



**Anticipating and
Enacting Worlds:
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Predictive processing theorists have claimed PTSD and depression are maladaptive and epistemically distorting because they entail wide gaps between top-down models and bottom-up information inflows. Without denying this is sometimes so, the “maladaptive” label carries questionable normative assumptions. For instance, trauma survivors facing significant risk of subsequent attacks may overestimate threats to circumvent further trauma, “bringing forth” concretely safer personal spaces, to use enactive terminology, ensuring the desired gap between predicted worries and outcomes. The violation of predictive processing can go in the opposite direction too, as when depression coincides with energy-depletion, and hence objectively strenuous situations in which things look farther away because they are (accurately anticipated to be) harder to reach. These examples partly encapsulate what predictive processing theorists call “active inference,” yet with differences. In the first case, actions fruitfully obviate predictions rather than fulfilling them. In the second, mental models do not dysregulate bodily processes, making coping harder. Instead, problems (e.g., personal obstacles, gastric illness) deplete energy, eliciting a depressive and adaptive slow-down. Some predictive proponents narrowly apply correspondence criteria when alleging mismatches between internal models and the world, while incongruously asserting that the brain did not evolve to see things veridically, but to execute actions. An alternative is to adopt pluralistic, pragmatic epistemologies suited to the complexity of mind. The upshot is that mental outlooks can depart from the norm without epistemically being distorted and that mismatches between anticipatory worries and outcomes, when they actually exist, can be a measure of adaptive and epistemic success.

Keywords: Anticipatory Moods, Biology of Mind, Cognition, Depression and Anxiety, Enactivism, Embodiment and Mind, Epistemology, Emotions, Illness, Philosophy of Psychology and Cognitive Science, PTSD, Pragmatism, Predictive Processing, Trauma.

Introduction

Predictive processing theory holds that the brain generates anticipatory top-down models that organize environmental encounters and experiences, but which also get updated when expectations conflict with sensory input from the world (Clark 2016). The theory has been applied to psychiatric conditions, with commentators concluding that depression and PTSD are maladaptive cases of epistemic breakdown that follow from mismatches between predictive models and incoming information flows (e.g., Barrett et al. 2016; Clark et al. 2018; Linson and Friston 2019; Fabry 2020; Kube et al 2020a, b; Smith et al. 2021; for exception, see Badcock et al. 2017). But what if accurately anticipating disasters to avoid them counterfactually means overpredicting bad results? To regard this as maladaptive and distorting seems not only unfair. The conclusion also carries normative connotations that, for example, sexual abuse survivors may find objectionable if overestimating risk is their way of averting further attacks. All of this holds more strongly if, as predictive processing theorists regularly assert, cognition is a coping tool. After all, tools like shovels and even subway maps are for handling tasks, which typically does not entail exact modelling of the world (see James 1907; Crippen 2017; Williams 2018).

Action-based approaches, such as enactivism, offer another way of framing psychiatric conditions (de Haan 2020). A core idea here is that experiential properties are actualized through behavior, as when different species enact the walkability or the fluid pliability of water depending on whether or not they

can stride across it (see Dewey 1896; Merleau-Ponty 1945; Varela et al. 1991; Gibson & Pick 2000). Action-based understandings also explicate affectivity (Dewey 1934; Colombetti 2014; Crippen 2021, 2022). It turns out, for instance, that things look farther away to depressed people (Riener et al. 2011), but this is not a prediction error. Rather, we objectively enter an enervating atmosphere when depression zaps our energy, so that targets really are harder to reach. And when depression leads to prediction errors, they can entail epistemic insight and be adaptive insofar as fretting over bad expectations can motivate action that prevents them, bringing out an objectively safer world relative to the sufferer.

While proposing some enactive corrections to predictive processing, my intention is not to repudiate the theory, but instead to take a cue from Wittgenstein (1953) and situate affective conditions in their “original homes.” For PTSD, one might consider wartime or sexual abuse. In the first scenario, restlessness and inflexible interpretation (e.g., of bangs as gunshots and not fireworks) is life-preserving and oriented towards genuine risks, even if their probability is low in a given instance (because even soldiers are not under attack most of the time). The second situation also calls for hypervigilance, sometimes even after escaping abusers given the high proportion of re-victimizations (Sorenson et al. 1991). Depression likewise can bolster anticipation of potential problems, for instance, by elevating analytic processing (Andrews & Thomson 2009; Andrews et al. 2020).

None of these observations denies the ills of PTSD and depression, including atrophy to brain areas (McEwen 2005; Chao 2016), which can be a side effect of neural activity critical to resolving current difficulties (Andrews & Thomson 2009; Bukhbinder & Schulz 2016). To articulate the point by way of an analogy, suppose there is a 10% chance that dogs in an area are rabid, but registering each as a certain threat and therefore fleeing prevents rabies over a lifetime yet causes occasional muscle sprains. It seems to follow (1) that overestimating danger ensures a gap between the anticipated worry of catching rabies and the outcome of not getting it; and (2) that the response is an adaptive and epistemically judicious answer to dangers, precisely because it promotes gaps between unfavorable predictions and their fulfillment. My argument will be that PTSD and depression can likewise involve adaptive and

epistemically warranted divides between worries and outcomes, even while long-term consequences can be injurious.¹ The violation of predictive processing also occurs in the opposite direction, as when depression coincides with energy-depletion, which brings forth objectively strenuous situations in which things look farther away because they are (accurately anticipated to be) harder to reach.

A more general idea is that emotions—and especially anticipatory ones like anxiety and worry—are conduits to fruitful cognition and action. Cognition is itself a tool not to be measured by the extent to which it mirrors outward events, though representing is sometimes among its functions. Having stated this, I follow Clark (2019, p. 269) in resisting the pressure to define cognition because “no such account is likely to command general assent.” It is worth adding, however, that definitional disagreement arguably follows partly from “cognition” connoting multiple things (more so if cross-cultural perspectives are considered, though not my focus). I accordingly accept a plurality of activities as “cognitive,” e.g., doing mathematics, slime mold navigating mazes and emotional anticipation (which implies forward-looking awareness). Obviously, I also reject presumptions that depression and PTSD are always maladaptive “illnesses” or “disorders.” A corollary to these points is that it is hopeless to look for a single epistemic standard. These claims relate to one of my criticisms of predictive processing: its anti-pluralistic, grand unifying ambitions (e.g., Friston 2010; Clark 2013, 2016; Hohwy 2013). Even supposing it is “the first truly unifying account of perception, cognition, and action” (Clark 2016, p. 2), and that it explains aspects of some psychiatric disorders, depression and PTSD sometimes contravene predictive processing tenets.

