Memory, Depression and Anxiety

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Depression and anxiety are associated with the interrupted operation of a number of different memory systems. Two memory systems in particular appear to be integral to the maintenance and continuation of symptoms; working memory and autobiographical memory. Within working memory, those experiencing poor mental health appear to have a reduced ability to store and manipulate both visual and spatial information, relative to their healthy counterparts. Working memory appears to be particularly impaired for emotional material. As such, novel interventions have emerged to improve working memory deficits in the mentally unwell, with the most promising results found for emotional working memory program s. Autobiographical memory has long been understood to play a key role in the onset and perpetuation of depression and anxiety, and techniques to edit autobiographical memory feature in our gold-standard psychological treatments for depression and anxiety. Voluntary retrieval of autobiographical memories of specific, single incident events is impaired, as is retrieval of memories that are positive in emotional valence. Individuals experiencing both depression and anxiety also report increased involuntary retrieval of autobiographical memories. This chapter discusses how current treatments target autobiographical memories to decrease symptoms, and introduces the new, science-driven memory interventions which seek to improve our treatment options for depression and anxiety.

Dysfunctional memory representations are a core feature of mental illness. Numerous meta-analyses and systematic reviews have asserted that individuals with mood, anxiety and stress-related disorders demonstrate poorer memory consolidation and storage, along with distorted patterns of retrieval from both short-term and longer-term memory systems (e.g., Chris R Brewin, Gregory, Lipton, & Burgess, 2010; Gotlib & Joormann, 2010; Mitte, 2008; Schweizer et al., 2019; Semkovska et al., 2019). Across memory systems, overall performance is impaired in mentally unwell samples. However, memory appears to be particularly affected for emotional information such that greater deficits, relative to healthy control samples, are observed for emotionally valenced information, relative to neutral information (e.g., recognition memory; Matt, Vázquez, & Campbell, 1992). This effect is observed at both the behavioural and neural levels (e.g. , in working memory; Schweizer et al., 2019). Two memory systems in particular appear to be impacted in depression and anxiety; working memory and autobiographical memory. In this chapter, we briefly overview working memory in depression and anxiety. We go into greater detail regarding autobiographical memory as this memory system is more strongly implicated in the onset, maintenance, and treatment of mental health issues.

Working memory

The nature of working memory impairments in depression and anxiety

Working memory is a capacity-limited resource for the storage and maintenance of information that is relevant to current goals and activities (see Chapters 2.9 and 2.10). The storage and updating of information in working memory supports many everyday cognitive skills, including inhibition of irrelevant information during task completion, the ability to maintain focused attention, and emotion regulation. Through these processes, problems with working memory may therefore impact mental and emotional wellbeing. There are now numerous reviews which have demonstrated that the storage and updating of

working memory is compromised in samples who experience mental ill health. In terms of depression, those who have experienced one or more major depressive episodes experience small-medium sized reductions, relative to healthy controls, in working memory storage and mental manipulation processes for both verbal and visual-spatial material (for meta-analysis, see Semkovska et al., 2019). Working memory updating in particular appears to be impacted in depressed patients (Snyder et al., 2013). Anxiety-related difficulties with working memory are of a similar magnitude, and are observed on working memory tasks which require either simple storage, or both processing and short-term storage of information (for meta-analysis see Moran, 2016). Anxiety-related reductions in capacity appear to be strongest for working memory for verbal and spatial information (Moran, 2016).

However, a recent meta-analysis has indicated that mental ill health may particularly impair working memory if the processed stimuli are emotional in nature (Schweizer et al., 2019). The meta-analysis indicated that in healthy individuals, there were trivially small effects in response time and accuracy on working memory task conditions (e.g., N-back task) using emotional stimuli, relative to those using neutral stimuli. Although the presence of emotional stimuli barely affected performance for healthy individuals, it had a much larger effect for those were mentally unwell. Mentally unwell individuals demonstrated reduced performance on trials that utilized negative or positive stimuli, relative to neutral stimuli. This was particularly noticeable when emotional stimuli were used as distractors (i.e., were irrelevant to the task at hand), compared to when emotional information was central to the task at hand. In this way, those with mental health problems are likely to have a relatively greater difficulty in ignoring irrelevant emotional information when trying to process and remember information. Given the increased experience of negative emotion in depression and anxiety, this working memory difficulty could be one reason why individuals experience problems in everyday cognitive tasks which depend upon working memory (e.g., studying).

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These behavior-based differences were also reflected at the neural level, with a parallel neuroimaging meta-analysis demonstrating robust differences between emotional versus neutral information on brain activity during task completion (for further detail, please see Schweizer et al., 2019).

One caveat regarding these findings is that they synthesise effects across diverse mental health populations including samples with mood, anxiety and stress disorders (e.g., Posttraumatic Stress Disorder), attention deficit hyperactivity disorder (ADHD) and schizophrenia. High rates of co-occurrence between depression, anxiety, and other psychological disorders do however support consideration of emotional working memory difficulties as a transdiagnostic process.

The role of working memory in symptom development and maintenance

When considering whether dysfunction of a cognitive system causes symptoms to begin, as opposed to simply maintaining current symptoms, it is important to determine if problems in the cognitive system are evident before the onset of disorder. If no difficulties are evident before symptoms begin, it may be that the symptoms cause the memory problem, rather than the memory problem causing symptoms. Understanding the direction of the relationship between a cognitive problem and symptoms is important for informing treatment. If the cognitive difficulty causes symptoms, intervening to improve the cognitive difficulty may treat, or potentially prevent, symptoms.

