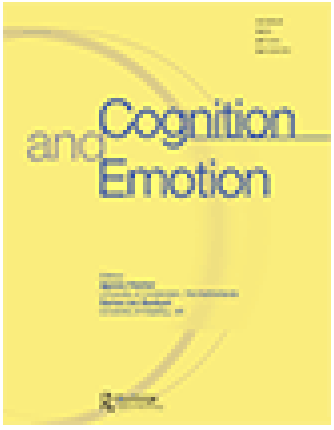

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Social anxiety and information processing biases: An integrated theoretical perspective

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Social anxiety and information processing biases: An integrated theoretical perspective

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Models of anxiety disorders posit that information processing biases towards threat may result from an imbalance between top-down attentional control processes and bottom-up attentional processes, such that anxiety could reduce the influence of the former and increase the influence of the latter. However, researchers have recently pointed to limitations of the top-down/bottom-up terminology and outlined the additional contribution of memory processes to attention guidance. The goal of this paper is to provide bridges between recent findings from cognitive psychology and anxiety disorders research. We first provide an integrative overview of the processes influencing the content of working memory, including the availability of attentional control, and the strengths of task goals, stimulus salience, selection history and long-term memory. We then illustrate the interest of this formulation to the study of information processing biases in anxiety disorders, with a specific focus on social anxiety.

Keywords: Social anxiety; Information processing biases; Working memory; Attention guidance.

Humans are beset by a myriad of inputs that compete for processing resources, such as entry in working memory (WM). Due to the limited capacity of the brain, mechanisms of attention face the challenge of balancing the extent to which the behaviour is affected by external or internal information. The allocation of resources is traditionally viewed as resulting from the dynamic interplay between top-down and bottom-up processes. Top-down processes have been referred to as the attentional selection determined by knowledge, expectations and current goals, whereas bottom-up processes have been defined as a prioritisation based on the properties of sensory information (Corbetta & Shulman, 2002). An imbalance between these two processes is central to theories of anxiety (e.g., Bishop, 2007; Eysenck, Derakshan, Santos, & Calvo, 2007). A core assumption is that anxiety decreases the efficiency of top-down processes and enhances the influence of bottom-up processes, leading to exacerbated threat-related biases.

However, the use of the top-down/bottom-up terminology raises several conceptual difficulties. First, the lack of agreement on the definition of these terms and the diverse processes they covered

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obscure their delineation (Rauss & Pourtois, 2013). Particularly, the notions of top-down and bottom-up have been widely used synonymously to the notions of controlled versus automatic, goal-directed versus stimulus-driven, endogenous versus exogenous, although these meanings do not always correspond. Second, researchers (e.g., Awh, Belopolsky, & Theeuwes, 2012; Hutchinson & Turk-Browne, 2012) point out the limited explanatory power of the top-down/bottom-up division and emphasise the need to take into account the additional contribution of memory processes to the attention guidance. Awh et al. (2012) support that selection history (i.e., the lingering effects of information activated in recent experiences) needs to be considered as an independent source of influence on attention. These authors empirically argue that information selection is biased towards previously relevant or rewarded stimuli, independently of the current task goals or the physical salience of the present stimulus. More generally, Hutchinson and Turk-Browne (2012) sustain that memory-guided attention should be incorporated to the existing taxonomy of attention.

Our goal is to bridge the conceptual gap between progresses in cognitive psychology and anxiety research. We first suggest an integrative overview of the latest conceptualisations of the processes influencing WM. In this endeavour, we wish to go beyond the classic bottom-up versus top-down distinction to focus on more specific, and in our view, more relevant characteristics of the processes implied. Then, we illustrate the utility of this formulation for the study of information processing biases in anxiety. For the sake of parsimony, we focus on social anxiety (SA) although this framework is applicable to other psychopathologies.

OVERVIEW OF THE CONCEPTUAL FRAMEWORK

As illustrated in Figure 1, a core premise of the conceptual framework is that WM serves as an interface where different, and sometimes contradictory, sources of external and internal information compete to be the momentary focus of attention (see also Chun, Golomb, & Turk-Browne, 2011). Based on current research from cognitive psychology, we argue that what enters within the WM may depend on the availability of attentional control and on the strengths of multiple influences

