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Fear and the focus of attention*

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Philosophers have not been very preoccupied by the link between emotions and attention. The few that did (de Sousa, 1987) never really specified the relation between the two phenomena. Using empirical data from the study of the emotion of fear, we provide a description (and an explanation) of the links between emotion and attention. We also discuss the nature (empirical or conceptual) of these links.

Keywords: emotion, attention, fear, conceptual analysis, anxiety, amygdala

Introduction

It is natural to think of emotions, or at least certain types of emotions, as being closely related to attention. Just think of someone who experiences intense fear when unexpectedly encountering a dangerous animal, such as a wild bear, while alone in the forest. She will stare at the animal, registering every movement and sound it makes. Her attention will be entirely focused on the object of her emotion.

The claim that there are important connections between emotions and attention is widely acknowledged by psychologists. Gerald Matthews and Adrian Wells, the authors of *Attention and Emotion: A Clinical Perspective* (1994), start their recent survey paper with the following claim: "[e]motions and attention are intimately linked. States of emotions influence both the contents of consciousness and performance on tasks requiring selection of stimuli or intensive concentration" (1999, p. 171). Cosmides and Tooby, in a paper on the evolutionary psychology of emotions, make a similar statement: "The entire structure of attention, from perceptual systems to the contents of high level reasoning processes, should be regulated by emotional state" (2000, p. 110). Similar claims about the relation between emotions and attention have been made by neuroscientists. Jaak Panskepp, for example, writes: "In general,

the executive emotional systems are conceived to generate a variety of internally experienced affective states and related 'evolutionary operands' or instinctual behavioral tendencies that emerge from widespread brain systems that have at least six attributes [one of which being that] they are able to [...] modulate attentional and sensory-motor sensitivities relevant for the evoked behavioral tendencies (e.g. hunger sensitizes olfactory acuity) [...]" (Panskepp, 2000, p. 22; see also Damasio, 1994).

By contrast, philosophers have largely neglected the relation between emotions and attention. Moreover, with a few very recent exceptions,[1] philosophers have shown no interest in the empirical studies linking emotions to attention. As far as we know, Ronald de Sousa may be the only philosopher to have explicitly addressed the question of the relation between emotions and attention.[2] In his book (1987; but see also 1980), de Sousa argued — apparently quite independently of the empirical research — that emotions are closely related to attention.

In this paper, we wish to pick up from where de Sousa left off, that is, to try and spell out in more detail (using empirical data from psychology and neuroscience) the relations between emotions and attention. Since we think that the relations between emotions and attention have been overlooked in the literature in general, we hope that this will help philosophers, as well as non-philosophers, to get clear on this topic. In order to do that, we need to present briefly de Sousa's account. As it will become clear, spelling out the relation between emotions and attention requires drawing distinctions between the different types of emotional and attentional phenomena. This will be the task of the third section. In the fourth section, we will present the empirical evidence for the claim that emotions involve attention. We will draw both from psychological and neuro-cognitive studies. To narrow down our inquiry, we will concentrate on the emotion of fear, this for practical and methodological reasons. First, not only fear, but also closely related emotional phenomena such as anxiety have been the objects of numerous empirical studies. Second, we share the belief of some researchers in the field of emotions (Fredrickson, 1998, p. 305) that the relations between emotion and attention should be spelled out emotion by emotion (or group of emotions by group of emotions) to avoid over-generalizations. In the fifth section, we will attempt to specify more precisely the relation between fear phenomena and attentional phenomena thus completing de Sousa's picture. Finally, we will ask ourselves whether these claims concerning emotion and attention are conceptual or empirical. In a nutshell, the problem is that, on the one hand, it seems to some that conceptual analysis might be

sufficient to establish that there is a relation between emotion and attention, while on the other hand, the picture commonly assumed by psychologists and neuroscientists is that the relation between emotional and attentional phenomena is contingent or causal. We will suggest that the disagreement on this issue might rest on different ways of conceiving the concept of emotion.

De Sousa's biological hypothesis

What is emotions' biological function?, de Sousa asks. His suggestion is that "the role of emotions is to supply the insufficiency of reason by imitating the encapsulation of perceptual modes" (1987, p. 195). Pure reason or logic is unable to determine what we ought to notice, what we ought to attend to and what to inquire about. To put it differently, pure reason is not able to determine salience. And the same is true with respect to practical issues, such as choices of strategies. Pure reason does not tell us whether to choose to minimize the greatest possible losses or to maximize the greatest possible gains, for instance. The claim, then, is that the emotions' biological role is to make up for these different shortcomings of pure reason. Thus, emotions would be "one of Nature's way of dealing with the philosopher's frame problem" (1987, p. 195). Thanks to fear, for instance, we would avoid the sad destiny of the robot that kept analyzing an infinity of irrelevant data instead of running away from a ticking bomb.[3]

How do the emotions achieve this? According to de Sousa, it is by imitating the encapsulation of perceptual modules. This means that an emotion "limits the range of information that the organism will take into account, the inferences actually drawn from a potential infinity, and the set of live options among which it will choose" (p. 195).[4] De Sousa goes even further than that, since he claims that emotions *are* "species of determinate patterns of salience among objects of attention, lines of inquiry and inferential strategies" (1987, p. 196). Thus, emotions seem to be linked in an essential way to attentional phenomena. But whether emotions are considered to be identical to attentional phenomena or whether they simply involve them, what is important for now is that their biological function is to direct the agent's attention.[5]

Interestingly, a similar hypothesis has been put forward by the neuroscientist Antonio Damasio.[6] On his view, what he calls *somatic markers* (that is emotions and feelings) that "have been connected, by learning, to predicted future outcomes of certain scenarios" (1994, p. 174), make up for the shortcomings

of pure reason. The somatic markers assist us in our deliberation by highlighting options as dangerous or favorable; they function as a "biasing device" (*ibid.*), which forces attention on the negative or positive outcome of options, so that the number of considered options is reduced. As Damasio puts it: "a somatic state, negative or positive, caused by the appearance of a given representation, operates not only as a *marker for the value of what is represented, but also as a booster for continued working memory and attention.*" (1994, pp. 197–8).

Why should one believe that emotions are related to attention? Actually, everyday experience suggests that such a relation exist. As de Sousa notes, the fact that we can induce or change emotions in others by drawing their attention to certain aspects of a situation appears to confirm his hypothesis. This is clear when one considers how Othello's love for Desdemona grew into a murderous jealousy. By cunning questions and remarks, Iago draws Othello's attention towards the relation between Desdemona and Cassio, suggesting that they are having an affair. In de Sousa own words, "the emotion is changed via the manipulation of what Othello thinks about, notices, and infers." (1987, p. 196).

It is also natural to think that emotions influence what we attend to and determine what information we take in. Consider a chess player engrossed in his game. As Mark Johnston (2001, p. 211) points out, his affective or emotional interest in the game shapes and directs his attention; given his interest, his attention will be focused on the game. Moreover, his interest will determine what he sees when looking at the chessboard — he will be aware of certain positional weaknesses of his adversary or of some strategic possibilities that a bored bystander would fail to notice.

Another related point is that as Dylan Evans notes, "[e]motions are often blamed for distracting us" (2001, p. 114). As we all know, it is difficult to keep one's mind on a philosophy book when one is in love. It might be thought that this speaks against the claim that the emotions' function is to focus our attention. But as Evans writes, "emotions distract us from one thought only in order to make us pay attention to another." (*ibid.*) It is because her attention is concentrated on the object of her love that the person who is in love cannot focus on her philosophy books.

Indeed, it is often not enough to say that one's attention is focused on the object of one's emotion. Emotions are often characterized by a sort of obsession. Othello, for one, is certainly obsessed with the idea that Desdemona might be unfaithful. As Peter Goldie notes, imagination has an important role to play in such emotions and thus presumably with obsession. Jealousy is characterized by imaginative thought focused on different related objects, such as the lover or the rival (Goldie, 2000, p. 225). And the same is true of emotions such as love, hate or anger.

These observations are compatible with a number of accounts of the relation between emotional and attentional phenomena. To name just a few, emotions could be, *by definition*, identical to or, more plausibly, include or presuppose attentional phenomena. It would thus be a conceptual truth that emotions include or presuppose attentional phenomena. Or, there could be a contingent, possibly causal relation between emotions and attentional phenomena.

Actually, we think that this is still a much too simple way of thinking about the problem. These observations suggest the existence of relations between the two phenomena, but we think that they also reveal the possible complexity of those relations. This is because both the concept of attention and the concept of emotion are superordinate concepts covering a quite heterogeneous reality. This complex reality can be revealed by philosophical analysis and scientific inquiry. Only once we realize that each concept denotes a plethora of phenomena does it become possible to refine de Sousa's thesis.

Some conceptual clarifications

As we mentioned in the previous section, some preliminary conceptual work is in order to answer the question about the relation between emotion and attention. In the first sub-section, we will describe the variety of emotional phenomena. In the second sub-section, we will present a certain number of distinctions concerning the attentional phenomena.

