Fearful Object Seeing[1]

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Abstract: What is it like to perceive a feared object? According to a popular neo-Gibsonian theory in psychology, fear biases our perceptions of objects so as to encourage particular kinds of actions: when we are afraid, spiders may be perceived as physically closer than they are in order to promote fleeing. Firestone mounted severe criticisms against this view, arguing that these cases are better explained by non-perceptual biases that operate on accurate perceptions of the external environment. In this paper I will argue that fear might indeed distort our perceptions of the world, but not in the way neo-Gibsonians suppose. In the view I favor, perceptual distortions occur as by-products of fearful attention, a special mode of attention that is part of an orchestrated defensive response that prepares the organism to deal effectively with a threat. To argue for this view I will rely on empirical evidence that fearful attention narrows down the focus of attention and favors processing of local rather than global features of stimuli, which may jointly explain why perceptual distortions might occur in fearful object seeing. This view has consequences not only for empirical investigations in fearful perceptual distortions, but also for an explanation of the intentionality of fear and the phenomenal integration of bodily and intentional elements in fear episodes.

Keywords: fear; emotional attention; fearful perception; perceptual biases; defense circuits

I – Introduction

What is it like to perceive a feared object? When a threatening object suddenly appears in the scene, it brings clear phenomenological changes to conscious experience. First of all, there is the bodily phenomenology of fear itself. We are taken by a sudden onset of rapid bodily changes as we feel our heart thumping, our breathing strained, our eyes widening, and so on. But does fear change how feared objects are perceived?

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There is a sense in which fear changes our conscious experiences of objects. Imagine, for example, perceiving at t^1 what you take to be a harmless bug crawling on your arm, while at t^2 you realize it's a very aggressive and poisonous insect. A set of bodily feelings associated with fear will arise at t^2, but those feelings are not detachable from your experience of the object; rather, the object will be experienced as threatening, as inextricably involved in the aforementioned bodily feelings. As the example illustrates, fear transforms your conscious experience of the object from t^1 to t^2.

Part of what it is for an object to be experienced as threatening is that the object itself is part of the fear episode. As many philosophers already pointed out, there is an irreducible element of intentionality in an emotion like fear (Goldie, 2002; Maiese, 2014; Barlassina & Newen 2014). We are afraid *of* the insect crawling on our arm, and this intentional element is quite plausibly an aspect of the phenomenology of fear. When we are afraid of something we do not experience a set of free-floating bodily changes, we experience a set of bodily changes as directed at the feared object. There is a tight coupling between interoceptive and exteroceptive phenomenology in fear episodes, so that if one is removed the other also falls with it. We cannot say that the feared object is experienced as threatening in the absence of bodily feelings, just as we cannot say that bodily sensations of fear are experienced but the feared object is not experienced as threatening. When we are afraid of an object, fear changes how the object is experienced. This is what I am calling "fearful object seeing" in this paper.[2]

But how exactly does fear transform our perceptions of feared objects? One aspect of fearful object seeing, as argued above, is that the object is experienced as threatening. Nevertheless, there may be more to fearful object seeing than this. Several studies suggest that fear may led us to perceived feared objects in a distorted manner, such as larger (Teachman et al. 2008), closer (Cole et al. 2013) or more inclined (Stefanucci et al. 2008) than they actually are. The theoretical framework behind these studies is Dennis Proffitt's neo-Gibsonian theory of embodied perception (2006), according to which perception provides us not only with opportunities for action, but also with the costs and risks associated with these actions. These costs and risks are supposed to be incorporated into perceptual experience in the form of perceptual biases that favor certain kinds of actions, so that a spider, for example, may be perceived as closer than it actually is in order to encourage fleeing.

Firestone mounted severe criticisms against what he calls a "paternalistic" view of perception, which conceives the visual system as "a teller of well-intentioned lies about the world so as to bias perceivers towards favorable action" (Firestone 2013, p. 456). In its place, Firestone proposes that the empirical data can be fully explained by non-perceptual biases that operate on accurate perceptions of the external environment. If this is correct, it would mean that fearful

2 Granted, in some cases fear will be directed at an abstract or social object rather than a material object; we can fear, for example, the rise of fascism or an upcoming economic recession. In this paper I will focus on fear of material objects and all claims should be understood as restricted to these cases.

object seeing does not distort our perceptions of spatial properties, although our spatial estimates may be biased by non-perceptual factors.

In this paper I will argue that perceptual distortions of spatial properties might indeed be part of fearful object seeing, but not in the way neo-Gibsonians suppose. I will present evidence that fear engages a special mode of attention that is characterized by alertness and a narrow focus onto the feared object. A more restricted focus of attention has been linked to changes in size perception (Kirsch et al. 2018), which may plausibly explain why some spatial distortions might occur. In addition, this mode of attention also favors processing of local rather than global features of stimuli, which provides subjects with uncertain information about the object's relations to other elements of the visual scene. Thus, when subjects are asked to make spatial estimates under fearful conditions, they might rely on other non-perceptual cues that biases their responses in a certain direction, and as a result they end up describing objects as closer or more inclined than they actually are. Firestone is therefore correct in pointing out the presence of non-perceptual biases in these studies, but this does not mean perceptual distortions do not occur as well. However, since spatial estimation tasks fail to distinguish perceptual and non-perceptual biases, we need other methods to investigate how fear changes our perceptions of the world. In this paper I will make some suggestions in this direction.

