08	.24**	.17*	-.03	.01
4. W1 Depression symptoms				-	.69***	-.04	.71***	.58***	-.14*	-.07
5. W1 Anxiety symptoms					-	-.06	.65***	.52***	.05	.06
6. W1 Overgeneral Memory						-	.12	.07	.02	.06
7. W1 Brooding rumination							-	.67***	-.09	-.04
8. W1 Reflective pondering								-	-.15	.03*
9. W1 Switch cost (emotion)									-	.44***
10. W1 Switch cost (non-emotion)										-

***$p < .001$, **$p < .01$, *$p < .05$. [1]*Pooled correlations*

A hierarchical multiple regression analysis was conducted to assess if brooding rumination, reflective pondering, or executive control for emotional or non-emotional information (measured by switch costs) would prospectively predict overgeneral memory. Average standardised betas (computed by summing the standardised coefficient estimates across results from the five imputed data sets and dividing by five) are reported in Table 3. Across the five imputed data sets, all standardized betas were identical. The first step of the regression accounted for a significant proportion of the variance in OGM. Almost one quarter (24%) of the variation in OGM can be accounted for by the variables entered at the first step in the regression. Baseline OGM was the only significant predictor of OGM at W2. Brooding rumination, reflective pondering, switch costs for emotion and non-emotional information were added at step 2. This step was non-significant and no individual predictors were significant, other than baseline OGM. Thus, there was no evidence that brooding rumination, reflective pondering or switch cost for emotion and non-emotion conditions individually predicted OGM. At step 3, interaction variables were added. The step was non-significant however a significant interaction between reflective pondering and switch cost in the emotion condition was found (β = -.28, p = 0.01). ΔR^2 estimates ranged from .064 to .065 (average = .07) for the interaction. To account for the possibility of different findings based on differing scoring algorithms of OGM, analyses were re-run using the proportion of OGM's as the outcome variable, with and without the inclusion of omissions and the number and proportion of specific memories, with and without omissions. Beta values were similar when the unit of analysis was the proportion of overgeneral memories (β = -.28, p = .01) or the proportion of overgeneral memories minus omissions (β = -.24, p

= .03). Similarly, in the opposite direction beta values were similar for the number of specific memories (β = .20, p = .03), the proportion of specific memories (β = .20, p = .03) and the proportion of specific memories minus omissions (β = .19, p = .04). . All VIF were < 3, which suggests there are no problems with multicollinearity in the regression model.

Table 3. *Hierarchical Regression Analysis of W1 Brooding Rumination, Reflective Pondering Scores, Executive Control for Emotion and Non-Emotion Scores on W2 Overgeneral Memory Scores*

		Dependent Variable: Number of overgeneral memories		
Step	Predictors	Step 1 β^1	Step 2 β^1	Step 3 β^1
1.	Age	.06	.06	.07
	Sex	.02	.02	.02
	W1 Depressive symptoms	.17	.13	.12
	W1 Anxiety symptoms	.04	.05	.05
	W1 Overgeneral memory	.45***	.45***	.45***
		Step 1 summary: F (5, 141) = 8.82, p <.001. R^2 = .24[1].		
2.	W1 Brooding rumination		-.01	.04
	W1 Reflective pondering		.06	-.01
	W1 Switch cost (emotion)		-.04	-.01
	W1 Switch cost (non-emotion)		-.07	-.09
		Step 2 summary: F (4, 137) = 0.45, p = .775. ΔR^2 = .01[1].		
3.	W1 Switch cost (emotion)*Brooding			.16
	W1 Switch cost (emotion)*Reflect			-.28**
	W1 Switch cost (non-emotion)*Brooding			-.14
	W1 Switch cost (non-emotion)*Reflect			.13
		Step 3 summary: F (4, 133) = 1.92, p = .111. ΔR^2 = .04[1].		

***p < .001, **p < .01, *p < .05. [1]Pooled estimates

Follow-up simple slopes analyses were conducted to test whether the relation between executive control for emotional information and OGM differed at low, mean and high levels of reflective pondering. The simple slopes analyses decomposing the baseline executive control for emotional information X baseline reflective pondering interaction showed that when reflective pondering is high, there is a significant negative relation between executive control and OGM, β = -21 (95% CI = -.41, .-01), p = .04. At the mean value of reflective pondering, there is non-significant negative relation between executive control and OGM, β = .06 (95% CI = -.21, .09), p = .44. When reflective pondering is low, there is a non-significant positive relation between executive control and OGM, β = .09 (95% CI = -.12, .30), p = .38.

3.5 Discussion

The primary aim of this study was to prospectively examine the capture and rumination and executive control mechanisms of the CaR-FA-X model, and to investigate whether they independently and in interaction predict OGM in adolescence. It was found that executive control was negatively associated with OGM, but only when reflective pondering levels were high. Thus, as switch costs increased (i.e. lower executive control) there was a decreased in OGM (i.e. greater specificity). Moreover, this association held after controlling for baseline OGM scores and symptoms of depression and anxiety. This suggests that reflective pondering may act as a protective factor against later OGM, in the context of lower executive control. Interestingly, brooding rumination, reflective pondering, and executive control for emotional or non-emotional information, did not independently predict OGM. There were no age or sex differences in OGM scores within this sample.

The CaR-FA-X model (Williams et al., 2007) proposes that rumination and executive control can act in isolation or in interaction to predict OGM. Our findings provide partial support for the theory. Although executive control and rumination did not independently predict OGM, rumination interacted with executive control to predict OGM over time, but not in the way the model suggests. Williams et al. (2007) proposed that the ability to search a hierarchy for a specific memory would be particularly difficult when an individual has impaired executive control and is also engaged in ruminatory thought processing. Williams et al. (2007) did not offer an explanation to the differing functions of rumination on OGM. Given the importance of investigating the subcomponents of rumination (Treynor et al., 2003), our study separated the maladaptive form of rumination (brooding) from the adaptive form (reflective pondering). Although our results did not find a relation between brooding rumination, executive control and OGM, the current results add to the CaR-FA-X model to show that the adaptive form of rumination can act as a protective factor against OGM, when executive control processing is lower.

Our findings build on previous work with 'at risk' adolescent populations. Rawal and Rice (2012b) reported an interaction between rumination and executive control. The authors reported high rumination in the context of low executive control predicted reduced AM specificity (more overgeneral) 1 year later. Our findings add nuance to this documented effect. Although we did not find brooding rumination to interact with executive control to predict OGM, we did find that reflective pondering, a subcomponent of rumination interacted with executive control for emotional information, predicted less OGM over time. In contrast, Hitchcock et al. (2014b) did not find an interaction between rumination and executive control. However, these

conflicting results may be because Hitchcock et al. included a sample of trauma exposed adolescents or because their sample was younger (pre-adolescent) than the present sample (adolescent). Taken together, our findings suggest that rumination and executive control interact to predict OGM in adolescents. This relation had a different effect on OGM depending on the type of rumination. Further research is warranted to explore this relation further.

Interestingly, the current findings and those of Rawal and Rice (2012b) and Hitchcock et al. (2014b) do not support the theoretical perspective that the mechanisms of the CaR-FA-X model can work in isolation to predict OGM. Although cross-sectional research has shown OGM to be associated with inhibitory processing (Raes et al., 2010), working memory (Nixon et al., 2013) and category fluency (Valentino at al., 2012), all three prospective studies with child and adolescent samples (i.e. the current findings; Hitchcock et al., 2014b; Rawal & Rice, 2012b) collectively do not support the mechanisms of the CaR-FA-X model working in isolation. This suggests that although some aspects of executive control are associated with OGM in adolescence, rumination and executive control in isolation do not theoretically underpin OGM. In the current sample, rumination in the context of executive control is a better predictor of OGM over time than rumination or executive control in isolation. These findings are in line with a growing literature base which suggests that rumination is closely related to executive control, particularly when processing emotional information (Hilt et al., 2014).

Our findings show that the relation between reflective pondering and executive control in reducing OGM in adolescence was specific to processing emotional stimuli, rather than non-emotional stimuli. The literature does tend to

support the notion that rumination is closely associated with the processing of emotional information (De Lissnyder, Koster, Goubert, et al., 2012; Hilt et al., 2014). Within the depression literature, neuropsychological research findings show that adults with depression have a heightened attentional engagement towards negative, emotional aspects of faces (Leyman, De Raedt, Schacht, & Koster, 2007). It could be that our findings tapped into the emotional difficulties that characterise major depressive disorder (American Psychiatric Association, 2013). This suggests that emotional processing difficulties reported in depression may be present in vulnerability factors associated with the disorder. At present, it remains unclear as to whether there are differences in the rumination, executive control and OGM relation due to the type of emotional information processed (i.e. sad vs. angry). A fruitful avenue for future research would be to test whether the relation is influenced by the valence of faces presented within the executive control task. This may influence our theoretical understanding of the underpinnings of OGM.

Our study has a number of strengths. First, our study used a prospective longitudinal design with participants who were at an important period of adolescence. We were able to investigate changes over a six month period at a time where executive processes and the prefrontal cortex are developing. This makes the current study the first to use a prospective design, while examining the isolated and combined effects of the subcomponents of rumination and emotion specific executive control to predict OGM in a community sample of adolescents. Second, our assessment of rumination allowed us to investigate the different effects of brooding rumination and reflective pondering on executive control and AM scores. Third, the objective measure of executive control provided the opportunity to

measure difficulty when processing emotional and non-emotional information that was held in working memory. Fourth, we controlled for symptoms of anxiety and depression as research has suggested even subclinical levels can impact task performance on executive tasks (Holmes & Pizzagalli, 2007; Ansari, Derakshan, & Richards, 2008). Finally, our method of assessment of AM was specific to non-clinical populations which provided a valid, thorough and comprehensive measure of AM.

In addition to the strengths of the current study, several observations and future recommendations must be noted. The novel characteristics of this study, while advantageous, require validation. Accordingly, replication of these findings and expanding on the complex relation between the mechanisms of the CaR-FA-X model in adolescence would enhance out theoretical knowledge of OGM. Our research aim was to measure executive control when processing emotional and non-emotional information, specifically for information held internally in working memory. For this task, we employed the IST. We considered this task valuable for the current research questions, however we are aware that that this task does not allow for examination of control processes within specific aspects of executive functions (i.e. inhibition, switching and updating; Miyake et al., 2000). Future research would benefit from developing a task which allows for the measurement of executive control for internally represented emotional and non-emotional information, while measuring different aspects of executive functions. Tests of executive function and executive control are limited by their test-retest reliabilities, as noted by many authors in this area (Burgess, 1997; Miyake et al., 2000). Although the internal consistency of the IST was high in the current sample, we found low to moderate test-retest reliability

with the IST, similar to previous research employing other executive control tasks (Henry & Bettenay, 2010). It is evident that this is a wider issue in the field than that of the current study. However, as we are the first authors to use the IST with adolescent populations, future research should establish the reliability and validity of this task for use in this population.

Despite the noted considerations, our findings have several important theoretical implications. We provide partial support for the CaR-FA-X model and add to the current model by demonstrating the protective factor of reflective rumination on OGM, particularly in the context of lower executive control. We also show that this relation is specific to executive control processing of emotional information. This study provides a novel contribution to the field and future research is warranted to confirm the protective nature of reflective pondering on executive control and OGM.

Chapter 4 (study 3): Reflective pondering predicts greater executive control for emotional information: An adolescent prospective study

This chapter is under review in Developmental Psychology. As such, the chapter is presented in the format of a manuscript following the guidelines of the journal.

Contribution to this chapter:

My Role: I designed the study, recruited and test all the participants. I wrote the first draft of the chapter without other co-authors and discussed drafts with both of my supervisors. My first supervisor is corresponding author on the paper as my university email address will not be valid after the PhD.

Signed:

Date:

Reflective pondering predicts greater executive control for emotional information: An adolescent prospective study

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4.1 Abstract

A prospective design was used to investigate the relationship between executive control for emotional and non-emotional material, brooding rumination and reflective pondering in adolescence, whilst controlling for the effects of depression and anxiety symptoms. In adult populations, rumination and executive control have been highlighted as vulnerability factors for later depression and rumination has recently been linked to executive control. However, research with adolescent populations is limited and little is known developmentally of the association between rumination and executive control. The present study examined the directional and predictive relationship between the subcomponents of rumination and executive control for emotional and non-emotional information, within adolescent development. A total of 149 adolescents (13-16 years) were tested at two time points, approximately six months between sessions. At each time point, participants completed a computerised, valenced measure of executive control and measures of brooding rumination, reflective pondering, depression symptoms and anxiety symptoms. Findings indicate that rumination precedes executive control and showed that reflective pondering was predictive of lower switch costs (i.e. greater executive control) for emotional information over time. These findings show the adaptive nature of reflective pondering on executive control. Contrary to research with adults, brooding rumination was not associated with executive control.

Keywords

‘Adolescence’ ‘Reflective Pondering’ ‘Brooding Rumination’ ‘Executive Control’ ‘Cognitive Control’

4.2 Introduction

Depression is one of the most common and incapacitating mental health disorders and, despite a wealth of research investigating the disorder, it is characterised by high prevalence and relapse rates (Ayuso-Mateos et al., 1999). Findings suggest that preventing or delaying depression onset can alter the developmental path and debilitating suffering across adulthood (Andrews, Szabo & Burns, 2002). With first onsets typically occurring during adolescence and 20-50% of adolescents reporting significant depressive symptoms (Kessler, Avenevoli, & Merikangas, 2001), it is important to enhance our knowledge of the factors that give rise to symptoms of depression. As research below demonstrates, rumination and executive control have been highlighted as important vulnerability factors in the development of depression. Understanding the relationship between rumination and executive control may be influential in enhancing our knowledge of psychopathology yet few research studies have investigated this relationship within adolescent development. The goal of this research was to evaluate the Impaired Disengagement Hypothesis (IDH; Koster, De Lissnyder, Derakhshan, & De Raedt, 2011) against the Resource Allocation Hypothesis (RAH; Ellis & Ashbrook, 1988) to investigate the direction and nature of the relationship between rumination and executive control within the adolescent period. To examine these models, we specifically tested the effects of both subtypes of rumination (brooding rumination and reflective pondering) on executive control for emotional and non-emotional information over time, whilst accounting for current symptoms of depression and anxiety.

Executive control, generally regarded as synonymous with the term cognitive control, have been identified as a key vulnerability factor for the development and

maintenance of depression (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lönnqvist, 2008; Joormann & D'Avanzato, 2010; Mathews & McLeod, 2005). Although debated (Miyake et al., 2000) and elusive to define (Epsy & Bull, 2005), executive control is a broad term that refers to a group of cognitive processes which are responsible for the flexible coordination and control of executive functions and processes towards a specific goal (Roberts, 1998; Shah & Miyake, 1999; Williams et al., 2007). Funahashi (2001), for example, defines executive control as a system responsible for the flexible coordination of executive functions. It is largely recognised that there are three separable, but related executive functions; inhibition, updating working memory and switching (Miyake et al., 2000). While there is debate in the literature as to which processes are involved in executive or cognitive control there is general agreement that the term refers to the control of cognitions accountable for the planning, initiation and monitoring of complex goal directed behaviour, particularly when distracting information is present (Dalgleish et al., 2007). These abilities allow individuals to respond flexibly and to adjust emotional responses and behaviour to changing situations (Joormann & D'Avanzato, 2010).

Recently, research has reported impaired executive control in adults at risk of depression (Owens, Koster & Deraksha, 2012), adults diagnosed with depression (De Lissnyder, Koster, Everaert, et, al., 2012), and adults in remission of depression (Vanderhasselt & De Raedt, 2009). The few studies which have been conducted with child and adolescent samples have produced mixed results. Some research has found associations between depression and deficits in inhibition and switching (Gunther, Konrad, De Brito, Herpertz- Dahlmann, & Vloet, 2011; Micco et al., 2009; Wilkinson and Goodyer 2006) and working memory (Baune, Czira, Smith,

Mitchell, & Sinnamon, 2012; Matthews, Coghill, & Rhodes, 2008), whereas some report no such relationship (Favre et al., 2009; Gunther, Holtkamp, Jolles, Herpertz-Dahlmann, & Konrad, 2004; Kyte, Goodyer, & Sahakian, 2005). A promising line of research that might explain these differences within the literature draws on the integration of information processing models of depression with the response styles theory of depression (Nolen-Hoeksema, 1991).

The response styles theory proposes that rumination, which consists of persistent focusing of attention on depressive affect and its consequences, exacerbates depression and negative thinking while also impairing problem solving (Nolen-Hoeksema 1991). There is a wealth of research linking rumination to the development, severity and maintenance of depression both cross sectionally (Kuyken, Watkins, Holden & Cook, 2006; McMurrich & Johnson, 2008) and longitudinally (Nolen-Hoeksema & Morrow, 1991; Schwartz & Koenig, 1996; Verstraeten, Vasey, Raes & Bijtterbeir, 2010), in both child (Abela, Brozina, & Haigh, 2002; Abela & Hankin, 2011; Abela, Vanderbilt, & Rochon, 2004; Broderick & Korteland, 2004; Kuyken et al., 2006) and adult populations (Nolen-Hoeksema, 2000; Smith & Alloy, 2009). There is also emerging evidence linking the tendency to ruminate with executive control (Altamirano, Miyake, & Whitmer, 2010; Davis & Nolen-Hoeksema, 2000; Koster et al., 2011; Whitmer & Banich, 2007). A greater understanding of rumination and its relationship with executive control could enhance our knowledge of cognitive vulnerability to depression.