Emotional phenomena

Following Lyons (1980, p. 53–57), philosophers commonly distinguish between *occurrent emotions*, such as the fear or the anger that you experienced the other day, and *emotional dispositions*, such as the disposition to feel fear when seeing dogs. This distinction is actually too crude. As Peter Goldie (2000) suggests, we typically posit certain emotions that last for years. Thus, *long-term emotions*, such as Marcel's jealousy for Albertine, have to be distinguished from shorter emotional episodes, such as the disgust you experienced when seeing a rotten corpse. Such episodes typically last a few seconds or even minutes, but no longer than an hour. We will call such episodes *short-lived emotions*. According to Goldie, what we called long-term emotions are "typically complex, episodic,

dynamic, and structured" (2000, p. 12); they involve a variety of elements, such as, of course, episodes of short-lived emotions, which themselves include perceptions, thoughts, feelings and bodily changes. Long-term emotions also include a number of dispositions, such as the disposition to have further short-lived emotions, thoughts, feelings, or to act or think in certain ways and to imagine certain things. All these elements come and go depending on, among other things, how they interact with and are structured by a narrative to which they belong.

Both philosophers and psychologists have in general concentrated on short-lived emotions. For instance, Ekman (1980) has been studying what is now known as "affect programs" (see also Griffiths, 1997, p. 77), which can be characterized by "automatic appraisal, commonalities in antecedent events, presence in other primates, quick onset, brief duration, unbidden occurrence, and distinctive physiology" (Ekman, 1994a, p. 16). According to Ekman, the claim that there are long-term emotions is in itself controversial. Indeed, he claims that "[w]hen we speak of an emotion lasting for hours, we probably are summating the recurrent emotion episodes within that time period" (1994b, p. 56). However, as Nico Frijda remarks, when people are asked to describe one of their recent emotional incidents, more than 50% describe episodes lasting more than an hour and 22% describe episodes longer than 24 hours. His studies show that these people have a sense of continuity of their experience; they perceive the episodes as wholes (see Frijda, 1994, p. 62). These descriptions seem to reflect the fact that the state of readiness characteristic of the emotion sometimes persist over time: "[...] enhanced activation during an emotion episode may be manifest even during sleep, in sleep disturbance and restless dreaming, and attention tends to remain focused on the event continuously" (Frijda, 1994, p. 62). Thus, it seems to us that there are Prima Facie good reasons to distinguish between long-term emotions and short-lived emotions.

Emotional dispositions can also be divided into different categories. A phobia of dogs or of spiders is an example of an emotional disposition, but so is irascibility or hostility. A disposition like spider phobia concerns a specific type of object and can last for years. A disposition like irascibility can be short lived — it can disappear as soon as you have had your morning coffee, for instance — but it can also be more deeply ingrained. There seems to be a continuum here between passing emotional dispositions and something like a permanent irritability or irascibility. In the latter case, one talks of an *emotional trait* or maybe of a *temperament*, terms that most naturally refer to the character-defining emotional disposition(s) of a person. Watson and Clark suggest that emotional traits are "stable individual differences in the tendency to experience a corresponding mood state." (1994, p. 92). Emotional traits are states directed towards less specific, more general types of events than an emotional disposition, like the latent fear of dogs, and they are more closely tied to the character of the persons than passing emotional dispositions. So if I am a hostile person, I am disposed to be hostile towards almost everyone that I meet.[7]

Another distinction that is commonly made, both by philosophers and psychologists, is the one between emotions and *moods*, such as depression and elation. Whereas emotions — i.e. both long-term emotions and short-lived emotions — are taken to involve intentional objects, in the sense that they are directed at something, moods are in general supposed to have no intentional objects.[8] In other words, while you cannot be proud of nothing or nobody, your depression or your elation is not directed at a particular object. Moreover, moods are generally taken to have different durations than emotions. As we mentioned, short-lived emotions typically last a few minutes to an hour while moods are thought to last for longer periods, from hours to days. Emotions, or at least short-lived emotions, are also thought to have "recognizable antecedent events" (for example, Davidson, 1994, p. 51), for instance, getting almost hit by a car; by contrast, the antecedents of moods are not always identifiable, or not necessarily punctual events. For instance, they can be caused by weather or by lack of sleep. Moods are often thought to be dispositional or functional states (Elster, 1999a, p. 272; Griffiths, 1999, p. 253; Davidson, 1994, p. 52). However, it should not be forgotten that moods have a distinctive phenomenology: there is a way it is like to feel depressed or elated — they cannot merely be reduced to dispositional or functional properties.

Some, like Frijda and Lazarus, distinguish emotions and moods from another class of emotional phenomena, namely "sentiments" (Frijda, 1994, p. 64–65; Lazarus, 1994, p. 80). According to Frijda, sentiments are dispositions to react affectively to certain objects or kinds of objects. However, the term "sentiment" is much more ambiguous than this suggests. It can, among other things, refer to long-term emotions.[9] Long-term love is naturally called a sentiment, for instance. It would be wrong, however, to say that such a state is merely a disposition to experience certain short-lived emotions with respect to the person you love. Much the same is true of long-term emotions such as admiration or indignation, which can be called "sentiments" but do not seem to be mere dispositions.[10]

To summarize, here is a list of the main emotional phenomena that have to be distinguished: first, occurrent emotions, which can be either long-term and short-lived, second, emotional dispositions, which can be more or less specific

as to their objects and which can be either passing or more permanent (emotional traits), and third, moods.

Attentional phenomena

In his *Principles of psychology* (1890), William James wrote about attention that "[f]ocalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others" (403–404). The contemporary research tradition on attention has followed James in thinking that selectivity in information processing is the essence of attention (Duncan, 1999; see also Matthews and Wells, 1999). This quasi unanimity concerning the core of the phenomenon of attention has been accompanied by sophistication concerning the different forms that attention can take. In what follows we will present some of the distinctions within attentional phenomena introduced by psychologists.

One natural way to make distinctions within attentional phenomena is by considering the different sources of the shifts of attention. In the literature, the shifts of attention are usually thought to have two possible sources: exogenous (bottom-up) and endogenous (top down). It is usually claimed that the source is exogenous when the shift of attention is caused by an outside stimulus that attracts the attention (because of its sudden onset or its intensity, for instance). The source is said to be endogenous when it is under voluntary control. The term "exogenous" is a bit misleading here because the stimulus that attracts attention may be something internal to the body, such as a pain in one's foot. For this reason, 'stimulus-driven' would probably be a wiser term to use. Moreover, the fact that some stimulus tends to attract attention is partly the result of some internal, possibly innate disposition of the subject, so that the source of involuntary attention is in a sense endogenous. The important point is that some forms of attention depend on the subject's voluntarily moving (or not moving) his attention somewhere. So we can introduce a first distinction between *involuntary attention* (the attention under the control of external stimuli) and *voluntary* or *intentional attention* (the attention under the control of the subject goals and will).[11] These kinds of attention seem to be different both from a phenomenological point of view and from a developmental point of view. First, as Posner and Fernandez-Duque (1999) note: "Voluntary control is accompanied by the subjective feeling of selection between potential actions and is one of the most distinctive features of human experience" (p.44). Thus, while involuntary attention is often unconscious, voluntary attention is conscious.

Second, developmental studies are showing, not surprisingly, that the first form of attention appears earlier in development than the second: as Mark Johnson notes "[i]n general, the transitions [in development] can be characterized as a shift from exogenous or automatic eye movement control to a more predictive system influenced by endogenous factors" (Johnson 1995, p.738). The development from exogenous to voluntary control is gradual as proved, amongst other things, by the phenomena of "obligatory attention". Between 1 and 3 months of age, infants have difficulty in disengaging their gaze from a stimulus to saccade to a peripheral stimulus.[12] In that phase, the infants are in some sense "stuck" between two phases of development: they are not prisoners of the outside stimuli, but they still don't have enough control on their attention to disengage it. Studies are showing that the voluntary control of attention in children is dependent of the development of the prefrontal cortex (see Johnson, 1995 and Rothbart et al., 1992 for more on the development of attentional capacities).

Some scientists have compared attention to a spotlight (Crick, 1984) that is moved on the world illuminating some part of it and leaving the rest in the dark. This metaphor can help us to introduce further distinctions. For instance, when we are looking for an object such as a four-leaf clover in a field, the spotlight may be moved until we find it (Treisman, 1986, 1998). If we want to study the details of a painting, or just pay attention to a very difficult talk, the attention must be held in place. It is thus natural to distinguish between the *shifting* or *orienting of attention* and the *maintenance of attention* (Mogg & Bradley, 1999, p.160; Allport, 1989; LaBerge, 1995). Note that this distinction is orthogonal to the one between involuntary and voluntary attention, both kinds of attention being susceptible to shifting and maintenance. Thus, we can voluntarily choose to look for four-leaf clovers by shifting our attention on a field or, because we are so innately disposed or because an affective state potentiates a certain class of stimuli, our attention can involuntary turn to certain objects.[13] By the same token, we can maintain our attention on something voluntarily or our attention can be kept focused on something involuntarily. The spotlight metaphor also suggests another phenomenon. We can indeed imagine that we can vary the focus of the spotlight in such a way that it would illuminate a large portion of a scene or only one object. Attention thus seems capable of being zoomed in or zoomed out.