It goes without saying that conceptual straightjackets similarly oversimplify emotions and moods. Anxiety, for example, is widely regarded as an aversive concern about uncertain future outcomes, but

¹ Predictive processing theorists might try to argue their way out of these objections with concept of “precisions.” Precisions refer to the probable weighting that a prediction is given. Thus in the dog example, the precision is low, which means the expected error of the prediction is high. Predictive processing theorists sometimes talk about low precision predications that have life altering significance, which the brain therefore takes seriously, despite the high rate of expected error. But none of these arguments obviate the fact that when it comes to expected worries, we want a gap between predictions and outcomes, and further, that the overestimation is often exactly what secures the desired gap. Another attempted rebuttal might be that agents are correctly predicting danger in the area in which 10% of dogs are rabid. But in addition to being *ad hoc*, there remains a prediction error between over-anticipated worries and their failure to occur, along with the fact that this error is desirable.

none of the definitional components necessarily apply, so that it is not just one thing. After all, we can suffer anxiety over past choices or about unpleasant dental procedures foreseen with certainty; we can also anxiously adjudicate between two great job options, just as we can anxiously await a fond meeting with a lover (Miceli & Castelfranchi 2005; Kurth 2015; Vazard 2018). It is worth remembering emotional concepts are handed down in language and culture and are accordingly unlike notions such as electron degeneracy that are nearly exclusively determined by scientists (Miceli & Castelfranchi 2005; Prinz 2007; Crippen 2018, 2023).² The challenge, therefore, is not to simply stipulate what emotions, moods and affective conditions are in order to fit theoretical lenses, which risks detaching inquiries from objects of investigation.

Affectivity, Anticipation and Cognition

Emotions running amuck cause problems, but this is so of any psychological faculty, with logic decaying into absurdity when employed zealously, hampering everything from investments to romance to solving syllogistic puzzles (Nietzsche 1888; Gigerenzer 2007). Despite this, the emotions have historically been singled out for muddying thinking. In the 1990s, however, researchers like Damasio (1994) began popularizing the idea that emotions support reasoning, repeating largely unnoticed assertions of past philosophers (see Loewenstein 1994). As a preliminary to my main arguments, this section outlines how emotions support cognition and are sometimes part and parcel to it, framing these claims in both predictive processing and enactive terms.

Let us start with neurobiological corroboration for the assertion that emotions buttress cognition. The amygdala bulbs are emotion centers that are critical to selective attention (Pessoa 2013, Ch 2), simultaneously cognitive and “interested,” hence affectively valanced. Besides lending emotional weight to options, the amygdala bulbs cooperate with hippocampal and cortical regions in memory formation,

² Other scientific notions such as relativistic concepts of space and time remain more reliant on everyday experience and language insofar as the scientific perspective twists and therefore depends on lived understandings (see Merleau-Ponty 1945, pp. vii-xxi; Crippen 2015), but for contrasting view, see Barrett (2017).

having language function too (Jacobs et al. 2012; Grupe, et al. 2013; Grupe and Nitschke 2013; Tyng et al. 2017; Babaev et al. 2018; Citron et al. 2020). Highly conceptual and cultural, envy, shame and embarrassment link to cortical and subcortical structures supporting semantic understanding (see Binder et al. 2009; Jankowski and Takahashi 2014; Bastin et al. 2016). The insular lobes undergird epistemically rich emotions like empathy, along with disgust and fear, which are world-directed, helping us wisely negotiate everything from social obstacles to food to cliff edges (Uddin et al. 2017; Cantone et al. 2019). The insular cortices communicate with the basal ganglia, operative in habit formation and reward appraisal, which is emotionally attentive (Hikosaka et al. 2014). This region additionally processes temporal and syntactic aspects of language and music (Grahn & Rowe 2009; Kotz, et al. 2009; Kotz & Schmidt-Kassow 2015).

Folk psychology tells a similar story about the integration of emotion, cognition, perception and action. Here, there are many lines of substantiation, including the fact that things acquire significance when they are used for emotionally infused goals; or that logically identical connectors (e.g., “I love you *and...*” vs. “I love you *but...*”) have different emotional registers and hence meanings in everyday discourse; or that emotions impact what we notice and how we link things together, chiseling experience and memory (James 1879a, 1884, 1890; Dewey 1925; Heidegger 1927; Luria 1968; Johnson 2007). For these reasons, emotional interests affect concept formation, illustrated by a carpenter, mechanic and drycleaner respectively regarding oil as a wood darkener, lubricant or a substance that stains fabric (James 1878a; also see De Sousa 1987; Barrett et al. 2016). Affectivity likewise inflects perception, so that a mountaineer encounters ice as weight-bearing or not, perceiving and cognizing these variations emotionally as safe or threatening, hence as affording walking or not (Crippen 2017). Koffka (1935, p. 7) accordingly suggests that attentive—thus affectively cadenced—engagements with surroundings help us categorize each thing, telling us “what it is” and “what to do” with it. Pessoa (2013, Ch. 2) echoes this, asserting that emotional brain areas underlie both the conceptual “What is that?” and the pragmatic “What is to be done?” Though mostly skirting neurobiology, ecological psychologists make a similar point when

framing affordances (action possibilities) as prospective (Gibson and Pick 2000). This is because perceiving behavioral avenues (the pragmatic “What is to be done?”) means grasping unrealized options that form our sense of “what things are” in our environments.

Human existence itself orients around the future, a fact exemplified by emotions like worry and loving hope. Anticipating the future characteristically involves expectant tension, which is both cognitive and emotional. Language is an example: the phrases “in the event” or “the fact” cognitively and emotionally anticipate the word “that” or “of” but not “tiger” (see Weaver 1949). Likewise, on an entangled cognitive and emotional level, “I love you *but...*” anticipates something more negative than “I love you *and...*”, usually giving the statements different meanings. Alphabetical and musical sequences similarly engender an integrated cognitive-emotional expectation of hearing the next part, maybe accompanied by widening eyes, a slight lean forward and other bodily actions.