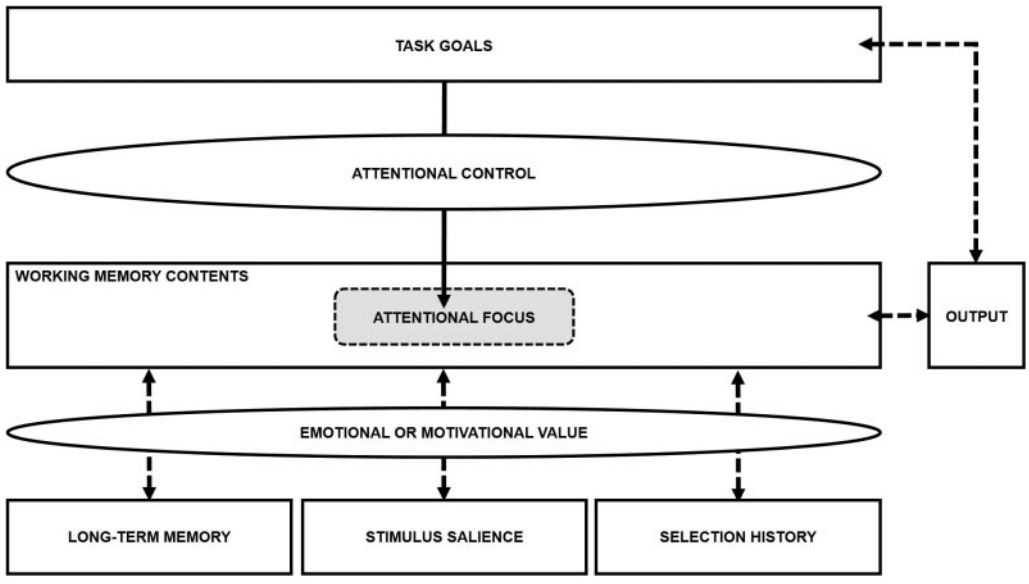

Figure 1. *The overview of the proposed conceptual framework of the processes influencing the WM content.*

including (1) task goals, (2) stimulus salience, (3) selection history and (4) long-term memory (LTM).

Working memory

Two predominant models of WM are Baddeley's multi-component model and Cowan's embedded-processes model. Baddeley's model (2007, 2012) revised from previous works (Baddeley, 1986, 2000; Baddeley & Hitch, 1974) theorised WM as constituted by four limited-capacity components. A modality-independent central executive is assumed to supervise the distribution of limited attentional resources and to coordinate information within three storage subsystems. Two of these subsystems are modality-specific buffers, the phonological loop that maintains sound- or speech-based material, and the visuospatial sketchpad that maintains visual and spatial information. The third subsystem, the episodic buffer, is a multidimensional coding store that integrates information from the phonological loop, the visuospatial sketchpad and LTM into meaningful episodes assumed to be accessible to conscious awareness. In contrast, the embedded-processes model of WM proposed by Cowan (1988, 1995, 1999) considers that the WM contents are not held within specialised storage buffers, but rather are elements of LTM sustained at a higher level of activation over a short period of time. Only the portion of activated memory that receives sufficient activation by becoming the attentional focus can be experienced consciously. Cowan also posits a limited-capacity central executive system that actively directs focal attention to goal-relevant information and away from goal-irrelevant information.

Despite the issue of whether WM should be conceptualised as a unitary or multi-component construct (for a review, see Miyake & Shah, 1999), two common principles of these models can be outlined. The first is the key role of an executive attention component that manages the allocation of limited attentional resources to elements held in WM to promote goal-directed processing. The second common point is that both models attempt to specify the relationship between attention and conscious awareness, sharing the assumption that only a subset of information held in WM can be consciously experienced because of limited resources. Whereas Baddeley hypothesised that conscious awareness arises in the episodic buffer, Cowan stipulated that consciousness is a matter of activation intensity resulting from the focus of attention and that a non-conscious portion of WM activated under a certain threshold is prone to interfere with ongoing cognitive activities.

Building on the commonalities of these models, we conceptualise WM as a temporary cognitive store located at the intersection between information conveyed through the senses and information retrieved from previous experiences. The transient content of WM may vary in terms of awareness, the most activated information being the focus of attention. It is limited in content as focal attentional resources are limited.

Sources of attention guidance

It is commonly accepted that attentional deployment is guided by the task goals and by the properties of external stimuli. In addition to these two influences, emerging evidence indicates that the deployment of attention is also subjected to the effects of selection history and LTM (Awh et al., 2012; Hutchinson & Turk-Browne, 2012). Although these factors interact to determine which information reaches the focus of attention, for clarity sake, we discuss them separately. Moreover, because research has mostly used visual stimuli, we primarily focus on this modality.