The structure of the paper is the following: in section II, I will describe in more detail the empirical evidence in favor of fearful perceptual distortions produced by neo-Gibsonians, and then proceed to discuss Firestone's objections as well as his alternative proposal (sections III and IV). Although I will concur with Firestone's objections that fearful object seeing is not paternalistic in the way neo-Gibsonians propose, I will argue that there is an alternative way of investigating fearful perceptual distortions that is not vulnerable to these objections. Sections V and VI will explain in detail how spatial perception may be modulated by fear. To argue for this point I will introduce Ledoux's notion of defensive organismic states (2012; 2014), as well as Patrick Vuilleumier's research on emotional attention (2005). In this picture, whenever a threat is detected, defense circuits will automatically put the organism in a state of high arousal and alertness, with attention narrowly focused onto the threatening object. A restricted focus of attention, according to current evidence, may lead to perceptual distortions in spatial properties. On this basis, section VII will conclude with some suggestions for future research on fearful perceptual distortions, and argue for the usefulness of the notion of defensive organismic states for understanding the intentionality of fear and the phenomenal integration of fear episodes.

II – Fearful Distortions

Research by Teachman et al. (2008) found that individuals independently assessed for high fear of heights consistently overestimate a vertical extent from a two-story balcony to the ground, as they stand on the balcony ledge looking down. The results are achieved via a size estimation task in which subjects are asked to estimate the size of a disk by asking a nearby experimenter to use a tape to indicate its diameter. Given the correlations between apparent size and distance (Epstein 1973), this estimate is taken to provide a converging measure of distance from the balcony to the ground. As predicted, subjects in the high-fear group showed consistent overestimations of the disk's size, which is accepted as evidence that the distance to the ground is perceived as larger than it actually is.

Another relevant study was conducted by Stefanucci et al. (2008), correlating fear with distorted perceptions of geographical slant. In this study, subjects were asked to stand on a skateboard on top of a hill and estimate the slant of the hill with a visual disk, in order to match the angle of the hill with a representation of its cross-section. After the estimation task, subjects were assessed for their state of fear as they were standing on the skateboard.[3] A control group, in turn, stood on a wooden box firmly attached to the ground at the same height as the skateboard, and reported little fear in the post-experimental assessment. As predicted, self-reports of fear while standing on the skateboard were significantly correlated with slant overestimation, relative to the low-fear control group. This is accepted as evidence that fearful subjects perceived the hill as more inclined than it actually was.

Finally, a study by Cole et al. (2013) investigated the role of fear in distance perception. In this study, subjects were brought to a room containing a live tarantula, and asked to estimate how many inches separated them from the spider. At the same time, they were also asked to report on how they felt about the tarantula at that time. They found that subjects' self-reported levels of fear were inversely correlated with distance estimations to the tarantula, while subjects who expressed disgust did not exhibit distance biases. Once again, this is accepted as evidence that the spider was perceived as closer than it actually was.

In order to explain these results, the authors appeal to Dennis Proffitt's neo-Gibsonian theory of embodied perception, according to which we perceive not only opportunities for action, but also the costs and risks associated with these actions (Proffitt 2006, p. 111). When we are wearing a heavy backpack, for example, the metabolic costs of climbing up a hill are different from the costs of executing the same action with no extra weight attached to our bodies. This metabolic prediction is incorporated into perceptual experience in the form of perceptual biases, making a hill to be climbed look steeper when one is wearing a heavy backpack. This effect occurs to help us adjust our gait, speed and rhythm of walking directly based on our perceptual experiences, without having to explicitly reason about how to carry out these actions relative to our action potential at the time (*ibid.*, p. 114).

In line with this argument, fear-induced perceptual biases supposedly exist in order to promote adaptive behavior. When we are facing an impending danger, we need to act quickly and effectively in relation to the feared object.

3 The assessment was embedded in a larger questionnaire, so subjects would not detect the purpose of the experiment (Stefanucci et al. 2008, p. 322).

The brain's predictions of how to deal with the threat is thus incorporated into perceptual experience in the form of perceptual biases that favor certain kinds of actions. The hill looks steeper in order to discourage what would be a risky descent, the ground looks further away in order to turn us away from the ledge, and the spider looks closer in order to prompt immediate fleeing. As Cole and colleagues put it, "if readiness to engage in action increases as the proximity of a threat increases, the needs of the perceiver are best served by misperceiving objects as closer when they are more threatening" (Cole et al. 2013, p. 35).

Firestone mounted a series of criticisms against what he calls a "paternalistic" view of perception (2013), proposing an alternative explanation of the data in terms of non-perceptual biases that operate on accurate perceptions of the environment. Although most of Firestone's arguments are explicitly targeted at perceptual modulations by changes in action potential, in the next section I will discuss two objections that are more directly relevant to fearful object seeing, and consider some possible replies on the part of neo-Gibsonians.

III – Against Paternalistic Perception

One objection raised by Firestone is that modulations of perceptual experience by action potential and affective states seem to contradict everyday phenomenology. After all, we do not experience the world expanding or contracting as we put on a heavy backpack or as we become afraid (Firestone 2013, p. 456). Moreover, these changes are quite large in magnitude (a difference in slant estimation of nearly 30% between fearful and non-fearful subjects in Stefanucci's experiment) and occur precisely where in space subjects are attending, concerning the exact features they are attending to. This means that lack of conscious awareness in these cases cannot be explained by change blindness, which concerns changes outside the focus of attention.

Proffitt's reply is that this argument is confused: these changes should be subjectively noticeable only if the object's actual spatial properties had changed as a result of a difference in action potential or affective states. In other words, we should perceive the hill changing its inclination as we become afraid only if the endpoint of the hill had actually moved along its horizontal axis, but of course this is not what happens. Rather, the endpoint of the hill remains exactly where it is, but the "perceptual ruler" used to *measure* perceived inclination changes (Proffitt 2013: 478-9). Metaphorically, fear might change our measuring instruments, but not the measured magnitude itself. This is why fearful subjects report the hill as more inclined but do not notice the hill changing its inclination.