This last observation leads into a second idea that will recur in later sections: that bodily behaviors are cognitively rich and not incidental to what emotions are in specific contexts. Posture, for instance, can modulate arousal, heart rate and brain function (Riskind & Gotay 1982; Muehlhan et al. 2014). Likewise, the narrowing or widening of the eyes that coincides with fear and disgust enhances “stimulus localization (‘where’) or stimulus discrimination (‘what’), respectively” (Lee et al. 2014, p. 745). Habits similarly are future-oriented (predictive) forms of emotional-cognitive anticipation, though this typically goes unnoticed until routines are interrupted, as when flipping a light switch during a power failure (see Dewey 1922, p. 181). Bodily habits enhance cognitive efficiency by limiting how we handle tasks and freeing attention to be directed elsewhere (Dewey 1922, p. 172; Graybiel 2008). Cultural habits also modulate affordance exploitation, hence the meaning we bestow on things like food (Gibson 1979, Ch. 8). We conceive and perceive certain substances as food affordances (as edible), additionally taking comfort in what is familiar, experiencing unpleasant perturbations if served things far outside our cultural expectations.

One might therefore say, in enactive terms, that emotional-bodily dispositions bring forth meaningful configurations in the world. Predictive processing offers additional reasons for claiming that emotional-bodily dispositions are cognitively and perceptually rich. Researchers from that quarter (Clark 2016; Friston et al. 2016; Fingerhut 2021) suggest that habitual behavior-programs function as top-down models that orient agents according to expected outcomes. By the same token, thwarted expectations adjust top-down habitual routines. Consider a pedestrian routine of walking when others do, thereby predicting a crosswalk signal is green without looking at it. A jaywalker, by breaking expectations, may prompt us to cross, until noticing with an emotional startle that our (predictive) behavior clashes with information from the street. From predictive standpoints, this highlights a number of points. One is that in places like South Korea, where jay walking is rare, the precision of behavioral predictive cues will be high, which is another way of saying the anticipated probability of error will be low. Second, if a Korean travelling in another country experiences repeated prediction errors, then that person's habitual models for crossing streets is almost sure to change, so that the movement of others will cease being a cue. A third idea is that there is a lot of sensory information that we do not register in the first place, unless it violates expectations.

Interoceptive feedback is core to some predictive processing accounts (e.g., Seth 2013; Barrett et al. 2016). Here, a top-down model may update to accommodate mismatches between it and inflows of feelings, as when we see a prototypically neutral situation as offensive because of gut inklings. Or expectations may engender emotions, as when a prior unfavorable model (i.e., habitual negativity) leads to bad feelings and self-fulfilling behaviors that ensure disappointing outcomes. In predictive processing parlance, this is called “active inference,” defined as “performing actions to bring about sensory states in line with predictions” (Seth 2013 p. 565), whether these sensory states are exteroceptive or interoceptive.

Predictive processing theory is also consistent with cognitive penetrability: the idea that “higher-level cognitive states, such as beliefs, desires, intentions, etc., can directly influence perceptual experience” (Marchi and Newen 2015, p. 1). An occurrence of this is when we are on a subway and mistakenly reverse

the east-west orientation of the side windows, with this prior assumption engendering the perceptual impression that we are travelling opposite to the direction we are actually going. Top-down models are usually framed as automatic programs (see Smith et al. 2021), thus departing from the just given illustration since we can voluntarily create the impression of travelling in reverse directions by picturing the windows facing different ways. Another example mentioned at the outset gets closer to typical predictive scenarios while gelling with enactivism. This is that depleted energy and hence reduced action capacity characterize an emotion like sadness, in turn making things look farther away, which entails a prediction that a target will be harder to reach. In enactive terms, de-energized agents literally bring out a burdensome world through their impaired coping ability, which differs from the predictive processing position that has top-down brain generated representational (mental) models largely dictating what experiences shall be (e.g., Wilkinson et al. 2017; Barrett 2017; Ongaro & Kaptchuk 2019). As later sections will elaborate, reframing things in enactive terms and downplaying more standard representational ones raises questions about normative assumptions that predictive processing theorists smuggle into their accounts, which perpetuate the general idea that depression is necessarily maladaptive and a disorder.

Depression and Anticipatory Problem Solving

Lifetime rates for serious depressive bouts range from about 10% to 17% in G30 countries (Lim et al. 2018), and at any time roughly 22% have at least one major symptom (Rottenberg 2014, Ch. 5). These facts, combined with the generally adaptive and epistemically fruitful dimensions of moods and emotions, make it worth pondering whether depression is sometimes a future-oriented problem-solving strategy, albeit without dismissing its painful nature. Using this conjecture to interrogate predictive processing theory within its own parameters, my intention is to establish that the ongoing maintenance of mismatches between the world and our models of it can be desirable by virtue of attuning us to problems, thereby helping us avoid them. Later, I will offer enactive refinements that sidestep the idea of mental

models and hence the notion of mismatches, though without entirely jettisoning predictive processing precepts.

An idea advanced by predictive processing advocates is that depressed individuals are burdened with top-down models that dysregulate bodily functioning, generating painful emotions and leading sufferers to attend more to negative than positive information (Barrett et al. 2016; Clark et al. 2018; Smith et al. 2021). In line with this, studies have found that depression elevates anxiety and negative expectations (e.g., Strunk et al. 2006; Grupe and Nitschke 2013). Compared to non-afflicted individuals, sufferers show increased amygdalar firing when forecasting bad outcomes or encountering sad images and words, likely amplifying pessimistic retrospective and prospective cognition (MacLeod et al. 1997; Abler et al. 2007). Moreover, the baseline activations of depressed individuals match what non-afflicted people show in various cortical and sub-cortical regions when expecting unpleasant stimuli (Abler et al. 2007). Together, this suggests the depressed are habitually “switched on” to anticipate unfavorable events.³