Two opposing models have been offered as theoretical frameworks for the relationship between rumination and executive control. The Resource Allocation Hypothesis (RAH; Ellis & Ashbrook, 1988) posit that there is a limit on the amount

of cognitive resources an individual has available and that engaging in ruminative or depressive thinking reduces these resources. As cognitive resources are allocated to ruminative and depressive thought, this in turn leads to deficits in other cognitive processing such as executive control. This would suggest that rumination precedes executive control. Research supports the RAH and indeed Watkins and Brown (2002) found that inducing rumination led to a decreased ability to inhibit irrelevant material and attend to task relevant material. Philippot and Brutox (2008) reported similar findings in which induced rumination led to deficits in inhibition. In contrast, The Impaired Disengagement Hypothesis (IDH; Koster et al., 2011) proposes that the difficulty in disengaging attention from distracting information puts individuals at risk for increased levels of rumination, particularly brooding rumination, indicating that executive control may precede rumination.

In a six month prospective design, Zetsche and Joornam (2011) used an emotional version of the negative priming task to show difficulty in interference control (also referred to as selective attention or cognitive inhibition, and involves executive control of inhibition and arguably working memory, see Diamond, 2013) prospectively predicted increases in rumination. Providing further support, De Lissnyder, Koster, Goubert, et al. (2012) employed the Internal Switch Task (IST) to assess impaired executive control for emotional and non-emotional information and found that impaired executive control moderated the association between brooding rumination and stress, suggesting that impaired executive control preceded rumination. Very few studies have assessed the relationship between rumination and executive control prospectively, making it difficult to draw strong conclusions about

the direction of this relationship and it could be proposed as a reason for mixed findings within the adult literature.

Only one study has investigated the direction of the relationship between rumination and executive control within adolescent development. Connolly et al. (2014) employed an array of neutrally valenced cognitive tasks to prospectively examine selective attention, sustained attention, attentional switching, divided attention and working memory, as well as rumination and self-reported depressive symptoms in a large community sample of adolescents. While none of the cognitive tasks predicated later rumination, heightened baseline rumination scores predicted deficits in attentional switching (also known as switching; set-shifting; cognitive flexibility) at follow up. The attentional switching task employed in Connolly et al.'s (2014) study could arguably be described as an executive control task as the task is not specific to measuring switching difficulties but also taps into other executive functions and cognitive processing. Indeed, Diamond (2013) argues that switching ability requires and builds on working memory and inhibitory processing. Despite the hotly debated issues surrounding terminology, tasks, and functions of executive control (Best & Miller, 2010; Diamond, 2013; Hughes, 2011) Connolly et al.'s (2014) findings refute the IDH, instead providing support for the RAH as rumination preceded executive control. Although Connolly et al.'s (2014) findings provide an advantageous introduction to this issue in adolescence, research has not yet tested whether specific subtypes of rumination such as brooding or reflective pondering prospectively predicts executive control or whether this this effect would still be found when emotional measures of are employed.

Given that rumination involves a passive focus on negative emotions, it could be expected that the relationship between rumination and executive control is more prominent on tasks which use emotional stimuli rather than neutral stimuli. When emotional tasks have been employed within the adult literature, findings highlight a relationship between depression and difficulties in inhibiting task irrelevant negative material (Joormann, 2004), difficulties in updating working memory with emotional information (Levens & Gotlib, 2010) and relationships between rumination and executive control (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; De Lissnyder, Koster, & De Raedt, 2012; Demeyer, De Lissnyder, Koster, & De Raedt, 2012). In adolescence, Hilt, Leitzke and Pollak (2014) found an association between rumination and executive control (particularly inhibiting emotional information), yet Wilkinson and Goodyer (2006) reported no such association. The disparity in the findings could be due to the valence of tasks as Hilt et al. (2014) employed emotional and non-emotional tasks of executive control whereas Wilkinson and Goodyer (2006) employed only neutral tasks. It is evident that further research is warranted, particularly at a time when rumination and cognitive functions are rapidly developing during adolescence.

Researchers have also questioned whether examining executive control for externally presented stimuli is the most adequate way to target the association between rumination and executive control (Demeyer et al., 2012; De Lissnyder, Koster, Goubert, et al., 2012). Chun, Golomb and Turk-Browne (2011) distinguished between external attention which involves the processing of external information and internal attention which involves the processing of information held in working memory. Given that ability to switch attentional focus between mental

representations is an internal process and rumination is characterised by internal negative thought processes, a task which measures executive control ability for internal mental representation help in working memory may be more efficient at detecting a relationship between rumination and executive control. Building on previous task designs (Chambers, Lo, & Allen, 2008; Garavan, 1998; Gehring, Bryck, Joindes, Albin, & Badre, 2002), De Lissnyder, Koster, Everaert, et al. (2012) devised the IST to measure executive control for internal representations held in working memory. The IST is primarily a measure of switching ability which also involves the ability to inhibit and over-ride previous previously relevant information and update working memory. Although executive functions have been shown to be separable (Miyake et al., 2000), research suggest that different functions, particularly switching, relies and builds on other executive functions such as working memory and inhibition (Diamond, 2013). In support of this, Koch, Gade, Schuch, and Philipp (2010) recently reviewed the literature and found switching and inhibition to be highly interrelated. As such, the IST was framed in terms of task demands, providing a measure of top-down executive control, over highly interrelated executive functions. Utilising the IST with adult populations, it was found that greater difficulty in processing emotional material was associated with increased brooding rumination in reaction to stress (De Lissnyder, Koster, Goubert, et al., 2012). These findings suggest that that executive control in the context of rumination is particularly hampered when processing internal, emotional information.

Although several studies have indicated that rumination is associated with executive control, at times prospectively, little attention has been given to the subtypes of rumination and their unique relationship with executive control.

Treynor, Gonzalez and Nolen-Hoeksema (2003) removed items from the ruminative response scale (RRS; Nolen-Hoeksema, 1991) in response to criticism that the relationship between depression and rumination could be explained by items on the RRS which were confounded with depressive content. In doing so, the researchers discovered a two factor model of rumination with 'reflective pondering' and 'brooding rumination' as two ruminative subtypes. Brooding rumination is a maladaptive form of rumination and has been defined as focusing attention on the meaning of negative, judgemental and self-blaming thoughts (Cox, Funasaki, Smith, & Mezulis, 2011; Treynor et al., 2003). Contrary to brooding rumination, reflective pondering is an adaptive form of rumination and is defined as focusing attention on neutral or positive content, non-judgmentally with a focus on problem solving (Treynor et al., 2003; Whitmer & Gotlib, 2011). Research has consistently produced results demonstrating that brooding rumination is implicated with onset and severity of depression in adolescence (Burwell & Shirk, 2007; Gibb, Grassia, Stone, Uhrlass, & McGreary, 2012) as well as preliminary research with adults proposing a link between brooding rumination and executive control (De Lissnyder, Koster, Goubert, et al., 2012; Whitmer & Banich, 2007). Recent research which does investigate the relationships between executive control processing and rumination in adolescent samples, do tend to examine rumination as a whole construct and employ non-emotional cognitive tasks (Connolly et al., 2014). Nevertheless, the adult literature tends to suggest that brooding rumination is related to executive control. The association between executive control and reflective pondering is less clear.

The relationship between reflective pondering and depression has produced mixed findings within the literature. Some findings suggest that reflective pondering

is related to depressive symptoms (Verhaeghen, Joormann, & Khan, 2005), others report no association between depression and reflective pondering (Cox et al., 2011). Yet other research suggests that reflective pondering is a protective factor against symptoms of depression (Treynor et al., 2003). For example, using a prospective design, Arditte and Joormann (2011) found that reflective pondering predicted later recovery from depression. Verstraeten et al. (2010) found higher levels of reflection predicted lower levels of depression in children aged 11 years and over. Similarly, Burwell and Shrik (2007) reported that reflective pondering was not related to depression in adolescent girls but instead was correlated with coping, proposing that reflective pondering may be a protective factor in depression and an adaptive form of rumination. Reflective pondering has further been reported to be predictive of less grief and depressive symptoms in bereavement (Eisma et al., 2015).

In a recent prospective study with adults, Vanderhasself, Koster, Goubert & Raedt (2012) investigated the IDH (Koster et al., 2011). They examined the relationship between executive control, stress, brooding rumination and reflective pondering and reported that participants who displayed little or no difficulties in attentional control at baseline were later able to activate reflective pondering thoughts in response to stress. However, when individuals demonstrated difficulty in attentional control at baseline, they could not activate reflective pondering thoughts in response to stress. Vanderhasself et al. (2012) paper refers to the term 'attentional control' in reference to the IDH (Koster et al., 2011). The authors describe this term as the ability to selectively attend to information which task relevant and to inhibit information which is distracting and task irrelevant. As such, it is put forward that attentional control in the context of the Vanderhasself et al.'s (2012) study is

interchangeable with executive control. Vanderhasself et al.'s (2012) findings provide partial support the IDH theory (Koster et al., 2011) since executive control preceded rumination. Surprisingly, these authors did not find a relationship between stress, executive control and brooding rumination. One reason for this could be the use of externally presented stimuli on the executive control task which may not have tapped directly into negative brooding ruminative thoughts as previously noted.

Despite encouraging findings, very few studies have investigated the relationship between rumination and executive control, particularly in adolescence. From a developmental perspective, it is particularly important to investigate the relationship between executive control and rumination within adolescence as this developmental period is characterised by rises in rumination (Hyde, Mezulis & Abramson, 2008) and depressive symptoms (Mezulis, Funasaki, Charbonneau, & Hyde, 2010) which can become habitual across the adolescent transition. This can place adolescents at heighted risk of depression (Mezulis, Priess & Hyde, 2010). Research has continually suggested that adolescence is a heightened risk period for the development of psychopathology, especially depressive and anxiety symptoms (McLaughlin & Nolen–Hoeksema, 2011; Twenge & Nolen–Hoeksema, 2002). Moreover, adolescence marks a period of ongoing development and maturation of the prefrontal cortex associated with cognitive abilities (Paus, 2005) and the relationship between rumination and executive control may be influential in enhancing the understanding of this development. Importantly, executive control is a key cognitive skill which supports goal directed behaviour and is linked to educational achievement in children and adolescents (St. Clair-Thompson & Gathercole, 2006). Conversely, impaired executive control processing can reduce the

ability to inhibit negative information and respond flexibly, resulting in reduced problem solving and reduced capability to change behaviour (Henry & Bettany, 2010). While research investigating the relationship between cognitive abilities, particularly executive control and rumination, is progressing within the adult literature, and studies examining this relationship in adolescence are lacking. A greater understanding of the direction of this relationship, particularly in children and young people, will enhance our understanding of cognitive vulnerability to psychopathology.

The current study used a longitudinal design to test the competing predictions of the resource allocation hypothesis and the impaired disengagement hypothesis. The former predicts that rumination will prospectively predict executive control, while the latter suggests that executive control will predict increases in rumination. Our study builds on previous research by applying a prospective design with an adolescent population, employing both emotional and non-emotional tests of executive control, and examining both brooding rumination and reflective pondering. To the best of our knowledge, this is the first study to investigate the directional relationship between rumination and executive control by employing emotional and non-emotional measures of executive control for internally represented information as well as investigating rumination by its subcomponents, brooding and reflective pondering within adolescent development.

4.3 Method

4.3.1 Participants

A community sample of adolescents was recruited from three secondary schools across Scotland, UK, to take part. Information packs were sent home with all

children between the ages of 13 to 16 years in participating schools. Consent was sought from each parent or guardian and written assent was required at both waves of the study from each adolescent. Following Gathercole, Pickering, Ambridge and Wearing (2004), no exclusion criteria was applied at recruitment. The uptake of free school meals was used to signify socio-economic disadvantage and deprivation (Hobbs & Vignoles, 2007) of the schools participating in the study. Examining the uptake of free school meals has been described within the literature as a reasonable measure for SES for an overall area (Halse & Ledger, 2007). In Scotland, the average percentage of uptake of free school means is 10% (range = 0% - 42%; School Meals Data set, 2013). In the current participant sample, the uptake of free school meals was 16% (range = 6% - 20%). There were no differences in the uptake of free school meals (School Meals Data set, 2013) in participating vs. non-participating schools, t (79) = -1.58, p = .12. This suggests that the included participant cohort was representative of the cohort of pupils from other schools who were contacted but did not take part in the project. All adolescents available on the days of testing with appropriate parental consent and written assent participated in the study. The final sample consisted of 149 adolescents (36% male) who were first tested at wave 1 (W1; mean age = 13.85, SD = 0.78) and 136 adolescents (37% male) who were retested approximately six months later at wave 2 (W2; mean age = 14.28, SD = 0.88). Thirteen participants (5 males and 8 females; 8.8% total) from W1 did not complete the study at W2. This was due to scheduling difficulties, participants graduating from school and a family bereavement resulting in the withdrawal of one participant.

4.3.2 Procedure

Ethical approval for the prospective studies was gained from the School of Psychological Sciences and Heath Ethics Committee, University of Strathclyde, in August 2013. All tasks were conducted in school based settings. At W1 children were individually administered a battery of assessments, including a computerised emotionally-valenced executive control task, a measure of rumination, and self-report questionnaires of depressive and anxiety symptoms. At W2 all assessments from W1 were administered again. At both time points the executive control task was administered first. Assessments of rumination, depressive and anxiety symptoms were randomised to control for order effects and were completed at the end of the session to avoid mood priming effects.

4.3.3 Measures

4.3.3.1 Depression: The Beck Depression Inventory-II (BDI-II; Beck, Steer, Ball & Ranieri, 1996)

The BDI-II is a 21-item self-report questionnaire measure of depression symptoms developed to measure symptoms of depression in adolescents and adult samples. Each item contains four statements reflecting varying degrees of severity. Participants are instructed to circle the number (ranging from zero to three, demonstrating increasing severity) that corresponds with the statement that best describes how they are feeling. Scores are summed to calculate a total BDI–II score, which can range from 0 to 63. The BDI-II has shown good internal consistency (α = .91; Osman, Barrios, Gutierrez. Williams & Bailey, 2008) when applied to non-clinical adolescent samples. The 'suicidal ideation' and 'sex' questions were removed from the scale as these were deemed inappropriate for the age of the sample

and the prospective design of the study (i.e. lacking in anonymity). Previous research has omitted these items for similar reasons (Balazs et al., 2013; Basner et al., 2014; Osman, Kooper, Guttierez, Barrios & Bagge, 2004; Wisco & Nolen-Hoeksema, 2010). This 19 item version of the BDI-II range 0-57 in severity. The BDI-II scores within the current study showed excellent internal consistency at (α_{W1} = .94) and (α_{W2} = .94) as well as good test-retest reliability (r = .83, p < .001).

4.3.3.2 Anxiety: The Multidimensional Anxiety Scale for Children 2nd Edition (MASC-II; March, Parker, Sullivan, Stallings, & Conners, 1997).

The MASC-II is a 50-item self-report measure developed to assess a wide range of anxiety symptoms in children and adolescents. Each item is rated on a 4-point Likert-type scale with higher scores indicative of greater anxiety. The MASC-II has demonstrated good internal consistency (March et al., 1997), particularly in non-clinical adolescent samples (Muris, Merkelbach, Ollendick, King, & Bogie, 2002) and good test-retest reliability (r = .87; March et al., 1997). The MASC-II displays significant correlations (r = .63) with other anxiety measures, but non-significant correlations (r = .19) with measures of depression (March et al., 1997). The MASC-II scores for the current data showed excellent internal consistency at (α_{W1} = .94) and (α_{W2} = .94) as well as good test-retest reliability (r = .82, p <.001).

4.3.3.3 Rumination: The Ruminative Response Scale of the Response Style Questionnaire Rumination (RRS; Nolen-Hoeksema, 1991)

The RRS is a 21-item response scale which describes ruminative responses. Each item is on a 4-point Likert-type scale (1 = almost never, 2 = sometimes, 3 = often to 4 = almost always) with higher scores indicative of great ruminative styles. Following the work of Treynor et al. (2003) the reflective pondering and brooding

rumination subscales were extracted from the RRS. Treynor et al. (2003) reported a coefficient alpha of .72 and .77 for the reflection and brooding subscale respectively. The current data showed excellent internal consistency for reflection (α_{W1} = .77; α_{W2} = .80), brooding (α_{W1} = .79; α_{W2} = .85) as well as good test-retest reliability for the refection scale (r = .66, p <.001) and the brooding scale (r = .68, p <.001).

4.3.3.4 Executive control: Internal Switch Task (IST; De Lissnyder, Koster, Everaert, et al., 2012)

The IST is a valenced, computerised measure of executive control. Faces were presented one at a time on at the centre of a computer screen. The faces were taken from the Karolinska Directed Emotional Faces (KDEF) (Lundqvist, Flykt, & Öhman, 1998) and 24 angry and 24 neutral faces, either male or female were selected based on a validation study of the KDEF faces (Goeleven, De Raedt, Leyman, & Verschuere, 2008). There were two conditions; a non-emotional task in which participants were asked to focus on the gender (male vs. female) of the faces and an emotional condition in which participants were asked to focus on the emotional characteristics of the faces (angry vs. neutral). This condition is referred to as the emotion condition. The conditions were counterbalanced between participants to control for within task order effects. There were 12 blocks of trials within each condition and each trial presented 10-14 randomised faces. Participants were given a practice phase before the start of each condition, this consisted of three practice trials relevant to the subsequent condition.

