Attention and Cognitive Control in Affective Perception for Embodied Appraisals

William P. Seeley, Bates College

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Abstract: Embodied appraisal theories like Prinz (2004) treat emotions as direct, noncognitive embodied responses to biologically and behaviorally salient aspects of the environment that are under environmental control. Prinz defines cognitive states and processes, in contrast, as mental states and processes that are under organismic control. Organismic control is, in turn, defined relative to top-down neurophysiological processes that originate in prefrontal cortex and are associated with executive control of behavior. Recent evidence from affective neuroscience shows that neurophysiological measures of emotional responsiveness to emotion laden facial expressions are modulated by the availability of endogenously controlled attentional resources in run of the mill high attentional load contexts. Endogenous shifts of attention are under the top-down control of neurophysiological processes originating in prefrontal cortex associated with executive control. I argue that this entails that embodied appraisals are, by definition, cognitive representations of the biological significance of environmental stimuli under organismic control.
Attention and Cognitive Control in Affective Perception for Embodied Appraisals

I would like to tell a short story with a fairly simple plot about the cognitive status of embodied appraisals in Jesse Prinz's (2004) embodied appraisal theory of emotions (EAT-P). EAT-P treats emotions as direct, noncognitive embodied responses to biologically and behaviorally salient aspects of the environment with bearing on our well being that are under environmental control. EAT-P defines cognitive states, in contrast, as mental representations and processes that are under organismic control. Organismic control is defined relative to top-down neurophysiological processes that originate in prefrontal cortex and are associated with the executive control of behavior. Prinz acknowledges that the physiological states constitutive of embodied appraisals can in some contexts be induced by thoughts and imaginings. However, he argues that direct, perceptual cases are foundational and more commonplace, that our everyday emotional experiences are under environmental as opposed to organismic control. And herein lies the rub. Recent research in affective neuroscience demonstrates that emotional responsiveness to emotion laden facial expressions is dependent upon the availability of internally generated, or endogenously controlled, attentional resources in ordinary perceptual contexts. The deployment of endogenously controlled attention resources is a canonical example of a top-down neurophysiological process originating in prefrontal cortex that is associated with executive control. Therefore, the evidence from affective neuroscience suggests that affective perception is rarely direct and unmediated in the sense Prinz suggests. It is rather, by Prinz's own definition, under organismic control.

1. A short story about emotions

EAT-P is designed to stand as an alternative middle ground between cognitivist and non-cognitivist theories of emotions. Non-cognitivists identify emotions with the experience of a range of bodily feelings associated with our encounters with biologically and behaviorally salient thoughts and stimuli. For instance, to borrow a hackneyed example, seeing a bear in the bushes on a hike directly causes our heart
to race, our skin to tingle, and our respiration rate to quicken. Of course, emotions are associated with
attendant thoughts. These thoughts include basic perceptual categorization judgments ("That is a
bear.") and appraisals of the relationship between their objects and ourselves (in this case an assessment
of high risk or immanent danger). But, the emotion is distinct from these thoughts. It is the feeling of
one's autonomic physiological responses to a stimulus that is the emotion on the non-cognitivists' account.

There is an intuitive plausibility to this view. Feelings are an intrinsic part of our folk understanding of
emotional states. Further, the simple cognitive judgment that a bear is an immanent danger doesn't alone
seem like an emotion. The feeling is the critical, defining part of one's occurent fear response in this case.

Cognitivists argue that there is something odd about the view that the content of an emotional
state is a non-cognitive bodily feeling. It makes sense to say that you were scared of that bear because
bears can be an immanent danger to medium-sized, thin-skinned mammals like yourself. It makes sense
to say that you froze in place because you recognized these facts about the relationship between hungry
bears and humans. But, it is not quite so sensible to say that you were scared of your racing heart, tingling
skin, and shallow quick breathing. Cognitive appraisals of organism-environment relations, of the
relationship between perceived or conceptualized objects, events, or actions and our own well-being,
would therefore seem to be critical aspects of emotions. The feelings associated with these appraisals may
color experience, draw attention, or otherwise enhance responsiveness to emotion-laden stimuli. But these
feelings are not the emotion itself on the cognitivists' account. They are an effect of otherwise cognitive
processes that tag stimuli relative to their bearing on our physical and psychological well-being. What
really matters emotionally for feelings is that they have the right cognitive etiology, that they are the
consequence of appraisals of the affective significance of a stimulus.