There is currently limited empirical evidence of poorer performance on working memory tasks in individuals at risk of future depression, relative to healthy controls (e.g., Wagner, Abramson, & Alloy, 2015; Watters et al., 2019), although there is some evidence that differences between at-risk and healthy samples may be observable in neural activity, if not at a behavioral level (e.g., Mannie et al., 2010). Another way to get at the issue of causality is to determine whether working memory can longitudinally predict later symptoms.

Much of the research in this area has examined control over emotional information in working memory (as opposed to measuring simple storage via working memory capacity). Poorer working memory-based manipulation of emotional information has been associated with an increase in depressive symptoms up to one year later (e.g., De Lissnyder et al., 2012; Pe et al., 2016). Again, the current evidence therefore suggests that it is the ability to update and manipulate emotional information in working memory that is the core working memory process influencing symptoms.

Although it is unclear if problems in working memory may cause depression or anxiety, it is evident that working memory problems can help maintain symptoms. The research findings we have reviewed here suggest that individuals may struggle to pursue relatively emotionally neutral goals (e.g., writing an assignment) when emotionally-valenced distractors as present (e.g., thoughts about an argument you had with a friend, worry about getting a good grade on the assignment). Similarly, poor ability to displace negative information from working memory may also lead to dwelling on negative views of the self, or repetitive negative thoughts in the form of rumination and worry. Rumination and worry are core features of depression and anxiety respectively, and both cognitive processes drive low mood (Joormann & Gotlib, 2008). Trying to improve working memory problems may therefore be useful for those suffering from poor mental health.

Working memory and treatment

Efforts have emerged to try to increase working memory capacity or functioning as a way to improve symptoms of depression and anxiety. Programmes training working memory (e.g., through repeated practice in completing N-back tasks) for neutral stimuli have not been consistently shown to improve symptoms of depression or anxiety (e.g., Onraedt & Koster, 2014; Wanmaker, Geraerts, & Franken, 2015). However, more promising results have been found when working memory is trained with emotional stimuli, relative to neutral stimuli (for

review see Koster et al., 2017), consistent with the above findings that it is poorer working memory for emotive information in particular which is associated with mental health. Emotional working memory programmes typically involve 4-8 weeks of daily completion of an N-back task which uses emotional faces or words as stimuli (e.g., Schweizer et al., 2011; 2013). Current support for emotional working memory programmes in improving mental health is based on positive effects on emotion regulation, with only a small number of studies exploring and subsequently demonstrating impact on symptoms of anxiety or depression (for review see Koster et al., 2017).

Consistent evidence of an impact of emotional working memory training programmes on emotion regulation and other cognitive factors (e.g.., working memory updating of emotional information) which may minimize depression and anxiety suggests that these programmes may be useful for the prevention of mental health issues. Working memory training programmes are also beginning to be combined with other therapeutic approaches including transcranial stimulation (e.g., Brunoni et al., 2014; Sergrave et al, 2014). Further evaluation of emotional working memory training with clinically depressed and anxious patients is needed, but current literature suggests that this is an exciting potential treatment approach for both reducing current symptoms and cognitive vulnerability to disorder.

Autobiographical Memory

Autobiographical memories of personally experienced events are particularly important in the course and treatment of depression and anxiety. While deficits in many memory systems, including working memory, co-occur with symptoms, with some evidence to suggest that these impairments may be evident in at-risk samples, autobiographical memory processes predict prognosis for both depression and anxiety in both youth and adults (Gutenbrunner, Salmon, & Jose, 2018a; Sumner, Griffith, & Mineka, 2010). That is, autobiographical memory deficits are not simply a by-product of mental illness, but rather,

play a causal role in symptom development and persistence. Indeed, treatment programmes which focus solely on improving autobiographical memory processes, and ignore the other cognitive, social, and biological determinant s of mental wellbeing consistently yield treatment gains for mood, anxiety and stress-related disorders, relative to control conditions (for review and meta-analysis see Barry, Sze, & Raes, 2019; Hitchcock, Werner-Seidler, Blackwell, & Dalgleish, 2017). In light of this, it is increasingly understood that autobiographical memory distortions are a transdiagnostic indicator of poor mental health. T his chapter is organized to present key autobiographical memory features for depression and anxiety separately, as the current literature has tended to evaluate memory within individual disorders.

Depression

Individuals experiencing depression often appear to be stuck in their personal past. Much of their mental life is characterized by replaying and ruminating on past events, with an excessive focus on the negative meaning that the event holds for themselves or the world. In recalling their past experiences, there are two key biases demonstrated by depressed individuals; impoverished quality of positive autobiographical memories, and a tendency to recall overgeneralized summaries of the past.

Reduced positivity

In healthy individuals, autobiographical memory appears to be naturally configured to prioritise the quality and ease of recall of positive self-referential information, which may serve to support positive self-concept. The emotional intensity of positively valenced memories is retained better over time, relative to negative memories. This phenomenon is referred to as Fading Affect Bias (Walker, Skowronski, & Thompson, 2003). Although the intensity of emotion associated with all memories fades over time, the intensity of positive memories reduces to a lesser degree than negative memories. So, while your most

humiliating experiences will not feel as intensely embarrassing when you look back on them later in time, you will continue to experience a strong rush of emotion when recalling your memories of the best days of your life.