The participants were required to keep a mental count of the number of faces which appeared on the screen depending on the task condition (male vs. female or angry vs. neutral) and press the spacebar as fast as possible (reaction time measure)

once they had updated their mental count. At the end of each trial, participants indicated using the number path on the keyboard, how many faces they had counted in each trial. Faces had an inter-trial interval of 200ms between the presentation of each face. An example of a block of trials in each condition is shown in Figure 1. To avoid the possibility of any trials becoming sequenced and predictable to the participants, the order of the trials and presented faces were randomly determined with a replacement procedure. As each face was randomly presented it created a measure of switch costs (male - female; female - male; angry - neutral; neutral – angry) and no-switch costs (male – male; female – female; angry – angry; neutral – neutral) within each trial. The difference in reaction time between switch and no-switch trials were calculated and used for analysis (referred to as switch costs). Switch costs reflect the executive control processes that are used when participants switch between multiple mental sets (De Lissnyder, Koster, & De Raedt, 2012). Thus, within the current study executive control is operationalised as the range of reaction time scores on the internal switch task. Higher reaction times (i.e. greater switch costs) reflect lower levels of executive control and lower reaction times (i.e. lower switch costs) reflect greater levels of executive control. Greater or lower executive control is reflective of the range of scores within the current sample. No cut off scores to reflect a high or low impairment group was used. Median scores were used to reduce the influence of outliers on the data (De Lissnyder, Koster, Everaert, et al., 2012). Correct and incorrect trials were included in the analysis. The IST has been shown to have good internal consistency as well as good re-test reliability when all trials are included (Koster, De Lissnyder, & De Raedt, 2013). The current data showed excellent internal consistency for both the emotion condition

(α_{W1} = .80; α_{W2} = .80) and the non-emotion condition (α_{W1} = .81; α_{W2} = .77) as well as modest test-retest reliability in the emotion condition (r = .48, p < .001) and non-emotion condition (r = .38, p < .01).

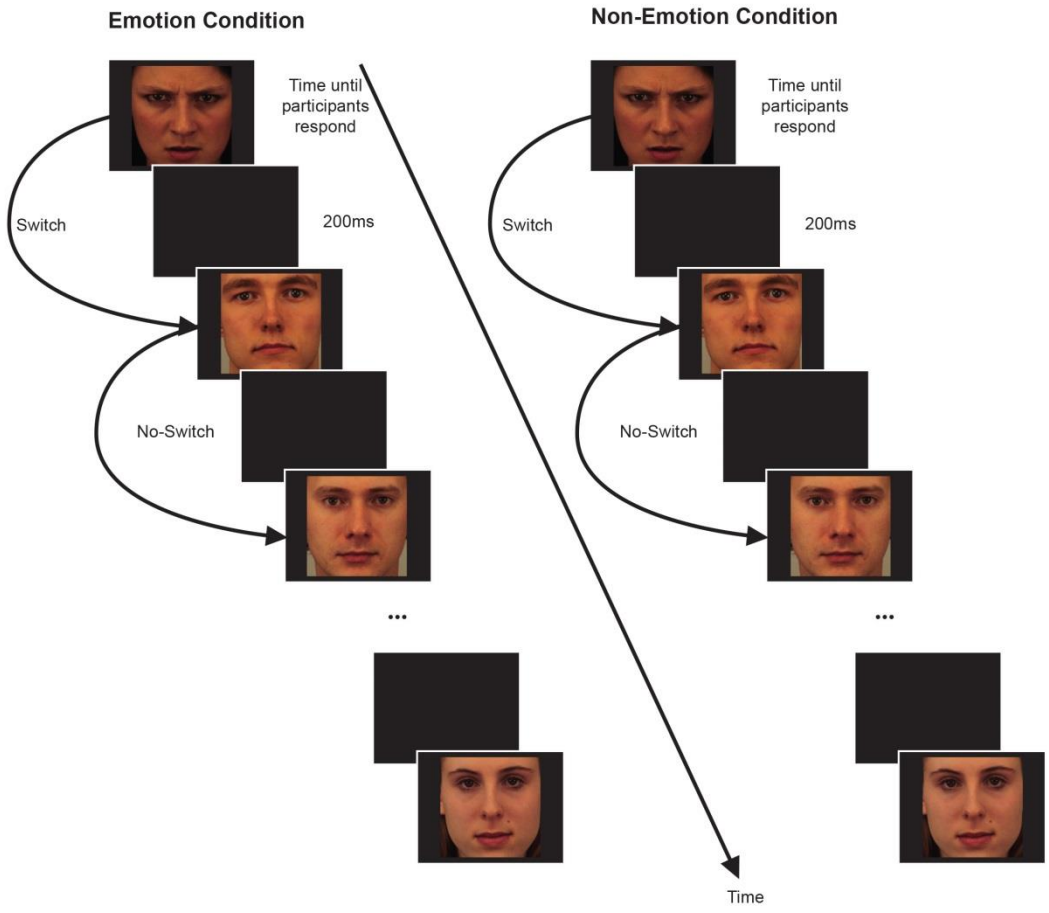

Figure 1. An example of a block of trials within each condition during the Internal Shift Task (constructed by author based on image in De Lissnyder, Koster, Everaert, et al., 2012).

4.3.4 Analytic strategy:

Data analysis proceeded in two stages. First, data was screened for skew and missing data. All measures displayed skewness and kurtosis values between -1.0 and +1.0, suggesting no transformation of data was necessary. Data from two participants had a significant Mahalaonbis D^2 value (p <.001) and were considered multivariate outliers, therefore these participants were excluded from all subsequent analyses.

Examination of the data revealed that 82.99% of participants had a complete data set across all the measures at W1 and 74.15% at W2. Missing data was only found within the depression and anxiety measures and data on individual questionnaire items ranged from 0.7% to 2%. To investigate if data were missing at random, Little's MCAR test was conducted: $\chi^2 = 3584.44$ (df = 3553; $p = .35$). This showed that the missing data was missing completely at random and no pattern exists within the data set. Missing data was imputed using Multiple Imputation (MI) in SPSS 22. MI was used as it provides unbiased estimates when the data is missing completely at random or missing at random and therefore produces more accurate parameter estimates than traditional methods (Baraldi & Enders, 2010). In addition, no single item in the present data set had more than 2% of data missing and the MI method can be effective when up to 80% of data are missing (Lee & Huber, 2011). Imputed values were within the same range as the original data (i.e. BDI-II had a score of 0, 1, 2 or 3) and five data sets were imputed. Imputed data created a data set which allowed analysis on 100% of the participant sample.

Next, multiple linear regression analyses were used to evaluate the prospective relationships between executive control and rumination. Sample size was determined using Tabachnick and Fidel's (2007) formula (104 + number of predictors) based on detecting a medium effect size, with a power of .80. The significance level was set at $\alpha < .05$. In all analyses, age and sex, baseline covariates and depressive and anxiety scores were added at step 1 to control for their effects. Previous research has indicated that current depressive and anxiety symptoms can impact task performance on a range of cognitive tasks in a way that conceals the unique relationship between rumination and executive function (Altamirano et al.

2010; Cisler & Koster, 2010). At step 2, predictor variables were added to investigate the unique additional contribution to the outcome variables after controlling for step 1 variables. Four such regression analyses were conducted to predict brooding rumination, reflective pondering and executive control for emotion and non-emotion conditions separately. Pooled estimates for the standardised coefficients and for significance testing of these were created through SPSS version 22. Where pooled estimates were not available, estimates were averaged across all five imputed data sets (Jones, Heim, Hunter, & Ellaway, 2014).

4.4 Results

Means and standard deviations for the main study variables and paired-samples *t*-test analyses to examine time point differences are presented in Table 1. Bivariate correlations for within and across time points are displayed in Table 2. The bivariate correlations at W1 and at W2 indicate that executive control for emotional information and non-emotional information and both forms of rumination, all significantly correlated. In terms of bivariate correlations between W1 and W2 variables, W1 executive control for emotional information was significantly negatively correlated with reflective pondering at both time points but was not correlated with brooding rumination at either time point. W2 executive control for non-emotional information was not correlated with reflective pondering or brooding rumination at either time point. There were no problems with multi-collinearity (all VIF <3) in the regression models.

Table 1. *Mean Scores, Standard Deviations and t-tests (with Effect Sizes) for all W1 and W2 Measures*

		Wave 1		Wave 2		*t*	*d*
		M	SD	M	SD		
Executive control:	Switch cost (Emotion)	541.98	310.17	485.43	293.66	2.22*	0.38
	Switch cost (Non-Emotion)	530.67	298.98	485.17	287.04	1.63	0.27
Rumination:	Brooding rumination	11.36	3.57	10.74	3.67	2.58*	0.43
	Reflective pondering	9.54	3.51	8.99	3.41	2.22*	0.38
Depressive symptoms:	BDI – ii	15.85[1]	11.96[2]	14.84	11.33	1.81[1]	0.30
Anxiety symptoms:	MASC - ii	61.64[1]	24.28[2]	59.69[1]	25.93[2]	1.55[1]	0.26

***$p < .001$, **$p < .01$, *$p < .05$.

[1]Pooled estimates

[2]Estimates averaged from results of the five imputed data sets

Note. RRS = Ruminative Response Scale, BDI-II = Beck Depression Inventory-II, MASC-II = Multidimensional Anxiety Scale for Children-II.

Table 2. *Bivariate Correlations Within and Across Time Points*[1]

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. W1 Switch Cost (E)[2]	-	.43***	-.09	-.15*	-.14*	.05	.48***	.45***	-.02	-.14*	-.15*	-.02	-.07	-.03
2. W1 Switch Cost (NE)[3]		-	-.04	.03	-.07	.06	.38***	.33***	.08	-.06	-.09	.06	-.19*	.01
3. W1 Brooding			-	.67***	.71***	.65***	-.05	-.00	.68***	.63***	.61***	.55***	.20*	.24***
4. W1 Reflective				-	.58***	.52***	-.16*	-.09	.50***	.66***	.48***	.52***	.22***	.17*
5. W1 BDI					-	.69***	-.06	.0	.59***	.63***	.83***	.60***	.19*	.38***
6. W1 MASC						-	.11	.12	.54***	.57***	.65***	.82***	.00	.31***
7. W2 Switch Cost (E)[2]							-	.41***	-.06	-.12	-.03	.06	-.07	.16*
8. W2 Switch Cost (NE)[3]								-	.01	.02	.05	.04	.06	.09
9. W2 Brooding									-	.71***	.69***	.62***	.03	.25**
10. W2 Reflective										-	.08***	.64***	.13	.25**
11. W2 BDI											-	.69***	.11	.32***
12. W2 MASC												-	-.05	.33***
13. Age													-	-.01
14. Sex														-

***$p < .001$, **$p < .01$, *$p < .05$.[1]Pooled correlations [2]E = Emotion; [3]NE = Non-Emotion

4.4.1 Does rumination prospectively predict executive control?

Multiple regression analysis was conducted to predict W2 executive control (measured by switch costs) when processing emotional and non-emotional information, respectively (see Table 3). The first step of the regression accounted for a significant portion of variance in switch costs in the emotion condition. Almost one third (30%) of the variation in switch costs in the emotion condition can be accounted for by the variables entered at the first step in the regression. Significant individual predictors were sex and W1 switch costs in the emotion and non-emotion conditions. When brooding and reflective pondering were added at the second step, the model was approaching significance ($p = .07$). ΔR^2 estimates were .03 across the five imputed data sets. This indicates that these variables explained an additional 3% of the variation in switch costs in the emotion condition after controlling for the variables in step 1. Only reflective pondering was a significant and negative predictor of switch costs (i.e. executive control) in the emotion condition at W2 from the variables entered at the second step[5]. Across the five imputed data sets, all standardized betas were almost identical (difference in βs = .01). Sex and W1 switch costs in the emotion condition and non-emotion condition were still significant predictors.

To investigate the effects of brooding rumination and reflective pondering on W2 switch costs in the non-emotion condition, analyses indicated that step 1 variables accounted for a significant portion of the variance (approximately 25%) in this outcome variable. Age and W1 switch costs in the emotion and non-emotion condition were significant individual predictors. The second step in the regression

[5] Separate analyses was conducted on the original data without the use of multiple imputation by removing participants with missing data ($N = 25$). Reflective pondering was still a significant, negative predictor of executive control at follow up ($\beta = -.28$, $p = .01$).

was non-significant, demonstrating that reflective pondering and brooding rumination were not significant predictors of W2 switch costs in the non-emotion condition. Age, W1 switch costs in the emotion and non-emotion conditions remained significant individual predictors of switch costs in the non-emotion condition at step 2.

Table 3. *Hierarchical Regression Analyses of W1 Rumination Scores on W2 Executive Control Scores*

		Dependent Variables: Executive Control Measures			
		W2 Switch cost (Emotion)		W2 Switch cost (Non-Emotion)	
Step	Predictors	Step 1 β^{1}	Step 2 β^{1}	Step 1 β^{1}	Step 2 β^{1}
1.	Sex	.19*	.18*	.09	.08
	Age	.03	.06	.13	.16*
	W1 Depressive symptoms	-.17	-.10	-.03	.04
	W1 Anxiety symptoms	.13	.19	.09	.15
	W1 Switch cost (Emotion)	.37***	.33***	.37***	.34***
	W1 Switch cost (Non-Emotion)	.20*	.23**	.18*	.21*
		Step 1: F (6, 140) = 10.21, p <.001. R^2 = .30[1].		Step 1: F (6, 140) = 7.89, p < .001, R^2 = .25[1].	
2.	W1 Brooding rumination		.03		-.02
	W1 Reflective pondering		-.22*		-.19
		Step 2: F (2, 138) = 2.63, p = .07. ΔR^2 = .03[1].		Step 2: F (2, 138) = 2.09, p = .13. ΔR^2 = .02[1].	

***p < .001, **p < .01, *p < .05. [1]Pooled estimates

4.4.2 Does executive control prospectively predict rumination?

Multiple regression analyses were conducted to predict W2 brooding rumination and reflective pondering (see Table 4), respectively. Findings show that 51% of the variance in brooding scores and 55% of rumination scores can be accounted for by the variables entered in step 1. Individual predictors of W2 brooding rumination were W1 brooding rumination and individual predictors of W2 reflective pondering were W1 reflective pondering and W1 depressive symptoms. When switch costs in the emotion and non-emotion condition were added at step 2, the model accounted for no significant further variance in either brooding or reflective pondering. W1 brooding rumination remained a significant individual predictor of W2 brooding rumination. W1 reflective pondering and W1 depressive symptoms remained significant individual predictors of W2 reflective pondering.

Table 4. *Hierarchical Regression Analyses of W1 Executive Control Scores on W2 Rumination Scores*

		Dependent Variables: Rumination measures			
		W2 Brooding rumination		W2 Reflective pondering	
Step	Predictors	Step 1 β^1	Step 2 β^1	Step 1 β^1	Step 2 β^1
1.	Sex	.04	.04	.03	.03
	Age	-.11	-.10	-.03	-.04
	W1 Depressive symptoms	.17	.19	.21*	.20*
	W1 Anxiety symptoms	.06	.04	.12	.14
	W1 Brooding rumination	.50***	.51***	.15	.15
	W1 Reflective pondering	.06	.05	.37***	.38***
		Step 1: F (6, 140) = 23.78[1], p <.001[1]. R^2 = .51[1].		Step 1: F (6, 140) = 28.21[1], p < .001[1], R^2= .55[1].	
2.	W1 Switch cost (Emotion)		.02		-.03
	W1 Switch cost (Non-Emotion)		.08		-.06
		Step 2: F (2, 138) = 0.98[1], p = .38[1]. ΔR^2 = .01[1].		Step 2: F (2, 138) = 0.85[1], p = .43[1]. ΔR^2 = .01[1].	

***p < .001, **p < .01, *p < .05. [1]*Pooled estimates*

4.5 Discussion

The primary aim of this research was to examine the prospective and directional relationship between executive control and rumination in adolescence. The study included a focus on the processing of both emotional and non-emotional information and on both subtypes of rumination (brooding rumination and reflective pondering). Findings revealed a negative relationship between reflective pondering and switch costs over time. Thus, higher levels of reflective pondering at W1 were predictive of lower switch cost scores (i.e. greater executive control) when processing emotional information at W2. Moreover, this relationship was present after accounting for age, gender, baseline executive control scores and symptoms of depression and anxiety. Interestingly, brooding rumination did not predict executive control in either the emotion or non-emotion condition and baseline executive control scores did not predict later brooding or reflective pondering. Taken together, these results highlight the unique predictive contribution of reflective pondering on executive control, specifically for emotional information.

The recourse allocation hypothesis proposes that ruminative thinking precedes executive control (Ellis & Ashbrook, 1988) and the current findings provide partial support for this. However, unlike the RAH, our findings did not support the idea that engaging in ruminative or depressive thinking would deplete executive control. Instead, reflective pondering was predictive of greater executive control for emotional information at follow up. Although no research has directly reported the effects of reflective pondering on executive control for internally represented emotional information within adolescents, other research has highlighted reflective pondering as a positive construct. Indeed, reflective pondering has been associated

with recovery from depression (Arditte & Joormann, 2011; Verstraeten et al., 2010), reduced grief in bereavement (Eisma et al., 2015) and coping in adolescent girls (Burwell & Shrik, 2007). Our findings build on recent reports which found rumination to precede executive control. To our knowledge, Connolly et al. (2014) are the only authors to prospectively examine and report findings of the predictive relationship between executive control and rumination in an adolescent population. They found rumination at baseline was predictive of later difficulties on a measure of executive control (i.e. attention switching task). Our unique strategy of separating out reflective pondering and brooding rumination, as well as investigating executive control for emotional and non-emotional information added nuance to Connolly's (2014) findings. Our findings show that rumination precedes executive control, and specifically that reflective pondering was predictive of greater executive control for emotional information at follow up.

The current findings are in support of recent research with adult populations. Vanderhasself et al. (2012) found a prospective relationship between reflective pondering and executive control. The authors found participants with high levels of executive control (i.e. greater executive control) in comparison to participants with low levels of executive control at baseline were able later active reflective pondering in times of stress. Vanderhasself et al. (2012) were not able to test whether rumination would predict later executive control as executive control was only tested at baseline. Nevertheless, these findings, with our own, highlight the adaptive relationship between reflective pondering and executive control.