A last category of attention used by psychologists is "vigilance". Vigilance generally co-occurs with freezing behavior (immobilization after having heard a loud noise or seeing something threatening). Consider fear: in this state, the organism is either actively orienting its attention towards the object of its fear or,

if the threat has not been identified yet, it is staying in an alert mode, not engaging its attention with anything, so that it would be ready to allocate attention to the danger as soon as it would identify its position.

Empirical evidence

In this section, we will discuss the experimental evidence for the claim that fear involves patterns of attention. We will start with evidence from psychology and psychopathology. As announced, we will focus on fear phenomena. As we will see, psychological studies show that there is robust evidence that different fear-phenomena are closely related to involuntary attention to threat stimuli. In the third sub-section, we will show how some of these results could be explained by some new findings in neuroscience.

Psychological evidence

In a paper on emotional disorders and attention, Kent Bach (1994) suggests that "[f]rom a descriptive point of view, [...], [the attentional aspects of emotional disorder] may be regarded as extreme versions of normal relations between emotion and attention". (p. 66) If he is right, data coming from experiments on subjects suffering from emotional psychopathologies are of special importance in understanding the nature of the relations between attentional and emotional phenomena. As we will see, evidence gathered in psychopathology confirms the claim that many emotional disorders are indeed problems in "attention management". For instance, many studies show that anxiety is accompanied by an increase in involuntary attention to threat stimuli and that it also tends to impair performance on certain tasks requiring attention. These results are consistent with studies on normal subjects that show that the threat stimuli capture attention automatically. This should come as no surprise if one supposes with Mogg and Bradley that "the main function of the mechanism underlying fear is to facilitate the detection of danger in the environment and to help the organism respond promptly and effectively to threatening situations" (1999, p. 145. Cf. Oatley & Johnson-Laird, 1987; see also Öhman, Flykt et Lundqvist, 2001). In what follows, we will briefly present the results from four well-known experimental tasks: homophone spelling tasks, emotional Stroop tasks, dot probe detection tasks and popout tasks.

A brief note before going farther. The experiments we are reviewing here are representative of most of the literature on emotion and attention in that they are concerned with the question of the voluntary and involuntary orientation of attention in emotional conditions and not with the possible variations in the breadth of attention. Though we won't describe them in what follows, there are some studies showing a narrowing of the attentional breadth in people suffering from anxiety or stress (see Derryberry and Tucker, 1994, p. 178–182 for a description of the phenomena). In such conditions, for instance, people seem to be slower in responding to peripheral targets than to more focal ones.

1. Homophone spelling tasks

Wells and Matthews (1994, Ch. 4) mention that, though a number of studies have failed to show that anxiety interferes with encoding tasks such as the recognition of threat-related stimuli or lexical decisions for threat-related words (Mathews 1988), homophone spelling tasks have been more successful in exhibiting this kind of interference (Eysenck, McLeod, & Mathews, 1987; Mathews, Richards, & Eysenck, 1989). In one of these studies, subjects were required to write down single words that they heard. Some of these words were homophones: one of its meanings was threat-related ("die"), whereas the other was neutral ("dye"). As expected, subjects characterized by *clinical anxiety* wrote down more threat-related homophones than did controls. Similar results were obtained with *trait anxiety* subjects (Eysenck, McLeod, & Mathews, 1987). Curiously, it appeared that *state anxiety*, which is an occurrent emotional state or mood, did not produce the same bias (Mathews et al., 1989; reported in Wells & Matthews, 1994, p. 68). However, the same kind of bias has been shown to obtain in the case of *particular anxiety disorders*, such as phobia. There is thus evidence that agoraphobic subjects (McNally & Foa, 1987) and panic subjects (Clark et al., 1988) tend to interpret ambiguous material as threatening. These data suggest that trait anxiety and phobia, but not state anxiety, are correlated with an increased attentional bias towards threat-related stimuli.

2. Emotional Stroop tasks

In the original Stroop task (Stroop, 1935), subjects were asked to name the ink colors of words while trying to abstract from their semantic content. It was shown that reaction time for color words printed in a different color from the color named by the word were longer than when the color word and the color matched.

In the emotional Stroop task, subjects are also shown words printed in different colors (Gotlib & McCann, 1984 for depression, Mathews & MacLeod, 1985 and Mogg, Mathews & Weinman, 1989 for anxiety; see reviews in Wells and Matthews, 1994, Mogg and Bradley, 1999 and MacLeod, 1999). Just as in the original test, subjects are asked to ignore the word content and to name the color as quickly as possible. Quite generally, subjects having emotional character traits, such as *trait anxiety*, take longer than control subjects do to recognize the color of words. And they are especially slower with fear-related meanings, compared to control subjects. This is assumed to reflect the fact that increased attention is given to the content of such words.[14] Thus, patients suffering from *generalized anxiety disorder*, a common anxiety disorder that tends to be chronic and is characterized by excessive anxiety or worry, muscle tension, autonomic hyperactivity and vigilance or scanning, take longer to name the colors of threatening words, such as "cancer" or "collapse". It was also found that *stress* increases the interference effects on subjects characterized by *trait anxiety*; when awareness of the word stimuli was restricted, high trait anxious students under examination stress manifested more interference effects than normal students (MacLeod & Rutherford, 1992).

Moreover, there is evidence for selective interference effects reflecting the subjects' *particular anxiety disorders.* Thus, panic patients manifest biased attention for physical threat words, such as "death" (Gandy & Telch, 1989; Hope, Rapee, Heimberg & Dombeck, 1990), whereas social phobics are more sensitive to social threat words. The same kind of selective interference bias has been shown for post-traumatic stress disorder in Vietnam veterans (McNally, Kaspi, Rienmann, & Zeitlin, 1990), drug overdose patients (Williams & Broadbent, 1986), for rape victims (Foa et al., 1991) and for spider phobics (Watts et al., 1986). Interestingly, already 6 to 7 years old children suffering from spider phobia manifest an increased interference from spider-related words (Martin, Horder & Jones, 1992).

Some Stroop task studies tried to provide evidence for a bias in unconscious and automatic processing by using *masked* or *subliminal* stimuli (MacLeod & Hagen, 1992; MacLeod & Rutherford, 1992). These results are disputed by some,[15] but combined with studies on conditioning to exclusively masked fear-relevant stimuli (including angry faces; Öhman, 2000b, p. 580), they seem to indicate the existence of automatic biases, that is, a tendency for the attention to be drawn to certain types of objects or situations even before the object has been consciously processed.

What about *state anxiety*? Rutherford and MacLeod (submitted) found that across both high and low trait anxious subjects, an increase in state anxiety increases color-naming interference effects on both negative and positive words. It is only in high trait anxious subjects that there was more interference with negative words. MacLeod concludes that "while elevated state anxiety may increase the degree to which everyone attends to emotional information in general, it appears to elicit preferential attention towards negative information rather than positive information only in high trait anxious individuals" (1999, 454). The same kind of result seems to follow from a study conducted by Mathews & Sebastian (1993), who found that the presence of a real threat, such as a snake, cancels the threat-related interference. Moreover, as shown by Amir et al. (1996), social phobics manifest less Stroop interference for congruent threat words when they are made to believe that they have soon to give a public speech. Mathews and Sebastian (1993) suggest that the presence of a real threat produces a shift of attention away from verbal representation to the real threat. This is an interesting, but controversial hypothesis, for other experiments appear to show a stronger interference effect when real threats, such as spiders, were present (see McNally, 1999, p. 485; Hayward, Ahmad & Wardle, 1994 and Chen, Lewin & Craske, 1996). In any case, it is clear that more studies are needed before it can be concluded that state anxiety caused by the presence of real threat does not produce color-naming interference.

3. Dot probe detection tasks

The clearest results have been obtained with variants of a dot probe methodology first introduced by MacLeod, Mathews & Tata (1986) and replicated by Mogg, Mathews & Eysenck (1992), and Mogg, Bradley & Williams (1995) (see reviews in Wells & Matthews, 1994, Mogg & Bradley, 1999, and McLeod, 1999). Patients suffering from *generalized anxiety disorder* and non-anxious control subjects were presented word pairs on a screen for a period of 500 msec. Some word pairs consisted in one threat-related word matched with a neutral word of the same length and frequency. One of the words would appear in the upper part of the screen, whereas the other appeared in the lower part. After the 500 msec., a dot probe replaced one of the words and subjects were asked to press a button whenever they detected the dot probe. Quite generally, subjects tended to be faster in their response to a probe that appeared in the attended region of the screen. It was found that subjects suffering from *trait anxiety* detected the dot faster when it appeared close to where there was a threat word, suggesting

that their visual attention was focused on such words. Results were opposite with control subjects, suggesting that they tended to shift attention away from threat-words. Similar results have been found for particular *anxiety disorders.* Thus, Beck and his colleagues (Beck et al., 1992) found that panic patients shifted their attention towards panic words and, quite surprisingly, towards positive words, to the detriment of neutral words.