This reply is unsatisfactory. If the ruler used to measure geographical slant is truly perceptual, as Proffitt claims, then changing the ruler should affect not only slant estimates, but slant *looks* as well. That is to say, if neo-Gibsonians want to claim that slant overestimations in fear take place because of the way things perceptually appear, we should expect the hill's perceived inclination to change *as if* its end point has changed, even if this is not what actually happens. Otherwise, nothing keeps us from saying, with Firestone, that slant overestimations occur because of non-perceptual biases that operate on accurate perceptions of the world.

But perhaps the appearance of inclination did change as if the hill's endpoint has moved, but subjects simply failed to notice it. Indeed, Proffitt acknowledges this is a possibility (2013, p. 479). In order to support this claim he cites a study by Glennerster and colleagues (2006), where subjects were immersed in a virtual room with a head-mounted display, and as they walked around, the room slowly expanded or contracted by up to a fourfold magnitude, and none of the participants noticed any changes in room size. One explanation for these results is that the visual system tends to assume a stable and stationary world in the face of change, and when changes are slow and gradual they may be below the threshold needed for a signal of change to be elicited in the brain. So here we have an example of a large perceptual change that takes place outside subjects' conscious awareness, which could be used as a response to Firestone's objection.

But this reply is also unsatisfactory. For starters, a parallel between Glennerster's and neo-Gibsonian studies would only hold if changes in the latter were also slow and gradual, for this is precisely what explains the lack of conscious awareness of change in the former. But nothing in the neo-Gibsonian studies suggests this is the case. In fact, the rapid onset of the fear response and the need to act quickly in response to the threatening object (which was the main reason for positing perceptual biases in the first place) both speak against these changes being slow and gradual. In addition, we've seen that the alleged spatial changes in fearful perception take place precisely where in space subjects are attending, and concern the exact features they are attending to. But in the Glennerster's study subjects are simply told to walk around the room, without any explicit instructions to attend to the walls. Without controlling for attention, lack of conscious awareness of the room's expansion could be explained by change blindness, an explanation that is not available in the neo-Gibsonian cases.

Firestone's second argument is that the scaling of visual information by action potential and affective states is informationally ungrounded, as there is no information in the optic array about the perceiver's abilities and affective states that could be used to derive spatial perception into "fear-height" units, for example (Firestone 213: 463). In order to make this idea clear, I will explain in more detail how neo-Gibsonians view the scaling of visual information into perspectival information that can be used for action.

When the visual system needs to derive spatial perception, it must transform the angular values specified in visual information into spatial units. In a traditional eye-height scaling model, the visual system measures sizes and distances of objects against the altitude of the perceiver's eyes, generating as output spatial properties in eye-level units

(Sedgwick 1986). In figure 1 below, B_1 is the eye-height of observer 1, so that the height of the pillar from her perspective is given by $B_1 + A_1$ (say, as 1.3 eye-heights tall). Observer 2, in contrast, is shorter, so for her the pillar is perceived as taller – say, as 2 eye-heights tall ($B_2 + A_2$).

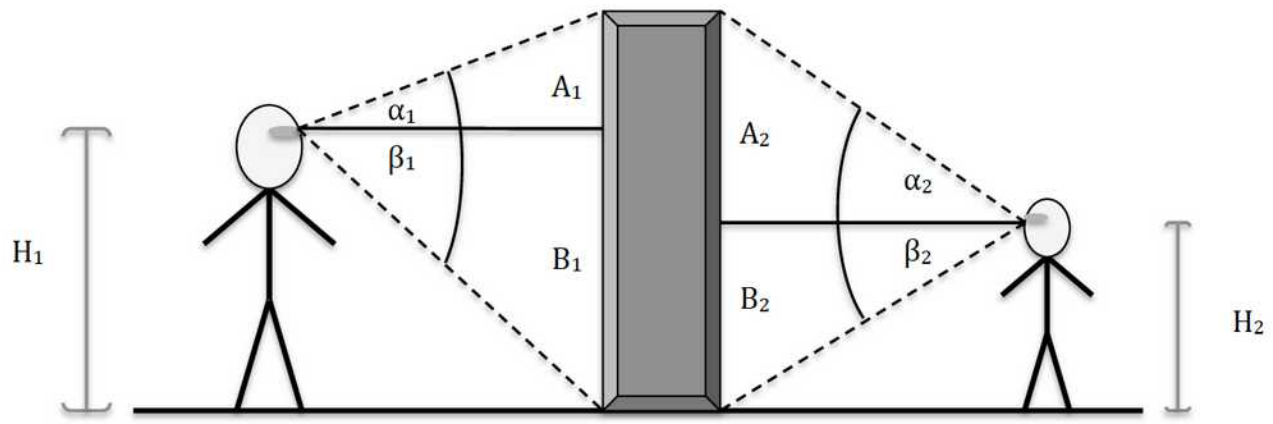

Figure 1: From Firestone 2013. Reprinted with permission.

Neo-Gibsonians propose that angular units in visual information are scaled not only by our visual perspective upon the world, but also by the state of our bodies and our ability to engage with the world in situated action (Proffitt 2013). When one is preparing to jump over a crevice, how wide the crevice is perceived to be depends on our jumping capacity. If we increase or diminish our action potential – for example, by wearing a heavy backpack – the values in the perceptual ruler used to scale angular units into spatial properties change, and spatial perception is therefore modulated.

Firestone argues that this scaling is informationally ungrounded. In the eye-height model briefly described above, we can explain why growing taller changes perceived height in terms of changes in the point at which the horizon cuts objects. This is what the difference between the two observers in the image above seeks to capture. But the visual system can discover this only because growing taller has the right kind of optical consequences and lawful supporting relations between visual angles and eye-height scaled size. This information is specified in the optic array in the values of the angles α_1 and $ß_1$ in the image above, so that changing these values, as in α_2 and $ß_2$ will therefore change perceived height. But there is nothing in the optic array about action potential and affective states, so how could the visual system use this information to convert visual angles into spatial information? That's what Firestone means when he calls the scaling of visual information by action potential and affective states "informationally ungrounded."