Although the kneejerk reaction is to assume that depressed states are maladaptive, there are reasons for sometimes questioning this value judgment. Let us start with the obvious: depression hurts, and pain motivates remedial action. For example, experimenters have compared squid with and without local anesthetic after tentacle amputation. Those with anesthetized wounds act uninjured, not mitigating their debilitation, becoming more susceptible to predation (Crook et al. 2014). Along comparable lines, depression (i.e., emotional pain) can signal problems and provoke restorative behaviors, with Andrews and colleagues (2020) citing depression induced by starvation and gastrointestinal illness as examples. The former increases food obsession, active exploration and expectant searching, while decreasing sex drive (which is not pertinent to immediate survival). The latter, by comparison, brings sleepiness, motor retardation, diminished libido and appetite suppression, all conducive to cautious restfulness. In both cases,

³ Though not focused on psychiatric conditions, Clark’s *Surfing Uncertainty* (2016, Ch. 9) dovetails with the claim that depressed are habitually “switched on” to anticipate unfavorable events.

lowered mood reflects physiological challenges, and accompanying symptoms—including the pain—stimulate appropriate solutions (Rottenberg 2014, Ch. 7; Wittman 2014; Andrews et al. 2020).

It has been widely observed that troubles increase thoughtfulness (James 1879b; Nietzsche 1888; Dewey 1916; Heidegger 1927; Csikszentmihalyi and Wong 1991), with depression likewise coinciding with rumination and conditions favoring it (Andrews & Thomson 2009; Bartoskova et al. 2018). These conditions include the avoidance of distractors like sex and social gatherings (De Fruyt et al. 2020; Elmer and Stadtfeld 2020). Another marker of depression is anticipatory caution, which manifests in various forms of motor retardation (Azorin et al. 1995; Caligiuri and Ellwanger 2000; Barrett et al. 2016). Depressed individuals further show heightened analytic ability, with test-elicited mood deflation also correlating with better performances on intelligence assessments (see Andrews & Thomson 2009; Karpinski 2018). Add to this that dreaming and thinking about trauma hasten recovery (Andrews and Thomson 2009; Wittman 2014; Pigeon & Carr 2016). Together, this suggests that rumination is an epistemic strategy for resolving personal difficulties.

Depressed individuals also avoid group interactions but not pair-wise engagements (Elmer and Stadtfeld 2020), exhibiting heightened awareness and evasion of costly social encounters, especially when their plight follows from a fall in status (Hendrie & Pickles 2009). Badcock and colleagues (2017, p. 188) frame such strategies as a “better safe than sorry” predictive processing program, aimed at reducing “expected surprise.” Specifically, the agent adopts a model that “minimises uncertainty in the social world when sensory cues indicate both a high degree of socioenvironmental volatility ... and an increased probability of aversive interpersonal outcomes.” A possible alternative, however, is that agents have negative models of themselves and avoid confirming situations. Here, the strategy would be to initially increase surprise, that is, the gaps between negative self-concepts and positive information from the environment, which would eventually change the unfavorable model, reducing prediction errors over time and easing depression. But notice here that the adaptive strategy entails an initial increase in prediction errors.

Barrett's research team (2016) offers another explanation, drawing on the concept of allostasis to elucidate depression within a predictive processing framework. Whereas homeostasis is the maintenance of fairly strict equilibriums, as in sodium balance, allostasis designates biological processes with variable optimal ranges. Brown fat, for instance, contributes to thermogenesis, perhaps insulating against heat loss too (e.g., Lee, Swarbrick and Ho 2013; van der Lans et al. 2013), thus reducing calorie expenditure, with torpor doing the same. Accordingly, optimum levels of brown fat and lethargy vary depending on whether one is in warm or cold climates. If brain-generated predictive models consistently misinterpret the environment as being colder than it is, this might lead an individual to huddle under blankets, oversleep, binge eat and not get to daily tasks, in short, to undergo depressive symptoms. Though my example, this illustration encapsulates the view that Barrett and colleagues advance when they attribute depression to brains miscalculating outcomes and misallocating energy resources. They pass quickly over the fact that trauma sometimes causes or contributes to depression. They also mostly neglect that various preexisting temperaments can be optimal in different situations. To elaborate, bold fish have advantages if encountering novel food, unless it is in a baited trap, in which case their more wary counterparts fare better (Rottenberg 2014, Ch. 5). Analogously, people scoring high on neuroticism tend to be tentative and depression-prone, which can be epistemically judicious in unpredictably dangerous settings. Neuroticism, moreover, correlates with creativity and intelligence, especially in anxiety-prone individuals (Moutafi et al. 2006; Perkins 2015). Along similar lines, certain forms of autism can bestow advantages in employment fields requiring extreme attention to detail, systematizing, intense focus and bias avoidance as well as the ability to work in relatively solitary conditions, which helped some companies survive the COVID-19 pandemic (see Jurgens 2023).

Another problem with Barrett and colleagues' (2016) narration of depression is that it starts by stipulating that "anything which regulates (i.e. acts on) a system must contain an internal model of that system" (p. 2). This claim has counterexamples, such as brainless slime mold solving problems that are complex by human standards (Crippen 2020), or the longstanding observation from artificial intelligence

quarters that the world itself is a better model than internal schemes of it (Feigenbaum 1968).⁴ Barrett's team nonetheless goes on to stress that the brain micromanages affairs. In a summative example, they ask readers to imagine that "a senior colleague ... approaches your office door." They posit that "your brain will predict your colleague's arrival by constructing an embodied simulation," thereby "redirecting blood flow to the legs from other organs that need it less," figuring out just "how much glucose is needed to stand up" (p. 9). Do we really need to construct an embodied simulation to execute this simple task? Moreover, if minor action requires redirection of blood from vital organs, then would a day of hiking cause kidney damage? Aside from not citing studies that support their illustration, Barrett's team neglects a vast range of peripheral mechanisms that affect blood flow and glucose consumption. Smith and colleagues' (2020) predictive account similarly stretches credibility by extrapolating that depressed people underestimate metabolic resources from the fact that they struggle to tap in synchrony with their heartbeats. It is not clear that the outcome demonstrates the conclusion. It could just be that people with problems reasonably direct their attention away from tedious tasks not helping them in significant ways.

