

Chapter 5

Biased Interpretation of Ambiguity in Depression and Anxiety: Interactions with Attention, Memory, and Cognitive Control Processes



Jonas Everaert, Sarah Struyf, and Ernst H. W. Koster

5.1 Introduction

Ambiguous situations are common in everyday life. Imagine that you notice a person in the audience frowning when you present your latest work or that you did not receive an invitation to a friend's wedding. People need to generate and select plausible interpretations to resolve the ambiguity of such situations to make sense of what is happening around them (Blanchette & Richards, 2010; Hirsch et al., 2016; Huppert et al., 2007). In the examples above, you might think that the person in the audience is in a bad mood because of a fight earlier that day and that the invitation for the wedding got lost at the post office. However, less benign interpretations are also possible. For instance, you might think that your presentation was poor and that you are not invited to the wedding because you are not a real friend of the couple. How people interpret ambiguity has major consequences for their mood state and emotional well-being (Everaert et al., 2017a; Hirsch et al., 2016).

Cognitive theories have postulated that biases in how ambiguous situations are interpreted contribute to the development and maintenance of anxiety and depressive disorders (Beck & Haigh, 2014; Clark & Wells, 1995; Clark et al., 1999; Ingram, 1984; Mathews & Macleod, 2005; Morrison & Heimberg, 2013; Ouimet et al., 2009; Rapee & Heimberg, 1997). Interpretation bias refers to a tendency to

J. Everaert (✉)

Department of Medical and Clinical Psychology, Tilburg School of Social and Behavioral Sciences, Tilburg University, Tilburg, The Netherlands
e-mail: j.everaert@tilburguniversity.edu

S. Struyf · E. H. W. Koster

Department of Experimental Clinical and Health Psychology, Faculty of Psychology and Educational Sciences, Ghent University, Ghent, Belgium
e-mail: sarah.struyf@ugent.be; Ernst.Koster@ugent.be

consistently resolve ambiguous situations in a characteristic direction such as inferring more negative or threatening and/or fewer positive or benign meanings. This hypothesis has generated a large body of empirical research using a variety of cognitive-experimental paradigms in various samples of individuals with depressive and anxiety symptoms (for an overview of measures to assess interpretation biases, see Chap. 3 by Würtz and Sanchez-Lopez; for an overview of mediators and moderators of interpretation biases, see Chap. 4 by Gadassi Polack et al.).

Extensive research has shown that clinical and subclinical forms of depression are characterized by a tendency to infer fewer positive and more negative interpretations to account for ambiguity (for a meta-analysis, see Everaert et al., 2017a). With respect to anxiety, research suggests that individuals with generalized anxiety disorder display an interpretation bias toward threats (Hirsch et al., 2016). Individuals with panic disorder display a tendency to draw more catastrophic self-referent interpretations of benign physical sensations (Clark et al., 1997; Hirsch et al., 2016; Rosmarin, et al., 2009). Finally, individuals with social anxiety infer more negative interpretations when elaborating on ambiguous social information and less positive online interpretations at the time of encountering ambiguous cues (Chen et al., 2020; Morrison & Heimberg, 2013).

Importantly, research indicates that interpretation biases predict future symptom levels (Hirsch et al., 2016; Rude et al., 2010). For example, Woud et al. (2014) observed that interpretation bias for panic-related scenarios predicted the onset of panic disorder 17 months later, even after controlling for anxiety sensitivity and fear of bodily sensations. In depression, a negative interpretation bias predicts symptom levels 4–6 weeks later (Rude et al., 2002) as well as diagnostic status 18–28 months later (Rude et al., 2003). In addition to its predictive utility, interpretation may causally influence depression and anxiety symptoms (Fodor et al., 2020; Hallion & Ruscio, 2011; Menne-Lothmann et al., 2014). Cognitive bias modification (CBM) studies that experimentally manipulate interpretation bias alter negative mood states (Menne-Lothmann et al., 2014) anxiety and depression symptoms following a stressful experience (Hallion & Ruscio, 2011; for an overview of how to manipulate interpretation biases, see Chap. 11 by Salemink et al.). Therefore, interpretation bias is often viewed as a transdiagnostic vulnerability mechanism that operates across anxiety and depressive disorders.

Although experimental research on interpretation biases has made important progress in elucidating its nature and role as a potential vulnerability factor for depression and anxiety disorders, the specific mechanisms driving the interpretation of ambiguity remain understudied and poorly understood. This is because interpretation processes have typically been studied in isolation as a distinct phenomenon (Everaert et al., 2012, 2020a, 2020b; Hirsch et al., 2006). Yet, knowledge of which factors contribute to the generation and selection of plausible interpretations seems important to advance scientific understanding of this purported vulnerability mechanism. This knowledge may not only be of theoretical importance but also clinical relevance in that it may inform potential approaches to ameliorate this cognitive bias and decrease the burden imposed by psychopathology.

Interpreting ambiguous situations represents a higher-level cognitive operation that involves integrating and weighing different aspects of a situation to construct new mental representations that resolve the ambiguity (Blanchette & Richards, 2010; Everaert et al., 2020a, 2020b). This process of ambiguity resolution is expected to rely on a set of basic attention and memory operations (Everaert et al., 2020a, 2020b; Everaert, 2021). Because depression and anxiety disorders are also characterized by mood-congruent biases in attention allocation and memory retrieval (Armstrong & Olatunji, 2012; Bar-Haim et al., 2007; Gaddy & Ingram, 2014; Herrera et al., 2017; Pergamin-Hight et al., 2015; Schweizer et al., 2019; Matt et al., 1992; Everaert et al., 2022), these information-processing biases in basic cognitive operations likely contribute to the skewed generation and selection of interpretations. These biases may shape how individuals with depression and anxiety resolve ambiguous situations. While research on interactions between cognitive biases in psychopathology is still at the early stages, some emerging work has started to illuminate potential interactions between interpretation biases and other cognitive operations. This chapter reviews theoretical frameworks and existing empirical research on potential interactions between interpretation bias and attention, memory, and cognitive control when processing emotional information. This chapter concludes by outlining directions for future research to advance research in this emerging area of interest.

5.2 Theoretical Frameworks on Interactions Between Cognitive Biases

Research on cognitive biases in psychopathology has been guided by cognitive theories of anxiety and depression. One of the earliest models that have attributed a critical role to cognitive biases is Beck's schema theory (Beck, 1967). In his cognitive model, three levels of cognition (i.e., dysfunctional schemas, biased information processing, and negative automatic thoughts) are proposed as vulnerability factors for the maintenance of anxiety and depressive symptoms (Beck, 1967; Clark & Beck, 2010). Dysfunctional schemas are generally described as negative attitudes and beliefs about the self, the world, and the future (i.e., *the cognitive triad*). These beliefs concern themes of loss and helplessness in depression (Beck, 1979) or threat and danger combined with low expectations of one's coping ability in anxiety (Beck, 1985; Beck et al., 2005). Stressful events or experiences are expected to activate dysfunctional schemas which then set the stage for biases in attention, interpretation, and memory that are congruent with the activated schema. Such negative biases in information-processing are expected to produce negative automatic thoughts, images, and memories that may elicit various emotional and/or behavioral problems. Beck's schema theory has been highly influential in guiding research characterizing the nature of information-processing biases in various emotional disorders with major implications for clinical practice (Woud, 2022). However, the

model's predictions regarding specific interactions between different aspects of information processing are less specific. This limitation has been addressed by later cognitive theories described below.

One integrative multi-process model of anxiety has been proposed by Ouimet et al. (2009). Drawing on dual-system theories, the model assumes that two distinct systems of information processing, the associative and rule-based system, operate in tandem in guiding problem-solving, making judgments, and regulating emotions. In the associative system, the processing of information involves rapid activation of associated concepts via spreading activation (associative processing). In the rule-based system, information-processing is characterized by the rational analysis of factual relations between concepts (rule-based processing). The integrative model proposed by Ouimet et al. (2009) posits that individual differences in associative and rule-based processing are responsible for cognitive biases at different stages of processing threat-relevant stimuli, thereby contributing to the development and maintenance of anxiety disorders. It is proposed that encountering potentially threatening stimuli activates threat-related concepts in the associative system, which directly orients attention toward the threatening stimuli in the environment. The rule-based system is expected to use inputs from the associative system to interpret and appraise the stimuli. The resulting enhanced activation of threat-related associations sets the stage for interpretations that are biased toward the threat. In parallel to the process of interpreting the stimulus, threat-related associations in the associative system will enhance attentional engagement with the stimulus. This may further increase the activation of corresponding threat-related associations, instigating a dysfunctional feedback loop. To overcome this feedback loop, the rule-based system needs to override the effects of the associative system on attention and disengage from attending to the stimulus by deploying executive control (e.g., behavioral responses to avoid attending to the threatening stimulus). Reinterpreting the stimulus (i.e., rule-based process) may be an effective strategy in overcoming fear responses by deactivating threat-related associations and reducing attentional engagement with the stimulus. By specifying potential interactions between the activation of threat-related associations from memory, attentional orienting, and attentional engagement as well as interpretation, the model sheds light on how cognitive biases may operate together in various anxiety disorders.

With respect to depression, Wittenborn et al. (2016) proposed a causal loop diagram integrating cognitive, social, and environmental factors that may explain the etiology of depression. This model specifies a reinforcing feedback loop involving attention, interpretation, and memory biases in the consolidation of negative cognitions. The model proposes that negative cognitive representations that are stored in long-term memory direct attention toward relevant information. Specifically, negative memory representations are hypothesized to both orient and maintain attention on negative material in the environment that matches the content of the memory representations. The resulting negative bias of attention is expected to increase one's perceived stress level and produce negatively biased interpretations of the situation. This enhanced processing of negative material through biases of attention and interpretation is in turn expected to set the stage for increased negative affect

and improved encoding of negative material into memory. This further consolidates the initial negative memory representations, which may in turn guide attention toward congruent information, etc. By defining a pathway with memory bias causing biases of attention and interpretation that in turn fuel memory bias, this model advocates the view that cognitive biases are highly interactive and interdependent processes that cannot be fully understood when studied in isolation.

In an attempt to understand how cognitive biases and their components interact and contribute to psychopathology, Everaert et al. (2020a) recently proposed a framework that is informed by recent advances in the fields of cognitive and affective science (see Fig. 5.1). The framework proposes several theoretical predictions about causal pathways between attention and memory biases at different stages of information-processing. Specifically, the framework proposes several mechanisms that may be important to understanding how attention biases, working memory difficulties, and long-term memory biases work together and, thereby, contribute to psychopathology. The framework proposes that attention bias improves memory for negative material by influencing both encoding and retrieval of emotional material. That is, attention bias may skew the processing of emotional material in favor of negative information, which increases the probability that negative material is encoded into memory and alters what is available for later recollection. In addition, attentional biases may also enhance memory biases after encoding by altering the retrieval of stored emotional items. In remembering emotional experiences, attention bias may influence which cues are used to guide memory search to retrieve

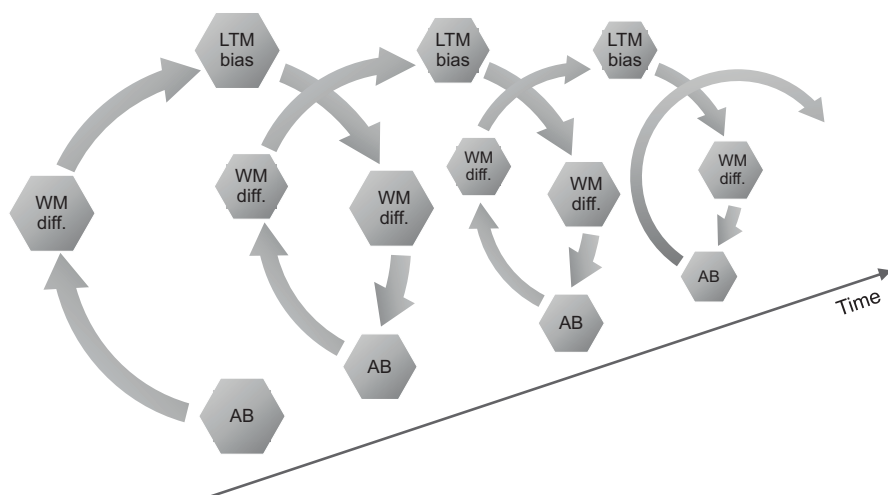


Fig. 5.1 Schematic overview of mechanisms and features of interactions among emotional biases in cognitive processes in psychopathology. *Note.* This figure illustrates five potential interactions: (1) attention bias (AB) during memory encoding modulates long-term memory (LTM) bias; (2) AB during memory retrieval modulates LTM bias; (3) LTM bias guides the allocation of attention; (4) working memory difficulties (WM diff.) modulate attention bias–LTM bias interactions; (5) interactions among biases of cognitive processes dynamically fluctuate across time and contexts

details of a past event. This attention bias during memory search is expected to increase the likelihood of remembering negative memories. In addition to the role of attention bias in influencing emotional memory, the framework proposes that memory biases may guide attention biases toward matching emotional material. Such a memory-guided attention bias may occur because someone's emotional learning history alters the attentional priority of certain cues in the environment. Alternatively, emotional memories can also be retrieved consciously when searching for relevant emotional information. Thus, the framework postulates that attention bias influences and is influenced by memory bias. It is expected that the interactions between these biased cognitive processes dynamically unfold over time. The framework suggests that such interactions between basic cognitive processes such as attention and memory are fundamental to many forms of higher-level cognition. Indeed, inferring interpretations to resolve ambiguity is a higher-level cognitive operation that is expected to rely on a set of basic attention and memory processes. The proposed attention–memory interactions may thus shape the (biased) outcome of interpretation processes. This framework is broadly applicable and may guide research on cognitive biases that operate within and across forms of psychopathology.

5.3 Empirical Research Examining Interactions Between Interpretation Bias and Basic Cognitive Processes

5.3.1 Attention Bias and Interpreting Ambiguity

Biased attention and interpretation processes are processes that have been proposed to be intimately related (Everaert et al., 2012; Everaert & Koster, 2020; Hirsch et al., 2006; Mathews & Mackintosh, 1998; Ouimet et al., 2009; Wittenborn et al., 2016). In the context of depression, empirical research yielded empirical support for an association between attention and interpretation biases. In one study (Everaert et al., 2014), participants with varying self-reported levels of depressive symptom severity were asked to complete a Scrambled Sentences Test (SST; Wenzlaff & Bates, 1998) that was developed for this study. In this test, participants unscramble emotional sentences in either a positive or negative manner (e.g., “born winner am loser a I” into either “I am a born loser” or “I am a born winner”; Everaert et al., 2014). When participants were unscrambling the sentences, biases in attention toward negative (e.g., “loser”) versus positive (e.g., “winner”) words were measured using eye-tracking. Results showed that a bias in fixation frequency favoring negative words was related to a higher proportion of SST sentences that were unscrambled in a negative manner (i.e., negative interpretations). This suggests that when attention is biased and prioritizes negative stimuli, more negative interpretations are derived. Of note, this relation between attention bias and subsequent biased interpretation of attended materials was also found by another study in a subclinical depressed

sample using an exogenous cueing task in combination with a SST (Everaert et al., 2013). Moreover, a recent study on social anxiety provided further evidence in support of the association between attention and interpretation biases in the processing of emotional facial expressions (Leung et al., 2022). In this study, participants were asked to label various emotional expressions as quickly and accurately as possible (i.e., happy, angry, sad, disgust, fear). Facial stimuli displaying subtle expressions (i.e., low-intensity emotion) were then used to measure interpretation bias. Results showed that regardless of social anxiety levels, attention bias toward angry (but not disgusted) faces was associated with more negative interpretations of these angry expressions. This interpretation bias in turn predicted better recognition of the faces displaying anger.

While these cross-sectional studies optimized conditions to examine the effect of attention bias on interpretation bias (e.g., the temporal order of tasks, similar stimulus materials across tasks), third variables (for instance, elevated negative affect) could account for the observed relations. Direct proof of causality requires experimental manipulation of attention bias to track effects on interpretation processes.

Going beyond cross-sectional data, some studies have explicitly tested the causal role of attention bias in shaping interpretations of ambiguous information. These studies experimentally manipulate the acquisition or attenuation of a cognitive bias through cognitive bias modification procedures (e.g., inducing a negative or positive attention bias) to track effects on subsequent cognitive processes (e.g., interpretation of ambiguous stimuli). In samples of individuals reporting varying depressive symptom levels, two recent experiments have trained participants to orient attention toward either positive or negative words using a dot-probe training task (Everaert et al., 2015). Transfer of attention bias training to interpretation bias was examined by the Scrambled Sentences Test (SST) following the training procedure. Across both studies, it was observed that individual differences in attention bias acquisition were not related to the performance on the interpretation task. This work did not provide evidence for a causal influence of attention bias on interpretation bias in the context of depression. However, in this study, there was little evidence of successful manipulation of attention bias (measured before and after training), which precludes strong statements about the absence of influences of attention on interpretation. Similarly, a multi-session attention bias training using a visual search paradigm could not find transfer effects to interpretation processes in a sample of adolescents with heightened symptoms of anxiety and/or depression (Voogd et al., 2017). This finding is remarkable because, in contrast to earlier work (Everaert et al., 2015), the results of this study revealed that training successfully reduced attentional bias. Hence, the results of the study by Voogd and colleagues provide stronger evidence against the idea of a causal impact of attentional bias on interpretation bias.

However, a different pattern of results emerged in a study examining how an induced attention bias to threat affects how subsequent ambiguous information is interpreted (White et al., 2011). Participants were randomly assigned to the attention training group or the control group. In the attention training group, an attention bias to threat was induced using a dot-probe training procedure. In the control condition, no experimental manipulation of attention occurred. Next, participants

completed a sentence completion task to measure interpretation bias. The task presented sentences describing ambiguous situations with the last word or phrase omitted. Participants needed to complete each sentence to disambiguate each situation by generating one word or short phrases that came to mind, and then selecting the response that they felt completed the sentence best. Results showed that participants who were trained to allocate attention toward threat displayed an increase in anxiety-related interpretations of ambiguous events when controlling for their initial interpretations of the ambiguous scenarios. Thus, attention bias may alter initial anxiety-related negative interpretations (White et al., 2011).

In addition to the potential influence of attention bias on interpretation bias, biased interpretations may, in turn, guide the allocation of attention to matching emotional information. To the best of our knowledge, in research on depression, there is only one study examining whether interpretation bias affects attention bias (LeMoult et al., 2017). In this study, adolescents with major depression received either six sessions of positive interpretation bias training or neutral training, followed by an interpretation and attention bias task. The training was effective in that adolescents receiving positive training also interpreted ambiguous scenarios more positively than did participants who received the neutral training. However, there was no transfer of the training to the dot-probe task as a measure of attention bias. This finding suggests that interpretation bias may not alter biased attention allocation in depression. However, a study on social anxiety did provide evidence for a causal effect of interpretation bias training on attention bias to threat (Amir et al., 2010). In this study, socially anxious individuals were randomly assigned to either a control condition or an interpretation bias modification program to make benign interpretations of ambiguous social scenarios. Results showed that only individuals who were trained to draw benign meanings of ambiguous situations showed a greater ability to disengage attention from threatening information.

Taken together, current research has not been able to provide unequivocal empirical support for mutual causal influences between attention and interpretation biases related to depression, but such reciprocal relationships may occur in anxiety. One potential explanation is that interpretation processes and *visual* attention are more closely connected in situations involving anxiety-eliciting threatening stimuli as compared to situations involving emotions such as sadness. This differential reliance on external stimuli (i.e., external attention) versus internal mental representations (i.e. internal attention) in anxiety versus sadness may (in part) explain observed differences between anxiety and depression with respect to performance on cognitive tasks using visual stimuli. Nevertheless, with unsuccessful manipulations of attentional bias and the problematic psychometric properties of commonly used cognitive paradigms to measure cognitive biases (Carlson & Herdman, 2012; Hirsch et al., 2016; O'Connor et al., 2021), there remain major challenges in this field of research.

5.3.2 *Cognitive Control Difficulties and Interpreting Ambiguity*

When someone generates an interpretation from ambiguous information, different options must be held online in working memory (WM), and the most plausible interpretation must be selected from its competitors. Difficulties in executive control likely influence this selection process. In particular, difficulties in inhibiting negative representations, shifting between negative and positive representations, and updating WM by removing irrelevant negative material may result in a disproportionate representation of negative versus positive interpretations in working memory (Everaert et al., 2020a, 2020b). In line with this notion, current research suggests that working memory difficulties when processing emotional information modulate how people with depressive symptoms interpret ambiguous information (Everaert et al., 2017a). This recent work indicates that both difficulties in shifting between negative working memory representations and difficulties in updating working memory to discard negative representations are uniquely related to depression-linked interpretation biases.

To date, similar work on anxiety-related difficulties in cognitive control when processing threatening information and interpretation bias is lacking. However, some studies have examined how working memory capacity may modulate the interpretation of ambiguity. One study tested whether working memory capacity for neutral information modulates the relation between social anxiety and threat-related interpretation bias in a nonclinical sample (Salemink et al., 2013). Participants' implicit social anxiety was measured using the Implicit Association Test (implicit social anxiety; Westberg et al., 2007). Interpretation bias was measured with the Word Sentence Association Paradigm (Beard & Amir, 2008) and working memory capacity was measured with the Complex Operation Span Task (Unsworth et al., 2005). Results indicated that working memory capacity moderated the relation between implicit social anxiety and threat-related interpretation bias. That is, social anxiety was positively related to interpretation bias for individuals with low but not high working memory capacity. Another study provided further evidence for the role of working memory in interpretation bias in high trait anxious individuals (Booth et al., 2017). In this study, participants were asked to read various ambiguous vignettes regarding physical or social threats under high and low working memory load. Participants' interpretations of the ambiguous vignettes were assessed via a recognition test. Results showed that trait anxiety was predictive of negative interpretation biases of social threat vignettes under high (but not low) working memory load. These findings provide some support for the hypothesis that the severity of biased interpretations of ambiguous stimuli is modulated by difficulties in executive control. However, it has yet to be investigated how cognitive control difficulties when processing emotional information are linked to interpretation biases for threat in anxiety.

5.3.3 *Memory Bias and Interpreting Ambiguity*

Inferring more biased interpretations may increase the probability that these mental representations are encoded into memory, as such setting the stage for a bias in memory retrieval. The potential impact of interpretation bias on memory seems particularly important because encoding of negative interpretations in memory may fuel negative beliefs about the self, others, and the future. Findings from studies examining associations between interpretation and memory in nonclinical samples suggest that memory recall is affected by interpretation biases operating during the encoding of emotional material as well as by interpretation biases acquired after emotional material has been encoded (Leung et al., 2022; Saleminck et al., 2010; Tran et al., 2011). Some evidence from cross-sectional studies in samples of individuals reporting a variety of depressive symptom levels suggests that inferring more interpretations in a biased manner increases the likelihood of subsequent biased retrieval of those interpretations (Everaert et al., 2013, 2014). In these studies, participants completed a Scrambled Sentences Test (SST) to measure interpretation bias, and, following a short break, they were asked to recall their previously constructed sentences during the SST as accurately as possible. In support of the notion that interpretation bias modulates free recall, a negative bias in interpretive choices during the SST was related to enhanced retrieval of negative sentences from memory. These findings suggest that emotional biases in interpretation regulate what is subsequently remembered (Everaert et al., 2013, 2014).

Furthermore, a study sought to extend this work by recruiting a sample of clinically depressed individuals (Joormann et al., 2015). In this study, participants completed an interpretation bias training inducing either a positive or negative interpretation bias. Next, participants read a series of ambiguous stories during an interpretation task, followed by a recognition test to measure interpretation bias and a recall task measuring memory for the ambiguous stories. The results showed that the training was successful at inducing a positive and negative interpretation bias and that there were training training-congruent effects on the recall for endings (i.e., interpretations) of the ambiguous scenarios. Providing further support for the role of interpretation bias in regulating memory, a recent study showed that changes in interpretation bias, as a result of a cognitive bias modification procedure, also resulted in congruent changes in negative memory bias (Nieto & Vazquez, 2021).

Unfortunately, research examining the impact of interpretation bias on memory is still at the early stages in research on anxiety disorders. In one study by Hertel et al. (2008), participants with social anxiety disorder and healthy control group were instructed to interpret ambiguous social scenarios and formulate an ending for each scenario. During the subsequent memory task, participants were asked to recall the details from the presented scenarios and their endings. Compared to individuals in the healthy control group, participants with social anxiety disorder endorsed more negative interpretations of these scenarios and showed better memory. In other studies (Hertel et al., 2008; Hirsch et al., 2006, 2016), non-clinical participants were asked to read ambiguous scenarios with socially threatening endings. They were

instructed to either imagine themselves as the central character of the scenario as vivid as possible or use no mental imagery. Next, they completed a memory task testing their memory of the scenarios. Results suggested that negative interpretations contributed to memory biases when participants used imagery and not when they processed the scenarios in a more verbal way (Hertel et al., 2008; Hirsch et al., 2006, 2016). These results suggest that memory in social anxiety may be influenced by interpretation processes (Hirsch et al., 2006). Though these studies used experimental manipulations of cognitive processes via instructions, future work should extend these findings by using cognitive bias modification procedures. This work could draw on previous studies examining how interpretation bias impacts memory in healthy individuals (Salemink et al., 2010; Tran et al., 2011).

While interpretation bias may impact memory, it is also plausible that the generation of interpretations is guided by prior knowledge and/or experiences in similar situations. Thus, memory bias is likely to influence interpretation bias. Because research on interactions between cognitive biases when processing emotional information is at the early stages, investigators have yet to examine the potential role of memory bias in shaping the generation and selection of interpretations in depression and anxiety.

5.4 Future Research Directions

Though research has made considerable progress in the past several years, important limitations remain and represent directions for future research. First, various aspects of interactions between interpretation bias and other cognitive processes have received only limited empirical attention or have yet to be investigated. To date, most studies have examined the role of attention bias in accounting for individual differences in interpretation bias toward negative or threatening material. As repeatedly noted in earlier sections of this chapter, various potential interactions between interpretation bias and other cognitive biases have received far less attention. Indeed, much has yet to be discovered about whether interpretation bias is also able to guide attention allocation as well as whether interpretation bias can both influence and be influenced by memory bias and emotional working memory difficulties in depression and anxiety. Research in this area may draw on comprehensive theoretical frameworks (e.g., Everaert et al., 2020a) to systematically explore how interpretation bias interacts with attention bias, cognitive control, and working memory difficulties. Also, though not discussed in this chapter, other cognitive processes such as mental imagery (Hirsch et al., 2006; Holmes et al., 2009; for an overview of the role of imagery in biased interpretational processing, see Chap. 6 by Blackwell) and expectations (Aue & Okon-Singer, 2015; Kube et al., 2020) may further help to understand emotional biases in interpretation processes in psychopathology.

Advances with respect to these issues require targeted research that can be guided by theoretical frameworks. Recent transdiagnostic research frameworks (Everaert

et al., 2020a, 2020b) may provide specific directions for studying how attention biases, working memory difficulties, and long-term memory biases work together when interpreting ambiguous information in various forms of psychopathology. Future research could employ experimental procedures from basic cognitive and affective science to study how attention biases during memory encoding modulate long-term memory biases, how attention biases during memory retrieval modulate long-term memory biases, how long-term memory biases guide the allocation of attention, as well as how working memory difficulties modulate the interactions between biases of attention and long-term memory. As in many basic science studies, experimental psychopathology research in this area could employ multiple experimental tasks of cognitive biases in a fixed temporal order with the same ambiguous stimulus materials in a single study to investigate how stimuli are processed throughout different stages. This experimental setup may help to elucidate specific interactions during the process of interpretation.

While biases in cognitive processes may have transdiagnostic properties, research has yet to discover the extent to which mechanisms of attention–memory bias interactions during the interpretation of ambiguity generalize across different forms of psychopathology. Indeed, differences between mental disorders may arise depending on the nature of biased cognitive processes that are characteristic of a particular disorder. For example, whereas depression involves biases in both implicit and explicit long-term memory (LTM) processes (Gaddy & Ingram, 2014; Matt et al., 1992; Everaert et al., 2022), anxiety is related to the enhanced recall of threat-related information but not to biases in explicit recognition or implicit memory tasks (Mitte, 2008). Such distinctive features regarding the nature of cognitive biases may determine which mechanisms of attention–memory bias interactions during interpretation processes can be plausibly expected (Everaert et al., 2020a, 2020b).

Second, future research on interpretation bias and its underlying mechanisms could adopt more dynamic or context-sensitive perspectives on cognitive biases. Traditional clinical theories consider interpretation bias as an inherently maladaptive process. Yet, emerging *flexibility perspectives* on mental health challenge such static views (Mehu & Scherer, 2015; Stange et al., 2017) and emphasize that an interpretation bias may not always be (mal)adaptive (Everaert et al., 2018). Indeed, negative interpretations may motivate people to adjust their behavior (e.g., tactfully voicing your opinion at work), and overly positive interpretations may lead people to ignore negative or threatening situations (e.g., physical symptoms that could signal a serious disease). Whether interpretations promote (mal)adaptation depends on the fluctuating demands of the context in which these interpretations are made (Everaert et al., 2018; Mehu & Scherer, 2015). Independent of the content of interpretations, the inflexibility with which emotional interpretations are formed and maintained may determine the misfit with situational demands, thereby increasing the risk for psychological complaints. Consistent with this notion, three independent studies have shown that greater severity of depression and social anxiety is not only associated with elevated negative interpretations but also with reduced revision of negative interpretations in the face of disconfirmatory positive information (Everaert et al., 2020a, 2020b; Everaert et al., 2018). Recent work also showed that

not interpretation bias, but reduced revision of negative interpretations based on positive information prospectively predicts changes in suicidal ideation (Everaert et al., 2021). These findings suggest that depression and social anxiety feature both biased and inflexible negative interpretations of ambiguity. Understanding how inflexible revision of interpretation recruits attention, cognitive control, and memory processes provides an important direction for future work to gain a better understanding of processes that are involved in toxic features of interpretation processes.

Finally, prior research has generally studied cognitive biases at the disorder level and ignored the heterogeneous nature of depression and anxiety. The dominant focus on the disorder level may be problematic because it overlooks critical differences in the importance of individual symptoms, differential relations between symptoms, as well as differential relations between symptoms, and risk factors such as cognitive biases (Fried, 2017; Fried & Nesse, 2015). From both a theoretical and clinical stance, knowledge of whether (clusters of) symptoms are more closely related to interpretation bias/inflexibility and its underlying cognitive processes is urgently required (Beevers et al., 2019; Marchetti et al., 2018). Therefore, future research could adopt a symptom-level approach to gain insight into how cognitive biases connect to (clusters of) depression and anxiety symptoms.

5.5 Conclusion

The past several years witnessed important methodological and empirical advances in discovering the nature and role of interpretation processes as well as its interactions with other cognitive mechanisms in depression and anxiety. This review provides an overview of theoretical models and recent research examining interactions between interpretation bias and attention, cognitive control, and memory operations. Though research is at an early stage, accumulated research findings provide some evidence for interrelations between interpretation bias and cognitive biases in attention and memory in depression and anxiety. Yet, there is much that remains to be understood about their complex interplay to gain a better understanding of the higher-level cognitive process of interpretation of ambiguous situations.

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Jonas Everaert is an Assistant Professor at the Department of Medical and Clinical Psychology at Tilburg University. His research bridges cognitive, affective, and social science approaches to uncover the nature, causes, and effects of biased interpretations and inflexible belief revision to develop transdiagnostic and transtherapeutic models of psychopathology. To this end, Jonas combines diverse methods and statistical techniques to capture toxic features of interpretation and socio-affective processes in the lab and in real life.

Sarah Struyf is a clinical psychologist and doctoral student at the department of experimental clinical and health psychology at Ghent University. From a perspective of risk and resilience factors for affective disorders, her research mainly focuses on individual differences in information-processing flexibility and emotion regulation. In her clinical work, she mainly has experience in the field of anxiety, depression, and developmental disorders such as ADHD and autism spectrum disorder in adolescents and adults.

Ernst H. W. Koster is full professor of clinical psychology at Ghent University at the department of experimental clinical and health psychology. He is co-PI of the Psychopathology and Affective Neuroscience Lab. His research examines cognitive risk factors for depression and anxiety and their modification through cognitive training.