This view also has an intuitive plausibility. Emotions are reactions to states of affairs that we
recognize as having a bearing on our apical and instrumental goals or more generally our well-being. But,
counterintuitively, it implies the possibility of affectless emotions. And this seems plumb wrong.
Assessing the threat of the bear on the trail independent of the associated feeling-response simply
wouldn't count as being scared. Feelings are not contingent reactions to emotions, they are intrinsic parts
of them. And short a plausible scientific story that writes feelings out of emotions, this is an aspect of our concept of emotions we would be hard pressed to give up.

EAT-P retains the central intuitions of both of these theories by grounding appraisals of organism-environment relations that bear on our well-being in those bodily states constitutive of the feeling of an emotion. The general claim is that these bodily states are direct perceptual responses that are under environmental control, states that directly register bodily changes for the sake of tracking and representing the organism-environment relations that reliably cause them. This enables EAT-P to account for the constitutive role of feelings in emotions, the world-directed contents of emotions, and the role emotions play in behavior. Emotions are perceptions of those bodily changes that encode the biological and behavioral significance of objects, events, actions present in our local environment and our recollections of them.

2. Organismic control, environmental control, and embodied appraisals

EAT-P defines cognition as a process that activates, maintains, or manipulates a representation that is under organismic, as opposed to environmental, control. The contrast between organismic and environmental control can be articulated via a distinction between percepts and concepts. A percept is defined within the theory as a mental representation directly caused by sensory interaction with the world. Impressions of percepts can be stored in memory to be used later under organismic control as concepts. But, Prinz argues that they are functionally distinct from concepts. Think of it this way. When we visually encounter an object in the world it causally generates a visual percept, a representation of its shape at an orientation. This percept may be matched to a representation drawn from memory. This process may, in turn, enable a perceiver to categorize the identity and/or salience of that object, event, or action, e.g. as the neighbor's friendly dog barking a greeting. However, the percept itself is not a concept -- it is not under organismic control. It is under direct, unmediated control of the environmental stimulus it tracks and represents. The representation drawn from memory by the percept is, in contrast, a concept. It is a state that is potentially under organismic control. But this claim comes with a caveat. In the perceptual case the
concept is activated as a direct causal consequence of the production of the perceptual state -- as a reflexive response to a perceptual experience. Therefore, it does not technically count as a cognitive state -- it is under environmental, not organismic, control. It is in this sense that embodied appraisals are non-cognitive mental states -- the conceptual apparatus constitutive of an affective appraisal is directly triggered in these contexts by perceptions of bodily change that are themselves directly triggered by the environmental stimuli they track and register, neither is under organismic control. They are not under organismic control but rather are parts of direct embodied responses that prime a dynamic perceptual and behavioral reactivity to dynamic affectively charged stimuli, e.g. a coiled snake or a foraging bear.