Proffitt replies that the relevant conversions may be obtained on the basis of perceptual learning, as people learn the various consequences of their actions based on their perceptions of the world (Proffitt 2013, p. 478). When learning about jumping abilities, for example, people can tell how well they've managed to jump over a crevice in different circumstances. When action is less than optimal, one will be able to tell the extent to which one failed to make the jump, and try to compensate next time one encounters similar circumstances. According to Proffitt, the frequency and magnitude of misses over time specifies a performance distribution that is used to scale the width of the crevice (*ibid.*). This distribution is discoverable through experience, and accounts for how the conversion in question could take place.

I will not discuss the success of this response when it comes to scaling visual information in terms of action potential; but it is far from clear how it is supposed to work in the case of fearful perception. For starters, how would one discover, in the case of fear, a performance distribution based on instances of less-than-optimal action? If Pedro is afraid of heights, he will avoid being near ledges regardless of whether the ground below looks two, five, or zero meters further than it actually is. And if Pedro happens to fall, it will probably not be because of how far the ground was perceived to be, which makes the scaling of visual angles into "fear-height" units irrelevant for the guidance of appropriate action. If there is no performance distribution to be learned relating perceptions of the ground from above and avoidance actions, this account leaves unexplained how or why perceptual biases occur. It seems that being in state of fear as one approaches the ledge is enough to promote avoidance behavior, leaving little role for perceptual biases to play in accounting for adaptive action.

Nevertheless, subjects still make consistent over and underestimations of spatial properties under the influence of fear, as demonstrated by the empirical studies mentioned in section II. But if we are not licensed to posit perceptual biases in the *explanans*, what accounts for the observed experimental results? Firestone argues that a much more plausible and parsimonious explanation can be given in terms of non-perceptual biases. In the next section I will go over three different sorts of non-perceptual biases put forward by Firestone to account for the experimental data.

IV – Non-perceptual Biases in Fearful Object Seeing

The first non-perceptual bias has to do with with task demands, or beliefs on the part of subjects about the purpose of the experiment. For example, as subjects are led to a room with a tarantula and asked to estimate how many inches separates them from the spider, subjects may reasonably suspect there must be a relation between these two elements, i.e., that fear of spiders should affect distance estimates. As such, subjects may more or less unconsciously adjust their responses in order to match the experiment's purpose, an effect that has been known to influence a great number of studies if not carefully controlled for.[4]

The second one concerns the possibility that when an experiment shifts perceptual reports – say, by asking subjects to make estimates concerning a certain sensory magnitude they perceive – it is possible that the shift reflects changes in judgment rather than perception (Firestone & Scholl, 2016, p. 9). For example, upon feeling terrified of the

4 Firestone 2013; Firestone & Scholl 2016; Durgin et al. 2009; Durgin et al. 2012; Shaffer et al. 2013; Valenti & Firestone 2019.

spider in the room, subjects could have concluded that the spider must be very close when asked about it. This argument draws on the fact that when we make judgments about the world, we often take into account not only what we perceive, but also how we feel, in order to reach certain conclusions. Psychologists are well aware of this effect, and a fruitful research program was constructed around it, in order to probe into affective biases on judgments of various types.[5] As these non-perceptual biases are a pervasive and well-established phenomenon, it is more parsimonious to explain the empirical data in these terms, rather than posit a more controversial set of perceptual biases that add nothing to the explanation.

Finally, the third source of biases concerns changes in subjects' impressions of how their environment affords certain actions (Firestone 2013, pp. 467). When subjects put on a heavy backpack, for example, a hill that afforded climbing with ease may now afford climbing with difficulty. Faced with this change in affordance impression, a subject might say "I can see perfectly well that this hill is not very steep, but when I am climbing it with this heavy backpack on, it feels twice as steep." This statement brings out the difference between our perceptions of the world and our impressions of how the world afford certain actions under different conditions. Applied to the particular case of fearful object seeing, a hill that afforded descending while one was on foot may no longer be felt as affording this action when one mounts on a skateboard. In this situation, a subject might express this change in affordance impression in various ways, including spatial remarks ("wow, this is so steep!"). But of course a hill may be *felt* as less descendable without *looking* any steeper. But since subjects in Stefanucci's studies were only given a slant estimation task to perform, it is possible that they were actually expressing their changed impressions through the only means they had available – slant overestimations – and not reporting on how the world perceptually appears.

But what would happen if subjects could voice their impressions in a way that was clearly distinct from their perceptions? An experiment by Woods et al. (2009) was designed to test this hypothesis, in an attempt to replicate previous findings by neo-Gibsonians that throwing a heavy vs. a light ball affects how distance to a target is perceived. But rather than a simple visual matching task, experimenters used three distinct assessments: (a) objective distance ("Base your response on how far away you think the object really is"), (b) apparent distance ("Base your response on how far away the object visually appears"), and (c) nonvisual factors ("Base your response on how far away you *feel* the object is"). They found distance biases only in the third condition, which corroborates the distinction between our perceptions and impressions of the world. Perhaps the only reason so-called perceptual biases were observed in neo-Gibsonian studies is that impressions were not properly distinguished from perceptions in the experimental tasks. But once the distinction is made, perceptual biases disappear and make no contribution to the *explanans*. These observations might lead us to con-

5 This is known as the "affect-as-information hypothesis." See Schwarz & Clore 1988.

clude that fearful object seeing does not involve perceiving certain spatial properties of objects in a distorted manner, although we might express our impressions as if it were the case.