Contrary to previous research in adult samples (De Lissnyder, Koster, Goubert, et al., 2012; Koster et al., 2011) brooding rumination was not associated

with executive control in our sample. From a theoretical perspective, the current findings do not therefore offer support for the Impaired Disengagement Hypothesis (Koster et al., 2011). The IDH suggests the difficulty in disengaging attention from distracting information increases the risk for rumination, particularly brooding rumination. The adult literature does tend to support the theory that rumination is associated with impaired executive control (De Lissnyder et al., 2010; De Lissnyder et al., 2011; Whitmer & Banich, 2007), particularly brooding rumination (De Lissnyder, Koster, Goubert, et al., 2012), and even when depressive symptoms are controlled for (Joormann, Drake & Gotlib, 2006). A possible explanation for the current null finding could be due to the age of our sample. The mean age of our sample was 13 years old and it may be that executive control was not yet impaired enough or present for long enough to exert its effect to a degree that would be reflected in higher levels of brooding rumination.

There is also a possibility that conflicting findings within the literature arises from lack of consistency of follow up times in multi-wave, prospective studies. The length of follow up in studies which investigate executive control differs greatly across studies. Some studies opt for long intervals such as 10 years (Hankin, Abramson, Moffitt, Silva, McGee & Angell, 1998) and others short intervals such as 6 weeks (Abela, 2001). The time course in which different aspects of cognitive functioning develop and relate to changes in depressive symptoms across differing time frames is historically understudied (Hankin, 2012). Vanderhasself et al. (2012) utilised a 6 week time frame, testing young adult participants weekly within this time. The authors did not find a relationship between brooding rumination and executive control in their sample. Connolly et al. (2014) employed a 15 month follow

up, with two testing sessions and an adolescent sample and reported a relationship between rumination (as a whole construct) and a measure of executive control. The current study which had two testing sessions approximately six months apart did not find an association between brooding rumination and executive control. It is therefore argued that a follow-up period for examining the relationship between brooding rumination and executive control should be no less than 6 months.

The current study produced further findings of interest. Depressive symptoms were correlated with reflective pondering at wave 1 and were a significant predictor of reflective pondering at wave 2. There was no prospective relationship between depressive symptoms and any other study variable. One possible explanation for this finding is that those individuals experiencing depressive symptoms were trying to overcome their depressive symptoms by engaging in reflective pondering. Joormann et al. (2006) noted that individuals with elevated levels of depressive symptoms or a diagnosis of depressive disorder were more likely to engage in reflective pondering as well as brooding rumination in comparison to non-depressed individuals.

Age was a significant predictor of executive control for non-emotional information and sex was a predictor of executive control for emotional information at follow up. It should be noted that although the age range was 13-16 years, the mean age of the current sample was 13.85 years. Interestingly, as age increased so did switch costs (i.e. lower levels of executive control) for non-emotional information at follow up. This is in contrast to expected findings that younger adolescents would have greater switch costs. This finding must be taken with caution. Age only became marginally significant (p = .047) at step 2 of the analysis, once brooding rumination and reflective pondering were added to the model. This suggests a suppressor effect

where the effect of age only becomes significant with the inclusion of brooding rumination and reflective pondering. It was not surprising to find females were more likely than males to show greater switch costs, particularly for emotional information. The transition from childhood to adulthood is marked by significant changes in executive control (Rutter & Rutter, 1993). Neuropsychological research highlights sex differences in areas of the brain responsible for the processing of emotional information (Killgore, Oki, & Yurgelun-Todd, 2001; Lang, Greenwald, Bradley & Hamm, 1993). The finding that females had larger switch costs in relation to males could also reflect research findings that suggest that females are more at risk of developing depressive disorders that begin in adolescence and persist throughout adulthood than males (Piccinelli & Wilkinson, 2000). Adolescence marks a significant period of developmental and the current findings indeed highlight that it is important to control for the effects of age and sex when examining executive control.

The current study had multiple strengths. We used a prospective design and were able to investigate changes over time between multiple cognitive vulnerabilities within adolescent development. We were able to examine executive control by utilising a measure that included emotional and non-emotional aspects as well as employing a measure of rumination which permitted specific analysis of adaptive and maladaptive forms of rumination and their relationship with executive control. We also controlled for depressive symptoms and comorbid anxiety symptoms, as research has shown even subclinical anxiety and depression levels can adversely affect executive control (Ansari & Derakshan, 2010; 2011; Holmes & Pizzagalli, 2007).

In addition to these strengths, several limitations and future recommendations must be noted. Like previous research in this area (Connolly et al., 2014) we had one follow up session, after the initial baseline assessment. The use of multiple time points in the design, along with a longer follow up could have permitted a more advanced evaluation of the relationship between executive control and rumination in adolescence. For example, a seminal paper by Davidson and colleagues investigated age related differences across the development of executive function and control processing (see Davidson, Amso, Anderson, & Diamond, 2006 for full details). They noted that executive function and control processes, specifically switching ability, differed fundamental across age and was progressive past the age of 13 years. Future research that systematically examines executive control and rumination across varying time points can clarify more specifically how and when these factors begin to relate to one another and subsequently to depressive symptoms within and across development. Despite good internal consistency, the executive control task reported low/moderate test-retest reliability in our sample. As noted by many researchers in this area, tests of executive function and executive control are limited by their test-retest reliabilities (Burgess, 1997; Miyake et al., 2000). A recent review highlighted test-retest reliabilities as low as .20 for some cognitive tasks (Henry & Bettenay, 2010). Although not very well understood in the literature, Rabbitt (1997) argues that the ability to exert executive control is strongest when a task is novel and as a task can only be novel once this is likely to explain the modest test-retest reliabilities in this area.

Notwithstanding these limitations, the current findings support the recourse allocation hypothesis which proposes that ruminative thinking precedes executive

control (Ellis & Ashbrook, 1988) by showing that as reflective pondering was predictive of greater executive control (i.e. lower switch costs) for emotional information. To the author's knowledge, the current study is the first study to prospectively examine the directional relationship between emotional and non-emotional executive control and the subcomponents of rumination within adolescent development, while controlling for the possible effects of anxiety and depressive symptoms. Future research is warranted to confirm the predictive relationship between reflective pondering and executive control.

Chapter 5: General Discussion

5.1 Overview

The present thesis evaluated the theoretical underpinnings and relationships between three key vulnerability factors that have previously been highlighted within the literature as important in understanding depression. This was conducted through a series of three studies investigating eleven research questions specific to child and adolescent populations. Within this broad aim, a number of secondary aims were investigated. The project began with what felt as the most appropriate question: what research has already been conducted? It became apparent through the literature that OGM, rumination and executive control were three important vulnerability factors not only associated with the onset of depression but with strong relations to each other. Despite marked progression in identifying such factors, little is known about their developmental trajectories, how they relate to each other and how they manifest themselves in non-clinical adolescent populations. Previous literature has predominantly focused on adult populations, and the limited research with child and adolescent populations is driven by cross-sectional designs, and has produced a profusion of mixed findings. There is also an over reliance on examining one vulnerability factor with the exclusion of important others and misguided conclusions within the literature about child and adolescent populations based on studies with adults. Thus, a number of issues and gaps in the literature needed to be addressed.

It was unknown whether the most prominent and comprehensive model of OGM (the CaR-FA-X model; Williams et al., 2007) was applicable to child and adolescent populations, whether multiple vulnerability factors were better able to

explain the development of OGM than isolated factors or whether the factors associated with OGM provided an underlying vulnerability to later OGM or were simply a correlate of OGM. These issues were examined in the current thesis, along with investigations into whether OGM manifested itself differently in clinical and non-clinical populations, or differently due to task variations in OGM research. Following this, a prospective empirical examination of brooding rumination, reflective pondering and executive control for emotional and non-emotional information was conducted to investigate whether these factors predicted OGM, and whether these factors were better able to predict OGM in isolated or in interaction in a community sample of adolescents. Finally, investigations into the directional relationship between rumination and executive control were conducted, with attention given to the adaptive and maladaptive effects of rumination and differences between difficulties when processing emotional vs. non-emotional material.

The following sections will discuss the outcomes and observations of each of the three studies conducted and how the findings within and across each of the studies relate to and differ from that of previous research. The findings highlighted a number of theoretical and practical implications and these along with the overall limitations of the thesis are discussed. Recommendations for best practice in conducting future research are offered and finally a concluding statement highlighting the significant contribution of the thesis is presented.

5.2 Study 1: A narrative synthesis of the applicability of the CaR-FA-X model in child and adolescent populations: A systematic review

5.2.1 Summary of results

A systematic review of the CaR-FA-X model with child and adolescent populations was presented in Chapter 2 and was the starting point of the investigation. The review focussed specifically on the applicability of the CaR-FA-X model (Williams et al., 2007) in child and adolescent populations and examined the published and unpublished literature to identify the contribution researchers have made to our understanding of OGM. The aim was to identify which mechanisms of the model were associated with and predictive of OGM in isolation or in interaction and numerous moderating factors were investigated. As is often the case in systematic reviews, this process revealed gaps and trends within the literature, and recommendations for future research are offered.

The review findings concluded that capture errors, trauma exposure and to a lesser extent rumination, avoidance and impaired executive control were associated with OGM in child and adolescent populations. Specifically, capture errors were found across various task measures and reported in multiple sample populations including non-clinical community samples and adolescents reporting a history of abuse, even after controlling for any effects from current symptoms of depression. Rumination in isolation however, was only associated with OGM in clinical populations which suggests that rumination alone may not be sufficient enough to elicit OGM in the absence of clinical disorder. Capture errors or rumination alone were not found to be an underlying vulnerability to later OGM, however this finding cannot be seen as unequivocal, given the lack of prospective studies.

A majority of studies supported the role of trauma exposure on OGM, and this finding was reported across clinical and non-clinical populations. However, while almost all of the studies reporting a significant effect controlled for symptoms of depression, few studies controlled for the impact of symptoms of post-traumatic stress disorder (PTSD) when investigating the trauma-OGM relationship. It is currently unclear what role PTSD has on the relationship between trauma exposure and OGM but as PTSD was shown to account for the relationship between trauma history and OGM in some studies (Nixon et al., 2013, study 2), it is evident that further studies are needed to better establish the role of symptoms of PTSD when investigating the relationship between trauma exposure and OGM. Findings suggested that the trauma–OGM relationship was not influenced by the type of trauma as the relationship was found across different types of trauma (e.g. war exposure, sexual abuse, negative life events). Furthermore, the trauma-OGM relationship was not influenced by the measurement of trauma as the relationship was reported across self-reported cases of trauma, parental reports and documented cases as well as longitudinal follow up studies from childhood and across variations of the AMT. These findings suggest that trauma exposure is an underlying vulnerability to OGM in child and adolescent populations. It must be noted however that some reviewed studies did not find an association between trauma exposure and OGM which suggests that other factors (e.g. rumination or executive control) might be involved in the trauma and OGM relationship (as discussed in Chapter 2).

Exploring the developmental trajectories of OGM, the reviewed studies found that experiencing a severe traumatic event in middle childhood predicted a 60% risk of OGM at aged 13, yet experiencing a traumatic event in infancy did not predict

OGM in adolescence (Crane et al., 2014). This suggests that it is exposure to trauma in middle childhood, rather than in infancy that is associated with the development of OGM. While this finding is promising, the majority of research in this area used retrospective reports of trauma and further research with proximal measures of exposure are needed to collaborate these findings. The role of avoidance on OGM was less clear in the current systematic review. Three studies investigated avoidance specificity, one reported null findings (Hitchcock, Nixon & Weber, N.d), one found reduced specificity was correlated with higher avoidance, supporting the FA mechanism of the CaR-FA-X model (Stokes, Dritschel, & Berkerian, 2004), and the other found avoidance was associated with reduced levels of OGM, contradicting the CaR-FA-X model (Kuyken, Howell, & Dalgleish, 2006). The three studies varied widely in methodology, and it would be therefore erroneous to draw definitive conclusions, however it did highlight an area for potential future research.

In contrast to capture and rumination and the functional avoidance mechanisms of the CaR-FA-X model, the role of executive control on OGM was least supported. A majority of the reviewed studies did not find a relationship between executive control and OGM. However, there was some support found for the relationship between impaired executive control (i.e. inhibition and verbal fluency) and OGM (Raes, Verstraeten, Bijttebier, Vasey, & Dalgleish 2010; Valentino, Bridgett, Hayden, & Nuttall, 2012) and two studies (Hitchcock, Nixon & Weber, 2014b; Nixon, Ball, Sterk, Best, & Beatty, 2013; study 1) found that greater working memory capacity was associated with greater specificity and reduced OGM. In the studies which did find an association, the relationship was found across different population samples and across variations of AM measures. Symptoms of

depression in those studies were also statistically controlled for. This suggests that the relationship between executive control and OGM was not due to a particular population, measurement of OGM, or the effects from symptoms of depression. Too few of the reviewed studies investigated whether impairments in executive control were an underlying vulnerability to later OGM or simply a correlate of OGM and no study found impairment in executive control in isolation to predict OGM prospectively over time (although Hitchcock et al., 2014 found a relationship between greater working memory capacity and reduced OGM over time). Theoretical issues with the investigation of executive control were discussed and it was concluded that the lack of emotional material employed in cognitive tasks and the low ecological validity of tasks may have been a cause for null findings.

The systematic review presented in Chapter 2 also investigated the possibility that mechanisms of the CaR-FA-X model were better able to discriminate OGM in child and adolescent populations when in interaction, rather than in isolation. The review findings concluded that rumination in the context of impairment in executive control may be better able to explain the development of OGM than any mechanism in isolation, particularly in non-clinical community populations or in at risk samples. It was also shown that reflective pondering may act as a protective factor for later OGM, in the context of lower executive control when processing emotional information (Study 2 of the current thesis presented in Chapter 3). However, only four studies, two published (Hitchcock et al., 2014b; Rawal & Rice, 2012b) and two unpublished (Hitchcock et al., N.d; Stewart, Hunter, & Rhodes, N.d) presented findings on the interaction between mechanisms of the CaR-FA-X model with child and adolescent populations and no study examined the subcomponents of rumination

or the differential effects of emotional vs. non-emotional material used in executive control tasks (other than Study 2 of the current thesis which was included in the review). It was highlighted that future research is needed to address this gap.

5.2.2 Current vs. previous findings

The findings emerging from the systematic review differ from previous reports with adult populations. For example, a recent review of the CaR-FA-X model with predominantly adult studies (Sumner, 2012) found a robust association between rumination and OGM and reported that research findings on capture errors were mixed. In contrast, the systematic review in the current thesis found no support for rumination in non-clinical child and adolescent populations and reported that capture errors were found across various task measures and reported in multiple sample populations including non-clinical community samples and adolescents reporting a history of abuse. These findings highlight the importance of not drawing conclusions about child and adolescent populations from studies with adults.

A recent review of child psychopathology (Hitchcock et al., 2014a), demonstrated that capture and rumination was associated with OGM (although this was based on only two studies). Current review findings reported in Chapter 2 added nuance to Hitchcock et al.'s (2014a) review by including further studies and investigating potential differences due to the clinical status of the participant populations. The systematic review reported in the present thesis found capture errors were related to OGM in non-clinical populations whereas rumination was only associated to OGM in clinical samples. Thus, if capture errors and rumination relate to OGM in a different way depending on the clinical status of adolescent populations, this has important implications for the design of future research.

The findings from the current systematic review are in line with previous reviews that support the role of trauma exposure on OGM (Hitchcock et al., 2014a; Sumner, 2012). Moreover, similar to previous reviews (Sumner, 2012), the current findings suggest a lack of consistent support for the type of trauma having an effect on OGM. The role of functional avoidance more specifically (i.e. measurement of avoidance rather than trauma exposure) on OGM is less clear in child and adolescent populations to that of adult samples. Sumner's (2012) review supports the role of functional avoidance whereas the current review reported mixed findings. While there was documented support for the role of trauma exposure on OGM, there was a lack of comparable studies specifically examining avoidance with child and adolescent populations (three studies) to draw conclusions from. This makes it difficult to draw comparisons to previous literature however it does present a possible opportunity for future research.

The current review findings found little support for the executive control mechanism in isolation (although two studies found that difficulties in verbal fluency and inhibition were associated with OGM). This is in contrast to a previous review with predominately adult studies. Sumner (2012) found impaired executive control, especially deficits in inhibition, working memory capacity, the ability to update and maintain information in working memory, and verbal fluency to be associated with OGM, again further highlighting the differences between reviews that include adult populations and those specific to child and adolescent samples. Hitchcock et al. (2014a) found mixed results for inhibition, working memory capacity and verbal fluency in child and adolescent populations but offered no explanations for such findings. Numerous accounts for null findings between executive control and OGM

in the current systematic review were highlighted within the study (see Chapter 2). This included the possibility that executive control in interaction with other mechanisms (e.g. rumination) may be better able to explain OGM in child and adolescent populations.

Previous reviews with child and adolescent populations (Hitchcock et al., 2014a) have not investigated the interactive effects of multiple mechanisms on OGM and therefore current findings cannot be compared. Nonetheless, findings presented in the current thesis demonstrated a relationship between heightened levels of rumination and executive control on OGM. Such findings can only reinforce that when investigating the CaR-FA-X mechanisms as underlying vulnerabilities to OGM in child and adolescent populations, it is important to investigate the interactive effects between mechanisms. It may be that future research that investigates both rumination and executive control will be influential in accounting for more of the variance in OGM in child and adolescent populations.

5.3 Study 2: A prospective investigation of rumination and executive control in predicting overgeneral autobiographical memory in adolescence

5.3.1 Summary of results

The second study of the thesis was presented in Chapter 3 and aimed to empirically address some of the limitations highlighted within the literature (e.g. the use of non-emotional stimuli in cognitive tasks, investigating rumination as a whole construct). Specifically, this chapter investigated whether brooding rumination, reflective pondering or executive control for emotional and non-emotional information predict OGM in isolation or in interaction over time in a community sample of adolescents. Furthermore, this study investigated whether executive

control for emotional information was better able to explain OGM than when processing non-emotional information, and whether brooding rumination was better able to account for OGM than reflective pondering. These relationships were explored after partialling out any effects due to symptoms of depression or anxiety which have been shown to negatively impact cognitive tasks (Altamirano et al. 2010; Cisler & Koster, 2010).

The results showed that no mechanism predicated OGM in isolation, however reflective pondering and executive control when processing emotional information interacted to predict less OGM over time. Specifically, reflective pondering moderated the relationship between executive control for emotional information and OGM, such that lower executive control when processing emotional material predicted less OGM, but only when reflective pondering levels were high. Thus, findings from the second study suggest that reflective pondering can act as a protective factor against an overgeneral memory retrieval style, in the context of lower executive control. These findings were independent of age and gender, and over and above any effects from symptoms of anxiety or depression. No relationship was reported between reflective pondering and executive control for non-emotional processing, nor was any relationship found between brooding rumination and executive control when processing emotional or non-emotional information. Overall, the conclusions and contribution of this study was that rumination and executive control when processing emotional information are important factors in the development of OGM. The findings highlighted the importance for future research to consider the impact of the subcomponents of rumination and the different effects of

executive control when processing emotional vs. non-emotional information, when investigating the development of OGM in adolescent populations.

5.3.2 Current vs. previous findings

Findings from the second study reported in the thesis built upon previous work with child and adolescent populations. Rawal and Rice (2012b) found that high levels of rumination (as a whole construct) in the context of low executive control (when processing neutral information) predicted OGM at follow up. The current thesis findings add nuance to this by investigating rumination by its subcomponents and executive control when processing emotional and non-emotional information. As such, lower executive control when processing emotional material, in the context of high levels of reflective pondering was associated with less OGM over time. However, this relationship was not found when processing neutral information in the executive control task. While no previous research has examined executive control when processing emotional information and OGM in adolescence, and thus current findings cannot be compared in this way, the findings do tap into a separate literature which suggests a link between rumination and executive control on tasks requiring the processing of emotional material (Hilt, Leitze, & Pollack, 2014).

The findings from the second study and those reported by Rawal and Rice (2012) suggest that the interaction between executive control and rumination is important in understanding OGM, however some research has reported null findings when investigating this relationship. Hitchcock et al. (2014b) did not find rumination and executive control to interact to predict OGM over time. Conflicting results were discussed in Chapter 3 and it was concluded that differences in findings could have been due to task, sample, or age differences across the studies. For example, it is

possible that the neutrally valenced cognitive task employed in Hitchcock et al.'s (2014) study was not sensitive enough (i.e. the lack of emotional stimuli) to target the relationship between rumination and executive control in their trauma exposed pre-adolescent sample. Implications from this have been thoroughly discussed in Chapter 3 and emphasis on the importance for future research in the OGM area to consider the use of emotional tasks was noted.

The findings that rumination interacted with executive control to predict OGM in the current study was specific to reflective pondering. Brooding rumination did not predict OGM in isolation or in interaction with executive control (reported in Study 2, Chapter 3). The lack of relationship between brooding rumination and OGM has also been reported in previous studies with community adolescent samples. Schoofs, Hermans, and Raes (2012) in two studies did not find brooding rumination to be associated with OGM. It could be that brooding rumination is only associated with OGM in clinical populations, or in non-clinical but adult populations. However studies with child and adolescent populations are lacking and studies that compare child and adolescent samples with adult populations on the subcomponents of rumination and their relation to OGM has yet to be tested.

Taken together, current and previous findings highlight that rumination in the context of executive control are important factors to be considered together when aiming to better understand the development of OGM in adolescence. Furthermore, the findings presented in this thesis highlighted the possibility that reflective pondering may serve as an adaptive factor in this development. It is evident that further research is needed to clarify these findings as research in this area is limited. If rumination and executive control are implicated in OGM (which previous

literature links to depression), it begs the question as to whether rumination precedes executive control or if executive control perpetuates rumination.

5.4 Study 3: Reflective pondering predicts greater executive control for emotional information: An adolescent prospective study

5.4.1 Summary of results

The third study in the thesis moved on from looking at specific mechanisms predicting OGM and examined the relationship between rumination and executive control. Specifically, study three investigated whether rumination preceded executive control, whether executive control leads to rumination and whether the directional relationship between rumination and executive control was dependent on different aspects of rumination or produce different findings depending on whether the emotional or non-emotional stimuli was presented.

The results demonstrated that rumination preceded executive control. Specifically, higher levels of reflective pondering were predictive of lower switch costs (i.e. greater executive control) when processing emotional information. This relationship was present after accounting for age, gender, baseline executive control scores and symptoms of depression and anxiety. Conversely, brooding rumination did not predict executive control when processing emotion or non-emotion condition nor did executive control predict later brooding or reflective pondering. These findings suggest that, at least with a sample of non-clinical community adolescents, reflective pondering is a unique factor predicting greater executive control. While investigations of the relationship between rumination and executive control are on-going within the adult literature, and to some extent the child and adolescent literature, this is the first known report to show reflective pondering as a predictor of

greater executive control when emotional information is being processes in an adolescent population.

5.4.2 Current vs. previous findings

The thesis has assumed that the relationship between rumination and executive control is an important one and formed the basis for the third study. There has been only one previous prospective investigation of this relationship with an adolescent population (Connolly et al., 2014). While the results in the thesis support previous findings that rumination preceded executive control (Connolly et al., 2014), the current findings were novel in that they were able to show reflective pondering was predictive of greater executive control when processing emotional information. Thus, the current findings support previous research with adolescent populations and extend them to include the maladaptive and adaptive nature of the subcomponents of rumination and provide a greater understanding of executive control when processing emotional and non-emotional information. Of course, given the unique contribution to the literature, these findings need to be replicated and results compared.

Additional findings from the third study demonstrated that brooding rumination was not associated with executive control. This is in contrast to previous research with adults that demonstrates impaired executive control is associated with brooding rumination (De Lissnyder, Koster, Goubert, et al., 2012). Multiple suggestions are offered in Chapter 4 for this null finding, including the young age of the current sample. For example, it was suggested that lower executive control may not have been severe enough or present for long enough to exert a relation with brooding rumination. However, given that the current project is the only examination of the different effects of the subcomponents of rumination on executive control

when processing emotional and non-emotional material with an adolescent population, further research is needed to investigate the relationships before definitive conclusions can be offered.

5.5 Overall summary of findings

A developing theme throughout the literature and reported in the current thesis was the lack of child and adolescent studies which investigated the theoretical underpinnings of key vulnerability factors previously associated with the onset of depression. This is surprising given that adolescence marks an important time period for the development of depression. Only one former study had investigated the directional relationship between rumination and executive control in adolescence and the current systematic review found that only 26 studies (3 unpublished) had investigated potential vulnerabilities to the development of OGM (an important factor in the development of depression) with child and adolescent samples. Interestingly, previous reviews of the literature (Sumner, 2012; Williams et al., 2007) discuss the theoretical underpinnings of OGM with reference to child, adolescent and adult studies combined. This is erroneous given that the current findings highlighted within this thesis found that vulnerability to OGM seem to manifest differently in child and adolescent populations to that of previously reported findings with adult populations. This could be one reason for the mixed findings in the field.

One of the main arguments emphasised throughout all three studies was the importance of investigating rumination and its relationship to executive control. Findings from the systematic review highlighted that the interaction between rumination and executive control may be instrumental in understanding OGM. It has been argued throughout that brooding rumination and reflective pondering need to be

evaluated separately, and the use of emotional stimuli in executive control tasks may enhance the understanding of the rumination-executive control and OGM relationship. The substantial focus within previous literature on investigating rumination as a whole construct and applying neutrally valenced executive control tasks was argued as a possible reason for the mixed results reported within adolescent (and potentially adult) studies. Moreover, most of the studies identified utilised cross-sectional designs that could not offer suggestions on causality, or recruited participants who were already depressed. This limits the ability to provide a greater understanding of the developmental trajectories of OGM. It is apparent that vulnerability research is an area with a lot of opportunity for future development.

The findings reported across the current thesis have demonstrated that reflective pondering is a unique contributing factor for the development of memory specificity, particularly that reflective pondering can serve as a protective factor in the relationship between executive control and OGM. Reflective pondering was also found to precede executive control and greater reflective pondering was predictive of greater executive control when processing emotional information over time. Taken together, the findings reported throughout this thesis strongly suggest that reflective pondering may be influential in providing an enhanced understanding of OGM and executive control.

5.5.1 Research Questions

In response to the eleven research questions set out in the introduction, below is a brief summary of answers to each question.

1. *Is the CaR-FA-X model applicable to child and adolescent populations?*

The thesis findings concluded that there is partial support for the applicability of the CaR-FA-X model in child and adolescent populations. For example, strong support was found for capture errors, trauma exposure. However, less support was found for impaired executive control and functional avoidance directly. The lack of studies, measurement issues and differences in sample populations were highlighted as potential explanations.

2. *Are the CaR-FA-X mechanisms better able to explain OGM in isolation or in interaction in child and adolescent populations?*

The findings reported within the thesis concluded that rumination and executive control in interaction may be better able to explain OGM than in isolation, particularly in non-clinical community populations or in at risk samples. However, there is a lack of studies investigating the interactive effects of the mechanisms with child and adolescent populations. Further research is needed to investigate the interactions between the CaR-FA-X mechanisms, specifically direct measures of functional avoidance are warranted.

3. *Does the CaR-FA-X model account for OGM in a different way in clinical and non-clinical populations?*

The capture and rumination mechanism of the CaR-FA-X model was found to differentiate between clinical and non-clinical populations. In particular, rumination in isolation was only associated with OGM in clinical populations. There were too few studies investigating the functional avoidance mechanism directly to provide a suffice answer to this question. However, trauma exposure more generally as an indirect measure of functional avoidance was associated with OGM across clinical and non-clinical studies which suggests that at least for trauma exposure, the CaR-FA-X model does not account for OGM in a different way in clinical and non-

clinical populations. Similarly, the relationship between executive control and OGM was reported across clinical and non-clinical populations.

4. *Do the CaR-FA-X mechanisms represent a vulnerability to the development of OGM?*

The capture and rumniation mechanism in isolation was not found to be an underlying vulnerability to later OGM, however this finding cannot be seen as unequivocal, given the lack of prospective studies. Similarly, the direct measurement of functional avoidance and impaired executive control over time was lacking and therefore further research is needed before a concise answer can be provided. Trauma exposure as an indirect measure of FA was found to be a vulnerability to later OGM in child and adolescent populations.

5. *Is executive control for emotional information better able to explain OGM than executive control when processing non-emotional information?*

Executive control for emotional and non-emotional information, in isolation, as measured in the empirical studies within this thesis was not associated with OGM. Therefore, it is currently not known whether executive control for emotional information is better able to explain OGM than executive control when processing non-emotional information. Further research is needed.

6. *Is brooding rumination better able to account for OGM than reflective pondering?*

Brooding rumination and reflective pondering in isolation were not associated with OGM in the current thesis. Therefore, it is currently not known whether brooding rumination is better able to account for OGM than reflective pondering. Further research is needed.

7. *Does brooding rumination, reflective pondering or executive control for emotional and non-emotional information predict OGM over time in a community sample of adolescents?*

Brooding rumination, reflective pondering and executive control for emotional and non-emotional information in isolation did not predict OGM over time in the community sample of adolescents recruited in the current thesis.

8. *Does brooding rumination, reflective pondering or executive control for emotional and non-emotional information interact to predict OGM over time in a community sample of adolescents?*

Reflective pondering and executive control when processing emotional information interacted to predict less OGM over time. Specifically, reflective pondering moderated the relationship between executive control for emotional information and OGM, such that lower executive control when processing emotional material predicted less OGM, but only when reflective pondering levels were high. No other mechanisms interacted to predict OGM.

9. *Does rumination precede the development of executive control or does executive control lead to rumination?*

Rumination was found to precede executive control in a community sample of adolescents. Executive control was not predictive of later rumination.

10. *Is the directional relationship between rumination and executive control dependent on different aspects of rumination?*

Yes. Reflective pondering was predictive of later executive control whereas brooding rumination was not associated with executive control over time.

11. *Does the directional relationship between rumination and executive control produce different findings when difficulties are specific to emotional or non-emotional information processing?*

Yes. Reflective pondering was predictive of later executive control but only when processing emotional information and not non-emotional information.

The theoretical and practical implications resulting from the findings in the thesis are considered in the subsequent sections.

5.6 Implications

5.6.1 Theoretical implications

The findings in the current thesis provide partial support for the applicability of the CaR-FA-X model (Williams et al., 2007) in child and adolescent populations. However, as noted in Chapter 2, the mechanisms (e.g. rumination) of the model can account for OGM differently depending on the clinical status of the participants. It could be argued that, at least for non-clinical child and adolescent populations, rumination as a whole construct is not an underlying vulnerability to OGM but only predicts OGM in young people who are already depressed. This has implications for the CaR-FA-X model as a model of vulnerability to OGM *prior* to clinical disorder. If OGM is a cognitive marker for later depression (Sumner et al., 2011), and rumination is a theoretical underpinning of OGM (Williams et al., 2007), it would be expected that rumination would predict OGM in non-clinical populations who may be at heighted risk of depression (e.g. adolescents). However, rumination alone (as a whole construct) was not found to predict OGM in non-clinical adolescent populations.

The findings from the empirical data reported in this thesis indicated that when rumination was split into subcomponents (brooding, the maladaptive form and reflective, the adaptive form), brooding rumination did not predict OGM, similar to the findings reported in the systematic review in non-clinical populations. However, reflective pondering was found to interact with executive control for emotional information to predict less OGM (i.e. greater memory specificity). This suggests that reflective pondering was acting as a protective factor between executive control and OGM. The CaR-FA-X model does not account for the different functions of the

subcomponents of rumination, the inclusion of protective factors, nor any differences of applicability of the model between adult or child and adolescent populations or the clinical status of populations. The findings presented in this thesis suggests that the model needs to be refined with specific attention given to child and adolescent populations, while accounting for the different effects between clinical and non-clinical adolescents. Furthermore, given the finding that reflective pondering may act as a protective factor between executive control and OGM, the model could be refined to include reflective pondering as a possible protective factor to OGM, specifically in non-clinical adolescent populations, who may present with lower executive control.

From a theoretical perspective, the thesis findings do not support the Impaired Disengagement Hypothesis (IDH; Koster et al., 2011). The IDH suggests the difficulty in disengaging attention from distracting information increases the risk for rumination, particularly brooding rumination and this was not found in the current thesis. However, the findings do provide partial support for the Resource Allocation Hypothesis (RAH; Ellis & Ashbrook, 1988) as rumination did precede executive control but not in the way the model suggests. Unlike the RAH, the findings presented in this thesis did not support the theory that engaging in ruminative or depressive thinking would deplete executive control but instead reflective pondering was predictive of greater executive control when processing emotional information. Very few theoretical models account for adaptive and possible protective factors in their models. The IDH does suggest that brooding rumination in particular could result from impaired executive control, however the model does not offer a theoretical framework for reflective pondering. It is evident

from the current findings that reflective pondering plays an important role in executive control and also OGM and theoretical models should be advanced to account for more sophisticated literature, which include protective and adaptive factors. Not only do the current findings have implications for current theoretical models, but they also have important practical implications.

5.6.2 Practical implications

As highlighted in Chapter 1, investigating vulnerability factors to depression in community samples can inform wide reaching school-based preventative interventions (Corrieri et al., 2014) and adolescents have been shown to be more open to preventative interventions in school based settings (Klingman & Hochdorf, 1993). Given that one of the main themes emerging from the thesis was the adaptive nature of reflective pondering, it is suggested that interventions aimed at increasing reflective pondering could improve executive control, and reduce OGM which in turn may lead to decreased symptoms of depression. It is important to note however that in the third study (Chapter 4), symptoms of depression were positively correlated with and predicted later reflective pondering. As discussed within the chapter, it may have been that the adolescents experiencing symptoms of depression were trying to overcome their symptoms by engaging in reflective pondering.

Literature presented in Chapter 1 noted that reflective pondering may have different effects depending on the clinical status of the sample. For example, while reflective pondering has been shown to be distinctive from brooding rumination in non-clinical populations (i.e. the adaptive and maladaptive nature of the subcomponents), this distinction was not found in adults who were currently depressed (Whitmer & Gotlib, 2011). Likewise, Joormann et al. (2006) concluded a

similar idea as they found reflective pondering to have different effects within a clinical group in comparison to a non-clinical group. They suggested that while brooding rumination and reflective pondering were separate variables in non-clinical groups, in clinical samples reflection and brooding perpetuate each other, concealing any distinction between them. Thus, reflective pondering may be adaptive in non-clinical populations, however in clinical populations the adaptive qualities of reflective pondering can become blurred with the maladaptive qualities of brooding rumination. If this is the case, it might help explain why symptoms of depression in study three predicted later reflective pondering (i.e. reflective pondering was not in the adaptive form). Whereas, when symptoms of depression were controlled in the analysis, reflective pondering was adaptive and predicted greater executive control. Consequently, if reflective pondering only has adaptive features in the absence of depression, it would be important for interventions targeting reflective pondering to be aimed at adolescents *prior* to the onset of depression.

It has also been reported in previous studies with adults that reflective pondering may become maladaptive when it co-occurs with brooding rumination (Takano & Tanno, 2009). This finding suggests that reflective pondering may become maladaptive by reactive or judgemental thoughts, especially in the context of brooding rumination, when self-negative judgements are more easily accessible. Taken together, these findings suggest that reflective pondering can be adaptive but this may be specific to individuals in the absence of depression. This has implications for developing preventative interventions and highlights an important area for further research, particularly with child and adolescent populations.