EAT-P defines representations and processes that are under organismic control, in contrast, as representations and processes that are under the top-down control of feedback projections from prefrontal brain regions associated with executive control systems, e.g. the role dorsolateral prefrontal cortex plays in spatial working memory and endogenously cued shifts of attention, or the role orbitofrontal cortex plays in endogenously cued shifts of attention related to the attribution of biological significance to a stimulus (which is encoded as its valence). Prinz argues that these executive processes may indirectly influence perceptual states by directing the orientation of our bodies or changing the direction of the focus of perception, but that they do not play a direct constructive role in the activation or maintenance of ensuing visual representations. Therefore, although endogenously directed attention itself is a canonically cognitive process, perception that is under the control of endogenous shifts of attention is not. Rather, changes in the orientation of attention occur prior to the engagement of perceptual processes -- like changing the position and focus of your camera lens prior to triggering the shutter reflex. Of course, emotions can be triggered by imagining an object, event, or action that would ordinarily elicit these kinds of responses. However, Prinz argues that the majority of our day-to-day emotional experiences are not cognitively mediated like this -- they are the product of direct, unmediated autonomic physiological responses to changing circumstances in our local environments (Prinz, 2004, p. 77).

3. Affective attention and affective perception
The EAT-P view that emotional responses are non-cognitive embodied appraisals is version of what Luiz Pessoa and Ralph Adolphs call the *standard hypothesis* about affective perception and attendant emotional responses. The standard hypothesis is that emotions are direct, unmediated responses to a special class of environmental stimuli, or that affective perception is initially handled by a fast, dedicated, modular system that directly feeds visual perceptual information to the amygdala via superior colliculus and pulvinar, and generates automatic emotional responses to biologically significant stimuli independent of cortical influences associated with cognitive processes like attention or perceptual categorization (Pessoa and Adolphs, 2010, p. 773; see also Prinz, 2004, p. 50).  

There are three critical sources of support for the standard hypothesis: behavioral evidence of fast, non-conscious perceptual responses to coarse-grained, low spatial frequency, emotion laden stimuli, e.g. degraded photographs of emotional facial expressions; anatomical evidence of a "low road" subcortical pathway in rodents; and the observation that it would be highly adaptive to have a capacity for fast, automatic, perceptual processing of biologically significant stimuli in a dense, noisy, and often dangerous environment.

The trouble with the standard hypothesis is that current research does not support it (see Pessoa & Adolphs, 2010). Response latencies within high-road cortical pathways are statistically indistinguishable from those observed in the subcortical pathway, even for prefrontal areas associated with working memory and attention. Further, reaction times for detecting fearful faces among distractors in patients with amygdala lesions are within the normal range. Finally, as mentioned above, affective responses to emotion-laden stimuli in moderately high attentional load tasks depend on the availability of attentional resources (see Pessoa et al, 2002). In these studies participants viewed a series of photographs of faces with fearful, happy, and neutral expressions on a standard computer display. In an attended condition they performed a gender discrimination task on the faces. In an unattended condition they fixated on the center of the face and performed a same/different orientation discrimination task while covertly attending to sets of eccentrically presented rectangular bars. As expected, and consistent with the standard hypothesis,  

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1. An analogous story can be told about cortico-thalamic connectivity with the amygdala in the auditory pathway (Winer, 2009).
fearful and happy faces produced greater amygdala activation than neutral faces in the attended condition. However, in the unattended condition, despite the fact that participants were staring directly at the center of the faces, amygdala responses to all three types of stimuli were equivalent and statistically indistinguishable from zero. Analogous results have been demonstrated for the perception of basic sensory features, pictures, and words (Rees et al, 1997, 1999; Koivisto & Revonuso, 2007). These results demonstrate that there is nothing special or unique about our quick and dirty perceptual responses to emotion laden stimuli. Affective perception is functionally analogous to, and depends upon the same cognitive resources as, feature detection, object recognition, and word recognition.

An embodied appraisal theorist can accept these results. EAT-P does not claim that embodied appraisals are never cognitive responses. In fact they often are. These include cases in which emotional responses are triggered by imagination, cases in which emotional responses are triggered by conceptualizing an emotion laden object, event, or action, e.g. simulating the consequences of particular behaviors for action planning and decision making, and cases where calculating the behavioral significance of a currently present stimulus requires some degree of conceptualization, e.g. an emotional response to the realization that a college exam appears harder than one had expected (Prinz, 2004).