The dot probe task has been modified by Bradley et al. (1997) in order to test for a bias with respect to emotional faces; the words were replaced by threatening, happy and neutral faces. This study provided evidence for an emotion-congruent attentional bias. Masked versions of the facial dot probe task (Mogg & Bradley, 1998) appear to show that there are *pre-attentive biases* for face stimuli.[16] Moreover, it was found that the attention increases when more severe threats are presented. Apparently, there is an additive effect of trait anxiety and the subjective value of the threat stimulus.

Another important result is that *stimulus duration* makes a difference. A study involving spider phobics showed an attentional shift at 200 msec. exposure time, in comparison with normal control subjects, while this was not so at longer stimulus exposure (Mogg & Bradley, 1999, p. 161). As Mogg and Bradley report, their "result[s] show that anxiety-related biases towards threat are not found across all attentional processes, but that they are most reliably evident at short durations that are more likely to reflect automatic initial orienting to external stimuli." (1999, p. 161)

State anxiety has also been studied with the help of the dot probe task. MacLeod and Mathews (1988) tested medical students both 12 weeks before an examination and a week before the examination, when state anxiety was supposedly high. It was found that the attention of high trait anxiety subjects was on both occasions directed towards threat-words, but they manifested an additional bias towards test-related stimuli in the week before the examination. Subjects with low trait anxiety, however, showed increased avoidance of threat-words during the second test. Thus, trait anxiety was a stronger predictor, compared to state anxiety. Wells and Matthews conclude that "these data show that attentional bias in anxious subjects is not merely a mood state dependent phenomenon, although such biases may be exacerbated by anxious moods. Trait characteristics appear to be more strongly associated with biased attention than state factors in anxiety." (1994, p. 71) Much as in the case of the Stoop task, one might wonder whether the presence of a real threat — the approaching examination — had not as an effect that attention shifted from mere linguistic representations of threats to the real threat.

4. Popout tasks

Another task that has been used to investigate attentional bias is the so-called "popout task". For instance, Öhman and colleagues have studied how frightening stimuli catch attention (Öhman, 2000a). For one of their experiments, they showed images made of nine pictures distributed in three rows of three. The images were either made of nine pictures all with the same emotional valence (for instance, all emotionally neutral) or of eight similar pictures (like flowers or mushrooms) and one intruder (like a snake or a spider). Subjects in that experiment had to press on a button on their left if they thought all the elements of the image were the same and press on a button on their right if they thought the image contained an intruder.

What Öhman et al. found is that reaction times were shorter for a frightening intruder than for a neutral stimulus, and this independently of the location of the intruder. Moreover, they found that the time taken to detect frightening stimuli is independent of the number of distractors. It is as if the spider or snake is "poping out" from the background, capturing attention automatically. This phenomenon does not replicate with a neutral stimuli on a background of frightening stimuli, like birds or flowers on a background of snakes. In that case, the reaction time increases with the number of distractors, in such a way, indeed, that it led them to think that the background images were drawing the attention of the subjects, interfering with the task (see Öhman, Flykt & Lundqvist, 2001 for this conclusion).[17] Öhman also tested subjects with snake phobia and with spider phobia. She found that the reaction times of people with snake phobia were faster than normal when the intruder was a snake than when it was a neutral stimulus or a spider.

Mogg and Bradley (1999, p. 158), using a similar paradigm, report that subjects were presented an array of faces, in which one facial expression was different from the others — a happy face in an crowd of angry faces, or vice versa, an angry face among happy faces. Subjects were required to detect the "odd face out" as fast as possible. As Hansen and Hansen (1988) showed, an angry face in a happy crowd was detected significantly faster than a happy face in a crowd of angry faces (according to Öhman, Flykt & Lundqvist, 2001, the experience of Hansen and Hansen suffers from some experimental design flaws. In a new version of the experiment using schematic faces instead of real ones, Öhman et al. found a pop out effect of angry faces in neutral or happy faces background). Byrne and Eysenck (1995) showed that this threat-superiority effect was greater in subjects suffering from trait anxiety;[18] by contrast, their study

suggests that state anxiety made no difference. This latter result is controversial. Other popout task studies indicate that the threat-superiority effect depends on the subject's state anxiety levels (Mogg & Bradley, 1999, p. 158).

Intermediary conclusion

The empirical evidence we reviewed suggests that fear-phenomena are related to attentional biases. More precisely, people in such states appear to experience *involuntary orienting of attention towards congruent stimuli* (but not exclusively to congruent stimuli since part of a normal response of fear also consists in orienting towards relieving cues — finding an escape route, a stick, a place to hide; for more on that neglected part of normal fear responses, see Derryberry and Tucker, 1994). As Mathews puts it, "anxiety and worry are associated with an automatic processing bias, initiated prior to awareness, but serving to attract attention to environmental threat cues, and thus facilitating the acquisition of threatening information" (1990, quoted by Öhman, 2000b, p. 581).[19] More precisely, the studies we have examined show that generalized anxiety disorder, trait anxiety and particular anxiety disorders are associated with attentional biases towards congruent stimuli. As to state anxiety, it is not clear that it has the same kind of effect; more studies are needed to determine the impact of state anxiety on attention. Finally, it has to be noted that the emotion of fear has not (yet) been the object of these types of studies. However, the data we considered suggest strongly that the emotion of fear, as experienced by normal subjects, involves an attentional bias towards threat stimuli of the same kind observed in pathological cases.[20] By analogy, and in spite of the data that suggest the contrary, one would expect that the related mood of anxiety is similarly associated with an attentional bias.

The neuro-cognitive perspective

In what follows, we will describe briefly some of the cognitive-neuroscientific findings on the emotion of fear. Then we will give a description of attention and of the "systems" of neurological structures that subserves it. Finally, we will consider some data showing that the amygdala is involved in attention and that some attentional structures are involved in emotions.

Description of the amygdala and its connections

In the recent years, the amygdala has been tagged as the hub for the emotion of fear (Ledoux, 1996, p. 168. See also Armony, 1997; Davis, 1992; LeDoux, 1995a,b).[21] As LeDoux puts it, "The amygdala is an essential part of the fear-conditioning circuitry" (1995b, p. 1051). Accurate descriptions of the connections between the amygdala and other cerebral structures, like the thalamus and cortical structures, have helped to further our understanding of some of the central characteristics of emotions.

It is known since the late seventies that the central nucleus of the amygdala (CNA), is involved in the control of emotional responses elicited by fear (Öhman calls this structure the "fear effector system"; 2000b, p. 578). As Ledoux puts it, "The central nucleus is [...] a key interface with motor systems involved in the expressions of conditioned fear reactions through various response modalities [...]"(1995b, p. 1051). For instance, through its efferent connections with the hypothalamus, the CNA controls the blood pressure increase characteristic of fear. The connections of the CNA with the midbrain Gray area are responsible for the startle response and the body's preparation for fight or flight behaviors.

The CNA received its inputs from another amygdalian structure, the Lateral Nucleus of the Amygdala (LNA) that projects to the CNA through the baso-lateral and basomedial nuclei of the amygdala. The LNA receives projections from multiple pathways. It receives projections from the thalamus (what LeDoux calls the "low road"; LeDoux and Phelps, 2000, p. 159) or from the neocortex areas as well as from the hippocampal formation (what LeDoux calls the "high road"). LNA "[...] appears to be especially important as the sensory interface of the agmydala, receiving crude stimulus information from the thalamus, perceptual information from the cortex, and higher-order information from the hippocampal formation" (1995b, p. 1053; it acts like a "significance evaluator"; Öhman, 2000b, p. 578). These different pathways are responsible for the processing of different aspects of the stimuli. The information coming directly from the sensory thalamus is thought to be very crude, i.e. loud noise or intense light; while the information coming from the cortex ranges from somewhat simple (shape) to complex (context).

It should finally be noted that as there are cortical projections to the amygdala, there is also a wider number of projections going from the amygdala to the cortex and neo-cortex (LeDoux, 1994, p. 222). LeDoux also mentions work by Weinberger and colleagues that suggests that the amygdala plays an important role in activating the cholinergic system in the basal forebrain, which modulates cortical arousal and conditioning (LeDoux & Phelps, 2000, p. 163).

Description of the attentional system

According to one of the most prominent researcher on attention, Michael Posner, the attention system involves separate networks performing orienting (posterior) and detecting (anterior) functions (1992). To these networks, Posner usually adds a third one responsible of maintaining an alert state (1995).