5.6.3 Impact on policy

As we learn more about the developmental trajectories and relationships between OGM, rumination and executive control and highlight protective factors, the understanding of risk to depression will improve. The mental health strategy for Scotland (2012-2015) and the Scottish Government's suicide prevention strategy (2013-2016) set out a number of objectives to improve mental health and reduce suicide rates. One of the key policy priorities is to investigate and address the underlying causes of distress, discover an evidence base in this area and develop preventative interventions. The focus on 'prevention' was highlighted in the mental health strategy as central to taking forward mental health policy in Scotland. With this in mind, the research presented in this thesis builds on these strategies through identifying the theoretical underpinnings of important risk factors associated with psychopathology but further investigation is needed before recommendations for policy change can be made.

The findings presented in this thesis highlighted reflective pondering as an important factor that can lead to greater executive control and less OGM, two factors highlighted in previous research that are implicated in the onset of depression. This suggests that reflective pondering may be a valuable target in preventative interventions, a key objective in the mental health policy for Scotland. Although reflective pondering seems to act as an adaptive factor, these were novel findings in an adolescent population. The relationships between rumination, executive control and OGM continue to be debated and developed within the literature. The advice to policy makers is to exert caution over the use of these preliminary data for policy

making purposes. Further research is needed before such findings should impact policy change.

5.7 Limitations and future research

Limitations and suggestions for future research specific to each study have been highlighted in the corresponding study chapters. Limitations ranged from the inability to conduct a meta-analysis on the data within the systematic review, the length of time between and the number of follow up testing sessions, low to moderate test-retest reliability of the executive control task, the inability to differentiate between different aspects of executive functions within the executive control task and the implications that follow from finding novel results (i.e. the need for replication). These have already been discussed and further research opportunities taking account of these limitations have been highlighted throughout the thesis.

In a more general sense, there were limitations of the research project as a whole. Due to practical time restrictions involved in testing and given the overlap of IQ with measures of executive control (Ardila, Pineda, & Rosselli, 2000; Baron, 2003; Friedman et al., 2006), and the heavy focus on executive control in the current thesis, it was decided that IQ would not be measured. It should be noted that lower IQ has been associated with reduced memory specificity (Heron et al., 2012) which would suggest that reduced IQ may be a contributing factor in OGM. However, Heron et al. (2012) with the same sample of adolescents demonstrated that verbal IQ was not associated with levels of memory specificity. This suggests that OGM is not simply a bi-product of lower IQ and the finding the IQ was related to OGM most likely reflects impairment in executive control, which is a contributing factor for OGM. Controlling for IQ when investigating impairment in executive control as a

predictor of later OGM, would therefore likely have partialed out any effect of executive control on OGM.

While justification is provided for the absence of an IQ measure, empirically there is mixed literature for the relation between IQ and measures of executive control. In child and adolescent populations, some authors report no associations between measures of executive tasks and IQ (Welsh, Pennington, & Groissier, 1991) whereas others report high overlap (Arffa, 2007). Therefore the possibility that lower IQ could have impacted scores on cognitive tasks is certainly viable, however there is reason to believe that the current results still represent true findings. For example, a majority of research in this area does not control for IQ and those which have controlled for IQ have shown rumination and executive control to predict OGM, independent of IQ levels (Rawal & Rice, 2012b). Additionally, the measure of executive control in the current study is predominately a switching task (although it does tap into other functions) and research has shown that switching ability is not strongly related to IQ (Friedman et al., 2006). Furthermore, the sample in the current research project forms a young community adolescent population and therefore any detrimental effects such as reduced IQ associated with increased severity of clinical depression (Iverson, Turner, & Green, 1999; Kaufman & Lichtenberger, 2006; Sackeim et al., 1992) would likely be minimised.

In relation to the community sample, a further limitation can be drawn. The aim of the current thesis was to examine multiple vulnerability factors in a community sample of adolescents, in order for findings to potentially inform theory and school based preventative interventions not targeted at specific populations (e.g. adolescents at familial risk of depression). For this reason, the recruitment of

adolescents was conducted to reflect a general school sample of adolescents (i.e. without exclusion). However, it is possible that some participants within the sample may have had prior or current psychiatric disorder. This means that while results are representative of a general community sample of adolescents, they may not reflect an adolescent sample *prior* to the onset of clinical disorder (or generalise to clinical populations). To determine whether results generalise to clinical or non-clinical populations prior to any psychiatric disorder onset, future research with clinical adolescent populations or non-clinical populations with exclusion of prior disorders would be needed. Despite this limitation, the current findings are representative of a community sample of adolescents and all findings reported controlled for the possible effects of symptoms of depression and anxiety (which have been shown to affect the thesis tasks and outcome variables). It was also noted (see Chapter 3 and 4) that symptoms of anxiety and depression were minimal to mild within the current sample. Although this does not exclude the possibility of prior (or current) disorder within the sample, it does allow the ability to confidently draw conclusions about the findings, independent of current symptoms of anxiety and depression.

A final limitation of the experiments is that although reflective pondering has demonstrated a beneficial effect on executive control and OGM, the long term consequences of maintaining such a ruminative style was not explored. This is important to note as Williams et al., (2007) suggested that OGM will lead to emotional disturbance (e.g. depression) if used over the longer term and it may be possible that reflective pondering can serve as a protective factor against the development of such emotional disturbance. While the current findings suggest that reflective pondering was associated with greater executive control and less OGM,

this was examined over a six month period and no comment can be made regarding any adaptive (e.g. protective against the development of depression) or maladaptive outcomes (e.g. development of depression) over a longer time course. It would be interesting for future research to explore whether reflective pondering leads to greater executive control and decreased OGM, in turn protecting against the development of depression.

5.8 Concluding remarks

Depression is a heterogeneous disorder, characterised by rising prevalence, high relapse rates associated with an conspicuous amount of negative outcomes to the person (e.g. health, academic, and social issues) and society (e.g. workplace absences, rising economic cost). It was argued in the present thesis that in order to adequately tackle these problems, a sophisticated understanding of the underpinnings and relationships between multiple vulnerability factors (both cognitive and emotional) linked with the onset of depression was required. These relationships warranted investigation particularly within adolescence as this time period marks a time in development associated with rises in rumination, cognitive change and the onset of depression.

In pursuit of this aim, the present thesis identified multiple gaps within the literature and presented numerous novel findings in response to these gaps. In turn, the results reported across the thesis have added a unique contribution to the literature and have highlighted numerous areas for potential further research. The current research project evaluated these aims with several different methodologies including a systematic review of the child and adolescent literature and through experimentally exploring the relationships between overgeneral autobiographical

memory, rumination and executive control with a community sample of adolescents. Results of these studies have provided partial support for the applicability of the CaR-FA-X model in child and adolescent samples, with future research recommendations and refinements of the model presented. This offered a significant novel contribution to the field as the findings within the systematic review highlighted differences between clinical and non-clinical adolescent samples, that interactions between the mechanisms may be better at accounting for OGM than in isolation as well as an emphasis on possible protective factors. These findings further highlighted the difference between the applicability of the CaR-FA-X model with child and adolescent populations from previous research with predominantly adult samples.

Results also highlighted the important different effects of the subcomponents of rumination and the significance of investigating executive control when processing emotional information. The data highlighted reflective pondering acted as a moderating factor in the relationship between executive control when processing emotional material and OGM, and was a marker for lower switch costs (i.e. greater executive control) when processing emotional material over time. No effects were found for brooding rumination or executive control when processing non-emotional material. Therefore examining rumination as a whole construct, and employing only neutrally valenced tasks of executive control is strongly advised against when examining these vulnerabilities. Finally, suggestions have been made for future research, refinements to theoretical models have been offered and advice noted for preventative intervention research. While a great deal of further research is required before a complete understanding of the development of depression (and protective

factors against its development) is achieved, the present thesis contributes to efforts and offers suggestions for avenues of research which may prove beneficial.

Taken together, the novel findings presented within this thesis add nuance to existing literature and contribute to gaining a greater understanding of the theoretical underpinnings of OGM and the relationship between rumination and executive control. Thus, theoretical researchers and intervention researchers alike should consider the importance of evaluating executive control (when processing emotional and non-emotional information) and rumination (by its subcomponents) and the influence of OGM when investigating vulnerability to depression in adolescents. The potential impact of providing a greater understanding of these vulnerability factors may help to improve understanding of depression and reduce some of the difficulties faced by a substantial proportion of the population.

Chapter 6: References

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Chapter 7: Appendices

7.1 Appendix A: Letter to Local Education Authorities

Letter to Council

Department: School of Psychological Sciences and Health

Title of study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

Dear,

My name is Tracy Stewart and I am a postgraduate psychology student at the University of Strathclyde, undertaking my PhD in psychological research. I am writing to request permission to invite schools in your authority to participate in a study that will explore how the way in which young people think can affect the way that they feel and act. Specifically, I am interested in investigating how young people remember past memories, how young people think and act when they feel sad or down and how they switch between different thoughts and actions. I am particularly interested in recruiting adolescents between the ages of 13 and 16 years old as this is the time period which is critical for the development of depressive symptoms. If granted permission I plan to investigate the initial development of depressive symptoms and how any initial symptoms develop and change over a six month period. This means that the adolescents will be asked to complete a range of tasks at time 1 and then again six months later at time 2. My aim is to gain a better understanding of what factors make a young person vulnerable to develop depressive symptoms so that more appropriate preventative interventions can be developed.

I am keen to recruit participants from schools throughout your authority. If I am granted permission by the schools, I would like approximately 134 adolescents between the ages of 13-16 years to take part in my research study. The adolescents will be tested in groups of two across a range of tasks. The first task will be a short picture vocabulary task. The researcher will say a word and the participant will be asked to select a picture from four alternatives that best illustrates the words meaning. The second task will involve showing the participant a ‘cue word’ (i.e. happy) and they will be asked to respond with a memory that reminds them of this word. The participant will complete a computer task that will ask them to keep a mental count of the number of faces presented on a screen (i.e. the number of female faces and the number of male faces). After a break, the next questionnaire will ask

the participant to indicate from a list of statements how often they respond to a low mood or feeling sad in a particular way. For example, they will be asked how often they think "why can't I handle things better?" Lastly, the participants will be invited to complete two short questionnaires that measure the occurrence of depressive symptoms and anxiety symptoms. Again these will be presented as a list of statements and the participant will be asked to indicate whether or not these statements apply to them.

The tasks will take approximately 1 hour in total to complete. Written consent will be obtained from the parents and written assent will be obtained from the adolescents to verify participation in this study. No school or individual pupils will be identifiable in any written reports. Information provided by children will not be shared with parents or teachers. I have been approved full PVG membership by disclosure Scotland (PVG membership No. 1201188368340387) and the study has been granted ethical approval by the School of Psychological Sciences and Health Ethics Committee.

I hope you will allow schools in your authority to take part in this study. I will, of course, be happy to send you a report based on the findings from the research and would be happy to discuss them with you. If you would like any further information please do not hesitate to contact myself or my supervisor Dr Sinead Rhodes. If you wish to contact an independent person to whom any questions may be directed or further information may be sought from, you can also contact the Chair of the Ethics Committee, Dr Susan Rasmussen.

Yours sincerely,

Tracy Stewart

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7.2 Appendix B: Letter to head teachers

Letter to head teacher

Department: School of Psychological Sciences and Health

Title of study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

Dear,

My name is Tracy Stewart and I am a postgraduate psychology student at the University of Strathclyde, undertaking my PhD in psychological research. I am writing to request permission to invite some of your pupils to participate in a study that will explore how the way in which young people think can affect the way that they feel and act. Specifically, I am interested in investigating how young people remember past memories, how young people think and act when they feel sad or down and how they switch between different thoughts and actions. I am particularly interested in recruiting adolescents between the ages of 13-16 years old as this time period is critical for the development of depressive symptoms. If granted permission I plan to investigate the initial development of depressive symptoms and how any initial symptoms develop and change over a six month period. This means that the adolescents will be asked to complete a range of tasks at time 1 and then again six months later at time 2. My aim is to gain a better understanding of what factors make a young person vulnerable to develop depressive symptoms so that more appropriate preventative interventions can be developed.

I would like approximately 134 adolescents between the ages of 13-16 years to take part. They will be tested in groups of two across a range of tasks. The first task will be a short picture vocabulary task. The researcher will say a word and the participant will be asked to select a picture from four alternatives that best illustrates the words meaning. The second task will involve showing the participant a 'cue word' (i.e. happy) and they will be asked to respond with a memory that reminds them of this word. Next, the participant will complete a computer task that will ask them to keep a mental count of the number of faces presented on a screen (i.e. the number of female faces and the number of male faces). After a break, the next questionnaire will ask the participant to indicate from a list of statements how often they respond to a low mood or feeling sad in a particular way. For example, they will be asked how often they think "why can't I handle things better?" Lastly, the participants will be invited to complete two questionnaires that measure the occurrence of depressive symptoms and anxiety symptoms. Again these will be presented as a list of

statements and the participant will be asked to indicate whether or not these statements apply to them.

The tasks will take approximately 1 hour in total to complete. Written consent will be obtained from the parents and written assent will be obtained from the adolescents to verify participation in this study. No school or individual pupils will be identifiable in any written reports. Information provided by children will not be shared with parents or teachers. I have been approved full PVG membership by disclosure Scotland (PVG membership No. 1201188368340387) and the study has been granted ethical approval by the School of Psychological Sciences and Health Ethics Committee. I have further been granted permission from your local authority to carry out this study.

I hope you will allow pupils from your school to take part in this study. I will, of course, be happy to send you a report based on the findings from the research and would be happy to discuss them with you. If you would like any further information please do not hesitate to contact me or my supervisor Dr Sinead Rhodes. If you wish to contact an independent person to whom any questions may be directed or further information may be sought from, you can also contact the Chair of the Ethics Committee, Dr Susan Rasmussen.

Yours sincerely,

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Phone: 0141 548 4284

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7.3 Appendix C: Parent/Guardian information sheet

Parent information sheet

Name of Department: School of Psychological Sciences and Health

Title of the study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

My name is Tracy Stewart and I am a postgraduate student at the University of Strathclyde, undertaking my PhD in psychology. You child is being invited to take part in a two time point research study. This means that your child will be invited to complete a range of tasks and after a period of six months your child will be invited again to complete the same tasks. Before you decide, it is important for you to understand why the research is being carried out and what it will involve. Please take the time to read the following information sheet carefully.

What is the purpose of this investigation?

This study is being conducted in order to investigate how the way in which young people think can affect the way that they feel and act. Specifically, I am interested in investigating how young people remember past memories, how young people think and act when they feel sad and how they switch between different thoughts and actions. Previous research has suggested that thoughts and feelings can change considerably over the adolescent period and that adolescents can begin to develop unwanted thoughts and feeling such as depressive thoughts. Due to this research I am interested in looking at the differences between the adolescent's responses on a range of tasks between time 1 and six months later at time 2. This means that I will be inviting your child to complete a range of tasks at a particular time and after six months I will be inviting them once again to complete the same tasks. If we can gain a better understanding of what factors make a young person vulnerable to these thoughts then more appropriate preventative interventions can be developed.

Does your child have to take part?

No, they do not have to take part, and participation in this study is entirely voluntary. Your child may withdraw from this study at any time without giving a reason. You may also withdraw your child's data after the experiment has finished if you change

your mind by contacting myself or my supervisor prior. As stated above your child will be invited to complete a range of tasks at time 1 and then again 6 months later at time 2. You can withdraw your child's data from time 1 up until the 28/03/2014. After this date your child's answers will be mixed with the other adolescent's answers and individual responses will not be able to be identified. If your child assents to taking part in the second stage of this research study, which will take place six months after stage one, you may withdraw your child's data from time 2 up until the 30/09/2014. Again after this date your child's answers will be mixed with the other adolescent's answers and individual responses will not be able to be identified.

What will my child have to do in the project?

To be part of this study there would be a few tasks that I would ask your child to complete. The first task that your child will complete is a memory task. I will show your child a range of words (i.e. smile) and will ask them to recall a memory that reminds them of that word. Next, your child will complete a short computer task. They will be invited to count the number of faces they see on the screen (i.e. how many female faces and how many male faces). Following on from this task after a break your child will be shown another set of statements. These statements are about things people do when they feel down or sad. An example of a statement on this questionnaire is "how often do you think - why can't I handle things better?" Your child will then be asked to indicate how often they think this by circling one of the answers which range from 'never' to 'always'. Lastly, your child will be asked to fill out another two short questionnaires by circling the answer that most applies to them. These questionnaires ask your child about depressive symptoms and anxiety symptoms that they may have experienced. The tasks will take approximately 1 hour in total to complete. As I am interested at looking at how the way in which young people think can change over time I will be inviting your child to complete the same tasks described above 6 months after they have completed the first set of tasks.

Why has my child been invited to take part?

Your child has been invited to take part in this study due to your child being within the age range of interest (13-16 years).

What happens to the information in the project?

The information your child gives will be kept confidential and will be securely stored. Information provided by children will not be shared with parents or teachers. The questionnaires will be stored in a locked cabinet within the University of Strathclyde, and the computerised data will be stored on a password protected

computer within the University of Strathclyde for a period of 5 years, and will only be viewed by the researchers in this study.
The University of Strathclyde is registered with the Information Commissioner's Office who implements the Data Protection Act 1998. All personal data on participants will be processed in accordance with the provisions of the Data Protection Act 1998.

What happens next?

If you would like your child to take part in this project you will first be asked to **complete a consent form and return it back to your child's school**. Once I receive your consent your child will then be asked if they would like to take part. If they give written assent they will be invited to complete the tasks discussed above. This will take place within the school, during school hours.
If you do not wish to take part thank you very much for your interest and for taking the time to read this information sheet.

What happens to the information in the project?