Barrett's team (2016) are, however, correct to say that depression can damage the body, and most can agree that injuries are generally undesirable, all else equal. Inflammation is part of the healing process in sprained joints but can damage surrounding tissue, and depression can harm the brain. Andrews and Thomson (2009) posit this when observing that depressive rumination involves sustained attention, in turn requiring continual firing in the ventrolateral prefrontal cortex, which can eventually cause neuron breakdown. This may account for certain cognitive deficiencies linked with depression, for example, with ventrolateral prefrontal dysfunction associated with unrealistically expecting negative evaluations from others (e.g., Guyer et al. 2008), something predictive processing theorists have highlighted (Smith et al. 2018).

⁴ Certain robot vacuums exemplify the principle of the world itself being a good model. Combined with detection-actuation mechanisms, the vacuum's round body and the fact that it turns into obstacles it hits, a robot cleaner can follow the circular shape of a pillar, the straight line of a wall, or the right angle of a corner (Crippen, 2022b; Crippen & Rolla, 2023). In other words, the vacuum can use the room and things in it to navigate without an internal model of its surroundings.

However, this does not especially vindicate the position that depression amounts to epistemic breakdown. First, when top-down beliefs do not adjust to accommodate large and chronic prediction errors, depression may indeed follow. But whereas predictive processing defenders see gaps between negative expectations and incoming information as causes (e.g., Barrett et al. 2016; Kube et al. 2020a; Smith et al. 2021), depressed mood can follow from accurately recognizing that reality does not match optimistic aspirations (Rottenberg 2014, Ch. 6). Second, cognitive impairment in depression seems to partly be a kind of injury resulting from processes that help agents prevent bad things from happening to them, so it is one-sided to frame the psychological condition in terms of maladaptive epistemic breakdown. Third, depression is characterized by questioning worry and less by firm beliefs about how things are. Thus, if depression triggers rumination and physiological changes conducive to it, and if rumination helps agents avoid future trauma, then an adaptive and epistemically judicious model would encourage gaps between worries and outcomes. This is more so if an individual is wounded to the point of being unable to sustain further trauma. Put simply, habitually worrying about bad consequences can be a path to ensuring that appropriate actions are taken to avert them. Seen accordingly, this would be a case in which a chronic mismatch between top-down anticipation and bottom-up occurrences is the desired result.

Avoiding and Creating Situations

As part of the “what if” stories we use to anticipate events and our ability to cope, anxiety stands out as an epistemic emotion (Vazard 2018), enhancing performance when levels are moderate (Barlow 2001, Ch. 1). Insofar as anxiety overlaps anticipatory tension, it can introduce drama, serving epistemic function by fusing fleeting episodes into a narrative unity that has form that endures in time, in some sense meeting preconditions that Plato held were needed for genuine knowledge (Crippen 2016). In this section, I examine anxiety in the context of PTSD. While granting the affliction can be destructive and that extreme anxiety is epistemically distorting, I explore how PTSD is sometimes an adaptive tactic for avoiding circumstances that inflict further harm, thereby enacting safer situations.

Like fear, anxiety makes dangers protrude. A difference, however, is that fear normally has specifiable objects, whereas anxiety is usually directed towards problematic uncertainty. Corticotropin-releasing hormone (CRH) especially accompanies wakeful alertness and arousal, hence anxiety (Schulkin 2017). Though involved in non-stressful facets of life as well, CRH and anxiety both prolong responses to fearful stimuli (Kurth 2018, Ch. 2). Anxiety therefore appears to be a temporally extended mood that alters fear attunement. High anxiety obviously characterizes PTSD, which can follow out of everything ranging from sexual abuse to wartime horrors to car accidents. Although certain neurobiological markers usually differentiate PTSD sufferers, it is unclear whether these follow from trauma or from predisposing vulnerabilities (Hendler & Admon 2016). Quite a few PTSD symptoms associate with elevated CRH and include emotional numbing, detachment, avoidance, sleep problems, concentration difficulties, impaired inhibitory control and anxious hypervigilance (King et al. 1998; Norman, Stein and Davidson 2007; Jovanovic and Norrholm 2011; Depue et al. 2014).

Popularized understandings link PTSD with paranoia, but this is a poor characterization. Heller (1961) captures this in *Catch-22*, a novel about WWII where the protagonist rages that world leaders and thousands of people he has never met wish to kill him, which is an accurate assessment. This is not to deny that some PTSD symptoms follow from psychophysiological wear and tear, nor to dispute that the condition is maladaptive in civilian life. It is instead to assert that vigilance and anticipatory angst can heighten sensitivity to legitimate threats that occur at unpredictable intervals, partly by cultivating implicit narratives about what is likely so that it may be averted. This amounts to a global synchronization between an agent and persisting and hence projected conditions. The anticipatory arousal undergone is simultaneously cognitive because the ongoing worry is interwoven with awareness—or “representations”—about potential future dangers that are not immediately realized (Crippen 2018, 2021).

The elevated CRH that accompanies PTSD might itself be seen as “predictive” insofar as it enhances vigilance and attunement to potential threats. Likewise, while the loss of neural suppression for quick successions of redundant sounds is usually framed as a PTSD deficit (see Villarreal and Hunter

2016), the phenomenon may instead be an adaptive predictive mechanism. In wartime, for example, it may be crucial to hear normally irrelevant clicks, which could supply life-saving signals about things to come. Similarly, domestic abuse survivors may be attuned to body language that most of us miss. Because it is hard to confirm unpredictably occurring perils have finally ended, people who have undergone extreme trauma may be left with intractable responses even after escaping danger. The result may be continued anxiety and hair-trigger reactions, which may—but not always for reasons to be explained—be maladaptive. Thus, predictive processing theorists frame PTSD as a failure to adjust top-down models to safer situations (e.g., Wilkinson et al. 2017; Kube et al. 2020b). Hence, PTSD is standardly “proposed to involve enhanced or overgeneralized fear learning and lack of extinction” (Stillman & Aupperle 2016, p. 1199). Yet it should be added that people in the midst of traumatic circumstances—like soldiers fighting wars—can also be diagnosed with PTSD. Here, it is strange to designate their responses as disordered overgeneralizations, and we will soon look at an instance in which the same determination is problematic even for those who have escaped danger.