What can we say about these non-perceptual biases? Although neo-Gibsonians go to great lengths to show that all relevant measures are being taken to prevent task demands (Philbeck & Witt, 2015, pp. 1124-1128), it is highly unlikely they will be definitely eliminated. For example, even if Stefanucci et al. embed fear assessments in a larger questionnaire in order to conceal the purpose of the experiment, it is unlikely this measure will completely eliminate the possibility of task demands. After all, regardless of being explicitly asked about it, subjects will suddenly feel fear when they stand on the skateboard, so that when prompted to make slant estimates in that state, they may suspect the experiment is investigating a link between the two elements, and adjust their responses accordingly.

Regarding the other two, there are indeed important methodological limitations to the study of perceptual biases using spatial estimation tasks. This method engages cognition, is embedded in experimental settings vulnerable to task demands, and does not clearly distinguish between perceptions and impressions. In other words, when someone makes a spatial estimation while feeling scared, it is always an open possibility that one is actually making a judgment that takes into account both what one perceives and what one feels, expressing one's impressions of the estimated magnitude, or adjusting one's response to match the experimenter's expectations.

But rather than view perceptual distortions and non-perceptual biases as mutually exclusive, why not make space for the possibility that they might occur side by side?[6] In this picture, whatever distortions take place at the level of perception could be interpreted and augmented by cognition. When fearful subjects in Stefanucci's experiment, for example, report that the hill looks 30% more inclined than non-fearful subjects, we need not take it as a literal description of a perceptual experience. One possibility is that some distortions in spatial perception might occur, which are then interpreted by cognition when subjects are asked to make slant estimates.

But here one may object: haven't we seen in section III that there is no reasonable account of a scaling process from visual angles to "fear-height" units, that could vindicate the idea of fearful perceptual distortions? Indeed we have, and that is why I believe this is the wrong way to argue for perceptual distortions in fearful object seeing. In the next section I will introduce Joseph Ledoux's notion of "defensive organismic state", where bodily and sensorimotor responses are integrated for the purposes of preparing an organism to deal with a threatening object (2012; 2014). One of the characteristics of this state is a heightened state of arousal and a mode of attention characterized by alertness and a narrowed focus of attention onto the threatening object. This special mode of attention – which we may call fearful attention – will have some effects on perceptual appearances, which may plausibly account for the perceptual distortions

6 Philbeck & Witt (2015) consider this possibility. I believe this is the right move for a neo-Gibsonian to make in the face of these challenges.

reported in fearful object seeing. But rather than view these distortions as meaningfully related to avoidance behavior – i.e., that distance biases to threatening objects exist to encourage fleeing – I contend that perceptual distortions are byproducts of fearful attention, which occur merely in virtue of its deployment regardless of the particular evasive action being performed.

V – Defensive Organismic States and Fearful Attention

When an organism faces a threat in its environment, it activates a set of hardwired behavioral and autonomic nervous system responses that help prepare the body to deal with the threat in the most effective manner. For an orchestrated response to occur, different subsystems must be coordinated and fully engaged with current survival demands. Ledoux calls the circuits responsible for detecting and responding to threats "defense circuits", which are a subtype of survival circuits that include circuits for maintenance of energy and nutritional supplies, fluid balance, thermoregulation and reproduction. Although the specificity of behavioral responses will vary across species, these circuits are pretty much conserved across mammalian species (Ledoux 2012, p. 654).

When a threat is detected and a defense circuit activated, a series of changes takes place within the organism, such as: (1) specific kinds of responses like freezing or fleeing rise in priority; (2) other activities like feeding and procreation are inhibited; (3) the brain and body are aroused; (4) attention is focused on relevant environmental and internal stimuli; (5) motivational systems are engaged; (6) new learning occurs; and (7) memories are formed. The overall net result is the establishment of a global organismic state that spreads throughout the brain and body to mobilize the organisms's resources to deal effectively with the threat. This is what Ledoux calls a "defensive organismic state" (Ledoux 2014, p. 2875).

Defensive organismic states are established in the following manner. Whenever the organism encounters a threat, information flows from the retina through the optical nerve to the thalamus. The thalamus in turn sends signals to the sensory cortex to allow the object to be recognized, but it also sends signals directly to the amygdala. This subcortical pathway has been called the "low road", in contrast with the "high road" through which signals travel to the neocortex before reaching the amygdala (Ledoux 2000). This allows the organism to initiate a whole set of bodily responses much faster on the basis of coarse visual information, before objects are fully recognized.

The amygdala in turn sends signals to various structures that modulate bodily responses, such as the medulla and pons involved in heart rate and breathing, trigeminal nuclei in the brainstem involved in the production of facial expressions, various hormonal structures that initiate changes in hormone levels, and the basal ganglia which controls motor responses.[7] In addition, the amygdala also sends signals directly to the visual cortex, which enhances sensory processing of threat-related stimuli. As a result, the organism is aroused, fully focused on the threatening situation, and ready to act: in other words, it is in a defensive organismic state.

According to Patrick Vuilleumier (2005), there are two ways in which the amygdala can enhance sensory processing of threatening stimuli: by engaging fronto-parietal networks that will allocate spatial attention to the stimulus and boost its sensory responses as attention normally does, and by the aforementioned feedback connections between the amygdala and the visual cortex, which can produce effects on sensory responses that are quite similar to attention, but that can operate independently from spatial attentional systems.[8] Although in some cases (i.e., in patients with parietal damage or with damage to the amygdala) we can have one of these effects without the other, typically they both produce additive effects on perception; whatever response boost a stimulus receives due to emotional attention, it will receive an additional boost from spatial attention as soon as attention is drawn to it.