Don't worry, nobody else will know what your answers are as your results will be put in with the other young peoples and no one else will be able to tell which answers are yours. The information you give will be kept confidential and will be locked away safe. This means that it will only be myself and my supervisors that are allowed to look at the answers you give. The answers that you give in the research study will not be shared with your parents or teachers either. The questionnaires will be stored in a locked cabinet within the University of Strathclyde, and the computerised data (the answers from the faces task on the computer) will be stored on a password protected computer within the University of Strathclyde for a period of 5 years, and will only be viewed by the researchers in this study.

Thank you for reading this information – please ask any questions if you are unsure about what is written here.

What happens next?

Your parent/guardian has completed a consent form and they are happy for you to participate in this study. If you are happy with what you have read here and would still like to take part I will give you an assent form to read and sign. You will be asked to read and sign the assent form to let me know if you would still like to take part.

If you do not wish to take part thank you very much for your interest and for taking the time to read this information sheet.

If you have any questions/concerns, during or after the study, or you might want to speak to someone else who is not part of the study then you can contact:

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7.4 Appendix D: Parent/Guardian consent form

Parent consent form (for child's participation)

Department: School of Psychological Sciences and Health

Title of study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

Please complete and return this form to your child's school and indicate whether you DO or DO NOT wish your child to participate.

- I understand that all information collected is confidential and that no responses will be linked to information provided in this consent form.

- I confirm that I have read and understood the information about the study described in the attached letter to me, and the researcher has answered any queries to my satisfaction.

- I understand that my child's participation is voluntary and that my child is free to withdraw from the study at any time, without having to give a reason and without any consequences.

- I understand that I can request to have my child's data from stage one of the study (time 1) removed from the study up until the date of 28/03/2014 by contacting the researcher or their supervisor.

- I understand that I can request to have my child's data from the second stage of the study (time 2) removed from the study up until the date of 30/09/2014 by contacting the researcher or their supervisor.

(Please tick one box only)

I AGREE to my child participating in this study ☐

I DO NOT AGREE to my child participating in this study ☐

NAME (of child): _____
NAME (PARENT/GUARDIAN):_____
SIGNATURE OF PARENT/GUARDIAN: _____

7.5 Appendix E: Child information sheet (Wave 1)

Child information sheet (Time 1)

Name of Department: School of Psychological Sciences and Health

Title of the study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

My name is Tracy and you are being invited to take part in my two time point research study. This means that I will invite you to complete a range of tasks and after a period of six months I will invite you again to complete the same tasks. Before you decide whether or not you would like to take part, it is important for you to understand why I am doing this research and what you will be invited to do. Please take the time to read the following information.

What is the purpose of this research study?

This study is being carried out to investigate how the way in which young people think can affect the way that they feel and act. Specifically, I am interested in looking at how young people, like you, remember past memories, how young people think and act when they feel sad and how young people switch between different thoughts and actions.

Do I have to take part?

No, you do not have to take part, participation in this study is entirely voluntary. This means that it is up to you if you want to take part or not. If you decide that you would like to take part and later change your mind that is fine. You can stop being part of this study at any time without having to give a reason. You can also ask to have your answers removed from the study up until the 25/04/2014. After this date all of your answers will be mixed with the other young people's answers and I will not be able to tell what answers are yours. This means that I will not be able to remove your answers from the study.

What will I have to do in the project?

To be part of my study there would be a few tasks that I would ask you to complete. The first task will involve you remembering a past memory. For example, I will show you the word 'smile' and I will then ask you to remember a memory that reminds you of that word. Next, you will be asked to complete a short computer task. You will be asked to count the number of faces you see on the screen (i.e. how many male/female faces). Following on from this task after a break you will be shown another list of statements. These statements are about things people do when they feel sad. For example one statement reads "how often do you think - why can't I

handle things better?" You will then be asked to indicate how often you think this by circling one of the answers which range from 'never' to 'always'. Next, you will be asked to fill out another two questionnaires by circling the answer that most applies to you. These ask you about depressive and anxiety symptoms that you may experience. It will take about 1 hour to complete all the tasks.
As I am interested at looking at how young people's thoughts, like yours, can change over time I will ask you to complete the tasks described above and then to complete them again 6 months later. If you take part the first time but decide after that you do not want to take part again that is fine, you do not have to take part or give any reason for not wanting to.

Why have I been invited to take part?

You have been invited to take part in this study due to you being within the age range of interest (13-16 years old).

What happens to the information in the project?

Don't worry, nobody else will know what your answers are as your results will be put in with the other young peoples and no one else will be able to tell which answers are yours. The information you give will be kept confidential and will be locked away safe. This means that it will only be myself and my supervisors that are allowed to look at the answers you give. The answers that you give in the research study will not be shared with your parents or teachers either. The questionnaires will be stored in a locked cabinet within the University of Strathclyde, and the computerised data (the answers from the faces task on the computer) will be stored on a password protected computer within the University of Strathclyde for a period of 5 years, and will only be viewed by the researchers in this study.

Thank you for reading this information – please ask any questions if you are unsure about what is written here.

What happens next?

Your parent/guardian has completed a consent form and they are happy for you to participate in this study. If you are happy with what you have read here and would still like to take part I will give you an assent form to read and sign. You will be asked to read and sign the assent form to let me know if you would still like to take part.

If you do not wish to take part thank you very much for your interest and for taking the time to read this information sheet.

If you have any questions/concerns, during or after the study, or you might want to speak to someone else who is not part of the study then you can contact:

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7.6 Appendix F: Child information sheet (Wave 2)

Child information sheet (Time 2)

Name of Department: School of Psychological Sciences and Health

Title of the study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

My name is Tracy and you are being invited to take part in the second stage of my research study. It has been six months since you last took part in my study about how the way in which young people think can affect the way that they feel and act. As this is quite a long time I would like to remind you about my study, what you will be invited to do and why I am carrying out this research. If you would still like to take part in the second stage of my research please take the time to read the following information.

What is the purpose of this research study?

This study is being carried out to investigate how the way in which young people think can affect the way that they feel and act. Specifically, I am interested in looking at how young people, like you, remember past memories, how young people think and act when they feel sad and how young people switch between different thoughts and actions.

Do I have to take part?

No, you do not have to take part, participation in this study is entirely voluntary. This means that it is up to you if you want to take part or not. If you decide that you would like to take part and later change your mind that is fine. You can stop being part of this study at any time without having to give a reason. You can also ask to have your answers removed from the study up until the 20/10/2014. After this date all of your answers will be mixed with the other young people's answers and I will not be able to tell what answers are yours. This means that I will not be able to remove your answers from the study.

What will I have to do in the project?

To be part of my study there would be a few tasks that I would ask you to complete. The first task will involve you remembering a past memory. For example, I will show you the word 'smile' and I will then ask you to recall a memory that reminds you of that word. Next, you will be asked to complete a short computer task. You will be asked to count the number of faces you see on the screen (i.e. how many male/female faces). Following on from this task after a break you will be shown

another list of statements. These statements are about things people do when they feel sad. For example one statement reads “how often do you think - why can’t I handle things better?” You will then be asked to indicate how often you think this by circling one of the answers which range from ‘never’ to ‘always’. Next, you will be asked to fill out another two questionnaires by circling the answer that most applies to you. These ask you about depressive and anxiety symptoms that you may experience. It will take about 1 hour to complete all the tasks.

Why have I been invited to take part?

You have been invited to take part in this study due to you being within the age range of interest (13-16 years old).

What happens to the information in the project?

Don’t worry, nobody else will know what your answers are as your results will be put in with the other young peoples and no one else will be able to tell which answers are yours. The information you give will be kept confidential and will be locked away safe. This means that it will only be myself and my supervisors that are allowed to look at the answers you give. The answers that you give in the research study will not be shared with your parents or teachers either. The questionnaires will be stored in a locked cabinet within the University of Strathclyde, and the computerised data (the answers from the faces task on the computer) will be stored on a password protected computer within the University of Strathclyde for a period of 5 years, and will only be viewed by the researchers in this study.

Thank you for reading this information – please ask any questions if you are unsure about what is written here.

What happens next?

Your parent/guardian has completed a consent form and they are happy for you to participate in this study. If you are happy with what you have read here and would still like to take part I will give you an assent form to read and sign. You will be asked to read and sign the assent form to let me know if you would still like to take part.

If you do not wish to take part thank you very much for your interest and for taking the time to read this information sheet.

If you have any questions/concerns, during or after the study, or you might want to speak to someone else who is not part of the study then you can contact:

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7.7 Appendix G: Child assent form (Wave 1)

Child assent form (Time 1)

Department: School of Psychological Sciences and Health

Title of study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

Please complete this form to show whether you DO or DO NOT wish to be part of this study.

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any questions that I have had.
- I understand that I do not have to take part in this project and that I can stop at any time without having to give a reason.
- I understand that any information that I give in this project will be confidential and will not be shared with anyone other than the researchers of this project.
- I understand that I can ask to have all of my answers in the project removed up until the date of 25/04/2014, by contacting the researcher or their supervisor.
- I assent to being a participant in the project.

Please write and sign your name below to indicate your participation in the above project.

NAME: _____

SIGNATURE: _____

DATE: _____

7.8 Appendix H: Child assent form (Wave 2)

Child assent form (Time 2)

Department: School of Psychological Sciences and Health

Title of study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

Please complete this form to show whether you DO or DO NOT wish to be part of this study.

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any questions that I have had.
- I understand that I do not have to take part in this project and that I can stop at any time without having to give a reason.
- I understand that any information that I give in this project will be confidential and will not be shared with anyone other than the researchers of this project.
- I understand that I can ask to have all of my answers in the project removed up until the date of 20/10/2014, by contacting the researcher or their supervisor.
- I assent to being a participant in the project.

Please write and sign your name below to indicate your participation in the above project.

NAME: _____

SIGNATURE: _____

DATE: _____

7.9 Appendix I: List of helpful websites

Helpful websites, phone numbers and email addresses of places that offer help and support to children and young people.

Scottish Association for Mental Heath
Offers support for people who are experiencing a wide range of mental health problems.
Email: enquire@samh.org.uk
Phone: 0141 530 1000
Website: www.samh.org.uk

Child line
A free helpline. Children and young people can talk to counsellors about any problem.
Email: By going online to - http://www.childline.org.uk/talk/pages/email.aspx
Phone: 0800 1111
Website: www.childline.org.uk

Get Connected
Provides a free, confidential helpline that gives young people in difficult situations the support and information they need to decide what they want to happen next.
Email: help@getconnected.org.uk
Phone: 0808 808 4994
Website: www.getconnected.org.uk

Support Line Telephone Helpline
Provides emotional support and information relating to other helplines, counsellors and support groups including helplines and face to face for young people.
Phone: 01708 765200

Helpful websites:
www.depressioninteenagers.co.uk - An interactive site with resources for young people with depression using self-help ideas and relaxation techniques.

www.myteenblog.com - Private community for teenagers who feel they are having a tough life and a safe space to seek help and support.

www.teenagehealthfreak.org - Lots of information including advice and information on bullying, eating disorders, legal rights, self-harm, suicidal, confidentiality when seeing a GP.

www.youthaccess.org.uk – Online information on local youth information, advice, counselling and support services.

www.youngminds.org.uk - A UK charity committed to improving the emotional wellbeing and mental health of children and young people.

7.10 Appendix J: Child debrief form (Wave 1)

Child de-brief form (Time 1)

Department: School of Psychological Sciences and Health

Title of study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

Thank you very much for completing the first part of my study. You have really helped me out. The reason I asked you to be part of this study was that young people at your age can start to feel a bit sad. I want to understand what makes young people feel like this so that myself and other researchers can try to find a way to stop young people feeling this way.

As thoughts and feelings can change over time, I will be asking you to complete these tasks again in six months' time. However, if you are worried about anything that was brought up in this study today then you may wish to talk to someone about this. You can speak to your teacher, your parents/guardians or your GP. You can also contact myself or my supervisor if you have any questions. If you would like to speak to someone who is not part of this study then you can contact the Chair of the Ethics Committee, Dr Susan Rasmussen. I have also provided a separate sheet of paper with contact information (website addresses, phone numbers and email addresses) for a wide range of places that offer help, support and advice for children and young people.

Thank you for taking part in stage 1 of this study.

Do you have any other questions that you would like me to answer?

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7.11 Appendix K: Child debrief form (Wave 2)

Child de-brief form (Final – Time 2)

Department: School of Psychological Sciences and Health

Title of study: A prospective study investigating how the way in which young people think can affect the way that they feel and act.

Thank you very much for taking part in my study. You have really helped me out. I wanted to investigate how the way in which young people think can affect how they feel and act. I am interested in how young people, like you, remember past memories, how they think and act when they feel sad and how they switch between different thoughts. The reason I asked you to be part of this study was that young people at your age can start to develop depressive feelings. I am trying to understand what makes young people feel like this so that myself and other researchers can find a way to stop people feeling this way.

If you are worried about anything that was brought up in this study then you may wish to talk to someone about this. You can speak to your teacher, your parents/guardians or your GP. You can also contact myself or my supervisor if you have any questions. If you would like to speak to someone who is not part of this study then you can contact the Chair of the Ethics Committee, Dr Susan Rasmussen. I have also provided a separate sheet of paper with contact information (website addresses, phone numbers and email addresses) for a wide range of places that offer help, support and advice for children and young people.

Thank you for taking part.

Do you have any other questions that you would like me to answer?

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7.12 Appendix 1. Data extraction form

1. General information

Study number:	
Reviewer ID:	
Publication type:	
Reference:	
Year:	
Authors:	
Authors contact details:	
Study funding source:	
Possible conflicts of interest:	
Notes:	

2. Study eligibility

Type of Study:			
Participants *(clinical; non-clinical, subclinical):*			
Mechanism of CaR-FA-X model measured:			
Multiple mechanisms:	Yes (state mechanism):	No:	
Outcome measure:			
Notes:			
Include:	Exclude *(with reasons)*:		

DO NOT PROCEED IF STUDY EXCLUDED FROM REVIEW

3. Population and setting

Population description *(from which study participants are drawn):*		
Setting *(including location and social context):*		
Study inclusion criteria:		
Study exclusion criteria:		
Method/s of recruitment of participants:		

Informed consent obtained:	Yes:	No:	Not clear:	Does not say:	
Notes:					

4. Participants

Total number:		
Age:		
Sex:		
Race/Ethnicity:		
Diagnoses/illnesses:		
Other relevant socio demographics:		
Excluded/included participants *(with reasons):*		
Notes		

5. Methods

Study aim/hypothesis(s):					
Design *(including time points):*					
Start point:					
End point:					
Total study duration:					
Ethical approval:	Yes:	No:	Not clear:	Does not say:	
Diagnostic criteria used *(clinical measure for inclusion or exclusion):*					
Qualified clinician for diagnostic criteria:					
Control for current depressive symptoms:					
Procedure:					

6. Measures and tasks

Outcome measure *(AMT or other):*		
• Task description:		
• Time limit:		

• Cue words *(including how many/valence)*:				
• Cue delivery:				
• Practice set:				
• Memory type used in analysis *(specific, over general, categoric)*:				
• Unit of measurement *(number/proportion)* :				
• Omissions:				
Notes:				
Mechanism 1: Capture and Rumination mechanism:	Yes:	No:	Yes, but not used in analysis:	
• Task:				
• Task description:				
• Aspect of mechanism 1 *(capture or rumination…as stated in paper)*:				
• Agreement on aspect *(with reasons)*:	Yes:	No:		
Mechanism 2: Executive Control:	Yes:	No:	Yes, but not used in analysis:	
• Task:				
• Task description:				
• Aspect of mechanism 2 *(inhibition, switching, working memory capacity….as stated in paper)*:				
• Agreement on aspect *(with reasons)*:	Yes:	No:		
Mechanism 3: Functional Avoidance:	Yes:	No:	Yes, but not used in analysis:	
• Task:				
• Task description:				

• Aspect of mechanism 2 *(trauma exposure, avoidance…as stated in paper)*:			
• Agreement on aspect *(with reasons)*:	Yes:	No:	
Notes (including other scales not used in analysis):			

7. Results

7.1 Results for between groups copy and amend table for each result (multiple mechanisms; multiple findings; more than two groups)

Statistical method applied to data:				
• Appropriateness of analysis:				
• Power:				
• Covariates in analysis:				
• Variables measured but not used in analysis *(correlations)*:				
• Missing *data (how was this handled)*:	Yes:	No:	Does not say:	
Primary Findings *(for between groups)*:				
	Group 1 (enter group), n =	Group 2 (enter group) n =		
	Mean:	Mean:		
	SD:	SD:		
• Effect size reported *(if so state)*:	Yes:	No:		
• Effect size calculated *(if so state)*:	Yes:	No:		
• Any additional statistic information:				
Secondary Findings *(amend table as such):*	Result:			
	Group 1 (state), n =	Group 2 (state), n =		
	Mean:	Mean:		
	SD:	SD:		
• Effect size reported	Yes:	No:		

(if so state):			
• Effect size calculated *(if so state)*:	Yes:	No:	
• Any additional statistic information:			

7.2 Results for within groups (Copy and amend table for each result (multiple mechanisms; multiple findings; more than two groups)

Statistical method applied to data:				
• Appropriateness of analysis:				
• Power:				
• Covariates in analysis:				
• Variables measured but not used in analysis *(correlations)*:				
• Missing data *(how was this handled)*:	Yes:	No:	Does not say:	
Primary findings *(for within groups)*:				
• Effect size reported *(if so state)*:	Yes:	No:		
• Effect size calculated *(if so state)*:	Yes:	No:		
• Any additional statistic information:				
Secondary Findings *(amend table as such)*:				
• Effect size reported *(if so state)*:	Yes:	No:		
• Effect size calculated *(if so state)*:	Yes:	No:		
• Any additional statistic information:				
Notes:				

7.3 Results for prospective studies (copy and amend table for each result (multiple mechanisms; multiple findings; more than two groups)

Statistical method applied to data:				
• Appropriateness of analysis:				
• Power:				
• Covariates in analysis:				
• Variables measured but not used in analysis *(correlations)*:				
• Missing data *(how was this handled)*:	Yes:	No:	Does not say:	
Primary findings *(for within groups)*:				
• Time 1 data:				
• Time 2 data:				
• Effect size reported *(if so state)*:	Yes:	No:		
• Effect size calculated (if so state):	Yes:	No:		
• Any additional statistic information:				
Secondary Findings *(amend table as such)*:				
• Effect size reported *(if so state)*:	Yes:	No:		
• Effect size calculated *(if so state)*:	Yes:	No:		
• Any additional statistic information:				
Notes:				

8. Applicability

Have important populations been excluded from the study? *(consider disadvantaged*		

populations, and possible differences in the intervention effect)		
Is the study likely to be aimed at disadvantaged groups? *(e.g .lower socioeconomic groups)*		
Does the study directly address the review question? *(any issues of partial or indirect applicability)*		
Notes:		

9. Other information

Key conclusions of study authors:		
References to other relevant studies *(not already in review)*:		
Correspondence required for further study information *(from whom, what and when):*		
Notes:		

7.13 Appendix 2. Quality assessment form and coding manual

QUALITY ASSESSMENT TOOL (Case-control)

"The degree to which a study employs measures to minimize bias and error in the design, conduct and analysis" (Khan et al., 2003).