Wilkinson and colleagues (2017, pp. 6-7) elaborate their predictive processing account of PTSD in terms of Bayesian precision weighting. They argue that an individual selects “a multi-level hypothesis” after a traumatic event. Because the hypothesis has life-threatening significance, the nervous system attends to and acts on even low precision predictions (i.e., low probability indicators) of a potential reoccurrence. Wilkinson’s team posits that this is why something only slightly reminiscent of a traumatic event can elicit a reliving of it. They add, however, that people rarely experience the reliving as the actual event itself because there remains intact a “higher-level hypothesis concerning where and when the subject is.” So although very unpleasant, the disruption is experienced as “just a flashback.”

There are a few shortcomings in this account. First, it applies a lot of theoretical machinery—with limited reference to empirically-backed memory science—to state something non-controversial: that things reminding us of a traumatic experience lead us to reflect back on it. Second and as already stated, it overplays the “maladaptive model” card. This is not to deny that PTSD is medically problematic. One

issue is amygdalar hyperactivity (Bukhbinder and Schulz 2016; Hendler and Admon 2016). Another is atrophy of hippocampal structures, the amygdala bulbs and multiple cortical regions (Bukhbinder and Schulz 2016; Chao 2016; Stillman and Aupperle 2016). Although it is difficult to disentangle predispositions and symptoms, extended elevation of stress-related hormones can lead to glucocorticoid toxicity and anatomical alterations such as hippocampal shrinkage (Lau et al. 2016). But glucocorticoids play life-preserving and indeed epistemically-enhancing roles through their involvement in adrenalin release and heightened vigilance (Sherin and Nemeroff 2011). So it is odd to assert that the response is maladaptive if it helps people negotiate menacing situations, just as few want to say it is the wrong choice if sprained muscles are the outcome of rapidly retreating from feral dogs in an area where rabies is common, even if the likelihood of its presence in a given animal is low. Also, although the exact causal paths are uncertain, schizophrenia is comorbid with PTSD (Fleming & Martin 2016). Hence, rather than primarily resulting from predictive models going awry, intense flashbacks may occasionally be a consequence of the atypical brain anatomy and physiology that underlie schizophrenia.

The broader lesson is that hypervigilance, anxiety and wakefulness can be epistemically judicious insofar as they psychobehaviorally facilitate “what if” anticipation of genuine but unpredictable threats. Consistent with this are measures showing that PTSD sufferers have less anterior cingulate and prefrontal activity than non-afflicted individuals (Shin et al. 2001). Among much else, these brain areas contribute to higher level attention allocation, impulse control and voluntary decision-making. Lower activity therefore suggests less strategic and more automatic processing (Kurth 2018, Ch. 2), more so when combined with increased firing in the amygdala bulbs, which may promote more reflexive emotional responses. But against common presumption, these outcomes have practical value when facing extremely dangerous yet unpredictably timed incidents. Indeed, it is injudicious and maladaptive for warzone soldiers to reflectively explore whether or not loud bangs may be fireworks, as opposed to an attack. Something comparable follows from one-time traumas, which may instill intransigently defensive predictive models. Nevertheless, in this case, the continued response may be rational if the agent cannot

bear to go through the occurrence again and also because the risk of repetition is high in some instances, for example, with roughly two-thirds of sexual assault survivors reporting multiple victimizations (Sorenson et al. 1991). In cases like this, therefore, researchers impose a considerable value judgment when claiming that “events are given more negative and threatening interpretations than they warrant, which in turn leads to high levels of negative affect, of anxiety and hypervigilance” (Wilkinson et al. 2017, p. 7). After all, it may be that such an emotional and cognitive stance accurately captures the costs of potential threats, and by amplifying dangers, helps agents avoid them.

Cognizing Created Realities

Predictive processing draws on Helmholtz’s 19th century work, but its roots go back further inasmuch as it is a Bayesian update of early Modern representational ideas about mind. Keeping with the skeptical trajectory of these older accounts, predictive processing leitmotifs converge on the premise that “perception *just* is controlled hallucination” (Wilkinson 2017 et al. p. 4); or that “what we perceive is not the world as it actually is, but the brain’s best guess of it” (Ongaro & Kaptchuk 2019, p. 1); or that “your brain is wired for delusion” (Barrett 2017); or again that “brains do not react to the world,” but instead build “internal models of the body in the world,” which they then “test ... against incoming sensory evidence” (Barrett et al. 2016, p. 1). Other leading predictive theorists like Seth (2019) and Clark (2016, Ch. 6.2) assert the same, though the latter tries to downplay the skeptical implications.⁵ Though my preference is for embodied understandings that downplay the role of representations, I favor pluralism over adherence to one perspective since mind is more complicated than the inanimate universe, and even that resists monistic (grand unified) theories. It is accordingly not my goal to repudiate representationalism or Bayesian ideas about mind. Rather, my aim in this section is to offer enactive interpretations that

⁵ The above is a majority position, but the literature obviously has exceptions. Facchin (2021) argues that predictive processing need not entail mental simulations. Others (e.g., Bruineberg et al. 2018) attempt to preserve core ideas from predictive processing, while rejecting the theory itself, partly on the grounds that it is too representational (which also means at odds with their ecological and enactive commitments).

downplay the need to talk about mental simulations and the skepticism that follows, at the same time offering epistemic vindication for the non-standard ways that depressed or traumatized individuals experience the world.

Predictive processing proponents have repeatedly discussed research positing that emotionally charged mental models lead people to see weapons where there are none (e.g., Fridman et al. 2019; Neemeh 2020). One experiment (Wormwood et al. 2017) focused on the aftermath of the 2013 Boston Marathon bombing and reported that angry locals tended to judge that people holding neutral objects were armed. Although researchers let participants take as long as they wished to classify stimuli, images were flashed for only a half second and were grainy enough to be ambiguous even if looking at them for extended periods.⁶ Other experiments require split-second reactions (e.g., Payne 2001; Baumann and DeSteno 2010; Wormwood et al. 2015). Those who have completed ADHD tests where the task is to click for the letter X and not click for occasional non-Xs will know that incorrect reactions do not correspond to misperceiving stimuli, but impulse control. One of the just mentioned experiments (Baumann and DeSteno 2010) confirms this point, for when individuals were asked to state whether they correctly identified the presence or absence of a gun after the split-second reaction window expired, errors reduced to nearly zero.