Task goals

Task goals bias the allocation of attention. According to the biased-competition model of visual attention (Dessimone & Duncan, 1995), WM is involved in goal-directed behaviour by keeping task-priorities and relevant information in a highly active state. Indirect evidence for this model is that visual search may be improved when observers know in advance the likely spatial location (e.g., Posner, 1980) or the specific feature (e.g., its colour) of the upcoming target (e.g., Maunsell & Treue, 2006). In addition to these strategic effects, other studies have indicated ironic

effects of task influence. These have shown that salient distractors can erroneously and automatically catch attention when they possess task-relevant attributes whereas those that do not match can be overridden (i.e, the contingent capture hypothesis, Folk, Remington, & Johnston, 1992). Such attentional capture has been described as "contingent to" to outline its dependence on the attentional set. In the same vein, studies have provided evidence that information actively maintained in WM for a subsequent task can automatically bias attention towards items that match the features of WM contents, even when they are not relevant for the task (see Olivers, Peters, Houtkamp, & Roelfsema, 2011; Soto, Hodsoll, Rotshtein, & Humphreys, 2008).

The availability of working memory capacity (WMC) can affect the ability to maintain task goals in the face of distraction. Specifically, individual differences in WMC predict performance on a variety of tasks involving attentional control (Engle & Kane, 2004; Kane, Conway, Hambrick, & Engle, 2007). The ability to remain focused on goal-relevant stimuli may also be modulated by the amount and the type of load that is imposed by ongoing processing: high perceptual load leads to efficient distractor rejection, whereas high WM load hampers distractor rejection (Lavie, 2005, 2010; Lavie, Hirst, de Fockert, & Viding, 2004).

In summary, these findings support the notion that task goals impact attention depending on the efficiency of attentional control and on the strengths of competing information. Goal-directed attention can be instantiated in a voluntary manner, but the subsequent allocation of attention can be automatically influenced by task features, even when it is detrimental to the ongoing task.

Stimulus salience

Despite the constraints of task goals, attention must be flexible so as to quickly switch from current goals to highly relevant sensory inputs in order to give them priority access to WM. Some external stimuli stand out from their neighbouring parts because they have salient low-level perceptual properties, or evolutionary adaptive value.

Several experiments have demonstrated that attention can be attracted by low-level perceptual properties of the stimuli, such as unique features (Theeuwes, 1992), abrupt onsets (Yantis & Jonides, 1984), new motions (Al-Aidroos, Guo, & Pratt, 2010) and novelty (Johnston, Hawley, Plewe, Elliott, & DeWitt, 1990). Attentional capture by these cues can arise mandatorily and irrespective of the observer's goals (Theeuwes, 2010, but see a competing view by Folk et al., 1992). Most research on attention capture has been devoted to uncovering the effects of perceptual salience in the visual domain. Yet, this phenomenon is not restricted to vision. In the field of auditory attention, research has shown that deviant auditory stimuli can also capture attention involuntarily (see Bidet-Caulet, Bottemanne, Fonteneau, Giard, & Bertrand, 2014). Additionally, researchers (Brosch, Grandjean, Sander, & Scherer, 2008, 2009; Matusz & Eimer, 2011) have observed that multi-modal settings, in which different stimulus modalities co-occur, can boost neural processing and increase salience.

Also salient is a variety of stimuli that have an adaptive value shaped by evolutionary history. To illustrate, studies have reported that biological threats to survival (e.g., snakes, spiders, threatening faces) are effective in capturing attention automatically (Öhman, Flykt, & Esteves, 2001; Öhman, Lundqvist, & Esteves, 2001). This attentional privilege has been attributed to an evolved "fear module" that may be automatically activated by threats to the survival of our ancestors, resulting in a biological preparedness to attend to these stimuli (Öhman & Mineka, 2001; Seligman, 1971).

Taken together, these data indicate that the inherent characteristics of the stimulus, like the low-level perceptual properties, or evolutionary motives, can increase its relative salience leading to attentional prioritisation.

Selection history

Prior experiences can also make the stimulus more salient. It is increasingly acknowledged that the

attentional deployment is sensitive to previously selected information. A well-known illustration is the priming of Pop-out, which refers to the finding that target detection in visual search is more efficient when target features or locations repeat on successive trials than when they switch (Maljkovic & Nakayama, 1994, 1996). Many other examples of history effects can be cited, such as contextual cueing (Chun & Jiang, 1998), inhibition of return (Klein, 2000; Posner & Cohen, 1984) and reward priming effects (e.g., Anderson, Laurent, & Yantis, 2011; Anderson & Yantis, 2012, 2013). Awh et al. (2012) argue that selection history is not adequately captured by the top-down/bottom-up distinction. Rather, the authors maintain that these effects should be considered as an independent source of information influencing the deployment of attention. In support of their contention, they summarised a number of studies demonstrating that history selection effects can be disconnected from both the task goals and the physical salience of stimuli. It should be noted that this interpretation relies on the narrow understanding of the top-down/bottom-up distinction, most researchers embracing a larger but more ambiguous definition.