However, the Fading Affect Bias is attenuated in depressed individuals. The emotional intensity of positive memories fades more than it does in healthy individuals, while the emotional intensity of negative memories does not alleviate as much as it does in healthy individuals (Hitchcock et al., 2019). And it's not just the emotional intensity associated with positive memories that is deteriorated in depression – memory content is also compromised. Both the currently depressed and those at elevated risk of depression report positive autobiographical memories that are less specific (Semkovska et al., 2019), less detailed, and less coherent than those reported by their never-depressed counterparts (Begovic et al., 2017). Their positive memories contain less verbal detail (e.g., adjectives), and also diminished vividness of mental imagery (Werner-Seidler & Moulds, 2011). The combination of these impairments results in positive memories that seem vague and hard to imagine. Indeed, depressed individuals commonly report that their positive memories don't feel like their own. Both the current experience and future risk of depression are therefore associated with a reduced vividness, detail, and emotional intensity of positive memories.

In addition to compromised quality of positive memory content, depressed individuals also experience a reduction in the ability to retrieve positive autobiographical memories. Under experimental conditions, healthy individuals are quicker to access positive memories relative to negative (Lloyd & Lishman, 1975). These laboratory-based findings have been replicated in a large-scale experience sampling study which demonstrated that people most frequently retrieve positive self-relevant information in everyday life (Killingsworth & Gilbert, 2010). But again, this natural preference toward recall of positive memories is

reduced in depression. It has therefore been suggested that negative memory bias in depression should not be thought of as having enhanced access to or faster recall of negative memories, but may actually be better explained as an attenuation of the natural positive bias that characterizes mental health, as those who are depressed appear to experience no differential ease of retrieval of positive relative to negative memories (e.g., Hitchcock et al., 2019).

Reduced ability to access positive autobiographical information is not only seen in the explicit retrieval of autobiographical memories, but also in how a depressed individual narrates their life story. When chronically depressed individuals were asked to allocate positive and negative attributes to the previous chapters of their lives (e.g., school, first job, children), Dalgleish et al. (2011) observed that depressed individuals repeatedly used the same negative attributes (e.g., 'hopeless') to describe different chapters, and that the carryover of positive attributes (e.g., 'fulfilled') between chapters was reduced relative to healthy controls. This suggests that depressed individuals do not simply have impaired access to positive memories, but also that they fail to link positive aspects of themselves (e.g. 'successful') between different components of their life (e.g., 'as a student', 'as an athlete', 'in my relationships'). In turn, this may support the lack of positive self-schemata (e.g., 'My life has been relatively successful') which characterizes depression (Beck, Rush, Shaw, & G., 1979).

The weakening of positive autobiographical memories has significant implications for the everyday techniques used to counter the depressed state. Retrieval of positive memories is a key emotion regulation technique used to combat transient low mood (Josephson, 1996). Decreased emotional intensity of positive autobiographical memories means that when depressed individuals do manage to retrieve positive memories, they do not experience an improvement in mood (Joormann & Siemer, 2004; Joormann, Siemer, &

Gotlib, 2007). In addition, one experiment (Werner-Seidler, Tan, & Dalgleish, 2017) suggests that this may be due to self-discrepancy between how the individual currently views their self and who they felt themselves to be when the prior experience occurred. In this way, recalling past positive events has a reduced positive impact on mood because the perceived self who experienced that event is discrepant from the current sense of self. For example, remembering how happy you were on the day your child was born may not improve your mood if you currently think you are a bad parent. Reduced emotional benefit of positive memories is evident into recovery from depression, which may predispose an individual toward experiencing another depressive episode in the future, as they are unable to shift the everyday, shorter term downturns in mood that we all experience. Moreover, recalling happy memories can dampen and thereby effectively regulate the cortisol response during stress in nondepressed individuals (Speer & Delgado, 2017). Thus, positive memory deficits in depression may reduce the regulation techniques and mechanisms that allow nondepressed individuals to cope with stress and improve their mood.

If the rose-tinted glasses we wear when recalling our past are so important to maintaining positive self-concept and positive mood, why might they slip off? As described above, there is evidence that reduced positivity remains even when depressive symptoms remit and is evident before the onset of depression, indicating that it is a durable cognitive marker of depression. The mechanisms that reduce natural positive bias are not yet understood, although there is some evidence to suggest that depressed individuals may have difficulty in ignoring internal emotional information (e.g., negative thoughts) that may disrupt the search process when attempting to deliberately retrieve autobiographical memories (Hitchcock, Golden, Werner-Seidler, Kuyken, & Dalgleish, 2018; J. M. G. Williams et al., 2007). That is, when searching for a positive autobiographical memory, depressed individuals may be cued by negative self-referential information (e.g., a thought of how useless their

memory is), and inadvertently access a negative memory instead of a positive one. Attention and interpretation biases at the time of memory encoding may also play a role (Dalgleish & Werner-Seidler, 2014). For example, if you focus on the negative aspects of a situation (e.g., '*I felt really stressed during my statistics exam'*) and ignore the positive aspects (e.g., '*I was actually able to answer most of the questions*'), you may actually encode the representation of the event as more negative than it was. In sum, there is extensive evidence to demonstrate that the emotional intensity, vividness, and ease of recall of positive autobiographical memories is impaired in depression.

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Overgeneral memory retrieval

Depression is also characterized by a reduction in the ability to retrieve specific, single incident memories that are located in place and time. When asked to recall one particular time that an event occurred (e.g., 'I asked a question in my statistics lecture on Tuesday'), depressed individuals instead tend to report generalized summaries of their past (e.g, 'I often struggle to understand in my statistics lectures'). This phenomenon is referred to as reduced autobiographical memory specificity or overgeneral memory (which we will use herein), and is typically assessed using cued recall tasks. One such task is the Autobiographical Memory Test (AMT; J. M. Williams & Broadbent, 1986), which presents the individual with written cue words of positive, negative, or neutral emotional valence, and requires them to retrieve a specific, single incident memory for each word (for psychometric analysis of the AMT see Griffith et al., 2009). Overgeneral memory performance on the AMT has been observed in depressed children and adolescents (for review see Hitchcock, Nixon, & Weber, 2014), and also adults (for review see Sumner et al., 2010). Importantly, overgeneral memory retrieval predicts the course of depression up to a year in advance, over and above the effect of current depressive severity (Sumner et al., 2010). Indeed, individuals

continue to demonstrate overgeneral memory retrieval even after their depressive symptoms have lifted, suggesting that overgeneral memory is a maintenance factor for depression.