But although an extensive body of research has shown how threatening stimuli benefits from enhanced sensory responses and facilitate a series of behavioral tasks[9], there has been little emphasis on the fact that fearful attention is more than just spatial attention that has been allocated to a threatening stimulus. As I suggested above, fearful attention is a special mode of attention, characterized by a high level of arousal, alertness, and a narrowed focus of attention onto the relevant object, for the purposes of gathering more information about it. This mode of attention is part of an orchestrated response that Ledoux calls a defensive organismic state. In the next section I will present evidence that fearful attention narrows down the focus of attention and produce changes in perceptual appearances, which may plausibly explain how and why perceptual distortions occur in fearful object seeing.

VI – Fearful attention and Perceptual Distortions

There is evidence that under conditions of emotional arousal – in particular, fear and anxiety – there might occur a restriction of the perceptual field, through a narrowing down of the focus of attention. Phenomenological descriptions of this effect may be found in reports from police officers, who often claim that in threatening situations their visual field seems to shrink around the threatening stimulus (i.e., an armed suspect), which is experienced with unusual clarity and sharpness of detail (Klinger & Brunson 2009). These reports are corroborated by evidence that in conditions of emotional arousal subjects' performance in monitoring a visual cue in the periphery falls drastically, while performance

7 The amygdala is a complex structure composed of various substructures, each playing its part in the establishment of the defensive organismic state. For ease of exposition I will not go into this level of detail, and refer readers to Ledoux (2000) for further anatomical details.

8 This is why Vuilleumier calls these effects "emotional attention". See Vuilleumier 2005 for the precise anatomic details of both pathways.

9 See Vuilleumier 2005 for review.

in a central fixation task remains unaffected.[10] This strongly suggests that emotional arousal indeed narrows down the focus of attention.

Derryberry and Tucker (1994) propose that the mechanisms responsible for narrowing down the focus of attention during defensive organismic states is a tonic activation system of attention by dopaminergic structures. This system helps the organism maintain a vigilant posture in the face of threat, by tonically maintaining neural activation associated with the representation of the threatening stimulus. As a result, attention is sharply focused and working memory conservatively represents redundant, threat-related informational content. Derryberry and Tucker describe the tonic activation system as grounded in reticular arousal systems, more specifically in dopaminergic systems that ascend from the brainstem nuclei to regulate motor circuitry and sensory processing (1994, p. 187). When defense circuits are activated by an external threat, the amygdala recruits the dopaminergic system which promotes tonic activation through its ascending pathways. This state of tonic activation helps narrow down the focus of attention onto the relevant source of information. The authors present evidence that this tonic activation system is lateralized, favoring processing in the left hemisphere, which is known to implement a mode of attention characterized by processing of local rather than global features of stimuli, that is to say, of details and relations between parts of the object, but not relations between the object and other elements of the visual scene (*ibid.*).

As attention is drawn onto the object in this manner, some changes in perceptual appearances will take place. First of all, spatial resolution is increased at the focus of attention (Yeshurun & Carrasco 2008), due to a shift in sensory neurons' receptive fields towards the center of attention. This may explain why police officers report seeing the contents of their restricted attentional field with higher clarity under threatening conditions. These effects make sense from an evolutionary point of view. When an organism first encounters a threat – say, a predator – it is important to gather more information about it so as to act in the more appropriate manner. In order to know whether it is appropriate to run, hide, or wait, it is important to know whether the predator is moving or stationary, awake or sleeping, distracted or vigilant, looking away or towards the organism, and so on. To have visual information about the predator in high spatial resolution may help resolve crucial ambiguities in this information. Depending on the information gathered, the organism's attention may then shift elsewhere – say, to an escape route or a hiding place –, but at least initially it is useful to have information in high spatial resolution about relevant properties of the object one encounters.

Shifts in sensory neurons' receptive fields towards the center of attention have been linked to distortions in size perception. Studies by Kirsch et al. (2018) show that restricting the focus of attention makes an object appear larger, relative to a condition with an expanded focus of attention that surpasses the object's boundaries. In this experimental de-

10 Easterbrook 1959, Kahneman 1973, Weltmann et al. 1971.

sign, subjects fixate a central cross and an attentional cue is briefly flashed peripherally. Then a pair of circular targets appear peripherally to the fixation cross, and participants have to indicate which target is bigger (experiment 1) or simply say whether they are of the same size or of a different size (experiment 2). The size of the attentional cue was either restricted to the target or expanded around it. Results have showed that restricting the attentional cue made subjects consistently indicate the cued target as larger relative to a neutral condition, at the same time that expanding the focus of attention made subjects consistently indicate the cued target as smaller (experiment 1). The results from experiment 2 also confirmed this prediction, significantly altering subjects' equality judgments in the expected manner depending on the size of the attentional focus. The authors' favored explanation, in accord with previous research (Anton-Erxleben et al. 2007), is that in the restricted focus condition more distant receptive fields are shifted towards the center of attention and are thus activated by the stimulus, making it appear larger. In the expanded focus condition, in contrast, the object no longer stimulates the more distant receptive fields, and thus it appears smaller (Kirsch et al. 2018, p. 89). Since fearful attention deploys a more restricted focus of attention onto the feared object, it is reasonable to suppose that spatial distortions in size perception will also take place in fearful object seeing in virtue of the same mechanism. This might explain why subjects in the studies by Teachman et al. report seeing the disk on the ground as larger under fearful conditions.[11]

Regarding the other studies involving distance and inclination misestimations, as attention is narrowed down onto the object, more attention is paid to the object's internal relations rather than to its relations to other elements of the visual scene. Under these conditions, it is plausible to suppose there will be a loss of perspective, as insufficient attention is paid to background and surrounding stimuli.[12] Thus, subjects might have uncertain perceptual information concerning spatial magnitudes such as distance and inclination, and end up reporting objects as closer or more inclined than they actually are. However, contrary to what neo-Gibsonians suppose, perceptual distortions are not meaningfully related to evasive actions. Distorted perceptions of distance, in other words, do not exist to help the organism flee. Rather, perceptual distortions of spatial properties are byproducts of fearful attention, and occur as soon as fearful attention is deployed, independently of the particular evasive action being performed. Firestone is correct in pointing out that perception is not paternalistic in this sense.