Long-term memory

In addition to these short-term memory effects, LTM acquired across the lifetime provide a rich set of information about the world and is used to direct our attention. Only few investigations have addressed the influence of LTM on the attentional deployment.

LTM has been traditionally split into subcomponents, such as episodic and semantic memory. Regarding semantic LTM, Moores, Laiti, and Chelazzi (2003) found that, during visual search, attention can be rapidly attracted by distractors that are semantically related to the target compared to unrelated distractors (see also Belke, Humphreys, Watson, Meyer, & Telling, 2008; Telling, Kumar, Meyer, & Humphreys, 2010). Other studies showed that repeated pre-exposure to complex scenes, in which the spatial location of a target has been learned, enhances the perceptual sensitivity for the subsequent target at the remembered location (Doallo, Patai, & Nobre, 2013; Patai, Doallo, & Nobre, 2012; Stokes, Atherton, Patai, & Nobre, 2012) and speeds search by triggering a shift of spatial attention to the expected location (Summerfield, Lepsien, Gitelman, Mesulam, & Nobre, 2006; Summerfield, Rao, Garside, & Nobre, 2011). These findings provide evidence that human beings are able to use LTM representations of scenes to facilitate attention guidance to locations in a real-world scene that has likelihoods of containing a previously relevant target object. According to Võ and Wolfe (2013), memory-guided attention in repeated visual search may profit from a combination of episodic guidance based on previous experiences and semantic guidance provided by the scenes, the contribution of the former being affected by the availability of the latter.

The emotional/motivational value of memory traces also needs to be considered as an important factor in attention guidance. Research has established that attention can be driven automatically by stimuli associated with learned value of threat or reward (Anderson, 2013; Schmidt, Belopolsky, & Theeuwes, 2015). In addition to this automatic capture of attention, several authors argue that emotional/motivational factors can also be exploited to guide attention in order to favour the well-being of the organism. Todd, Cunningham, Anderson, and Thompson (2012) support that emotional memories shape the attentional filter (i.e., an affectively motivated template filtering perception) favouring attendance to stimuli that had acquired an affective relevance during past experience (i.e., affect-biased attention). In the same vein, Mohanty and Sussman (2013) stress the role of expectation and attention-related anticipatory biases in prioritised processing of threatening or rewarding stimuli. In that sense, findings from recent studies (Wieser, Flaisch, & Pauli, 2014; Wieser, Miskovic, Rausch, & Keil, 2014) show that aversive conditioning (e.g., faces paired with danger cues such as aversive noise or aversive hand gesture) leads to experience-dependent changes in cortical sensory networks, resulting in facilitated sensory processing of these social cues. Crucially, the impact of emotional/motivational factors on processing is also

susceptible to be modulated by state and/or trait anxiety, and sensitivity to reward (e.g., Pessoa, 2009).

Summary

The above development reviews several factors determining what is activated in WM, with the assumption that the degree of awareness is related to the level of activation of WM content. These determinants vary in terms of automaticity and voluntariness, as well as in terms of task pertinence, stimulus salience and experience-based relevance. This complex reality, obviously, cannot be captured by the top-down/bottom-up dichotomy.

SOCIAL ANXIETY

A hallmark feature of SA is the excessive fear of social situations, especially those that carry a potential evaluation or scrutiny from others. Models of SA (Clark & Wells, 1995; Heimberg, Brozovich, & Rapee, 2010; Rapee & Heimberg, 1997; for a review, see Wong, Gordon, & Heimberg, 2014) predict that information processing biases play a role in the maintenance of the psychopathology. Numerous studies have supported this assumption by showing, for example, that high socially anxious (HSA) individuals tend to display an attentional bias towards external threat (e.g., Miskovic & Schmidt, 2012) and a greater likelihood of favouring the threatening meaning of ambiguous cues (Amir, Beard, & Bower, 2005; Heuer, Lange, Isaac, Rinck, & Becker, 2010). In addition to being sensitive to external threat, those individuals are also more likely to engage in the processing of internal stimuli relevant to their fear, such as bodily states, thoughts and emotions (e.g., Spurr & Stopa, 2002). Moreover, theories of anxiety (Bishop, 2007; Eysenck et al., 2007; Hirsch & Mathews, 2012) and empirical data (for reviews, see Berggren & Derakshan, 2013; Eysenck & Derakshan, 2011) suggest that anxiety disorders may be associated with impaired attentional control component of WM.