While the above-mentioned studies accordingly do not show biases (top-down models) changing what people perceive, they do show that negative dispositions can change behavior, which is consistent with both predictive processing and enactivism. Other work shows that negative expectations can lead individuals to regard things in more gloomy ways, along predictive processing lines (Kube et al. 2020). When active inference is involved—that is, when people act in ways that generate (sensory) outcomes that align with their mental models—the outcome is not just brain-generated representations, since behavior

⁶ Wormwood et al. (2017) inadequately highlight just how ambiguous the stimuli are, which are not presented in their published article. Instead, they place a link appended at the very end of only the e-version of their article (so not in the print or PDF rendering). The link is obscured, i.e., one needs to hit “Supporting Information” for it to appear. The link does not lead to a webpage but instead prompts the download of a docx file that has a variety of information, with two examples of the stimuli they used tucked away on the last page.

enacts sensory effects that correspond to the predictive model (Seth 2013). Nonetheless, the account remains skeptical. One might indeed characterize predictive processing as “*The Matrix* view” of the mind, and not only because of the claim that perception is controlled hallucination. It is also in the sense that predictive commentators (e.g., Barrett et al. 2016) argue that the brain generates bodily harm by causing allostatic dysregulation and hence depression, mimicking *The Matrix* notion that mental representations from the virtual world make injuries real. Without denying this is ever true, there are scenarios which reverse this causation. Specifically, problems in the body (e.g., starvation, gastrointestinal illness) can generate depression (i.e., outcomes in the mind or brain) and therewith perceptual consequences, albeit ones that coincide veridically with the challenging situation of sufferers. (This is to the extent that things look further away to depressed people not because of faulty ways of seeing, but because low-energy states make it harder to reach intended targets.)

In fact, “veridically coinciding” is perhaps a bad way of characterizing affairs, also complicit in skeptical epistemologies because the terminology often stipulates inner simulations that correspond to external events, thereby raising questions about possible mismatches between private experiences and the world. Though not denying that misperceptions and misjudgments ever occur, enactivism, pragmatism and phenomenology counter that experiential properties are less mental representations than they are qualities of interactions between organisms and things (e.g., Peirce 1878; Dewey 1896, 1925; Mead 1938; Merleau-Ponty 1945; Varela et al. 1991; O’Regan & Noë 2001; Myin & Degenaar 2014; Di Paolo et al. 2017). For example, a pond manifests differently depending on whether the agent is a swimming dog, a water strider, a plummeting person hitting it at terminal velocity, or a wading fisherman, who will virtually never perceive or judge a deep pool to be walkable, whatever mental models she may deploy (Crippen 2010, 2020).

Moving to sociocultural situations, we find much the same: the embodied situation of a woman may lead her to see a menacing quality in a street with bars, rowdy crowds and sexually aggressive gazes. Here, the woman’s experience is significantly choreographed by the risks limiting her action. That

a male experiences the same environment differently does not obviate the fact that the threats are objectively there for the woman as action-limiting protuberances (Crippen 2022) or what Gibson (1966, 1979) calls “negative affordances.” It does, however, undermine the claim that predictive models project the menacing quality onto a neutral environment. It thereby makes it less unreasonable to assert that environmental entities actually have emotional qualities (a view Barrett calls “affective realism” and rejects, see Barrett et al. 2016, Barret 2017). Even if the woman’s past trauma induces “increased reactivity and false alarms (i.e. the perception of threats where none exist)” (Barrett et al., 2016, p. 9), describing it this way amounts to a problematic value-judgment. The reason is that her elevated vigilance may be precisely what eliminates threats in her current and future worlds, so that she avoids additional trauma. In other words, she enacts an objectively safer space.

AI framings of emotions, though schematic, supply a bridge between pragmatic varieties of enactivism and the concept of active inference from predictive processing. One such account (Cañamero & Gaussier 2005) has sadness as an adjustment of AI “metabolism,” so that activity slows when the robot is unequipped to satisfy goals. In human cases, malaise is similarly characterized by reduced motivation and motor retardation, among much else. Depressed moods may coincide with low expectations, so that sufferers act with a kind of tentativeness that produces failure. Here, things are not merely breaking down in people’s heads nor necessarily because their brains are dysregulating the rest of their bodies. It is rather because something is wrong in their body and because of behavioral stances taken in consequence. Even supposing the brain is causing bodily dysregulation, negative experiences are not really projected since physiological problems make it harder to achieve goals.

Let us close with an illustrative parable of a person who experiences depressed mood in winter months.⁷ Granting that seasonal depression is maladaptive in contemporary contexts, annual changes in mood and arousal would arguably be beneficial at high latitudes in the past (i.e., in their “original homes”),

⁷ Traffanstedt and colleagues question whether seasonal affective disorder exists (2016), but Young (2016) identifies numerous methodological and conceptual problems in the critique.

in addition to being predictively accurate. To see why, consider a 1st century Siberian, who would have had relatively little to do outside in the winter. Increased sleep would have preserved scarce calories, as would have lethargy and the accompanying inclination to stay indoors. Suppose that immobilizing inflammation was also at play, which is a general symptom of depression (Ratcliffe 2015, Ch 3). This would have further limited capacity for outdoor work, thus making judgments about its infeasibility more accurate. In other words, there would not be much in the way of prediction errors between top-down models and bottom-up inflows. This is because the top-down model fits bottom-up environmental and interoceptive information and also because the agent's biological state limits capacity to work. Further, inasmuch as serious outdoor winter work was less practical in 1st century Siberia, increased lethargy would probably not manifest as depression. In short, the cleft between standards or models for what we ought to do and what we actually find ourselves accomplishing is a reason we might experience seasonal depression as a “disorder” today, and this would have applied less in the past.