PLEASE REFER TO THE QAT CODING MANUAL BEFORE COMPLETING THIS TOOL

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability. ✓

Selection

1. Is the case definition adequate? (High Quality = *)	
a) Yes, with independent validation*	☐
b) Yes, e.g. record linkage or based on self-reports	☐
c) No description	☐

2. Representativeness of the cases (High Quality = *)	
a) Consecutive or obviously representative series of cases *	☐
b) Potential for selection biases or not stated	☐

3. Selection of controls (High Quality = *)	
a) Community controls *	☐
b) Hospital controls	☐
c) No description	☐

4. Definition of Controls (High Quality = *)	
a) No history of disease (endpoint) *	☐
a) No description of source	☐

Comparability

1. Comparability of cases and controls on the basis of the design or analysis (High Quality = *)	
a) Study controls for depression or depressive symptoms (Select the most important factor.) *	☐
b) Study controls for any additional factor (This criteria could be modified to indicate specific control for a second important factor.)*	☐

Exposure

1. Ascertainment of exposure? (High Quality = *)	
a) Secure record (e.g. surgical records) *	☐
b) Structured interview where blind to case/control status *	☐
c) Interview not blinded to case/control status	☐
d) written self-report or medical record only	☐
e) No description	☐

2. Same method of ascertainment for cases and controls? (High Quality = *)	
a) Yes*	☐
b) No	☐

3. Non-response rate (High Quality = *)	
a) Same for both groups*	☐
b) Non respondents described	☐
c) Rate different and no designation	

QUALITY ASSESSMENT TOOL (Cohort)

"The degree to which a study employs measures to minimize bias and error in the design, conduct and analysis" (Khan et al., 2003).

PLEASE REFER TO THE QAT CODING MANUAL BEFORE COMPLETING THIS TOOL

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability

Selection

1. Representativeness of the exposed cohort (High Quality = *)	
a) Truly representative of the average population in the community *	☐
b) Somewhat representative of the average population in the community *	☐
c) Selected group of users e.g. nurses, volunteers	☐
d) No description of the derivation of the cohort	☐

2. Selection of the non-exposed cohort (High Quality = *)	
a) Drawn from the same community as the exposed cohort *	☐
b) Drawn from a different source	☐
c) No description of the derivation of the non-exposed cohort	☐

3. Ascertainment of exposure (High Quality = *)	
a) Secure record (e.g. surgical records) *	☐
b) Structured interview *	☐
c) Written self report	☐
d) No description	☐

4. Demonstration that outcome of interest was not present at start of the study (High Quality = *)	
a) Yes*	☐
b) No	☐

Comparability

1. Comparability of cohorts on the basis of the design or analysis (High Quality = *)	
a) Study controls for depression or depressive symptoms (Select the most important factor.) *	☐
b) Study controls for any additional factor (This criteria could be modified to indicate specific control for a second important factor.)*	☐

Outcome

1. Assessment of outcome (High Quality = *)	
a) Independent blind assessment*	☐
b) Record linkage*	☐
c) Self-report	☐
d) No description	☐

2. Was follow-up long enough for outcomes to occur (High Quality = *)	
a) Yes*	☐
b) No	☐

3. Adequacy of follow up of cohorts (High Quality = *)	
a) Complete follow up – all subjects accounted for*	☐
b) Subjects lost to follow up unlikely to introduce bias - small number lost - >80% follow up, or description provided of those lost) *	☐
c) Follow up rate < 20% and no description of those lost	☐
d) No statement	☐

QUALITY ASSESSMENT TOOL (Cross-sectional)

"The degree to which a study employs measures to minimize bias and error in the design, conduct and analysis" (Khan et al., 2003).

PLEASE REFER TO THE QAT CODING MANUAL BEFORE COMPLETING THIS TOOL

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability

Selection

1. Representativeness of the exposed cohort (High Quality = *)	
a) Truly representative of the average population in the community *	☐
b) Somewhat representative of the average population in the community *	☐
c) Selected group of users e.g. nurses, volunteers	☐
d) No description of the derivation of the cohort	☐

2. Non-respondents: (High Quality = *)	
a) Comparability between respondents and non-respondents characteristics is established, and the response rate is satisfactory. *	☐
b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory.	☐
c) No description of the response rate or the characteristics of the responders and the non-responders.	☐

3. Ascertainment of the exposure (risk factor) (High Quality = *)	
a) Validated measurement tool. *	☐
b) Non-validated measurement tool, but the tool is available or described.	☐
c) No description of the measurement tool.	☐

Comparability

1. The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled* (High Quality = *)	
a) Study controls for depression or depressive symptoms (Select the most important factor). *	☐
b) Study controls for any additional factor (This criteria could be modified to indicate specific control for a second important factor). *	☐

Outcome

1. Assessment of the outcome (High Quality = *)	
a) Independent blind assessment. *	☐
b) Record linkage.*	☐
c) Self report.	☐
d) No description.	☐

2. Statistical test (High Quality = *)	
a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value). *	☐
b) The statistical test is not appropriate, not described or incomplete.	☐

CODING MANUAL FOR CASE-CONTROL STUDIES

SELECTION

1. Is the Case Definition Adequate?

a) Requires some independent validation (e.g. >1 person/record/time/process to extract information, or reference to primary record source such as x-rays or medical/hospital records).

For the purpose of the current review for a case to be independently validated, trauma has to be operationalized as a Criterion A event required for diagnosis of post-traumatic stress disorder (PTSD) in the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders, 4th ed., American Psychiatric Association, 2000) or earlier/later versions depending on the study date.

DSM V (2013 onwards): The diagnostic criteria for the manual's next edition identify the trigger to PTSD as exposure to actual or threatened death, serious injury or sexual violation. The exposure must result from one or more of the following scenarios, in which the individual:

- *directly experiences the traumatic event;*
- *witnesses the traumatic event in person;*
- *learns that the traumatic event occurred to a close family member or close friend (with the actual or threatened death being either violent or accidental); or*
- *experiences first-hand repeated or extreme exposure to aversive details of the traumatic event (not through media, pictures, television or movies unless work-related).*

DSM-IV & DMS-IV-TR (prior to 2013): The person has been exposed to a traumatic event in which both of the following were present:

- *The person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others.*
- *The person's response involved intense fear, helplessness, or horror. Note: In children, this may be expressed instead by disorganized or agitated behaviour.*

Interviews conducted blind or where a sample of the interviews were double coded (or verified by another person) can be awarded an (a).

Self-reports measures where validated by another person (i.e. a family member) can also be awarded an (a).

b) Yes, e.g. record linkage or based on self-reports

c) No description

2. Representativeness of the Cases (trauma group)

a) All eligible cases with outcome of interest over a defined period of time, all cases in a defined catchment area, all cases in a defined hospital or clinic, group of hospitals, health maintenance organisation, or an appropriate sample of those cases (e.g. random sample).

b) Not satisfying requirements in part (a), or not stated.

3. Selection of Controls

This item assesses whether the control series used in the study (control group) is derived from the same population as the cases and essentially would have been cases had the outcome been present.

a) Community controls (i.e. same community as cases and would be cases if had outcome)

b) Hospital controls, within same community as cases (i.e. not another city) but derived from a hospitalised population

c) No description

4. Definition of Controls

a) If cases are first occurrence of outcome, then it must explicitly state that controls have no history of this outcome. If cases have new (not necessarily first) occurrence of outcome, then controls with previous occurrences of outcome of interest should not be excluded.

b) No mention of history of outcome

COMPARABILITY

1. Comparability of Cases and Controls on the Basis of the Design or Analysis
A maximum of 2 stars can be allotted in this category.

Either cases and controls must be matched in the design and/or confounders must be adjusted for in the analysis. Statements of no differences between groups or that differences were not statistically significant are not sufficient for establishing comparability. Note: If the odds ratio for the exposure of interest is adjusted for the confounders listed, then the groups will be considered to be comparable on each

variable used in the adjustment. There may be multiple ratings for this item for different categories of exposure (e.g. ever vs. never, current vs. previous or never).

a) Study controls for depression/depressive symptoms (Select the most important factor.) *

b) Study controls for additional factor (Age, gender, SES……)*

EXPOSURE

1. Ascertainment of Exposure

To be awarded an (a) below the study case group must be assessed by a suitable qualified clinician (i.e. clinical psychologist, psychiatrist) or other who is independently able to determine that a person should be in the case group.

An (a) can be awarded if a parent/guardian can give independent validation of a child's negative life events/exposure to trauma.

An objective measure of executive control and/or rumination should be awarded a (a) below.

Negative life events or trauma operationalised via an interview should be awarded a (b) below, only if the experimenters are blind to the groups or where a sample of the interviews are independently double coded.

a) Secure record (e.g. surgical records) *

b) Structured interview where blind to case/control status*

c) Interview not blinded to case/control status

d) Written self-report or medical record only

e) No description

2. Same method of ascertainment for cases and controls?

a) Yes*

b) No

3. Non-Response Rate

a) Same for both groups*

b) Non respondents described

c) Rate different and no designation

CODING MANUAL FOR COHORT STUDIES

SELECTION

1. Representativeness of the Exposed Cohort

Item is assessing the representativeness of exposed individuals in the community, not the representativeness of the sample of women from some general population. For example, subjects derived from groups likely to contain middle class, better educated, health oriented women are likely to be representative of postmenopausal estrogen users while they are not representative of all women (e.g. members of a health maintenance organisation (HMO) will be a representative sample of estrogen users. While the HMO may have an under-representation of ethnic groups, the poor, and poorly educated, these excluded groups are not the predominant users of estrogen).

a) truly representative of the average in the community*
b) somewhat representative of the average in the community*
c) selected group of users e.g. nurses, volunteers
d) no description of the derivation of the cohort

2. Selection of the Non-Exposed Cohort

a) drawn from the same community as the exposed cohort*
b) drawn from a different source*
c) no description of the derivation of the non-exposed cohort

3. Ascertainment of Exposure

To be awarded an (a) below the study case group must be assessed by a suitable qualified clinician (i.e. clinical psychologist, psychiatrist) or other who is independently able to determine that a person should be in the group.

An (a) can be awarded if a parent/guardian can give independent validation of a child's negative life events/exposure to trauma.

An objective measure of executive control and/or rumination should be awarded a (a) below.

Negative life events or trauma operationalised via an interview should be awarded a (b) below, only if the experimenters are blind to the groups or where a sample of the interviews are independently double coded.

a) secure record (e.g. surgical records, *clinical data*)*
b) structured interview*
c) written self-report

4. Demonstration That Outcome of Interest Was Not Present at Start of Study

In the case of mortality studies, outcome of interest is still the presence of a disease/ incident, rather than death. That is to say that a statement of no history of disease or incident earns a star. *Ensure that time 1 variable (T1 measure of outcome) is controlled for within the analysis.*

a) yes*
b) no

COMPARABILITY

1. Comparability of Cohorts on the Basis of the Design or Analysis

A maximum of 2 stars can be allotted in this category. Either exposed and non-exposed individuals must be matched in the design and/or confounders must be adjusted for in the analysis. Statements of no differences between groups or that differences were not statistically significant are not sufficient for establishing comparability. Note: If the relative risk for the exposure of interest is adjusted for the confounders listed, then the groups will be considered to be comparable on each variable used in the adjustment. There may be multiple ratings for this item for different categories of exposure (e.g. ever vs. never, current vs. previous or never).

a) Study controls for depression/depressive symptoms (Select the most important factor.) *

b) Study controls for any additional factor (Age, gender, SES……)*

OUTCOME

1. Assessment of Outcome

For some outcomes (e.g. fractured hip), reference to the medical record is sufficient to satisfy the requirement for confirmation of the fracture. This would not be adequate for vertebral fracture outcomes where reference to x-rays would be required.

A study can be awarded an (a) response if memories were tested with a version of the autobiographical memory test (or other versions of this test) and a selection, or all, memories were double coded.

a) independent or blind assessment stated in the paper, or confirmation of the outcome by reference to secure records (x-rays, medical records, etc.)*

b) record linkage (e.g. identified through ICD codes on database records)*

c) self-report (i.e. no reference to original medical records or x-rays to confirm the outcome)

d) no description.

2. Was Follow-Up Long Enough for Outcomes to Occur

An acceptable length of time should be decided before quality assessment begins (e.g. 5 yrs. for exposure to breast implants).

It is unknown in the child and adolescent literature as to how long any given CaR-FA-X mechanisms takes to have an effect on OGM. Given the heterogeneity in follow up times in this area there is no lower follow up period for the studies included in the current review. To select (a) the paper must adequately describe each testing time, how long the follow up was and what tests were applied at each testing session.

a) yes*
b) no

3. Adequacy of Follow Up of Cohorts

This item assesses the follow-up of the exposed and non-exposed cohorts to ensure that losses are not related to either the exposure or the outcome.

Loss to follow-up is problematic in most cohort studies and often leads to bias. There is not a predefined minimum of attrition that has been universally accepted, although a number of researchers have proposed acceptable follow up rates. For example, Babbie (1973) suggests that 50% is adequate, 60% is good and 70% is very good. Recent authors however suggest that the minimum acceptable follow up should be 80% (Altman, 2000). For the current review, acceptable follow up will be set at 80%. If <20% of subjects were lost to follow-up, but Rubin's (1976) nomenclature test was applied and data was demonstrated as Missing Completely At Random (MCAR), upgrade to (a) as "the probability that the data was missing depend neither on the observed data nor on the levels of the variable having missing data itself".

a) complete follow-up, all subjects accounted for*
b) subjects lost to follow-up are unlikely to introduce bias – small number lost <20%*
c) follow-up rate <80% and no description of those lost
d) no description *or unclear*

CODING MANUAL FOR CROSS-SECTIONAL STUDIES

SELECTION

1. Representativeness of the Exposed Cohort

Item is assessing the representativeness of exposed individuals in the community, not the representativeness of the sample of women from some general population. For example, subjects derived from groups likely to contain middle class, better educated, health oriented women are likely to be representative of postmenopausal estrogen users while they are not representative of all women (e.g. members of a health maintenance organisation (HMO) will be a representative sample of estrogen users. While the HMO may have an under-representation of ethnic groups, the poor, and poorly educated, these excluded groups are not the predominant users of estrogen).

a) truly representative of the average in the community*

b) somewhat representative of the average in the community*

c) selected group of users e.g. nurses, volunteers

d) no description of the derivation of the cohort

2. Non-respondents

a) Comparability between respondents and non-respondents characteristics is established, and the response rate is satisfactory. *

b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory.

c) No description of the response rate or the characteristics of the responders and the non-responders.

3. Ascertainment of the exposure (risk factor)

To be awarded an (a) below the study case group must be assessed by a suitable qualified clinician (i.e. clinical psychologist, psychiatrist) or other who is independently able to determine that a person should be in the case group.

An (a) can be awarded if a parent/guardian can give independent validation of a child's negative life events/exposure to trauma.

An objective measure of executive control and/or rumination should be awarded a (a) below.

Negative life events or trauma operationalised via an interview should be awarded a (b) below, only if the experimenters are blind to the groups or where a sample of the interviews are independently double coded.

a) Validated measurement tool. *

b) Non-validated measurement tool, but the tool is available or described.

c) No description of the measurement tool.

COMPARABILITY

1. The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled

A maximum of 2 stars can be allotted in this category. Either exposed and non-exposed individuals must be matched in the design and/or confounders must be adjusted for in the analysis. Statements of no differences between groups or that differences were not statistically significant are not sufficient for establishing comparability. Note: If the relative risk for the exposure of interest is adjusted for the confounders listed, then the groups will be considered to be comparable on each variable used in the adjustment. There may be multiple ratings for this item for different categories of exposure (e.g. ever vs. never, current vs. previous or never).

a) Study controls for depression/depressive symptoms (depression/depressive symptoms.) *

b) Study controls for additional factors (Age, gender, SES……)*

OUTCOME

1. Assessment of Outcome

For some outcomes (e.g. fractured hip), reference to the medical record is sufficient to satisfy the requirement for confirmation of the fracture. This would not be adequate for vertebral fracture outcomes where reference to x-rays would be required.

A study can be awarded an (a) response if memories were tested with a version of the autobiographical memory test (or other versions of this test) and a selection, or all, memories were double coded.

a) independent or blind assessment stated in the paper, or confirmation of the outcome by reference to secure records (x-rays, medical records, etc.)*

b) record linkage (e.g. identified through ICD codes on database records)*

c) self-report (i.e. no reference to original medical records or x-rays to confirm the outcome)

d) no description.

2. Statistical test

a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value). *

b) The statistical test is not appropriate, not described or incomplete.