But here one may object: if perceptual distortions in fearful object seeing are not meaningfully related to evasive action, and are instead byproducts of fearful attention, shouldn't we expect more variability in the reported distortions of inclination and distance? That is to say, if subjects have uncertain perceptual information concerning these magni-

11 Although it doesn't mean that the magnitudes of these size distortions will be reflected in subjects' spatial estimates (see below).

12 This hypothesis is tentatively endorsed by Cole et al. (2013: 38).

tudes, we should expect random estimations in both directions, i.e., spiders as closer or further away, hills as more or less inclined, etc. And yet, results show misestimations in one direction only, consistent with their being meaningfully related to evasive action.

Here is where I think the appeal to non-perceptual biases is specially helpful. As I see it, fearful attention causes distortions in perceived spatial properties through the narrowing down of attention and preferential processing of local rather than global features of the stimulus. As a result, information about the object's relations to other elements of the visual scene might be uncertain. As this information is important for the estimation of certain spatial magnitudes, when subjects are asked to make spatial estimates in these conditions they might rely on other sources of information, such as their state of emotional arousal, their impressions of the stimulus, or task demands, in order to conclude that the hill must be very steep or that the spider must be very close.[13] A similar point could also be made about size distortions. Although research shows that restricting the focus of attention changes size perception, we should not expect the disk size overestimations reported in Teachman et al. to reflect actual perceptual experiences. Since spatial estimation tasks are vulnerable to non-perceptual biases, these results most likely express how big subjects felt/judged the disk to be, rather than how it perceptually appeared. Therefore, I agree with Firestone that non-perceptual biases most likely occur in spatial estimation tasks, but this doesn't mean size distortions do not occur as well, as a result of a restricted attentional focus.

To conclude this section, when a subject reports seeing objects as closer, larger or more inclined than they actually are while in a state of fear, neo-Gibsonians would take this as a literal description of a perceptual experience. Firestone, in contrast, would say that perception supplies us with accurate representations of these spatial magnitudes, but that non-perceptual biases affect our spatial estimations. My proposal lies somewhere in between: fearful perception distorts perceived size of feared objects and provides us with uncertain information about their relations to other elements of the visual scene. When subjects are asked to make estimates on spatial properties that require this information, non-perceptual biases kick in, making subjects align their perceptions with their impressions, affective states and task demands. This is not, however, a conclusion we would arrive at based only on spatial estimation tasks. Indeed, as Firestone points out, these tasks do not clearly distinguish between non-perceptual and perceptual biases, so nothing keeps us from explaining them in terms of the former. Rather, my proposal is backed by independent evidence for the effects of fearful attention on the perception of spatial properties, which explain how and why perceptual distortions might occur in fearful object seeing.

13 See Zillman 1971 for the proposal that under conditions of information uncertainty subjects might use emotional arousal as cue.

VII – Conclusions

This paper began with the question of whether fear can change how objects are perceived, something I've called "fearful object seeing". One aspect of fearful object seeing is that the feared object is experienced as threatening, as inextricably involved in the bodily feelings associated with fear. But it was still an open question whether fear could also change how certain spatial properties of objects are perceived, as suggested by empirical evidence (section II). In order to explain these findings, I introduced a neo-Gibsonian theory of perception (Proffitt 2006), according to which fear biases perception so as to favor adaptive actions, which explains why a threatening object may appear as closer, larger or more inclined than it actually is; if a spider is perceived as closer than it actually is, we may initiate flight behavior earlier than we would have in normal conditions. In this manner, perceptual biases could have contributed to the survival of our ancestors in the past, and were selected by evolution for that purpose (section II). Against this view, Firestone argued that the reported distortions can be fully (and better) explained by non-perceptual biases that operate on accurate representations of the world (sections III and IV).

In section V, I argued in favor of perceptual distortions in fearful object seeing through an alternative route. For this purpose, I resorted to Ledoux's notion of defensive organismic states that prepare the organism to act in relation to a threatening stimulus. One characteristic of a defensive organismic state is that the organism is fully aroused and alert, with attention narrowly focused onto the feared object (section V). Building on research by Patrick Vuilleumier (2005), I have called this "fearful attention", which is a special mode of attention that involves more than spatial attention directed at a threatening stimulus. This mode of attention arises as part of an orchestrated and integrated response (a defensive organismic state), involving high arousal and a narrowed focus of attention. I then identified two ways in which fearful attention may cause distortions in how spatial properties are perceived: a narrowed focus of attention may make objects look bigger in virtue of shifting sensory neurons' receptive fields towards the center of attention, and processing of local rather than global properties of the stimulus might provide the organism with uncertain information about the relation between the stimulus and other objects in the visual scene. In this condition, subjects may use their emotional arousal as cue in order to estimate that objects must be closer or more inclined than they actually are (section VI).

We are now finally in a position to give a full account of fearful object seeing. In the present proposal, to perceive a feared object is to perceive it in a fearful attentional mode, i.e., in a state of arousal and alertness, with attention narrowly focused onto the feared object. Since arousal and physiological bodily responses are integrated with perceptual and attentional processes as parts of the orchestrated response that is characteristic of defensive organismic states, this explains why exteroceptive and interoceptive information are functionally and phenomenally integrated in an episode of fearful object seeing. The object is experienced as threatening, as inextricably involved in the pattern of bodily feelings and arousal characteristic of fear, and its threatening presence is immediately felt in the organism's readiness to act in relation to it.