So while I have shown that large prediction errors are often advantageous in cases where predictive processing theorists label them as undesirable causes of disordered states, I here emphasize an additional point: that depression need not involve wide gaps between expectations and realities, which also counters predictive processing claims. To repeat earlier claims, a depressed mood is here characterized by the fact that people have trouble moving forward and accomplishing tasks (Ratcliffe 2015, Ch. 6; Crippen 2021, 2022a). This brings forth a dreary world, thereby fulfilling a predictive model of it, if one wants to use that language, perhaps elevating pessimism and lowering self-worth in the process. The affliction associates with inflammation, which, among other purposes, serves to immobilize animals that are recovering from illness or injury. Evidence suggests that sad people have suppressed exploratory impulses and find themselves aesthetically preferring enclosed spaces (Mealey & Theis 1995), which makes sense because they are vulnerable. It also turns out that hills look farther away or steeper when energy is drained by illness, fatigue, low blood sugar or heavy backpacks, which make movement harder (Bhalla and Proffitt 1999; Schnall, Zadra and Proffitt 2010; Zadra et al. 2010). Depression is energy depleting, so one would

expect environments to look less accessible in this case too, and sad people indeed have this experience (Riener et al. 2011). Anxious people in climbing exercises likewise bring forth a more difficult wall insofar as they do not reach as far and engage in more tentative exploration of handholds (Pijpers et al. 2006; Graydon et al. 2012), with something similar holding for people exhausted by financial debt in stair climbing experiments (Liu et al. 2018).

This enactive framing of predictive accounts, which is fairly congenial to ecological psychology as well, stresses that things do not merely look less accessible to the depressed; they in fact are less accessible because bodily conditions make reaching them more difficult. Thus, depression amounts to a bodily bringing forth or enacting of a more strenuous world. To the extent that depressed people avoid group activities, the condition may also bring out a less socially supportive world, just as the expectation of failure may partly be fulfilled by the agent lacking motivation to pursue onerous tasks. PTSD can have similar consequences, so that, for example, people behaving in chronically aggressive ways find the world responding angrily back, amplifying their symptoms.

Again, without denying that we ever misperceive or misconceive, few hallucinate themselves walking through walls and smashing their heads on the air of open doorways quite simply because these outcomes do not occur, regardless of internal representations (Crippen 2010). But in everyday language, we speak of “hitting walls” or “opening doors” when encountering obstacles and opportunities. The changed action-capacities that coincide with depression or PTSD can be close to this insofar as these conditions change the avenues environmentally available to people, irrespective of particular mental models their brains may generate. Openings and closures accordingly are there also in experiences, here defined as qualities of interactions between agents and surroundings.

Conclusion

This article has advanced the tenet that cognition knots with emotions, moods and interests in epistemically fruitful manners, interrogating the claim through predictive processing lenses and embodied views such as enactivism and pragmatism. I focused on anticipatory emotions, exploring cognitive sides of them, articulating the position in the context of depression and PTSD. While granting merits of predictive processing, I pointed out that cognitive-behavioral changes that accompany depression and PTSD can help sufferers anticipate and thereby avoid undesirable repercussions. In turn, this suggests that the mismatch between anticipatory worries and outcomes is often a measure of epistemic and practical success. The specific reason for including an enactive interpretation was to show that many psychobehavioral changes accompanying depression and PTSD are not merely consequences of activity in the brain, but outcomes of literally changing the world. Within this frame, I highlighted a second counter to predictive processing accounts of depression and PTSD: cases where there appear to be little or no mismatch between mental models and the world. Both of the just mentioned scenarios (i.e., adaptive mismatches and lack of mismatches) undermine predictive processing narratives about psychiatric disorders and the grand unifying ambitions of the outlook.

An idea carried in the second scenario is that the world and our bodily architecture impose hard limits on how we can encounter things. Even in fairly extreme circumstances, therefore, it is difficult to perceive (or hallucinate) whatever our internal models dictate because we cannot act however we want. This is why psychosis almost never leads people to believe they are walking on water or through walls. Even in PTSD, hallucinations are rare unless individuals also suffer from schizophrenia (Steel 2015), which involves nervous system breakdown, not merely predictive models gone awry. One overarching idea is that cognition is a practical tool and not specifically an inward mirror of outward events, though it can be this in certain circumstances. An epistemological corollary is that it is perhaps time to jettison truth vs. utility dichotomies. Thus, when we claim that walls are solid in everyday life, we are recognizing that we will get injured if trying to walk through them (Crippen 2010, 2017). To the extent that we encounter them this way, even though they are mostly space on an atomic level, we perceive them veridically, if one

wants to use that language (and notice that even atomic accounts of matter are action-based, i.e., grounded in what scientists can do to or with entities they investigate). Accordingly, it gets a little empty for cognitive scientists to advise replacing “categories of the objective world” with “categories of an organism’s perceptual world” (Hoffman 2009, p. 153) since the two are practically indistinguishable of when it comes to the impact that smashing headfirst into a wall has on us.

Summing up, then, central claims made in this article were (1) that predictive processing accounts neglect cases in which mismatches between predictions and outcomes can indicate adaptive success and epistemic attunement to a problematic situation, as per the earlier dog illustration and various PTSD examples. It also turns out (2) that predictive processing advocates are sometimes wrong even to suppose there is a gap between predictions and outcomes, as in the case of depressed people seeing objects as farther away, compared to those in sanguine moods. This means (3) that even if one accepts correspondence epistemologies (which predictive proponents often tacitly assume), that there is not much in the way of prediction errors here. But (4) given the repeated claims from predictive processing devotees that mental models are for action, correspondence criteria are incongruent with many of their accounts.

Occasionally, emotions and moods can be maladaptive and epistemically problematic, though the reverse is usually so. As a last case in point, consider Wormwood and colleagues’ (2017) previously cited finding that Boston students who were manipulated into anger interpreted ambiguous but neutral stimuli as threatening in the same week as the marathon bombing, yet not a month or five months after. This interesting result can rightly be classified as problematic bias and one that predictive processing helps explain. It accordingly stands as a reminder of a meta-issue pursued throughout this article: that the complexities of psychic life call for explanatory pluralism. This invites us to recognize that developing better accounts of mind may require mixing currently antagonistic outlooks, such as traditional representationalism and radical enactivism. Something similar holds for comparatively simpler matters. We cannot find necessary and sufficient conditions for anxiety, or epistemologies that hold in all situations.

Likewise, we cannot show that depression and PTSD always or even usually involve maladaptive prediction errors.

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