Beyond these findings, the relations between WM and the above-mentioned processing biases have not been considered in a framework integrating models of WM and attentional control. This lack of integration might be detrimental to our understanding of the processes involved in the maintenance of SA because processing biases are likely to be intricately related, one bias having a direct influence on another bias (i.e., the combined cognitive bias hypothesis, Hirsch, Clark, & Mathews, 2006). We contend that these biases should not be considered in insolation, but rather, they need to be understood in the context of an interrelated cascade of processing.

In the following sections, we propose a first step in that direction, by relating evidence from cognitive psychopathological approaches of SA to the models of WM and attentional control processes exposed in the preceding section. Figure 2 depicts how SA modulates attention and WM.

Task goals

Models of SA (e.g., Clark & Wells, 1995) postulate that maladaptive self-beliefs contribute to the maintenance of the disorder. Clark and Wells' model predicts that, on the basis of early learning experiences, HSA individuals develop a series of problematic assumptions about themselves and social situations. These have been classified into three categories: (1) excessively high standards for social performance (e.g., "I must not show any signs of weakness"), (2) conditional beliefs concerning the consequences of performing in a certain way (e.g., "If people get to know me, they won't like me") and (3) unconditional negative beliefs about the self (e.g., "I'm unlikeable"). Such self-beliefs may lead individuals to appraise social situations as dangerous, which subsequently results in an avoidance response and prevents the disconfirmation of the negative self-beliefs.

Accordingly, research has demonstrated that HSA individuals hold negative cognitions about themselves and about how they should perform in social contexts. In a study by Moscovitch and Hofmann (2007), HSA and control participants

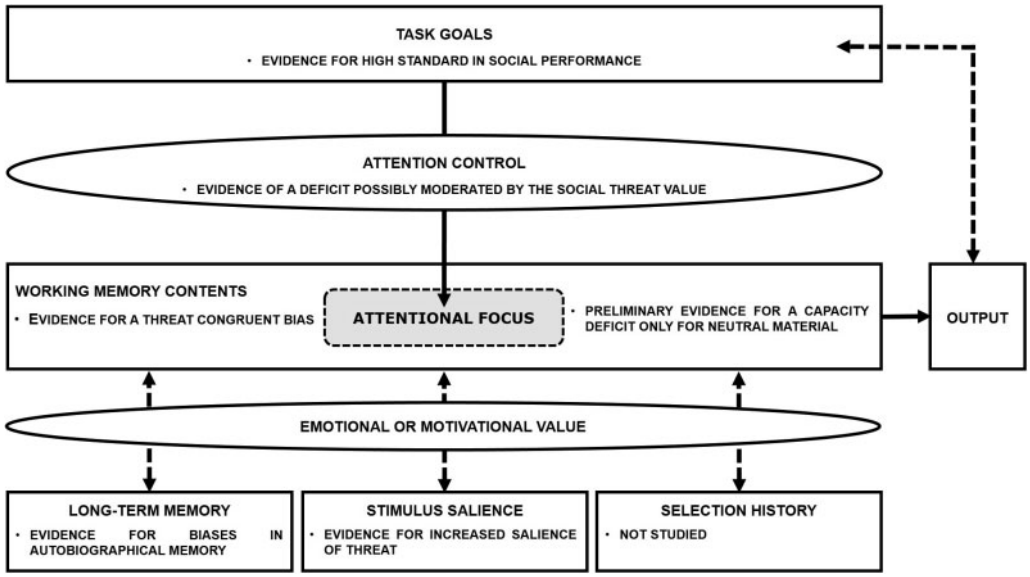

Figure 2. *The overview of the modulations by SA on attention WM processes.*

were randomly assigned to one of three experimental conditions in which they were exposed to cues that make them believe that other's standards were either high, low or ambiguous. The participants had to rate their own level of performance and the audience standards in anticipation of giving a public speech. The results indicated that, in anticipation of a social event, HSA individuals hold higher other's standards for their performance than controls, and anticipate a significantly lower performance. Moreover, they retrospectively appraised their performance as being significantly lower than controls in the high and ambiguous performance standard conditions. In another study, Voncken, Dijk, de Jong, and Roelofs (2010) have shown that negative beliefs about being negatively evaluated seem to be associated with relatively poorer performance in social situations and with an increased risk of subsequent rejection by peers. To our knowledge, research examining the relationship between these maladaptive thoughts and task goals in SA is sparse. Using the Self-Beliefs Related to SA scale (Wong & Moulds, 2009, 2011a) and the Cognitive-Behavioral Avoidance scale (Ottenbreit & Dobson, 2004), Wong and Moulds (2011b) reported that each maladaptive self-beliefs proposed by Clark and Wells' model are differently related to particular forms of avoidance in the social domain. Specifically, it has been shown that high standard beliefs predicted less behavioural avoidance, stronger unconditional negative beliefs predicted more behavioural avoidance, and stronger conditional beliefs predicted more cognitive avoidance. On the basis of these findings, one may speculate that HSA individuals are particularly motivated to actively monitor any sign of social threat, rejection or inadequacy to social standards. In other words, they could hold a self-protection goal, biasing attentional control towards the active monitoring of social threat.

Attentional control

There is evidence that SA is negatively correlated with self-reported attentional control after controlling for depression and state anxiety (Moriya & Tanno, 2008). A study by Wieser, Pauli, and Muhlberger (2009) provided additional evidence for the association between SA and reduced attentional control, showing that HSA individuals exhibit more difficulties than low socially anxious (LSA) individuals in inhibiting prepotent responses

to irrelevant emotional and neutral faces during an emotional saccade task. An event-related potential study (Judah, Grant, Mills, & Lechner, 2013) indicated impaired efficiency of attentional control (i.e., deficits in inhibition and shifting functions) on non-emotional material in the HSA group compared to the control group. Furthermore, the self-focus manipulation exacerbated impairments of attentional control, specifically for the inhibition function, in the HSA sample. In a related vein, Judah, Grant, Lechner, and Mills (2013) have shown that the WM load moderates late attentional biases of HSA individuals. Whereas low WM load resulted in avoidance of emotional stimuli, high WM load resulted in difficulty in disengaging attention from these same emotional stimuli. Using an operation span task with threat-related and neutral words, Amir and Bomyea (2011) also found that HSA individuals have a diminished ability to maintain neutral words in WM compared to LSA individuals whereas the groups did not differ for social threat words. The HSA group show enhanced WMC for socially salient words relative to neutral words. This finding suggests that HSA individuals may show deficit in maintaining benign or neutral information in WM, but may have greater WMC for socially salient words.

To sum up, this collection of evidence supports the notion that SA is associated to a general deficit in attentional control, although it is still unclear whether the nature of this deficit is moderated by the social threat value of the processed material. As a result of this deficit, HSA individuals might be less efficient at preventing threat-related distractors from gaining access to WM.

Salience of the stimuli

The preparedness theory of phobias (Öhman & Mineka, 2001; Seligman, 1971) predicts that phylogenetic fear-relevant stimuli are more prone to become the object of fears and phobias. In this perspective, social fear and phobia are viewed as resulting from an evolutionary-based predisposition to acquire fear of social stimuli that signal dominance and aggression from other humans (Öhman, Dimberg, & Öst, 1985). For example, a study conducted by Lissek et al. (2008) on biological preparedness demonstrated that, compared to healthy controls, HSA people show a greater proclivity to acquire aversive associations between socially relevant unconditioned stimuli (critical facial expressions and verbal insults) and co-occurring neutral conditioned stimuli (neutral facial expressions). So far, threatening facial expressions have been mainly used as a medium by which emotional reactivity is elicited in SA (Staugaard, 2010). Abundant studies have demonstrated an exacerbated attentional bias towards threatening faces in HSA participants compared to their LSA counterparts, which takes the form of faster spatial engagement for threatening faces than for non-threatening faces (Mogg, Philippot, & Bradley, 2004; Pishyar, Harris, & Menzies, 2004), and/or delayed disengagement from this cue once attention has been oriented to it (Buckner, Maner, & Schmidt, 2010; Schofield, Johnson, Inhoff, & Coles, 2012). Hence, converging evidence emanating from different methodologies suggest that socially threatening stimuli have an increased salience for HSA individuals.

Selection history

To our knowledge, no study has investigated the lingering effects of selection history in SA. Yet, one may speculate that individual differences in SA can also modulate the magnitude of history-driven effects on attention. For instance, selection history may be implicated in carry-over effects, and consequently contribute to the predisposition of HSA individuals to initiate rumination after social exposure. This issue needs to be addressed in future research.

Long-term memory

Models of SA (Clark & Wells, 1995; Rapee & Heimberg, 1997) posit that memory biases for social threat may contribute to the maintenance of SA. In order to test this hypothesis, researchers have used explicit, implicit and autobiographical memory paradigms. However, despite theoretical predictions, the existing literature failed to consistently

find support for memory biases towards social threat in SA (for a review, see Morrison, Gordon, & Heimberg, 2012).

Most studies have failed to identify an explicit memory bias for threatening words in SA (Hirsch & Clark, 2004). On the other hand, studies using facial expressions have yielded mixed results (e.g., Bielak & Moscovitch, 2012; Coles & Heimberg, 2005, Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Lemoult & Joormann, 2012). Differences in methodology could account for these inconsistencies. The few existing studies on implicit memory have indicated that HSA individuals may be characterised by a threat bias for social words and scenarios (Amir, Bower, Briks, & Freshman, 2003; Amir, Foa, & Coles, 2000). Nevertheless, other data failed to support such an implicit memory bias for threat in SA (Rapee, McCallum, Melville, Ravenscroft, & Rodney, 1994; Rinck & Becker, 2005). Additional investigations are needed before any firm conclusion can be drawn.

As is the case in explicit and implicit memory biases, the evidence for biases in the retrieval of threat-related autobiographical memories in SA is mixed (for a review, see Morgan, 2010). Nonetheless, research more consistently supports a bias in the properties of anxiety-related autobiographical memories and in the perspective from which social memories are recalled by HSA individuals. For example, D'Argembeau, Van der Linden, d'Acremont, and Mayers (2006) reported that the memories for social events recalled by HSA subjects contained more self-referential information and fewer external sensorial details than LSA group's memories. In addition, by contrast to LSA controls, HSA individuals tended to remember social interactions more from an observer perspective (i.e., viewing themselves from an outside point of view) than from a field perspective (i.e., viewing themselves from their own perspective). No group differences were found regarding memories for non-social events. Another study (Anderson, Goldin, Kurita, & Gross, 2008) supports these findings by showing that HSA individuals used more self-referential and anxiety words than controls when recalling SA-related memories.

In summary, there is weak evidence for memory biases towards threat in HSA individuals, with the exception of autobiographical memory of social situations. HSA individuals do not seem to present deficits in their autobiographical memory capacity per se. Rather, they tend to show a bias supporting personal memories congruent with a socially inadequate self. In line with our integrated framework, one may speculate that the autobiographical memory bias observed in SA might be the mere consequences of other biases, located upstream in the information processing stream. A likely possibility is that attentional biases select the information to be processed and, consequently that will be available for storage in LTM, hence explaining the autobiographical memory biases.

Relations among cognitive biases

Models of anxiety predict rather indiscriminantly emotional processing biases and impaired attentional control. These predictions are mostly supported by empirical evidence. Yet, these cognitive factors have been mainly studied separately, neglecting the fact that they may influence each other or interact to promote anxiety, as already suggested by several authors (Hirsch et al., 2006; White, Suway, Pine, Bar-Haim, & Fox, 2011). A benefit of the proposed conceptual framework is to further understanding of information processing in SA by taking into account the effects of potential mediators and moderators amongst all these factors.

From the above review, it appears that the available evidence concerning the attentional and WM particularities in SA are (1) task goals determined by high standards for social performance and concerns for social rejection, (2) preferential access and maintenance in WM of information relevant to social threat and (3) heightened sensitivity to socially threatening stimuli.

As depicted in Figure 3, we propose that the high standards for social performance and concerns for social rejection capture attentional control for the monitoring of potential social threat. This condition has two important consequences. First, it leaves little resources to monitor non-threatening social information. Second, WM is more likely to host

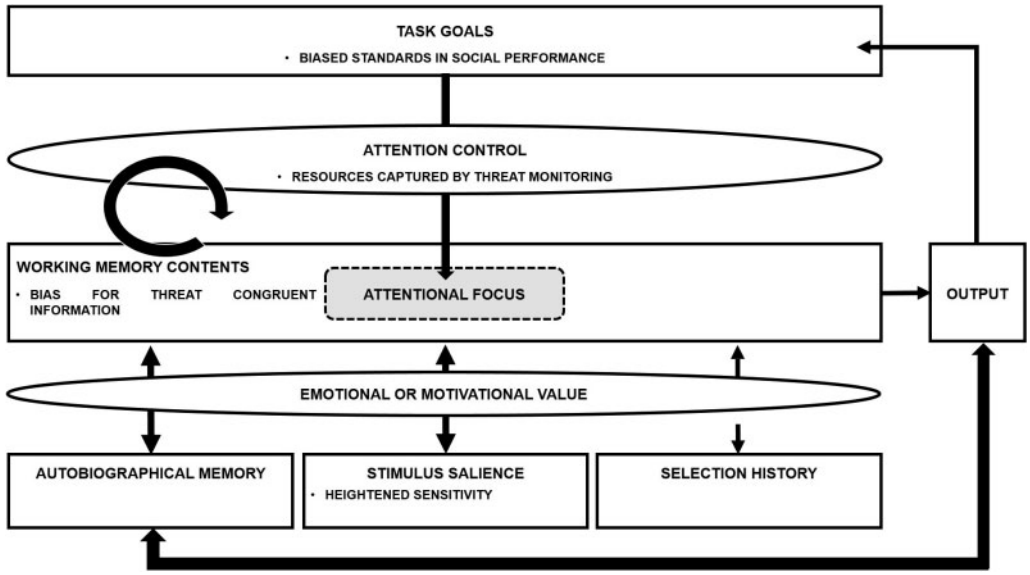

Figure 3. *An integrated account of information processing biases and deficits in SA.*

information relevant to social threat than benign information. This perspective accounts for the counter-intuitive observation reviewed above (Amir & Bomyea, 2011), that, in SA, WMC seems unaffected for socially threatening information, while it is impaired for neutral information.

Another determinant of the bias for social threat content in WM is the heightened sensitivity for social threat that automatically activates threatening information in WM. As reviewed above, there is evidence that HSA individuals show difficulties to inhibit or to disengage from automatically activated threat cues. This might seems contradictory to the report that HSA individuals do not present attentional control deficits in processing threatening information, while they do in processing neutral information. The conceptual framework offers a resolution of this apparent contradiction: HSA individuals, by strategically and wilfully allocating their attentional resources to the monitoring of potential rejection, would lack additional resources that are required for the inhibition or disengagement from automatically activated threat cues. This is illustrated by the loop between WM content and attention control. This notion is congruent with an observation by Amir, Bomyea, and Beard (2010) who randomly assigned HSA participants to benign interpretation training or a control condition, hence manipulating concern for rejection. Following the programme, individuals, who were trained to make benign interpretations, hence requiring fewer resources to monitor rejection, developed a greater ability to disengage attention from automatically activated threatening stimuli whereas those in the control condition did not change.

The bias favouring threat access to WM would constraint the processing of self-relevant information, and ultimately shape the qualitative characteristics of autobiographical memories (e.g., the perspective from which they are experienced). Hence, we propose that the autobiographical memory biases observed in SA might be the mere consequence of biased WM content. This proposal is congruent with a study by Hertel, Brozovich, Joormann, and Gotlib (2008) who demonstrated a close relationship between interpretation and memory biases in SA. They found that participants with SA generated more socially anxious and negative continuations for potentially

threatening social scenarios than did controls, suggesting greater availability for socially threatening information in WM. Moreover, HSA participants were also more likely than controls to exhibit memory intrusions that were consistent with previously made interpretations.

CONCLUSION AND FUTURE DIRECTIONS

A central feature of the conceptual framework is that the WM content arises from an interaction between multiple factors, such as the availability of attentional control, task goals, stimulus salience, selection history and LTM. These factors vary in terms of automatic versus strategic activation, of being goal versus stimulus-driven, of originating in internal versus external sources of information. Applied to SA, this framework appears to be heuristic for different matters. First, it offers a theoretical frame to review and distinguish different particularities of SA in terms of WM and attentional processes. Second, it provides plausible explanations to resolve apparent contradictions and counter-intuitive observations in the literature. Third, it suggests an agenda for future research. With regard to this last point, this review suggests the development of a systematic research programme investigating potential processing biases and deficits in the control of attention for neutral or socially threatening information. The counter-intuitive observation that WMC is preserved for socially threatening information, but depleted for neutral information needs to be further examined. Also, the hypothesis that the attentional control is jeopardised by the concerns for social rejection needs to be further ascertained, as well as the hypothesis that diminishing the rejection threat should free attentional control resources and lead to better performance on benign information. Another potential fruitful research avenue is to consider cascading effects among biases and deficits. We have outlined several hypotheses in that direction directly derived from the proposed framework. Even if some congruent data can be found, these hypotheses are in need of direct and systematic testing.

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