The first system, responsible for the orienting responses, is subserved by three structures with different functions. The first structure is the *posterior parietal lobe.* Damage to that structure produces difficulty in disengaging from attentional focus on a target. More precisely, "[...] strokes or tumors of the parietal lobe of the cerebral cortex produce a constellation of physical changes called the neglect syndrome. Cognitive studies have shown that although much of this syndrome resolves over time, there remains a deficit in the ability to disengage from a current focus of attention and to deal with a target on the side opposite the lesion." (1992, p. 26) The second structure is the *superior colliculus.* Damage to that structure also has the effect of slowing down attention shift, but this time independently of the fact that attention was or was not engaged elsewhere. The third structure is the *lateral pulvinar nucleus of the posterolateral thalamus.* Human patients with damage to this structure have problems restricting their attention to a target that appears among distractors. Data from lesions led Posner to propose the following characterization of the way those structures interact to produce orienting responses: "The parietal lobe first disengages attention from its present focus; then the midbrain is active to move the index of attention to the area of the target, and the pulvinar is involved in restricting input to the indexed area." (1995, p. 618)

A second system, located in the *medial surface of the frontal lobe,* is responsible for voluntary attention. Voluntary attention is the capacity we have to voluntarily detect targets for focal processing (when, for instance, you are looking for a feature that is not popping out). It is believed to be the form of attention necessary to succeed in Stroop tasks. The structure responsible for this kind of attention, and more generally for inhibition of automatic response,[22] is the *anterior cingulate gyrus.* The anterior cingulate gyrus has connections with the basal ganglia (also showing activity in inhibition of reflexive motor responses), the dorsolateral frontal cortex and with the posterior parietal lobe. The connection with the posterior parietal lobe suggests that this brain structure can be responsible for voluntary changes of attention to a new visual location.

The last system implements the alerting network. The brain region in charge of that network is the *frontal region of the brain* as shown by both patients with lesions and normals (1995, p. 622). Alertness is different from other forms of attention in that it does not "act to improve the buildup of information concerning the nature of the target" (Posner, 1995, p. 621), but rather acts to enhance the speed of actions taken toward the target. It seems that once a creature is in an alert state, his executive functions are somewhat suspended: "At least one study shows that during the maintenance of vigilance, the metabolic activity of the anterior cingulate gyrus is reduced over a resting baseline value [...]. These anatomical findings would support the subjective observation that, while waiting for infrequent visual signals, one has to be prepared to orient but also has to empty one's head of any ideas that might interfere with detection." (Posner, 1995, p. 622).[23] Posner and Petersen also note the role of the neurotransmitter norepinephrine (NE) in the maintenance of the alert state. It appears that the posterior visual system (formed by the parietal lobe, the superior colliculus and the pulvinar) is most strongly innervated by the NE pathways. This suggests that alertness puts the posterior system in a waiting mode.

Attention and fear

In this section we will review some recent evidence showing that cerebral structures, traditionally thought to be part of the emotional network, might contribute to attentional function (and vice versa).

Holland and Gallagher (1999) have proposed that the central nucleus of the amygdala might be involved in aspects of attention, mostly the modulation of orienting responses and the enhancement of associability of particular events when expectancies are violated. In what follows we will focus on the first aspect, the orienting responses (OR).

As Holland and Gallagher remind us, "important events must be capable of interrupting an animal's ongoing stimulus processing. Typically, novel stimuli with abrupt onsets [...] trigger orienting responses (ORs). ORs often include movements directed towards the stimulus, autonomic responses and neural activity characterized as vigilance. These behaviors suggest the apportionment of further processing to the eliciting event." (1999, p. 68). Previous studies on the amygdala have showed that the amygdala plays a role in the OR: "[...] lower-voltage stimulation produced primarily 'alerting' and 'searching' behaviors [...] specific stimulation of the CN has been found to generate autonomic alerting behavior, along with desynchronization of the cortical EGG." (1999, p. 69)

Holland and Gallagher have examined the case of simple Pavlovian conditioning in rats. Prior to training, a stimulus elicits orienting behaviors, "including, for visual clues, rearing on the hind legs and other behaviours directed

towards the light source, as well as autonomic responses like decreased heart rate." (1999, p. 69) Repetition of the neutral stimulus produces habituation. If the stimulus is paired with food, the ORs re-emerge at a higher level. Holland and Gallagher have shown that in cases of lesions to the central nucleus of the amygdala, rats fail to acquire those conditioned ORs, despite the fact that they can acquire conditioned responses to delivery of food (the latest results show that they are not impaired in learning) or that they orient spontaneously to new stimuli. They conclude from this that "[...] it appears that the CN was very selectively involved in learning to orient to a stimulus that reliably predicted a biologically important event: food." (1999, p. 69) In other words, it seems that the central nucleus of the amygdala is involved in learning what needs to be paid attention to.

Bush, Luu and Posner (2000) have recently proposed a comprehensive theory of the Anterior Cingulate Cortex (ACC) that is of interest for our purpose. The results of previous studies have shown that the ACC is involved, amongst other things, in cognitive and affective functions.[24] As they explain, these functions are processed separately: the dorsal region of the ACC being in charge of the cognitive functions and the rostral-ventral of the affective functions. The cognitive subdivision of the ACC is part of a distributed attention network. It is indeed connected with the lateral prefrontal cortex, the parietal cortex and the premotor, and supplementary motor areas. The affective subdivision is connected to "the amygdala, periaqueductal gray, nucleus accumbens, hypothalamus, anterior insula, hippocampus and orbiofrontal cortex, and has outflow to autonomic, visceromotor and endocrine systems" (Bush et al., 2000, p. 216). This part seems to be involved mainly in the assessment of emotion stimuli and control of emotional regulation.

Bush et al. (2000) report what they call a "reciprocal suppression" of the affective subdivision when subjects are performing cognitive tasks (and *vice versa*). They also found reciprocal suppression of the cognitive subdivision when subjects where in intense emotional states, as well as when the subjects experienced intense depression.

Intermediary conclusion

There are a few conclusions we can draw from the neuro-cognitive data we just reviewed.

1. The rapid detection of fear-related stimuli (spider or snake) in normals might be explained by the fact that these stimuli are relayed directly from the thalamus to the amygdala. As Öhman (2000b) notes, this would make evolutionary sense:

"[...] threat stimuli must be detected wherever they occur in the perceptual field, independently of the current direction of attention. [...] Many perceptual channels can be automatically and simultaneously monitored for potential threat. When stimulus events implying threat are located by the automatic system, attention is drawn to the stimulus, as the control for its further analysis is transferred to strategic level of information processing. The switch of control from automatic to strategic information processing is associated with activation of physiological responses, particularly the orienting response" (p. 578).

In this context, "this rapid subcortical pathway may function to "prime" the amygdala to evaluate subsequent information received along the cortical pathway. For example, a loud noise may be sufficient to alert the amygdala at the cellular level to prepare to respond to a dangerous predator lurking nearby, but defensive reactions may not be fully mobilized until the auditory cortex analyzes the location, frequency, and intensity of the noise, to determine specifically the nature and extent of this potentially threatening auditory signal" (LeDoux & Phelps, 2000, p. 159). It would then seem that the full emotional reaction is somewhat post-attentive or at least that the emotional activation is simultaneous with the shift of attention (Öhman, Flykt & Lundqvist, 2001, p. 313).

2. Efferents projections of the amygdala to the cortical structures explains how fear can influence cognitive processes while the afferents projections from the cortical structures to the amygdala explains how cognition can influence (causing or maintaining) emotions. Concerning the first possibility, Ledoux proposed recently that "[g]iven that the cortex and the amygdala are simultaneously activated by thalamic sensory inputs (Quirk et al., 1997b), it is possible that thalamic activation of the amygdala might begin to regulate cortical processing before cortical representations are fully built up. Amygdala regulation of the cortex could involve facilitating the processing of stimuli that signal danger even if such stimuli occur outside of the attentional field (Armony et al., 1996, 1997a, 1998) [...] The amygdala can also influence the cortical sensory processes indirectly by way of projections to various arousal networks, including the basal forebrain cholinergic system, the brainstem cholinergic system, and the locus cerouleus [sic] noradrenergic system, each of which innervates widespread areas of the cortex (Saper, 1987). Thus, once the amygdala detects danger, it can activate these arousal systems, which could then influence sensory processing, perhaps by regulating cortical attention [...]" (2000, p. 139–140). It can finally inluence cognition through projections to "thalamic nuclei (e.g., mediodorsal nucleus, medial pulvinar nucleus), which are in turn reciprocally interconnected with relatively precise cortical fields. By regulating thalamic

activity, limbic circuits may facilitate or sustain processing within localized regions of the cortex [...]" (Derryberry & Tucker, 1994, p. 177).

3. As shown by Holland and Gallagher (1999), the amygdala is also involved in learning about stimuli that will have value for the organism and to which the organism will pay attention in the future. In some sense, the amygdala might be implicated in the pre-setting of the sensory systems.

4. Work on attention subsystems shows that when an organism is in an alert state, the centers responsible for voluntary attention are working at a lower rate metabolically. Given that the amygdala is responsible for putting the organism in an alert state, this would explain in part why our attention disengages when we encounter an emotionally charged stimulus. The other part of the explanation would come from mentioning the fact that the subsystems responsible for the disengage operation are connected to the amygdala through the cingulated cortex.

5. Work on the anterior cingulate cortex show that this structure has two subdivisions (one affective and the other one cognitive) and that these subdivisions suppress each other reciprocally. The link of that structure with the amygdala might explain how emotions act on attention. The fact that, with emotions, there is a suppression of the cognitive subpart of the anterior cingulate cortex might explain the disruption of attention we experience when we have an emotion and the fact that voluntary attention might be hard to control while we are under the influence of an emotion. This is consistent with, and gives a biological description of, the recent computational modeling studies reported by Ledoux that show that "the subcortical pathway can function as an interrupt device that enables the cortex, by way of amygdalo-cortical projections, to shift attention to dangerous stimuli that occur outside the focus of attention" (Ledoux & Phelps, 2000, p. 160). The reciprocal suppression model also explain how we can "snap out of our emotion" by moving our attention on other objects. This can happen either by putting ourselves in an environment lacking the emotional object or by focusing our attention on some non-emotional object (in this case the pre-frontal and frontal structures of the cortex might play an important role).