Embodied appraisal theorists need only assert that the latter kind of high attentional load tasks don't make up the bulk of our ordinary, everyday emotional commerce with the world. This claim has an initial plausibility. It doesn't feel like our emotional responses require any mental work and it would clearly be adaptive to be hardwired to the biological & behavioral significance of objects and events in our environment in just this way. Unfortunately, the computational story about perception does not sort out so cleanly.

Perceptual systems are limited capacity computational systems that help us function in a dense and noisy environment replete with potentially salient information. Selectivity is, therefore, a critical feature of perceptual systems. Of course, some features stand out because they are significantly different than their neighbors, they are brighter, more luridly colorful, faster, or simply move suddenly -- if something changes position abruptly you should likely pay attention to it, at least until you can assess its
potential salience to your well-being. However, it is hardly likely that behaviorally salient perceptual features are ordinarily the most perceptually salient -- this is certainly rarely the case when I am making peanut butter sandwiches at my crowded kitchen counter. The same is true of emotion laden stimuli. It is certainly likely to be the case that we have developed stereotyped response patterns to stable categories of biologically salient emotional stimuli. However, Pessoa's research demonstrates that the differences among neutral and expressive faces are not perceptually salient. They don't naturally call attention to themselves in a crowd, even when we are looking right at them. And if this is the case for a perceptually stable and important class of emotional stimuli like expressive faces in an uncluttered experimental environments, the problem most certainly generalizes to the motley variety of crowded novel circumstances that we actively engage in day-to-day life.

*Biased competition models* for attention suggest a solution to the problem of selectivity. Top-down cortico-fugal affective, unimodal perceptual, and sensorimotor attentional networks bias perception to behaviorally salient environmental features in everyday perception by priming the firing rates of populations of neurons in visual, auditory, and somatosensory sensory systems to our cognitive and behavioral expectations, e.g. an attentional circuit connecting dorsolateral prefrontal cortex, frontal eye fields, and the visual system via superior colliculus biases visual processing as early as the lateral geniculate nucleus in the thalamus, and an analogous circuit connecting orbitofrontal cortex, ventromedial prefrontal cortex, and anterior cingulate cortex with amygdala biases affective attention and perception at an analogously early stage (Duncan and Barrett, 2007). These attentional circuits enhance the firing rates of populations of neurons that would fire for the perception of target objects or events at expected locations and inhibit the firing rates of neurons that encode for distractors at those locations. Critically, all of these networks converge on superior colliculus and amygdala, generating a cross-modal sensorimotor-affective circuit that biases both our perceptual and emotional responses to environmental stimuli to cognitive expectations about their structure, function, and affective significance, e.g. significance to our well-being and the goals of our current behavior. Iterations of these cortico-fugal attentional circuits, in turn, implement working memory and explain how cognitive resources are used to actively modulate the
production of perceptual representations, including somatosensory representations of bodily change constitutive of embodied appraisals.

4. The cognitive status of embodied appraisals.

The evidence from affective neuroscience demonstrates that attentional resources are required for affective perception in moderately high, but fairly run-of-the-mill, attentional load tasks. The problem of selectivity suggests that affective perception is an analogously high attentional load task in most ordinary, everyday contexts -- if the bulk of the affectively salient perceptual features in the local environment germane to everyday behavior are not particularly perceptually salient relative to the rest of the visual field, then we have to be on the look-out for them. This entails that Pessoa's results generalize -- attentional resources are required for affective perception and embodied appraisals in ordinary, everyday contexts. Of course this is an empirical claim, but the convergence of evidence Pessoa and Adolphs report from affective neuroscience supports it. Furthermore, biased competition models demonstrate that affective attention, like selective attention more generally, is a process through which an organism activates representations of perceived and expected objects and events in order to direct perception and actively shape the contents of perceptual representations. Therefore, EAT-P commits us to the view that embodied appraisals are on balance, by definition, cognitive states, or mental representations that are under organismic control in everyday perceptual contexts.
References:


