

Chapter 6

Mental Imagery and Interpretational Processing Biases



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6.1 Introduction

The term “mental imagery” refers to “representations and the accompanying experience of sensory information without a direct external stimulus” (Pearson et al., 2015, p.590), or in less formal terms “‘seeing with the mind’s eye,’ ‘hearing with the mind’s ear,’ and so on” (Kosslyn et al., 2001, p. 635). People may experience mental imagery in many different circumstances in the course of their daily lives, for example when recalling events from the past, imagining possible events in the future, or simply daydreaming, and this everyday mental imagery is thought to play a number of important roles (Blackwell, 2020a). Dysfunctions in mental imagery may therefore have wide-ranging impacts and in fact are found across many psychological disorders (e.g. Ji et al., 2019b).

The use of mental imagery in cognitive behaviour therapy (CBT) and psychological therapies more generally has a long history (e.g. Singer, 2006; Edwards, 2007). The development of mental imagery approaches within CBT mirrors the broader development of CBT itself, with techniques arising from both the more cognitively focused and the more behaviourally focused traditions (Blackwell, 2021). This chapter starts by considering the relationship between mental imagery and interpretation biases. This then forms a basis for the second part of this chapter, which reviews the use of mental imagery as a means or tool to change interpretation biases.

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6.2 The Relationship Between Mental Imagery and Interpretation Biases

Mental imagery and interpretation biases are closely interconnected and can serve to reinforce each other. To fully understand this interconnection, it is necessary to consider the nature of mental imagery and its basic properties, as well as the functional roles mental imagery is thought to play in daily life.

The neural representation of mental imagery is very similar to that of actual perception in sensory areas of the cortex (Pearson et al., 2015). This has been most intensively investigated in relation to visual imagery, where research has indicated the involvement of even very early levels of the visual cortex such as V1 (Pearson, 2019). Retrieval or generation of mental imagery, for example when recalling a past event or imagining one in the future, involves a distributed network of activation including frontal areas and early sensory pathways. This leads to an experience that is sensory, but has an internal rather than an external source. The neural “as if perception” representation of imagery means that imagining a situation or scene provides us with an experience “as if reality” (Ji et al., 2016). This in turn means that imagery can have a particularly strong impact on emotion (e.g. Holmes & Mathews, 2005), cognition (e.g. Holmes & Mathews, 2005), and behaviour (e.g. Renner et al., 2019).

As mentioned earlier, mental imagery appears to be involved in many different functions in daily life. For example, we often experience mental imagery when we recall events from the past or imagine possible events in the future. This allows us not only to “picture”, but also to replay and re-experience events from the past, and to “pre-play” and pre-experience future possibilities, including our emotional reactions. Imagery-rich recall of past events can have a significant impact on how we feel in the present, in terms of not just mood, but also our sense of self (D’Argembeau, 2021; Stopa, 2009; Rathbone et al., 2012), and our past experiences are also often drawn on to predict what might happen in the present or future. In relation to future-oriented imagery, this can be particularly helpful in planning, decision-making, and making predictions. For example, it can help us “test out” future possibilities in our imagination and thus inform our decisions, enhance our motivation, or protect us from potentially dangerous courses of action. There is also evidence that people’s experience of future-oriented mental imagery is connected to their perception of the future. For example, optimism is associated with particularly vivid positive future-oriented imagery, depression with positive future imagery that is not very vivid, and anxiety with particularly vivid negative future imagery (Ji et al., 2017). Further, if someone finds it difficult to imagine an event occurring, they may evaluate it as unlikely to occur (Kahneman & Tversky, 1982; Szpunar & Schacter, 2013).

Most people experience past- and future-oriented episodic imagery, often termed “mental time travel”, frequently throughout the day, and much of this imagery occurs spontaneously, triggered via external or internal cues (e.g. Berntsen & Jacobsen, 2008; Barsics et al., 2016). Importantly, the retrieval of such imagery is part of the reconstructive process of memory (Schacter & Addis, 2007). That is,

when we recall an event or imagine something in the future, we do not just “read off” an exact copy of a stored perception from memory, but rather reconstruct the perceptual experience. This means that this process is open to influence from our own emotional and motivational state at the time of retrieval or imagining, which may affect the relative accessibility of different kinds of information, and from other cognitive biases.

When it comes to the interconnection between mental imagery and interpretation bias, some aspects of this interconnection have in fact already been spelt out explicitly in the context of certain disorders. For example, in the context of social phobia, Hirsch et al. (2006) proposed a *combined cognitive biases hypothesis* to describe the interplay between the imagery dysfunctions and interpretation biases associated with this disorder (for an overview of associated cognitive biases of interpretation biases, see Chap. 5 by Everaert et al.). Drawing on both previous experimental studies and theoretical considerations, they suggest that negative interpretations (e.g. of one’s behaviour or appearance in a social situation) can be incorporated into the content of imagery experienced (e.g. seeing oneself blushing bright red, shaking, and sweating). Such distorted imagery may not only increase anxiety directly, but also contribute to and reinforce negative interpretations, as well as blocking benign interpretations that could arise from observation of external reality. Given that people with social anxiety often tend to have an internal rather than external attentional focus in social situations, they may be particularly likely to use such imagery as a source of information to monitor their performance. Further, negative interpretations made during or in the aftermath of social situations may be incorporated into imagery and thus the episodic memory of these events, meaning that these memories may serve to reinforce negative interpretations or provide a source for negative social imagery in future situations.

In the context of depression, Holmes et al. (2009a) explored some potential relationships between imagery and interpretation bias. Depression is characterized not only by a negative interpretation bias (Everaert et al., 2017), but by frequent experience of negative imagery and a relative lack of positive imagery (Holmes et al., 2016). Holmes et al. (2009a) suggest that the emotional meanings of negative interpretations may be enhanced via their representation in imagery form, therefore reinforcing depressed mood and thus a negative bias. Further, when positive or benign interpretations do occur, these may not be represented via imagery, but rather processed verbally, contributing to self-comparisons that may in fact further reinforce depressed mood (e.g. Joormann et al., 2007; Holmes et al., 2009b).

Beyond these disorder-specific accounts, drawing on our knowledge of the nature of mental imagery and its basic properties also provides an opportunity to consider more broadly how we might best understand the relevance of mental imagery for interpretation biases. A first possibility to consider is that the mental imagery experienced in daily life may reflect distorted perceptions or memories, and this could influence someone’s interpretation or even perception of an event (see Fig. 6.1). In fact, there is evidence from laboratory studies that mental imagery can distort not only interpretation of situations (e.g. Hirsch et al., 2003), but also interpretation of simple ambiguous visual scenes (e.g. perceiving a neutral face as angry; Diekhof

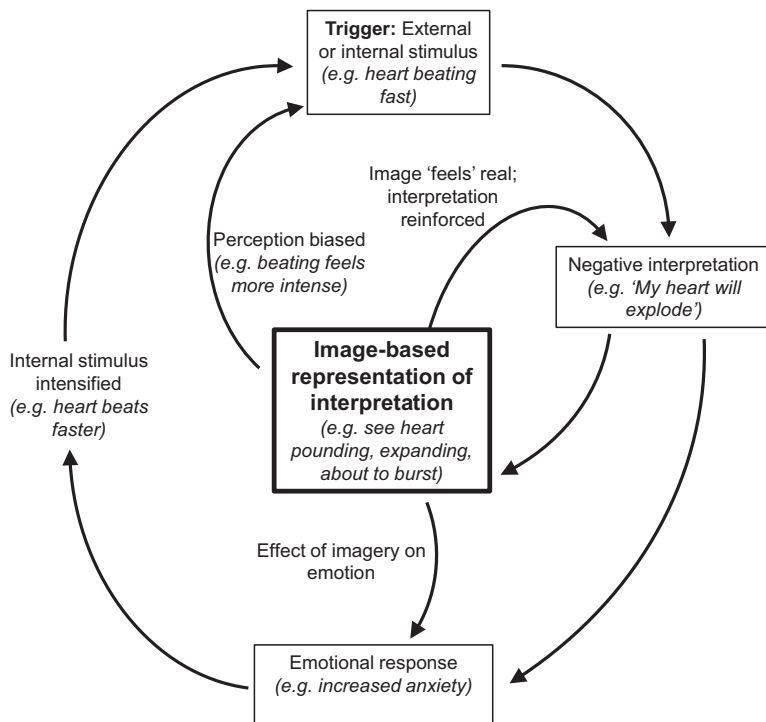


Fig. 6.1 Illustration of one interconnection between imagery and interpretation biases: Biases in interpretation may be represented by or incorporated into imagery, which then reinforces the biased interpretation and its downstream effects. The interconnection is illustrated here using the example of a panic attack, for which the initial triggering stimulus (the target of interpretation) is internal (e.g. heart beating fast); in other disorder contexts the initial triggering stimulus may be external (e.g. a social situation)

et al., 2011), and even simple perceptual information (e.g. Pearson, 2014). To illustrate, when someone who is afraid of spiders thinks of a spider, they may “see” it in their mind’s eye as larger, faster, and more aggressive than it is in reality (Pratt et al., 2004). On encountering a spider they may “see” the feared event of a spider running up onto them and under their clothes in their mind. The realness of such imagery may reinforce their perceptions of spiders, and also feel like a premonition of what is about to happen, leading to a sense of danger. As another example, someone with panic disorder may “see” their heart pumping harder and harder, expanding as if about to explode, reinforcing their interpretation of their physical sensations as dangerous (e.g. Day et al., 2004; see also Fig. 6.1). As a final example, someone with social phobia may misinterpret their image of themselves looking foolish, blushing, and shaking, as reality, reinforcing their interpretation of how others see them (Hirsch et al., 2006).

A second possible basis for the relationship between imagery and interpretation bias is that the relative accessibility of positive versus negative imagery in memory

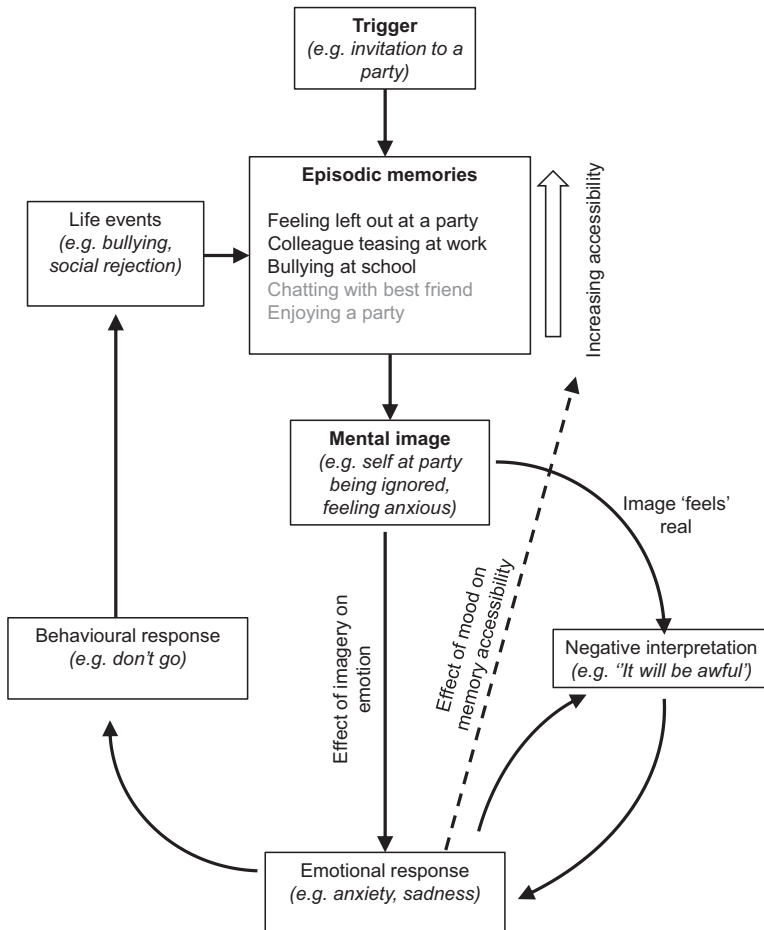


Fig. 6.2 Illustration of one interconnection between imagery and interpretation biases. Retrieval from episodic memory, the contents of which stem from life events or imagined scenes, can lead to experience of a mental image that is then taken as a prediction or explanation of an event, that is, an interpretation. The relative accessibility of positive versus negative material in memory, which can be influenced by current mood, can therefore be reflected in a bias to interpret events relatively positively or negatively. The interconnection is illustrated here using social anxiety as an example

might lead to biased evaluations of situations (Fig. 6.2). For example, if when someone thinks about the future only negative, but no positive, possibilities come to mind, and further if the negative imagery is much more vivid than the positive imagery, this may lead them to interpret the future pessimistically. At an extreme, if someone is only able to retrieve negative memories or imagine negative outcomes, it would be very difficult for them to interpret an ambiguous situation in a positive way. Additionally, following Kahneman and Tversky (1982), even when someone is

able to imagine positive interpretations, if imagining these is difficult the interpretations may be seen as less plausible than easily imagined negative possibilities.

As a third, and broader, perspective, much of the time what manifests as an interpretation bias may be a reflection of dysfunctional imagery. That is, cognitive biases can be conceptualized as the product of memory-based representations (Arntz, 2020), and these representations, or the schemas that provide the building blocks for interpretation biases, may be stored and retrieved in the form of key episodic memories rather than verbal propositions (Brewin, 2006). Or, to put it another way, if across many situations what is retrieved from memory (or what pops to mind) are negative images that reinforce negative beliefs about a situation or its outcomes, this will manifest as a bias in interpretation (also represented in Fig. 6.2). Although there is most likely an important role for non-episodic, semantic memory in interpretive processes and interpretation biases (Hirsch et al., 2006), to some extent dysfunctional imagery and dysfunctional interpretations could potentially be seen as mutually reinforcing components of a common underlying processes (see also Nanay, 2021).

6.3 Using Mental Imagery to Change Interpretation Biases

This section will first consider the use of mental imagery within standard CBT approaches. It will then discuss cognitive training approaches that use mental imagery to target interpretation biases directly.

6.3.1 Using Mental Imagery in CBT

There are many ways in which mental imagery may be used to change interpretation biases within standard CBT (for an overview of therapeutic techniques to change interpretation biases, see also Chap. 12 by Woud & Hofmann). To some extent, any CBT therapeutic procedure that might be used to change interpretation biases could potentially be enhanced via the use of imagery, given imagery's properties such as its effect on emotion and realness (Blackwell, 2019). Interestingly, imagery occurs recurrently throughout Beck's writings and descriptions of cognitive therapy (e.g. Beck, 1976; Beck et al., 1979). For example, when introducing cognitive techniques in the context of depression, Beck et al. (1979) suggests that therapists define the term *cognition* to patients; the definition he then provides explicitly mentions both thoughts and images. Further, in order to demonstrate the relationship between cognition and emotion to patients – the cornerstone of the cognitive model – Beck suggests an imagery-based behavioural experiment. When it comes to therapeutic interventions, Beck's (1979) suggestions include using replay of positive memories or imagery of positive future events to improve mood in depression (albeit with the caveat that with severely depressed patients this runs the risk of turning negative),

and manipulating the content of anxiety-inducing imagery to reduce its impact (similar to imagery rescripting, described later in this chapter). Mental imagery therefore clearly played a central role in cognitive therapy as he envisioned it. However, until relatively recently the possibilities offered by using mental imagery within CBT have often been neglected (Blackwell, 2021).

Josefowitz (2017) provides a detailed description of how imagery can be used to enhance one common CBT tool for changing interpretation biases, the thought record. Within CBT, keeping a record of negative automatic thoughts can help to identify a patient's interpretation biases (e.g. a tendency to interpret social ambiguity as rejection) and the beliefs hypothesized to underpin them (e.g. "I am unlikable"). The process of collecting evidence against and challenging negative thoughts, and the underlying beliefs, can then help in correcting these biases when they occur in the moment and in starting to change the beliefs that are theoretically their underlying source. As outlined by Josefowitz (2017; see also Greenberger & Padesky, 2015), imagery can be used to evoke and better understand the meaning of negative automatic thoughts, via identifying images or memories associated with the thought and examining their meaning. Generation of imagery can be used to increase the believability of evidence against negative thoughts, for example, via detailed recall and re-experiencing of events that contradict the belief. Imagery can then be used to increase emotional engagement with and believability of alternative thoughts or beliefs, helping to increase how real they "feel" and not just how logically they can be understood, and further to improve their accessibility in memory. For example, in the context of social anxiety, a key technique to counteract negative beliefs about how the patient appears to others during social interactions is video feedback; observing video footage of themselves in a social interaction provides a powerful way to show that in fact how they look in reality is very different to how they think and imagine they appear. The patient can then later mentally rehearse the image of how they really looked to reinforce this benign (and accurate) interpretation (Warnock-Parkes et al., 2017).

Other standard CBT techniques used to change interpretations can also be enhanced or carried out via imagery. To the extent that exposure-based approaches can be conceptualized as a way of changing interpretations – for example of a feared stimulus or situation as threatening – these can also be conducted entirely in imagery, that is, imaginal exposure (for an overview of how stimuli may be interpreted in fear conditioning paradigms and exposure, see Chap. 7 by Scheveneels and Boddez). However, *in vivo* exposure can potentially also be enhanced by drawing on imagery, for example, via imaginal rehearsal of the exposure between sessions (McGlade & Craske, 2021), or reactivation of a past mastery experience to increase self-efficacy prior to exposure (Raeder et al., 2019). When exposure involves an element of cognitive restructuring, for example, in enhanced reliving for post-traumatic stress disorder (Ehlers et al., 2005), the cognitive restructuring may also be incorporated into the memory via imagery to enhance emotional integration, as with imagery rescripting (discussed below). Behavioural experiments, which offer an efficient and direct way of changing interpretations via testing beliefs and predictions directly, can also be enhanced via imagery in a similar way (e.g. use of imagery in preparation,

making predictions, or in replaying and reinforcing learning) or in the ways suggested by Josefowitz (2017) for thought records. Imagery can also be used to effect change in meta-cognitive appraisals, that is, interpretations of thoughts, such as the belief that they are dangerous and uncontrollable. For example, via visualizing thought processes in a concrete manner (e.g. as a river flowing past, or as memories on a cinema or TV screen), the patient can learn to re-interpret them as controllable and non-threatening mental events rather than overwhelming and compelling (e.g. Wells, 2005; Holmes et al., 2019).

Perhaps the most direct and imagery-intensive technique for changing interpretations in standard CBT is imagery rescripting; a major aim of imagery rescripting is to modify or update dysfunctional or distressing appraisals of events, thoughts, or memories, and this is carried out primarily via imagery (Arntz, 2012). There are many different forms of imagery rescripting, but in general they involve some form of imaginal reliving of a distressing memory (or future projection), and then with the help of the therapist constructing an alternative ending, which is then incorporated into the memory via imagery. For example, in one kind of protocol often applied in the context of childhood trauma (e.g. Arntz & Weertman, 1999), a patient might first relive (via imagery) the traumatic event through their own eyes, as they perceived it at the time. They then relive the scene again, but take the perspective of their adult self, coming in to intervene in the situation. In the final step, they relive the scene again from their child perspective and witness the adult's intervention; after this they can request further interventions (often providing comfort to the child). While such an imagery rescripting procedure undoubtedly contains an element of simple exposure to the distressing memory, it also provides a powerful way to update the beliefs, for example, that the child was responsible or that the danger felt by the child is still present. In another form of imagery rescripting (Holmes et al., 2019), the thoughts, beliefs, and emotions encapsulated in the image are explicitly elicited and "antidote" thoughts and emotions identified; these antidotes are then built into an image that is used as an alternative ending for the scene.

Imagery rescripting can be applied not only to memories, but also to future projections or "flashforwards" (e.g. Taylor et al., 2020), nightmares (e.g. Kunze et al., 2017), and even metaphorical images generated purely for the purpose of being rescripted (Butler et al., 2010): Essentially it can be applied to anything image-based with a problematic meaning that causes distress or impairment. Imagery rescripting is not generally conceptualized as directly trying to change interpretation biases. Nevertheless, from the perspective that such biases are in part the output of the representations targeted in rescripting (Arntz, 2020), via imagery rescripting we would expect such biases to also change. However, while there is now much evidence accumulated for the effectiveness of imagery rescripting in changing beliefs and reducing symptoms (e.g. Morina et al., 2017), whether it does in fact change interpretation biases themselves is unexplored.

6.3.2 *Mental Imagery and Cognitive Training*

In the past 20 years there has been increasing interest in changing interpretation biases via simple cognitive training procedures. While these do not form part of the standard CBT repertoire, they build on the same scientific foundations and are increasingly being investigated as adjuncts to CBT and other treatments (e.g. Williams et al., 2013; Woud et al., 2021). These kind of cognitive training approaches are generally described as *cognitive bias modification* (CBM) procedures (Koster et al., 2009). Of relevance for this chapter, in several forms of CBM mental imagery plays a central role.

The most commonly investigated form of CBM for changing interpretation biases (CBM-I) is based on repeated presentation of ambiguous scenarios that are consistently resolved in a specific manner. For example, to train a negative bias (for experimental purposes), the scenarios would be consistently resolved negatively, whereas for to train a positive bias (e.g. for therapeutic purposes) they would be consistently resolved positively. In the original version (Mathews & Mackintosh, 2000), ambiguous scenarios were presented as written text of a few lines, followed by a word fragment of a final word that would resolve the ambiguity, which participants would have to resolve. For example, “You get out of bed at the start of a busy day. You think about the day ahead and everything you need to do. As you do so you start to feel full of ...”, “_n_r_g_” (*energy* for a positive resolution), or a “d_e_d” (*dread* as negative resolution). Comprehension questions requiring yes/no responses would also be used to reinforce the interpretations (e.g. “Does your energy increase as you think about the day ahead?”). Because this original CBM-I training paradigm is covered in detail in another chapter it will not be further discussed here (for an overview of how to manipulate interpretation biases, see Chap. 11 by Salemink et al.). However, it is important to note that participants were instructed to imagine themselves in the situations and anticipate the ending, with the rationale that this would help resolve the word fragment; that is, learning to imagine more positive resolutions would help complete the task more efficiently. As this imagery was seen as a central mechanism for how the training could change interpretation biases, versions of the training intended to enhance this imagery component were then developed, and these will now be discussed further.

In these more imagery-focussed versions of the scenario-based CBM-I, the paradigm was adjusted to facilitate generation of vivid imagery (e.g. Holmes & Mathews, 2005; Holmes et al., 2006). This “imagery CBM” paradigm used the same kinds of ambiguous scenarios as the original paradigm, but they were presented as audio descriptions, rather than written text, and participants listened to them via headphones. This meant that participants could close their eyes and focus on generating and being absorbed in imagery. Further there was no requirement to solve word fragments, and the comprehension questions were removed. Instead, after each scenario participants were simply asked to report how vividly they had imagined it. Finally, the training itself was preceded by an introduction to mental imagery led by the researcher, in which participants were guided through various mental imagery

exercises and practice scenarios in order to increase the likelihood that they would be able to engage in the imagery in the required way during the training.

Early experimental studies focussed on the potential of imagery CBM to change interpretation biases and state affect, and in particular the role of the imagery component. Several such studies demonstrated the importance of participants being instructed to imagine themselves in the training scenarios to have these effects, contrasting this against instructions to focus on the words and meanings (e.g. Holmes et al., 2008a, 2009b; Nelis et al., 2012).

Subsequent clinical studies using imagery CBM have mostly been conducted in the context of depression. As mentioned earlier, depression is characterized not only by a negative interpretation bias (Everaert et al., 2017), but also by deficits in positive imagery, and positive *future*-oriented imagery in particular (Holmes et al., 2016). Compared to people who are not depressed, people with depression or depressed mood are not only less likely to experience spontaneous positive future-oriented imagery (Ji et al., 2019a), but when they deliberately try to imagine positive events in their future the imagery they generate is less vivid (Morina et al., 2011). It was proposed that positive imagery-based CBM might therefore be particularly beneficial in the context of depression, by training these two processes in conjunction (Holmes et al., 2009a). That is, via repeatedly imagining positive outcomes for ambiguous situations in the training, depressed individuals may acquire a more positive bias to automatically imagine positive outcomes for ambiguous situations in daily life.

The first clinical study used a single-case series design to make the transition from experimental paradigm to potential clinical intervention (Blackwell & Holmes, 2010). In this study, seven adults with current major depression completed a 1-week training schedule. This comprised a first training session in the lab, and then six subsequent training sessions completed at home, one each day. Each training session included 64 scenarios, with no scenario repeated, so over the course of the week participants imagined themselves in 448 different scenarios. Following promising results in this study, further initial translational studies also found promising results in reducing negative interpretation biases and symptoms of depression over 1 week of training, this time compared to a sham training control condition (Lang et al., 2012; Torkan et al., 2014), including when added to Internet-delivered CBT (Williams et al., 2013, 2015, albeit for the second study only amongst people who completed the training and not in an “intention to treat” sample). However, a larger randomized controlled trial (CBT) examining a 4-week training schedule (Blackwell et al., 2015) found no difference between the imagery CBM and a sham training control condition in reductions in depression. Interestingly, post-hoc and secondary analyses of data from this trial found that the imagery CBM was superior to the control condition in reducing anhedonic symptoms of depression (Blackwell et al., 2015) and increasing behavioural activation (Renner et al., 2017). Anhedonia is the loss of interest and pleasure in previously enjoyed activities, and together these results suggest that repeatedly imagining ambiguous situations resolving positively may help increase the anticipation of situations being rewarding and increase motivation to engage in goal-directed behaviour. Through the lens of interpretation

biases, this could be expressed as interpreting ambiguous situations as being potentially rewarding and worth investing effort in. Several lines of research have now followed up on the idea of imagery CBM as a potential means to reduce anhedonia, with encouraging results (Pictet et al., 2016; Bibi et al., 2020; Westermann et al., 2021).

A parallel line of research has examined the use of an imagery CBM paradigm to reduce negative interpretation biases and thus reduce worry and rumination amongst people with depression and generalized anxiety disorder. This follows work indicating a role for interpretation biases in contributing to these kinds of perseverative negative thinking (e.g. Hayes et al., 2010). Hirsch and colleagues used a training procedure similar to that described above (i.e. aural presentation of scenarios and no word fragments), but also including comprehension questions. After initial experimental work (Hirsch et al., 2009; Hayes et al., 2010), clinical studies also found promising results for reducing negative interpretation biases, repetitive negative thinking, and symptoms of depression and anxiety compared to sham training (e.g. Hirsch et al., 2018, 2020, 2021), and these effects could be enhanced by additional imagery instructions (Feng et al., 2020; Hirsch et al., 2020). Generalized anxiety is an area where imagery deficits and dysfunctions are also apparent, and hence such an imagery-focussed training may be particularly helpful (Koerner & Blackwell, 2021).

Another line of research using scenario-based CBM-I has investigated using imagery to enhance the effects of a training specifically focussed on modifying the kinds of “cognitive errors” identified by Beck as characterizing depression (Lester et al., 2011). This training is text-based as in the original Mathews and Mackintosh (2000) paradigm but uses scenarios specifically tailored to tackle “cognitive errors” such as selective abstraction, dichotomization (black and white thinking), and catastrophization (Beck et al., 1979). An experimental study with non-depressed participants found that adding an instruction to generate future-oriented imagery related to the scenario after completing the comprehension question led to greater immediate reductions in negative interpretation biases compared to a version of the training without this additional instruction (Lee et al., 2015). A clinical study in which participants were diagnosed with current major depression found superiority of this training to a sham training control in terms of immediate effects on interpretation biases, but not in stress reactivity or depression symptoms 1 month later (Yiend et al., 2014). However, only one training session was used and it seems likely that more training sessions would be needed to have effects on symptom outcomes.

Moving away from scenario-based training, another imagery-based CBM-I paradigm uses ambiguous picture cues as the basis for modifying interpretation biases. In this “picture–word” training, ambiguous photos of everyday scenes are paired with a caption of one or a few words that can be used to resolve the valence of the scene in a particular direction. For example, a photo of a clifftop could be paired with the word “view” for a positive resolution, or with the word “slip” for a negative resolution. Participants are asked to combine the picture and word to form a mental image of a scene in which they are actively involved (e.g. standing on the clifftop and admiring the view vs. standing on the clifftop and slipping down). An initial

experimental study found that combining the picture and word via imagery, as opposed to forming a sentence, led to greater training-congruent changes in state mood and interpretation bias (Holmes et al., 2008b). A subsequent study with dysphoric individuals found that a single session of positive training (i.e. the pictures were always paired with positive captions) led to more positive mood, interpretation bias, and better performance on a behavioural task than a single session of negative or mixed valence (50% positive, 50% negative captions) training (Pictet et al., 2011). This picture–word training has been combined with scenario-based training in some clinical studies (Lang et al., 2012; Blackwell et al., 2015), but its effects in clinical applications have not been tested in isolation amongst adults. In adolescent samples, one study has investigated the effects of repeated sessions of Internet-based training using the picture–word paradigm on its own (De Voogd et al., 2017). In this study, adolescents with elevated symptoms of depression or anxiety were recruited and they completed the training at home. The results did not suggest that the training was effective in changing interpretation biases and symptoms of depression and anxiety relative to a sham training control, and participant feedback suggested that they found the task difficult to understand and engage with. In contrast, in an experimental study carried out in schools with adolescent male participants (Burnett Heyes et al., 2017), a single session of picture–word training appeared effective in changing state mood and interpretation biases, and participants apparently found the training easy and in fact enjoyable to engage with. The difference between these two studies' results could plausibly be due the fact that participants in the study by De Voogd et al. (2017) were required to complete the training from home after school in their own time with only written instructions, whereas in the study by Burnett Heyes et al. (2017) they completed the training during school hours with instructions and initial guidance from a researcher. A third study has used a picture–word training paradigm as part of a package of training methods to try to reduce hostile attributions amongst school children (Schmidt & Vereenoghe, 2021). The combined training package appeared effective and also acceptable to the participants, but it is not possible to disentangle the contribution of the picture–word paradigm itself from the combined package. Overall, although the picture–word paradigm has been used in some clinical studies there is not yet compelling evidence for its potential as a stand-alone training paradigm for reducing negative interpretation biases and symptoms in this context.

When it comes to evaluating the clinical effectiveness of imagery-based CBM-I methods, this is complicated by the fact that most meta-analyses tend to group them together with other CBM-I approaches. As an exception to this, Hitchcock et al. (2017) included a meta-analysis of purely imagery-focussed CBM-I training in their broader review of episodic memory training-based interventions and found that these were superior to no training or waiting list but not to sham training conditions. However, this meta-analysis only includes a small number of studies as the majority were published after the date of their literature review. The most recent meta-analysis including all CBM approaches targeting interpretation biases (Fodor et al., 2020) found that in terms of reducing symptoms of anxiety, CBM-I (all kinds combined) was superior to both a waitlist ($d = 0.55$, 95% CIs: 0.19–0.91) and sham

training ($d = 0.30$, 95% CIs: 0.10–0.50), but when it came to reducing symptoms of depression, CBM-I was superior only to waitlist ($d = 0.63$, 95% CIs: 0.23–1.04), but not sham training ($d = 0.26$, 95% CIs: –0.06–0.57). However, in the context of depression, the results were unstable due to a poorly connected network and should be treated with caution. Further, since the literature review of this more recent meta-analysis was completed several more studies using imagery-based CBM-I in the context of depression or depressed mood with positive results have been published (Bibi et al., 2020; Hirsch et al., 2020, 2021; Sit et al., 2020). Overall, studies so far indicate the potential for imagery-based CBM-I methods to reduce negative interpretation biases and symptoms of depression and anxiety in clinical applications. However, the clinical trials conducted so far are all relatively early-phase translational studies and larger trials and replications would be needed to make confident recommendations about clinical applications.

6.4 Conclusions and Future Directions

As outlined in this chapter, mental imagery and interpretation biases appear closely interconnected, with a number of potential mechanisms via which they could influence and reinforce each other. Further, mental imagery can be used in many ways within a CBT framework to change negative interpretation biases, whether via doing so directly or via changing the underlying beliefs that may give rise to such biases. Building on the basic properties of mental imagery, such as its realness and effect on emotion, allows its incorporation into many standard CBT techniques that can be used to change interpretation biases. Additionally, there are some imagery-specific techniques used within CBT such as imagery rescripting that are powerful methods for changing such biases, albeit not conceptualized as such. Finally, more recently targeted cognitive training procedures have been developed that focus on changing interpretation biases directly and include mental imagery as a central element.

A number of questions remain to be explored in relation to the ideas presented in this chapter. For example, as noted earlier, many of the techniques presented here are not normally conceptualized as changing interpretation biases, and although from a conceptual perspective they may be expected to change such biases, whether they in fact do so is not known. Greater investigation of the effect of such techniques in isolation on cognitive processes such as interpretation biases would help clarify this. Second, the extent to which imagery may enhance such techniques is also largely based on theoretical considerations and clinical intuition, and has not been investigated systematically (with a few exceptions, e.g. McEvoy et al., 2015; van Teffelen et al., 2021). Third, in relation to cognitive training techniques, while approaches such as imagery-based CBM-I show promise in reducing negative interpretation biases and symptoms of psychopathology, most of the clinical studies are at relatively early phases of translational research, and larger pragmatic trials would be needed to make confident claims about their effectiveness or clinical utility (for

an overview of the stepwise process in the context of translational research, see Chap. 2 by Cludius and Ehring). Further, exactly how they might be most clinically useful is not yet clear (e.g. Blackwell, 2020b). For example, it may be that imagery CBM is best seen as a potential adjunctive intervention to other treatments, or it could possibly have a useful role to play as stand-alone low-intensity self-help intervention.

A somewhat bigger question, that goes beyond the remit of this chapter, is a more fundamental one about the relationship between imagery and interpretation biases, or rather episodic memory and interpretation biases. As noted earlier, interpretation biases may simply be the output of representations commonly described as beliefs or schemas (Arntz, 2020), in line with Beck's cognitive model (Beck, 1976). These in turn may in part be contributed to by, or even represented as, episodic memories (Brewin, 2006). Thus imagery-based representations may be fundamental to at least some manifestations of interpretation biases. For example, an interpretation of a friend's lack of contact as meaning that they do not like you could be the result of an involuntary memory popping to mind that makes this idea "feel" true. From this perspective, creating positive representations in memory that may be easily accessed may be a more effective method of changing such biases than targeting the apparent biased cognitive processing itself. In fact, this has been speculated to be a potential mechanism of imagery CBM (Blackwell & Holmes, 2017) and is the direct aim of other cognitive training procedures such as competitive memory training (COMET; Korrelboom et al., 2009). To elaborate, if we are intending to directly change biased processing we might aim to instil processing rules such as "in the context of ambiguity, retrieve/generate a positive interpretation" or "accept positive interpretations that occur, reject negative ones"; conversely, if we are intending to change the underlying representations we might not aim to change this level of processing, but rather aim to make it more likely that positive interpretations will be retrieved or generated – and then accepted – by changing the source material from which these interpretations arise (see Arntz, 2020, for more detailed consideration). However, this question of how interpretation biases are best conceptualized and most effectively changed goes beyond the scope of a single chapter in this volume.

Regardless of how this more fundamental question is resolved, and when, both the basic science underlying mental imagery and the research conducted so far indicate great potential in using it to change interpretation biases. In fact, in the face of any approach to change interpretation biases one could usefully ask "could mental imagery be used to enhance this technique" (Blackwell, 2021). This of course cannot be assumed and requires systematic testing, but is a question with potential to open many fruitful avenues for research and clinical practice.

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