6. The anterior cingulate cortex, as well as other neocortical regions, have been shown to play a role in the inhibition of habitual response (thus playing a role in tasks like the Stroop). This is interesting because it seems that many emotional disorders, like phobias, post-traumatic stress disorders, and generalized anxiety, might come from an inability to inhibit fear responses. As reported by LeDoux and Phelps,

> [...] findings suggest that fear disorders may be related to a malfunction of the prefrontal cortex that makes it difficult for patients to extinguish fears they have acquired. Recent studies have shown that stress has the same effects as lesions of the medial prefrontal cortex (fear exaggeration). Given that stress is a common occurrence in psychiatric patients, [...], it is possible that the exaggeration of fear in anxiety disorders results from stress-induced alterations in the medial prefrontal region." (2000, p. 161)

The nature of the relation between fear phenomena and attention

In this section, we will attempt to specify the relation between emotional phenomena, or more precisely fear phenomena, and attention phenomena. In order to do this, we will extrapolate from the empirical evidence discussed above but we will also draw from phenomenological observations to fill the gaps. Finally, we will address the question whether the claims in question are conceptual or empirical.

Specifying de Sousa's hypothesis

As we have seen, de Sousa claims that the emotions' function is to direct our attention. More precisely, he suggests that emotions determine a) what information is processed, b) what inferences are drawn, and c) what options are considered in deliberation. The data we have considered concern only the first part of this tripartite thesis. But even if one only considers the question of whether emotions have an impact on information processing, that is, if one takes attention to be essentially a matter of selectivity in information processing, it should by now be obvious that there is room to further specify de Sousa's claim. We will try to do so with respect to the different fear phenomena that we have distinguished, starting with the emotion of fear.

– *Fear as short-lived and long-term emotion.* Quite generally, it seems plausible that a short-lived emotion of fear involves both an involuntary shifting of attention towards its intentional object, or more precisely, what de Sousa (1987, p. 116) calls the *target* of the emotion and its fear-related features (what de Sousa (*ibid.*) calls the *focal properties* of the target) and an involuntary maintaining of the attention on the object of one's emotion. This is particularly obvious in the case of fear directed at a real object. When experiencing the fear

of a bear charging us, for instance, one's attention, be it visual or auditory, involuntarily shifts towards the bear and this shift co-occurs most of the time with overt movements of the sensory organs and of the body. What seems to happen first is that the bear and its fear inspiring features — its bared teeth, its trenchant claws, its fierce gnarl, etc. — attract one's visual or auditory attention. We have seen that for certain types of stimuli there seems to be an innate pre-setting of the attentional mechanisms that makes detection of the threatening stimulus automatic (they are "efficient attention capturers" in Öhman, Flykt and Lundqvist's words (2001, p. 306)). But innate or learned or induced by an emotional state, these pre-settings explain why we experience an involuntary shift of attention in those cases. This would validate de Sousa's claim that emotion is encapsulated like perception. In fact, in this case, it is attention that is encapsulated. After this initial shifting, the attention will be maintained on the object of one's fear as long as the emotion is experienced, and typically as long as one is being threatened by what one fears. As a consequence, it will prove difficult to attend to things that are unrelated to the object of one's fear. This effect is explained by the reciprocal inhibition of the cognitive and affective parts of the anterior cingulated. We can hypothesize that as long as we are in the emotional state, we won't have total voluntary control on shifting and maintaining attention.

Short-term fear might also involve vigilance or alertness. Sometimes, in the middle of the night, one might hear what sounds like footsteps in other parts of the house. These sounds immediately catch one's attention; one is in an alert state, waiting for other footstep sounds that would confirm one's fear. As is usually the case, one might hear nothing for a while. But, who knows, maybe the thief has stopped moving and is waiting for you to fall asleep again! So one keeps listening, like a 'cork on a Champaign bottle', heart beating fast and loudly, ready to swing into action. In the same way, you might fear something even before having perceived what you fear — you might have been told that there is thief in the house. In such a case, your attention will not be focused on anything in particular. It will just be in an alert mode, ready to focus on the threat as soon as it materializes. We should note that if this alert state allows agent to react faster to new sounds, it also causes him to make mistakes concerning the target. As Posner puts it: "The trade-off between improved speed and reduced accuracy with warning signals has led to a view that alerting does not act to improve the buildup of information concerning the nature of the target but instead acts on the attentional system to enhance the speed of actions taken toward the target." (Posner, 1995, p. 621–622)

Some might doubt that fear exists as a long-term emotion. The term 'fear' most often refers to a short-lived emotional experience having at least most of the time an intentional object. Sometimes, it also refers to an emotional disposition, as when one says that one fears dogs. However, it is not difficult to think of a long-term emotion of fear. Just imagine a child who fears his brutal father. This fear can last for months or even years. And it is naturally conceived as a whole, with a beginning and, hopefully, an end at some point. Quite generally, since long-term emotions involve episodes of short-lived emotions, they are likely to punctually involve the same kind of attentional phenomena as short-lived fear. Thus, when these short-term emotions occur, the attention of the child will involuntarily be focused on his father. Thus, it will be difficult for the child to concentrate on other things, something which is likely to reflect on his learning abilities, for instance. Moreover, the thoughts and imaginings that come with the long-term emotions are likely to involve the same kind of selective bias. Even in the absence of his father, the child will almost constantly think of him, something that is likely to distract him when he tries to concentrate on other tasks. He will remember the brutality he experienced and will anticipate in imagination what is waiting for him later. His imagination and memory might be prolonged by the emotional state he is in, thus creating a state similar to some extent to a mood of anxiety or anxiety state. The effects on his attention would thus be similar to the ones described in these phenomena. In addition to the effects of memory and imagination on prolonging the emotions, it is plausible that long-term emotions also involve voluntary attention. The jealous person will try to find evidence for the suspected unfaithfulness. One can think that motivation plays a role in what will be the focus of attention. In the same way, the child's attention might be intentionally focused on his father and the signs of a new outburst.

As we noted above, emotions can be induced by drawing someone's attention to certain things. This is what Henry Tilney tries to achieve in Jane Austen's novel *Northanger Abbey*; by describing the gothic atmosphere of the old abbey and getting her imagination to run free, he manages to produce fear in Catherine. Paraphrasing de Sousa's description of Othello's emotions, it can be said that Catherine's emotions are changed via the manipulation of what she thinks about, notices, and infers. None of the studies we reviewed have considered this aspect of the thesis, but such a phenomenon seems to be explainable by the re-afferent projections from the cortex to the amygdala. Another form of interaction between emotion and attention is when a shift of attention causes an emotion to disappear. The best way of not experiencing fear is certainly to

try to attend to something other than what seems threatening. Note that in some cases what is achieved is sometimes only that the emotion lapses for a certain time. Lazarus gives the following example of such a case: "[...] when a couple has an argument one morning, which is marked by intense and mutual verbal expressions of anger, the anger tends to disappear as the two go off to work and attend to the demands of their jobs. However, when they come home from work that evening it may return, though perhaps in different form, with verbal attack giving way to coldness and sulking" (1994, p. 83).

– *The mood of anxiety.* Anxiety as a mood differs from the emotion of fear in that it has no intentional object. Still, contrary to anxiety as an emotional trait, it is not purely dispositional or functional; there is a way it is like to be in such a mood. Though the empirical evidence is not clear, the phenomenology of such a mood suggests that it also involves some sort of involuntary disposition of the attention to be oriented towards and maintained focused on a certain class of objects. That is, rather than being directed towards a particular object, attention will be directed towards anything that can be interpreted as threatening. Actually, what characterizes such a mood is that more things are interpreted as threatening than normally. It is as if the mood colors the world, to speak metaphorically. This might involve a top-down effect of the mood on sensory modalities; then agent would be more likely to expect a certain class of objects to be present in the environment. In other terms, threat stimuli will become more salient, biasing the involuntary attention towards them. This explains why someone feeling anxious is likely to experience fear emotions. The mood of anxiety seems also to involve a focus of attention on negative thoughts. The anxious person keeps thinking about how things have gone wrong and about how they might go wrong again.