In addition, we may also perceive some of the object's spatial properties in a distorted manner, as an effect of fearful attention. These distortions, however, are not meaningfully related to evasive action, and occur merely in virtue of the deployment of fearful attention. When we are asked to make spatial estimates on magnitudes about which we have uncertain information, we may describe objects as closer or more inclined than they actually are. These misestimations, therefore, show up only when the question arises of how close, or how inclined, objects appear to be, and are not part of our perceptual experiences per se. We do not, in other words, perceive spiders as closer and hills as more inclined than they actually are while in a state of fear. As Firestone points out, when we are asked to make estimates about these magnitudes, we rely not only on what we perceive, but also on how we feel, in order to reach certain conclusions about them. He is therefore correct in saying that non-perceptual biases can explain the empirical results reviewed in section II. If perceptual distortions arise – and section VI gave us good reasons to suppose that they do – they will not be revealed by spatial estimation tasks, and must be investigated through other methods.

A more promising path may be found in experimental designs that investigate the effects of spatial attention on size perception (Kirsch et al. 2018, Anton-Erxleben et al. 2007). These designs could be adapted with the introduction of threatening cues that should mimic the effects of an explicit restriction of the attentional focus. In a hypothetical design adapted from Kirsch et al. (2018)[14], we could have an expanded focus condition with threatening or neutral cues flashed peripherally before two circular targets appear on the screen, and subjects have to indicate whether the targets have the same size or a different size. If threatening cues in an expanded focus condition manage to replicate results previously found with an explicit restriction of the attentional focus (*ibid.*), this would be evidence that fearful attention can alter size perception in the predicted manner, i.e., by restricting the focus of attention. A second experiment could then use the same design but with a restricted rather than an expanded focus condition. If we still find responses that are consistent with targets following threatening cues being perceived as larger, that would be evidence that fear can potentiate the effects of spatial attention on size perception, since both neutral and threatening cues should restrict the focus of attention in this condition. This would be in line with evidence by Phelps et al. (2006) that threatening stimuli potentiates the effects of spatial attention on the perception of other sensory magnitudes such as contrast.

In addition, since arousal is a fundamental aspect of defensive organismic states, we should also investigate the independent effects of arousal on perceptual appearances, other than through the narrowing down of the focus of attention. There is some evidence, for example, that norepinephrine and serotonin can modulate the temporal properties of

14 See section VI.

sensory neuron responses (Hurley et al. 2004). These findings may be relevant in light of further evidence that spike timing is involved in the neuronal coding of the spatial structure of the environment, playing a role in the representation of spatial properties like location and movement (Panzeri et al. 2002). Since these neuromodulators are both released during defense circuit activation (Ledoux 2012), they could induce perceptual distortions in spatial properties through spike timing modulation. This is an open empirical question that demands further investigation. Although there is some research on the effects of arousal on spatial perception[15], these studies deploy estimation tasks and so are vulnerable to the same problems highlighted in this paper. More neuroscientific evidence is needed as to the exact role of spike timing in spatial representation, as well as to the precise effects of norepinephrine and serotonin on spike timing. This is an open path of research that would give us a more complete picture on the modulatory effects of fear on spatial perception.

Before concluding the paper, it is worth saying that Ledoux's notion of defensive organismic states may also help us illuminate important and difficult questions in the philosophy of emotions. As briefly mentioned in section I, many philosophers already pointed out that there is an irreducible intentional element in an emotion like fear, and that bodily and intentional aspects of fear form a unified whole: the bodily feelings associated with fear are directed at feared objects, and feared objects are inextricably involved in these bodily feelings. Nevertheless, it is notoriously difficult to explain how bodily feelings are integrated with object perceptions in a way that preserves the unity of the bodily and the intentional. Some proposals mention the co-occurrence of bodily feelings and perceptual representations of external objects (Prinz 2004, p. 181) or causal chains relating bodily feelings to their external sources (*ibid.*: 62). Barlassina & Newen object that neither approach is fully satisfactory, and that both elements need to be properly integrated rather than just co-occurrent or causally related; but they admit that it is very hard to explain how such an integrative process could take place (2014, p. 663). The problem, as Maiese points out, is that once we start out with bodily feelings and perceptual states as separate components, it is indeed very difficult to put them back together again, so that the only way to preserve unity is to construe them as a unified whole from the beginning (2014, p. 522).

Ledoux's notion of defensive organismic states can be very useful in this respect. These states are, by definition, *sensorimotor integrative devices* that serve specific adaptive purposes (Ledoux 2012, p. 655). The defense circuits which give rise to these states are tuned to responding to particular kinds of environmental situations, and use this information to control behavioral responses, attentional and perceptual processes, and internal physiological adjustments that form an integrated response that helps the organism deal effectively with a threat. When an episode of fear arises on the

15 For instance, on depth (Shahbazi et al. 2011) and width perception (Geuss et al. 2010).

basis of a defensive organismic state, the unified character of bodily and intentional elements is already secured at the level of the underlying defensive state.

In this picture, we do not experience certain bodily feelings which then get combined with perceptual information in a composite defensive state; rather, bodily feelings arise already as part of an orchestrated response to help us deal with a particular threatening object, which involves attending to it in a special way and being ready to act upon it in a state of vigilance and arousal. The bodily phenomenology of fear, therefore, cannot be separated from how the object is perceived and how the organism prepares itself to act upon it. Defensive organismic states can nicely account for how these different elements hang together and are integrated in a biological survival circuit. As such, they can be a valuable tool for philosophers interested in explaining the intentionality of fear and the phenomenal integration of interoceptive and exteroceptive elements in fearful episodes.

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