Why would trouble recalling specific autobiographical memories cause depressive symptoms? We retrieve specific memories hundreds of times a day in service of other cognitive skills. For example, specific memories give us an idea of the steps we need to take to solve a problem. When confronted with the problem of an overdue library book, you may recall what you did last time a book was overdue (e.g., extend the loan), which will guide you in what you now need to do to overcome the problem (e.g., open your computer, log into the library system) and avoid the negative consequence of a fine. Experimental induction of a specific memory retrieval style improves problem solving in both healthy (Jing, Madore, & Schacter, 2016) and depressed (McFarland, Primosch, Maxson, & Stewart, 2017) individuals, demonstrating that specific memory retrieval plays a causal role in this life skill. The efficacy of many other cognitive skills also relies on the ability to retrieve specific autobiographical memories, including social skills (Beike, Brandon, & Cole, 2016), planning (Jing, Madore, & Schacter, 2017), and cognitive reappraisal (Jing et al., 2016). Overgeneral memory retrieval can thereby impair the everyday cognitive skills that we need for successful psychological functioning.

Overgeneral memory retrieval may also lead to overgeneralised beliefs about the self. Depression is characterized by pervasive negative beliefs about the self, for example, of being a failure, unlovable, or unworthy. Such negative beliefs are not simply applied to one situation (e.g., 'I am no good at my job') but are instead applied overgenerally to all aspects of life (e.g., 'I am total failure'). In cognitive models of depression, these are referred to as core beliefs. Core beliefs are the primary cause of depression, and thus, changing these beliefs is the key focus of cognitive-based treatments for depression. There have been recent indications that the ability to retrieve specific autobiographical memories may influence how

widely negative self-beliefs are generalized. In a sample of adolescents at elevated risk of depression, Askelund and colleagues (2019) demonstrated that the specificity of retrieval from autobiographical memory predicted the strength of negative self-cognitions one year later. This built upon a prior experiment which demonstrated that retrieval of specific, positive information (e.g., 'I finished a half marathon earlier this year') may serve to restrict or place a boundary on negative generalisations about the self (e.g., 'I am a failure'). The experiment demonstrated that for those experiencing depression, retrieval of specific, positive information was slower, such that negative generalisations about the self were less strictly bounded than in mentally healthy individuals (Hitchcock, Rees, & Dalgleish, 2017). In this way, overgeneral memory bias may maintain the overgeneralized negative self-beliefs that drive depression.

There are some suggestions that problems with memory specificity may predate the emergence of depressive symptoms, and subsequently cause the primary onset of depression. In the Askelund et al. (2019) study described above, the ability to retrieve specific memories of positive events predicted lower morning cortisol and fewer negative self-cognitions, both of which are markers of depression, at one-year follow-up. Further, in adolescents who were exposed to stressful life events, negative self-cognitions mediated the effect of memory specificity on depressive symptoms. Although these findings suggest that the ability to retrieve specific autobiographical memories may influence the development of depression, it is important to note that moderating factors (e.g., whether this effect is only present for those who have experienced stressful life events) are in need of further exploration. This is an important area for future research, as intervention into overgeneral memory in adolescents who are not yet depressed could be an effective way to prevent depression from emerging.

So what causes overgeneral memory retrieval? The CARFAX model (J. M. G. Williams et al., 2007) proposes that overgeneral memory results from a failure during the

search process that governs deliberate retrieval of autobiographical information. To retrieve specific information from autobiographical memory, a search process must progress down a hierarchy from general representations of the past, to more detailed event specific information (Conway & Pleydell-Pearce, 2000). The CARFAX model outlines three mechanisms that might interrupt the retrieval process before it can reach event specific information, which will cause a generalised memory to be reported instead. These are Capture and Rumination, Functional Avoidance, and reduced eXecutive control. During the search, autobiographical information about the self which is irrelevant to the search may capture attention and be ruminated on, thereby diverting resources away from and effectively terminating the search process. An individual may functionally avoid retrieving specific event information as specific information, particularly of negative events, is often more emotionally intense than general information. This avoidance of specific, negative memories to reduce negative affect is then proposed to spread out to avoidance of positive, specific information as well. Finally, the executive control needed to govern the retrieval processes may fail, for example, by failing to keep the search model in working memory or by failing to inhibit irrelevant information during the search. In sum, each of these three mechanisms may work independently or interact to interrupt the deliberate search process before it can reach event specific information.

There is mixed empirical support for the CARFAX model. An early review by Sumner (2012) demonstrated support for the executive function and capture and rumination mechanisms in independently predicting overgeneral memory. By contrast, a more recent meta-analysis (Chiu et al., 2018) indicated that rumination was not significantly associated with overgeneral memory. In terms of interactions between the mechanisms, Ros and colleagues (2017) used structural equation modelling to evaluate all three mechanisms in a sample of younger (n=175, aged 19-36 years) and older (n=175, aged 53-88 years) adults.

Results provided support for the role of executive functions in predicting overgeneral memory in younger adults, and support for both the executive function and functional avoidance mechanisms in older adults. There was no evidence to support interactions between the mechanisms.

There has been more limited evaluation of the CARFAX model in depressed samples. Sumner and colleagues (2014) demonstrated that rumination and executive function interacted to predict overgeneral memory in those with a history of major depression, but the overall pattern of results was not consistent with predictions made by the CARFAX model. In depressed youth, increased avoidance has been found to predict later retrieval of specific memories, but only for negative events (Gutenbrunner, Salmon, & Jose, 2018b). A key difficulty in evaluation of the model in depression has been inconsistency in whether the CARFAX mechanisms (rumination, avoidance, reduced executive control) are evaluated as a predictor of overgeneral memory, or as a factor which mediates the impact of overgeneral memory on depressive symptoms (e.g., as in Liu et al., 2016). Thus, although overgeneral memory appears to be important in the course of depression, current research suggests that the theoretical models underlying the phenomenon may be in need of refinement.

Treatment of depression

Retrieving and evaluating autobiographical memories is fundamental to psychological therapy. Reduced ability to retrieve specific memories, particularly positive specific memories, may therefore not only form a cognitive risk factor for depression, but also has implications for the individuals' ability to engage in and benefit from psychological treatments. One of the most effective and widely used treatments for depression is Cognitive Behavioural Therapy (CBT). The core focus of CBT is to challenge the maladaptive negative beliefs (e.g., 'I am unlovable') that drive depressive symptoms (Beck et al., 1979). As we touched on above, autobiographical memories of prior experiences are the building blocks

of these beliefs (Beck et al., 1979). For example, memories of being repeatedly berated by a parent when you were young may underlie the belief that 'I am not good enough'. As a result, much of the work that we do in CBT involves encouraging an individual to reappraise their past in a more flexible and adaptive way.

During CBT, negative memories of the past are revisited to identify maladaptive appraisals about the self or world that are embedded in memory. These are termed 'hot spots' or 'stuck points' as they provoke strong emotion upon recall, and often represent the negative belief which is maintaining symptoms. When revisiting a memory of being berated by a parent, the individual may identify being told that they 'can never do anything right' as the most distressing aspect of the memory. A core belief of 'I can never do anything right' might then be used as a starting point for therapy. According to cognitive models of depression, subsequently targeting this belief during CBT will improve depressive symptoms.

In addition to using autobiographical memories to help identify the maladaptive core beliefs that keep depression going, many of the CBT techniques that are subsequently used to change these beliefs require an individual to retrieve specific pieces of information about their past. An example of this process in demonstrated in Figure 1. Evidence gathering tasks require the therapist and patient to pick a maladaptive belief (e.g., 'I have nothing to contribute to society') and then find specific, concrete pieces of evidence that either support (e.g., 'My ex told me that I am useless') or challenge (e.g., 'My friend invited me for a coffee yesterday') that belief. The overall goal is to weaken the negative belief by demonstrating that it is not always true. The ability to retrieve specific pieces of positive autobiographical information that counter negative beliefs is therefore likely to influence a patient's ability to complete these belief-challenging tasks. The efficacy of CBT is thus likely to be influenced by the individuals' tendency to recall their past in a negative and overgeneral manner.

As these autobiographical memory deficits have also been shown to causally predict depression, novel memory-based treatment programmes have begun to emerge for depression (for review see Hitchcock, Werner-Seidler, et al., 2017). A summary of randomised controlled trials (RCTs) evaluating autobiographical memory-based interventions is presented in Table 1. The most prolific of these interventions is Memory Specificity Training (MEST; Raes, Williams, & Hermans, 2009). MEST aims to improve the ability to retrieve specific, single event memories through repeated practice using cued-recall tasks. Participants are presented with word cues of positive, negative, or neutral emotional valence, and asked to retrieve a specific memory that the word reminds them of. These training tasks are completed over a series of group-based sessions and self-guided practice at home. A recent meta-analysis demonstrated that MEST is effective at improving memory specificity (Cohen's *d* for pre-to-post treatment change = 1.21), and subsequently, depressive symptoms (Cohen's *d* for pre-to-post treatment change = 0.47) (Barry et al., 2019). Given these promising findings, MEST is now being trialed in clinical practice and translated into a computerized, self-guided format in order to increase dissemination.

Therapeutic techniques have also emerged to improve the vividness of positive autobiographical information. This includes using strategies to support positive memory retrieval. Memory strategies that have been used for centuries to support long-term memory have been adapted for positive autobiographical memories. For example, Method-of-Loci (in which a to be-remembered event is paired with a location on a familiar spatial route, such as the commute to work) can improve not only the ability to retrieve positive memories on demand, but also depressive symptoms (Dalgleish et al., 2013). Stand-alone memory-based treatments have also emerged from basic science. Competitive Memory Training (COMET) is based on the principles of competitive memory retrieval hierarchies (Chris R. Brewin, 2006); that is, by making positive representations in memory more accessible than

negative representations, it is hypothesized that this will lead to improvement in depressive symptoms. This type of approach focusses on strengthening the adaptive meanings, contextual associations, and emotional salience of positive autobiographical events. Meta-analysis has indicated that COMET is effective in reducing depressive symptoms, relative to treatment as usual (commonly antidepressant medication, although this varied between studies; Hitchcock, Werner-Seidler, et al., 2017).

Finally, interventions are emerging which seek to simultaneously target both memory specificity and positivity. For example, Memory Flexibility Training uses repeated cued-recall tasks to improve the ability to retrieve specific memories, but also to move flexibly between specific and general levels of autobiographical information. Further, the programme focuses on retrieval of positive autobiographical information, to balance out the tendency to retrieve negative information in depression. Following from an earlier uncontrolled trial, an RCT comparing MemFlex to Psychoeducation demonstrated a significant improvement in the ability to deliberately retrieve both specific and general memories and small effects on depressive symptoms (Hitchcock, Gormley, et al., 2018). In sum, autobiographical memory-based treatment programmes have shown promise as a new, low-cost, and low-intensity treatment option for depression.

Summary

Depression is characterized by an inability to retrieve specific, single incident autobiographical memories, and with a reduced vividness and emotional intensity of positive autobiographical memories. These deficits, particularly reduced specificity, have been linked to poorer prognosis for depression, with emerging evidence to suggest that reduced specificity may be a causal risk factor of depression. These memory biases are likely to influence a depressed patient's ability to effectively engage in CBT, our gold-standard treatment for depression. New treatment options have been developed to target

autobiographical memory biases in depression, with recent meta-analyses demonstrating promising effects on both memory problems and symptoms of depression. Further research seeking to advance understanding of the mediators and moderators through which autobiographical memory impacts prognosis for depression, and how this can be used to improve treatment options, is therefore ongoing.

Posttraumatic stress

The encoding and consolidation of trauma memories in posttraumatic stress disorder (PTSD) are elaborated on elsewhere in this volume (REF to 9.10 Brewin chapter). However, it is important to note that trauma also has a broader impact on autobiographical memory, such that reduced specificity (Moore & Zoellner, 2007) and positivity (Dalgleish et al., 2003; Moradi, Taghavi, Neshat-Doost, Yule, & Dalgleish, 2000) of autobiographical memories are also evident in those who are experiencing posttraumatic stress. Indeed, the CARFAX model (William et al., 2007) outlined above discussed how autobiographical memory distortions may arise in those who experienced either depression or trauma. In terms of overgeneral memory retrieval, the experience of trauma was proposed to initiate functional avoidance. Indeed, it has been previously asserted that the presence of an explicit trauma memory may be necessary to trigger functional avoidance, and thereby the overgeneral retrieval style that is then erroneously applied to positive memories as well (Moore & Zoellner, 2007). Overgeneral memory both before (Bryant, Sutherland, & Guthrie, 2007) and following (Kleim & Ehlers, 2008) trauma-exposure is a significant predictor of PTSD prognosis. The memory specificity interventions developed for depression have therefore begun to be evaluated in treatment of PTSD. Two small, early-stage RCTs have established promising effects of MEST on both overgeneral memory and symptoms of PTSD (Maxwell et al., 2016; Moradi et al., 2014). A larger RCT is now needed to evaluate treatment efficacy, particularly against established treatments.

The integration of the trauma memory into the broader autobiographical life story also plays a key role in the development of posttraumatic stress. Berntsen and Rubin (2007) proposed that the centrality of the trauma to the life story will impact later functioning, such that individuals who view the trauma as a central part of their life story will experience poorer emotional wellbeing. In support of this theory, participant ratings of the centrality of the traumatic event to their identity significantly, positively predict psychological wellbeing post-trauma (Groleau, Calhoun, Cann, & Tedeschi, 2013). Indeed, working to situate the trauma within the broader context of an individual's life is a key feature of cognitive-based therapies for PTSD. In this way, the experience of trauma can impact the recollection of other events from the autobiographical past, which in turn predicts posttraumatic stress.

Summary

Trauma memories are clearly a defining feature of PTSD. However, there are a number of other features of autobiographical memory, including for events other than the trauma itself, which are impaired during posttraumatic stress. This includes the ability to retrieve specific single incident memories, particularly for positive events, and the broader structure of the autobiographical life narrative. Thus, the experience of trauma not only creates a trauma memory which must be effectively processed and integrated into the life story in order to ensure adaptive adjustment following trauma, but trauma exposure can also initiate a range of avoidance strategies that generalise and are applied to non-trauma-related autobiographical memories. As these more general autobiographical processes may support the generalisation of maladaptive trauma-related appraisals to an individual's wider life, treatment of posttraumatic stress is likely to benefit from targeting the entire range of maladaptive processes within autobiographical memory.

Anxiety

There is also evidence that reduced positive bias and memory specificity are also observed in those experiencing elevated anxiety (e.g., Moscovitch, Gavric, Merrifield, Bielak, & Moscovitch, 2011). Most notably, recent research has demonstrated that overgeneral memory retrieval predicts the primary onset of generalized anxiety symptoms in youth who are chronic ruminators (Gutenbrunner et al., 2018a). Consistent with such research, interventions targeting reduced specificity of positive memories (e.g., COMET) are showing promise for treatment of anxiety (e.g., Staring et al., 2016). A summary of these interventions is presented in Table 1. There are however a number of autobiographical memory features that are distinct characteristics of anxiety disorders.

Threat bias

Similar to the preferential recall of negative information in depression, anxiety is associated with the heightened accessibility of threatening information (for meta-analysis see Herrera, Montorio, Cabrera, & Botella, 2017; Mitte, 2008). Threat bias is observed in explicit and implicit memory, but is particularly noticeable in memory for personalized material (Coles, Turk, & Heimberg, 2007). Individuals experiencing elevated anxiety are quicker to retrieve personal memories associated with nervousness and anxiety compared to positive memories (for review see Morgan, 2010). A bias toward threat-related autobiographical information is evident across the anxiety disorders (e.g., panic disorder, social anxiety disorder), and is proposed to play a causal role in the experience of anxiety.

Let's look at Social Anxiety Disorder, as an example. The autobiographical memories that socially anxious individuals retrieve consistently contain more self-referential information than non-anxious controls (Anderson, Goldin, Kurita, & Gross, 2008; D'Argembeau, Van der Linden, d'Acremont, & Mayers, 2006). As such, their memories of past social events include more detail regarding their own physical appearance, physiological experiences, and how other people interacted with them, relative to non-socially anxious

individuals. Indeed, a focus on self-relevant information is also evident in the perspective from which socially anxious individuals recall past events. Rather than using a field perspective, or 'first-person view', socially anxious individuals recall social memories from an observer perspective (i.e., seeing oneself from the vantage point of others), whereby they orient themselves as the focus of others' attention (Coles, Turk, & Heimberg, 2002).

Cognitive models of social anxiety (e.g., Clark & Wells, 1995; Rapee & Heimberg, 1997) propose that enhanced memory for threatening, self-related information (e.g., of others staring at my shaky hands) creates a mental representation of social situations as dangerous. It is this threat-focused mental representation which drives anxious thoughts (e.g., people will notice that I am shaking) and physiological reactions when confronted with a social situation, and promotes use of safety behaviours that are designed to minimize perceived threat (e.g., keeping my hands in my pockets). Over time, repeated retrieval of threat-focussed information from memory reinforces the belief that social situations are dangerous, thereby creating a vicious cycle which maintains an anxiety disorder. Consistent with this theory, the threat-related content and perspective of autobiographical memory retrieval in social anxiety predicts worse self-evaluation, more negative thoughts, and more safety behaviours (Spurr & Stopa, 2003). Threat-bias therefore serves to maintain an anxiety disorder.

Fear memories

Autobiographical memories for fearful events are a driving force of anxiety. Fear memories store the association between an event (e.g., being bitten by a dog) and a conditioned stimulus (e.g., dog). Fear memories thereby underlie the activation of a fear response to a conditioned stimulus. This means that they are integral in fear learning, as a fear memory must be weakened to allow extinction of a fear response. Indeed, disrupting the reconsolidation of a fear memory can eradicate the behavioural expression of fear (Kindt, Soeter, & Vervliet, 2009). We do not elaborate on the consolidation and reconsolidation of

fear memories here, as that is covered elsewhere in this volume (REF to 3.7 Kensinger & Fields and 6.8 Nadel & Sederberg chapters). Instead, we will focus on how working with the fear memory is a key feature of treatment for anxiety disorders.

Treatment of anxiety

Editing of memories plays a key role in treatment of anxiety. Exposure therapy, the National Institute for Health and Care Excellence recommended treatment for a range of anxiety disorders, is one treatment which specifically targets a fear memory. Exposure therapy is an extinction-based treatment, in which principles of fear extinction are used to weaken the association between a conditioned stimulus and a fear response. This involves repeatedly exposing the individual to the feared stimulus, which may be the object of a phobia (e.g., spider, airplane), a situation thought to induce a panic attack (e.g., a shopping center), or social situations for those who are socially anxious. Exposure can be 'in vivo', in which the individual is in the same physical environment as the object or situation, or imaginal, in which the individual uses mental imagery to imagine the stimulus. The therapist will work with the individual to design an exposure hierarchy, which usually begins with the individual being exposed to the least feared situation first (e.g., imagining a spider) before working up to exposure to the most feared event (e.g., holding a spider). Over repeated exposure, the expectation that the stimulus will cause harm is repeatedly violated, and this new learning is updated in memory. It is increasingly understood that new learning is not encoded in the original fear memory itself, but rather, that a new 'safety' memory is formed. The safety memory competes with the fear memory for activation when confronted with a conditioned stimulus, inhibiting activation of the fear memory and thereby a fear response.

The later return of fear is a key limitation of the efficacy of exposure therapy. Many successfully treated individuals will go on to experience a return of anxiety within the following months or years (for review see Vervliet, Craske, & Hermans, 2013). As we have

outlined, the fear memory itself plays a key role in the experience of a fear response. As such, researchers have begun to draw upon advances from experimental science of fear memories to develop techniques that may enhance the effect of exposure therapy (for review of the basic science see Phelps & Hofmann, 2019).

Many of these techniques aim to further deteriorate the quality of the fear memory. One way this may be achieved is through explicitly reactivating the fear memory before beginning exposure tasks. Based on the principles of reconsolidation, it is proposed that reactivating the fear memory will make it more labile, and therefore more vulnerable to the integration of new information gained during the exposure task. Recent research suggests that activating the fear memory before exposure may both increase the speed with which fear attenuates, and also delay the return of fear. Telch and colleagues (2017) demonstrated that snake/spider phobic individuals who had their fear memory reactivated before an exposure therapy task had a lower fear response to a snake/spider one-month later, relative to phobic individuals who had their fear memories reactivated after an exposure task (when no impact on updating of the fear memory would be expected). However, it has yet to be determined that reductions in these physiological fear responses translate to a reduction in clinical measures of anxiety. Mapels-Keller et al. (2017) demonstrated no significant difference in clinical outcomes at six-months or one-year post-treatment for individuals who experienced a fear memory reactivation versus a neutral memory reactivation prior to exposure. Studies using drugs to influence reconsolidation, rather than behavioural reactivation of the fear memory, have produced similarly inconsistent results (for discussion see Kroes, Schiller, LeDoux, & Phelps, 2016). There have been a number of recent proposals that outline how these techniques could be further developed for treatment purposes (e.g., Phelps & Hofmann, 2019; Weisman & Rodebaugh, 2018). Efforts are therefore ongoing to translate basic science into memory intervention techniques that can improve clinical practice.

Summary

Memory for fearful events is at the core of anxiety. Fear memories drive physiological fear responses, and biases toward threat-related information in how past events are recalled motivate the cognitive representations that cause negative cognitions and safety behaviours. Working with autobiographical memories is therefore key to treating anxiety, whether this is through directly challenging the accuracy of threat-related content using behavioural experiments and cognitive restructuring in CBT, or through weakening the fear memory using exposure therapy. Ongoing efforts to improve the efficacy of anxiety treatments are drawing from basic science and experimenting with novel techniques that will enhance our longer-term impact on fear memories, and thereby the physiological, cognitive and behavioural expression of anxiety.

Involuntary retrieval of autobiographical memories in anxiety and depression

Research into involuntary memory retrieval has been much more transdiagnostic in nature. Much of the early research on memory biases in anxiety and depression focused on voluntary retrieval (which we have detailed above), with involuntary retrieval primarily examined in the context of posttraumatic stress. Autobiographical memories that arise spontaneously, in the absence of conscious intention, are proposed to occur through a directive retrieval process. While voluntary memory retrieval occurs through deliberate activation of a generative retrieval process, memories that arise through directive retrieval are activated by cues in the internal or external environment (Schlagman & Kvavilashvili, 2008). Involuntary memory retrieval is a frequent phenomenon, with the average adult experiencing 2-5 involuntary memories a day (Berntsen, 2009). However, the frequency of involuntary memory retrieval is increased not only in posttraumatic stress, but also in both depression and anxiety (for review see Chris R Brewin et al., 2010).

This increased experience of involuntarily retrieved memories is commonly referred to as intrusive memories. Intrusive memories tend to be of specific episodes and may be either visually or verbally based, with consistent evidence that visually-rich memories induce greater emotional distress upon recall (Holmes, Arntz, & Smucker, 2007). In depression, intrusive memories are often of past negative experiences, and can be triggered by rumination or other negative thought sequences. In anxiety, involuntary recollections are also for earlier adverse experiences, with specific details of the experience being matched to the type of anxiety experienced (i.e., health-related in health anxiety, panic-related in panic disorder). The cues that unconsciously trigger involuntary recollections are also matched to the type of anxiety (e.g., social cues in social anxiety).

Intrusive memories are experienced as uncontrollable and emotionally distressing upon recall, and associated with a longer duration and greater severity of symptoms (Chris R. Brewin, Reynolds, & Tata, 1999). A lack of contextual integration of involuntary memories can also lead to dissociation (Reynolds & Brewin, 1999) – a state in which the individual feels disconnected from their mind, body or the world around them. Several other pathways through which involuntary memories maintain symptoms have been proposed, such as by initiating rumination and avoidance (Watson, Berntsen, Kuyken, & Watkins, 2012). The appraisals that an individual makes of an intrusive memory are also important. Assigning a negative meaning to intrusions (e.g., 'I cannot cope', 'I am going crazy') is associated with greater severity of symptoms (Starr & Moulds, 2006). In sum, increased involuntary retrieval of autobiographical memories is observed in both depression and anxiety, and appears to promote other features of poor mental health.

Implications for treatment

Treatment for anxiety and depression is therefore increasingly targeting the experience of intrusive autobiographical memories. Diaries are kept in which the individual

notes where they were, what they were doing, and what they were thinking when an intrusive memory occurs, in an attempt to identify the cues that initiated involuntary retrieval. Identifying the cues that trigger involuntary retrieval can help an individual to understand when to expect such intrusions, and thereby reduce their distressing and uncontrollable nature.

Imagery rescripting techniques for memories of traumatic events have also been tested for use with memories of less-traumatic adverse experiences. Imagery rescripting requires the individual to hold the memory of the distressing event in mind, but to then change the way in which the event ends, such that the event resolves in a more desirable manner (A. Arntz, 2012). The change does not have to be realistic or plausible. For example, if you keep experiencing involuntary retrieval of an event memory in which you were publically humiliated by a classmate, a therapist may guide you to change the ending of the event such that you retort with a witty comeback.

Imagery rescripting of aversive memories has been shown to effectively treat symptoms of social anxiety, health anxiety, obsessive compulsive disorder, phobias, and depression (for reviews see Arnoud Arntz, 2012; Morina, Lancee, & Arntz, 2017). In terms of mechanisms of action, one way that memory rescripting may improve symptoms is by changing the meaning associated with the event. Indeed, rescripting autobiographical memories does impact memory appraisals and core beliefs (e.g., in social anxiety; Reimer & Moscovitch, 2015). Alternatively, as in extinction-based treatments, memory rescripting may strengthen a safety memory that can compete with the fear memory, thereby decreasing fear responses (see Kunze, Arntz, & Kindt, 2019). Currently, while the mechanisms underlying the effect of memory rescripting are unclear, the consistent treatment effects relative to control conditions suggest that further development of memory rescripting techniques for anxiety and depression is warranted.

Summary

Although much of the early research on memory in the context of depression and anxiety focused on memory biases in recollection, more recent work has demonstrated that involuntary retrieval of memories also serve to maintain symptoms of mood and anxiety disorders. Subsequently, treatment techniques have been adapted from trauma-focused interventions in order to target and reduce the distressing nature of involuntary autobiographical memory retrieval in a wider range of clinical presentations. An increasing focus on memory processes, translated from basic science, is taking important steps toward improving the efficacy of psychological interventions. As autobiographical memory processes both predict prognosis and are at the core of psychological intervention for a number of mental health issues, enriching memory processing is an exciting avenue for further research.

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