– *Anxiety as character trait and phobia.* This kind of dispositional anxiety has been the object of most of the psychological studies we reviewed. This is certainly because it is of primary therapeutical interest. But it should also be noted that it is much easier to study than occurrent emotional states, such as short-term emotions and moods — not to speak of the ethical problems that frightening subjects would involve. As expected, trait anxiety involves the dispositions that give rise to the mood of anxiety. As we have seen, these studies suggest that subjects characterized by trait anxiety have an involuntary tendency to have their attention caught by threat-related stimuli, such as words referring to things conceived as threatening, something which interferes with color-naming tasks, but which speeds up detection tasks. They thus exhibit a bias in involuntary attention towards congruent stimuli. Moreover, studies also show

that anxious adults have special difficulty shifting visual attention from a negative focus (reported by Rothbart et al., 1992). Studies such as the homophone spelling tasks show that trait anxiety is related to a lowering of threshold with respect to what counts as dangerous; more things are interpreted as threatening than normally would be. This is also true of particular emotional dispositions, such as spider phobia. Thus, such emotional dispositions seem to involve attentional biases towards the class of phobic objects, and would explain the fact that "[...] it is often the spider phobic individual in the company who discovers the spider inconspicuously moving across the ceiling." (Öhman, Flykt & Esteves, 2001, p. 467)

A conceptual or an empirical truth?

The last question that we would like to address concerns the status of the claim that establishes a link between emotion and attention. Is it part of our concept of emotion that it has to have links with attention or is it just a contingent fact that we discover empirically? Consider for instance the following claim:

(T) if x fears y, then x's attention is focused on y.[25]

The question is whether (T) is a conceptual truth or an empirical truth.[26] Before Quine, it was in general supposed that a conceptual truth is one that is true purely in virtue of its meaning. Quine (1936, 1951) famously argued that there can be no such propositions. However, *pace* Quine, there seems to be a difference in the way we come to know that something is red and the way we come to know that something cannot both be red and green. The first depends on experience in a way that the second does not; and it is natural to believe that one's understanding of the concepts *red* and *green* — something which is not in itself independent of experience, for to possess the concept *red*, a speaker must be at least initially willing to judge that something is red if his experience represents certain things as having the corresponding shade — is sufficient to know the second truth. Thus, the truth that something cannot be both red and green could be known *a priori*, simply by reflecting on how we apply our color concepts.[27] More would have to be said to defend the claim that there are *a priori* truths and how the grasp of concepts contributes to this kind of knowledge. We shall simply assume that a convincing post-Quinean account of *a priori* truths can be formulated.[28]

Given this, two conceptions of the claim that emotions involve attention, or more precisely, that to fear something involves focusing one's attention on

that thing, can be distinguished. On what we will call the *Philosophers's picture* (because it is likely to attract philosophers), it would be a conceptual truth that fear, or at least short-lived fear, involves attention towards the object, or more precisely, the target of one's fear.[29] Aaron Sloman (personal communication) proposes something along those lines:

> "Consider", he says, "someone who claims that it is possible to be in very intense pain without paying attention to it, even when there's nothing else to divert attention elsewhere, e.g. a life-threatening attack. We might wonder whether such a person has learnt the ordinary concept of "pain" or was perhaps confusing it with "injury". We know that injury, even serious injury, sometimes does not direct attention, e.g. under anesthetic. But a state is not pain if there's not the slightest disposition to attract attention".[30]

The same might be true, he suggests, with emotion and attention. Maybe someone who says he experiences an emotion like fear without paying attention to the target of his emotion (his attention might be focused on the phenomenal characteristics of his state, of course) is not really having a *bona fide* fear emotion directed at a target, but just a general increase or decrease of excitation that he mislabels as a fear emotion.[31]

By contrast, what we will call the *Psychologists' picture* (because it is a conception largely assumed in psychology), claims that emotional phenomena and attentional phenomena are distinct, but contingently related, so that claims relating the two are empirical. Thus, one could suggest, say, that a shift in attention would cause a short-lived emotion of fear, which would cause certain attentional phenomena. In the case of character traits, there might be empirically discoverable dispositions to have one's attention biased in certain way. The link posited between fear emotions and attention can be theory-driven. It could for instance be justified by an adaptive theory that would posit the link between the two because it would increase the fitness of organisms which have their fears linked with attention. But it could also be based on an induction from everyday observations of fear. Indeed, the objection against the Philosophers' picture would be that the philosopher confuses two armchair activities: conceptual analysis and the distillation of commonsensical empirical generalizations based on everyday observation.

The divide between the Philosophers' picture and the Psychologists' picture is related to a deeper disagreement concerning the nature of the concept of emotion. The Psychologists' picture assumes that the concept of emotion is one that is almost entirely to be specified by science. This is, for instance, Paul Griffiths way of seeing things: the different concepts of emotions are concepts

of natural, or more precisely, psychological kinds.[32] In his opinion, there is nothing more interesting about fear that holds by definition than that "[f]ear is 'whatever is happening to people in these paradigm cases'" (1997, p. 5). A less extreme view would hold that even though there are a number of conceptual truths about emotions and hence fear, the main truths are empirical.[33] Either way, conceptual analysis could do almost nothing to help us to understand the emotions. In Griffiths' words, "conceptual analysis alone cannot determine the real nature of the extension of fear. Linguistic intuitions about the extension of a natural kind term may simply be mistaken [...]. All conceptual analysis will reveal is the current stereotypes of fear." (*ibid.*) He concludes that "[c]urrent science, rather than conceptual analysis, must be used to fill in the schematic element of the meaning of 'fear'." (*ibid.*) In the same way, one could think that concepts like short-lived emotions, long-term emotions, moods, temperament, etc. refer to natural kinds, that is, that they have an underlying biological and neurological structure that causally explains their surface features. If we accept the idea that in the case of psychological concepts like "emotions", "moods", and "vigilance", science determines the content of the concept, then the question of the link between emotion and attention becomes a purely empirical question.

Griffiths' conception contrasts starkly with the conception that has largely been assumed by the philosophers of emotion, who have traditionally taken themselves to be in the business of conceptual analysis. Instead of claiming that natural kind terms can be involved in interesting conceptual truths, they tend to simply deny that emotion concepts are scientific. This is, for instance, Peter Goldie's view. Distinguishing scientific explanation and prediction from another sort of explanation and prediction which is claimed to be personal and normative, Goldie writes: "[o]ur thought and talk of emotions is embedded in an interpretative (and sometimes predictive) narrative which aims to make sense of aspects of someone's life. These concepts give us, so to speak, the equipment with which to understand, explain and predict what people think, feel, and do: a personal and thoroughly normative approach." (2000, p. 103) This does not mean that there are no exchanges between commonsense psychology and scientific psychology. After all, scientific psychology starts with commonsense concepts. And as Goldie notes, commonsense psychology sometimes absorbs scientific concepts. The important point is that they are not in the same business.

It is not our purpose to settle this deeper disagreement here. Let us simply consider whether (T) is a conceptual truth or not. As usual, with conceptual analysis, reflection begins with thought-experiments, which allow us to consider

what knowledgeable speakers' intuitions are concerning certain relations between concepts. So, for instance, we can propose the following thought experiment:

> *Imagine a mad neurosurgeon who decides to destroy all of the brain system's subserving attention (you also have to imagine that attention is subserved by structures that are different than the one necessary for emotions). Imagine, furthermore, that the neurosurgeon, emulating Penfield's experiments, stimulates the amygdala of that patient, producing in the patient, through a complex causal chain of events,*[34] *a qualitative experience comparable to what we experience when we have an emotion of fear. Would the patient experience fear? Would he be, like Schachter's patients who were injected with adrenaline, tempted to characterize his state as an emotion of fear in some contexts and not in others? And if he calls it an emotion of fear, is he misapplying the concept of emotion?*

It might be said that, given that the phenomenal experience is caused in a deviant way, the patient's state does not count as an emotion of fear. To avoid this problem, let us suppose that the qualitative experience is causally related to some object, a hologram of a frightening dog, say. This is the target of his emotion. We can try to imagine that the neurosurgeon has put in place a non-deviant causal chain between the dog hologram and the brain stimulation. As a result, the patient perceives this hologram, in the sense that his eyes register the visual information — let us assume that this is possible in the absence of the systems responsible for attention. What we need to imagine is that the patient's attention is not focused on the hologram. The information about the hologram is processed flatly, so to speak, just as is that about the furniture and the room. The dog hologram and its frightening features are not salient in his mind. Now, the question is: does he experience fear or not? More precisely, is he afraid of the hologram dog?

Intuition would probably vary as to what the correct response is. Some would say that the use of the term "fear" by the patient is perfectly correct; for them, it would only be prejudice to say that he does not experience an emotion of fear. Like most cases of self-attribution, the patient has only his phenomenology to judge if the concept applies to him, and in that case, it would simply be wrong to say that his phenomenology led him astray. In the same way, it could be said that a third-person attribution of the emotion of fear to the patient would also be correct. After all, we can imagine that the patient has all the usual symptoms of fear. The claim would be that the fact that the patient's attention is not focused on the dog hologram does not make enough of a difference. If this were correct, our concept of emotion would seem to be independent of the concept of attention and the link between the two would be contingent.

The problem, however, is to determine how much conscious attention contributes to our emotional phenomenology. Is the phenomenology of the patient's experience really the same as your experience the last time you were attacked by a fierce dog? In fact, it is quite likely that there is an important phenomenological difference between the two cases.

This points towards a second reply: since the patient's attention is not focused on what is supposed to be the target of his fear, it is false to say that he experiences fear of the dog hologram. Instead, he experiences a state analogous to a mood; a state sharing important traits with real fear, but which lacks something essential, i.e. a target. Thus, if the patient claims that he is experiencing an emotion of fear, he is using the terms inappropriately; he has not grasped the concepts of emotion and of fear that belong to commonsense psychology. Thus, one could say that for something to be a target of an emotion, it needs to be the focus of the person's attention. This line of thought is confirmed by the fact that if one were to ask the patient what he is afraid of, it is not clear that he would point to the dog hologram. After all, this hologram is not salient in his mind.[35] If this is on the right track, Griffiths' almost positivistic conception goes too far: there are some conceptual truths involving emotions that should be of interest to psychologists and neuroscientists. This does not mean that empirical work on the relation between fear or related phenomena and attention is of no interest: the details of what is involved in the attention — e.g. what sort of information processing is at stake — and the nature of the mechanism that underlies attention are empirical questions.

Conclusion

Our main goal in this paper has been to offer a clearer account of the possible relationships between emotion and attention. In order to do this, we have proposed a more precise and empirically informed picture of the complex relations between the different fear phenomena and attentional phenomena at stake. The conclusion is that de Sousa's hypothesis is on the right track with respect to fear and anxiety.

A question that requires further investigation is whether de Sousa's hypothesis is generally true of all kinds of emotions. The precise impact of emotion on attention might be different depending on what kind of emotions are considered. Thus, Williams et al. (1988) claim that depression and anxiety have different impacts on attention. It might also be suggested that negative emotions like fear

have a quite different impact on attention than positive emotions like love, joy or interest, which broaden our attentional focus (Derryberry & Tucker, 1994; Fredrickson, 1998).

Finally, we think that clarifying the relation between fear, or more generally emotions, and attention might help to understand a number of traditional philosophical issues by increasing the realism of the description of their objects. For instance, both de Sousa and Damasio claim that the influence of emotion on attention is beneficial for the organism — emotions make us more rational. We think it would be interesting to evaluate that thesis in light of the empirical data we have gathered, specially the data concerning the pre-setting of perceptual capacities. Moreover, it is also plausible that the impact of emotions such as fear on attention will play a crucial role in the explanation of some cases of practical irrationality, such as akrasia (de Sousa, 1987, p. 200) and irrational belief, such as self-deception (Mele, 2000).

Notes

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1. See Mele (2000); Evans (2001), pp. 113–117.

2. Cf. Wilson (1972, p. 90) for the claim that something is the object of an emotion only if the emotion is caused by attention to its object — the object must be perceived or thought about, for instance.

3. See de Sousa (1987, p. 195) and, for a description of the frame problem, see Dennett (1987). See Elster (1999a, p. 289–291) for the claim that this account presupposes a caricature of reason and more particularly of rational-choice theory "according to which a rational agent would always take account of all possible outcomes of all possible options" (290). Instead, the organism could adopt simple mechanical decision rules. Note that Elster's objection aims only at the so-called rationality of emotions, not at the claim that emotions direct our attention.

4. See also Elster (1999) for the claim that "strong feelings can affect cognition, by clouding or distorting it"; such feelings have "the capacity for inducing a disregard of alternatives to the option they favor and of its long-term consequences." (p. 198). And in psychology, cf. Oatley and Jenkins (1996) for a similar claim: "Emotions function to manage our multiple motives, switching attention from one concern to another when unforeseen events affecting these concerns occur." (p. 253)

5. It should be noted that we will not consider the empirical evidence concerning the related question of the influence of emotion on memory and that of the interaction between imagination and emotion.

6. Damasio claims that he read de Sousa only later (1994, p. 201).

7. Interestingly, these traits seem to have a physiological basis as shown in rats that have been bred for particular emotional characteristics. As Davidson puts it: "The Maudsley reactive strain has been bred for many generations to exhibit qualities of fearfulness, and a number of studies have revealed that the reactive rats (those who display heightened fearfulness) have fewer benzodiazepine receptors compared with those who are low in fearfulness [non-reactiveness] [...]"(Davidson, 1994, p. 54).

8. See for instance Elster (1999a, p. 272). But cf. Goldie (2000, p. 143), for the claim that moods have less specific objects than emotions.

9. See Ben-Ze'ev (2000).

10. One can also speak of a religious sentiment or a patriotic sentiment. These certainly involve emotions — awe for God or love for one's country, for instance — but they also involve characteristic cognitions, such as the belief in the existence of God or the judgment that one's country is great.

11. This distinction is close to the one made by Descartes, between passive and active attention.

12. Johnson thinks that this is explained by the development of tonic inhibition of the colliculus. As he says, "This as yet unregulated tonic inhibition of the colliculus has the consequence that stimuli impinging on the peripheral visual field no longer elicit an automatic exogenous saccade as readily as in newborns" (Johnson 1995, p. 739).

13. This example also demonstrates a very important feature of attentional phenomena: what is sometimes called the 'pre-setting' and 'post-setting' of the perceptual sensory systems. We talk of "pre-setting" in a particular sensory system, if some objects have saliency (that is, if they are more likely to attract attention) independently of current cognitive states (for instance, they could be the results of natural selection or prior learning). We talk of "post-setting" if this saliency is the result of higher cognitive processes, like expectation or beliefs.

14. Note that it might also be that the subject's attention is drawn away from the threat-related words.

15. Though Wells and Matthews recognize that "the bias may operate with rather little conscious awareness of the stimuli" (1994, 111), they raise a number of methodological problems — there are difficulties in assessing the threshold for awareness and the magnitude of the bias effects are very small, for instance — and conclude that these studies do not show that anxiety influences automatic or unconscious processing (1994, 103–11; but see Öhman 1999, p. 341).

16. Actually, there might be hemispheric asymmetry, for subjects were faster to detect probes that there were presented in the left visual field (Mogg and Bradley 1999, p. 158).

17. "The fearful participants were overall less accurate than the nonfearful ones, particularly when deciding that there was a target among fear-relevant distractors, which suggests that fear produced by the distractors interfered with target detection." (Öhman, Flykt and Esteves, 2001, p. 474)

18. Öhman replicated these results with agoraphobics. He found that agoraphobics were faster than normal controls at spotting the angry faces in the "crowd".

19. "Thus the conventional attentional spotlight would only come into play after this first preliminary and preattentive analysis of the stimulus array." (Öhman, Flykt and Lundqvist, 2001, p. 300)

20. This seems confirmed by Lang's (1995) work on startle.

21. Amygdala seems to be involved in other emotions as well. Rolls (2000), for instance, suggests that the amygdala is not specialized for the decoding of only a certain category of stimuli. According to him, some neurons of the amygdala are activated by rewarding and other by punishing stimuli. He also reports that the human amygdala is activated by the pleasant taste of a sweet solution (p. 186)

22. Ledoux and Rogan (1999) also mention the role of this structure in the extinction of emotional reactions when association of a stimulus with pain is weakened. According to them, fear and anxiety that persists abnormally may involve alterations of this region.

23. "Cognitive studies of attention have often shown that detecting a target produces widespread interference with most other cognitive operations (Posner, 1978). It has been shown that monitoring many spatial locations or modalities produces little or no interference over monitoring a single modality, unless a target occurs (Duncan, 1980). This finding supports the distinction between a general alert state and one in which attention is clearly oriented and engaged in processing information." (Posner and Petersen, 1990, p. 33)

24. Lesions of that structure have resulted in a host of symptoms including inattention, apathy and emotional instability.

25. It should be noted that insofar as the attention is involuntary it might be unconscious.

26. Some philosophers like Kent Bach (1994) claim that emotions "[...] are *inherently* attentional and motivational" (p. 52), saying that there seems to be "an intuitive sense of these relations [between emotional disorder and attention] in folk psychology [...]", but it is not clear what kind of truth they think these statements express.

27. See Peacocke (2000).

28. See Boghossian and Peackocke (2000) for different (both meaning-based and non-meaning based) accounts of *a priori* truths.

29. This, it seems, is not de Sousa's view; he seems to think that his so-called biological hypothesis is an empirical one.

30. It could be objected that certain drugs and some forms of leukotomy can lead patients to insist that they still *have* the pain, but no longer *mind* it (see Dennett (1978) "Why we can't make a computer feel pain"). It thus seems that one could feel pain without desiring to avoid it. The question, of course, is whether the patients are right when they claim they feel pain.

31. That this is so can be explained in terms of the genealogy of our concepts. This is what Sloman suggests in his "Motives, Mechanisms, and Emotions": "Our words and concepts have been honed for centuries against the intricacies of real life under pressure of real needs and therefore give deep hints about the human mind." (p. 231)

32. The concept *emotion* also purports to refer to a natural kind, but Griffiths argues that just as for the concept of the sublunary phenomenon, there is no natural kind which corresponds to it.

33. An even less extreme position would be to say that there are both conceptual and empirical truths about emotions and that philosophers and scientists should divide the task of uncovering or discovering these truth amongst themselves.

34. We add this proviso because it is clear that the conscious experience of an emotion depends not only on the amygdala, but also on other structures like the ones responsible for the working memory.

35. And contrary to cases where you are not aware of what you fear because the focusing of your attention is unconscious, there is no way you can come to realize that your attention is focused on the hologram.

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