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Does the Problem of Variability Justify Barrett's Emotion Revolution?

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Abstract
The problem of variability concerns the fact that empirical data does not support the existence of a coordinated set of biological markers, either in the body or the brain, which correspond to our folk emotion categories; categories like anger, happiness, sadness, disgust and fear. Barrett (2006a, b, 2013, 2016, 2017a, b) employs this fact to argue (i) against the faculty psychology approach to emotion, e.g. emotions are the products of emotion-specific mechanisms, or "modules", and (ii) for the view that emotions are constructed from domain-general "core systems" with the aid of our folk concepts. The conjunction of (i) and (ii), she argues, heralds a paradigm shift in our understanding of emotion: emotions aren't triggered but made. In this paper, I argue such a shift is premature for a faculty psychology framework can accommodate the neurobiological variability of emotion. This can be done by treating emotions as developmental modules: non-innate systems which behave like modules, but form as a product of ontogenetic development.

1 Introduction

What is the status of faculty psychology in emotion-research today? Faculty psychology, in general, is an approach to the mind that takes seriously the heterogeneity of our mental faculties. It presupposes that fundamentally distinct kinds of psychological mechanisms are required to explain mental phenomena. The most popular version of it today takes the mind to be made up of modules: functionally specific mental structures that underly certain cognitive capacities, e.g. perception, language acquisition, and so on (Fodor 1983). Empirically-informed research on emotion tends to fall into the faculty psychology paradigm, much of it assuming that emotions are the products of emotion modules: systems/mechanisms/programs hard-wired into our brains by evolution, and purpose-built to generate our emotions.

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While the modularity of emotion has proved influential, its legitimacy has always been controversial. The standard complaint is that this picture is too reductive and cannot fully account for the richness of our emotional lives. In recent years, we have also seen an altogether different criticism, one arguably more damning, viz. experiments inspired by the faculty psychology approach to emotion ironically yield data that undermines this very approach. More specifically, the data, it turns out, do not support the existence of a coordinated set of biological markers, in the body or the brain, which correspond to our folk emotion categories, e.g. anger, sadness, happiness, disgust and fear (Barrett 2013). This is the problem of variability.

What is the right lesson from variability? In her work, summed up in *How Emotions Are Made: The Secret Life of the Brain*, Barrett takes the absence of biological "fingerprints" to herald a paradigm shift in our understanding of emotion: emotions aren't triggered but made. Or more specifically, emotions are psychological constructs as they result from domain general "core systems" instead of any emotion-specific mechanisms or modules. Moreover, they are also social constructs because our folk concepts play a role in how emotions form. That is, our folk categories, like 'fear' and 'anger', aren't just involved in how we categorise our emotions. They also literally figure in how our emotional experiences are constructed in the first place. On this view, there is no objective, scientific taxonomy of emotions to be discovered. Our emotion categories, rather, are things we make up on the fly based on our socio-cultural contexts.[1]

Barrett has done a great service in arguing for the variability of emotion. However, it is my view that she also sets up a false dilemma: either emotions have biological fingerprints or they are psychological-cum-social constructs. I think we should accept the empirical data at face value, in which case there is an absence of biological markers that correspond one-to-one with our folk emotion categories. But doing so does not preclude the possibility of there being emotion modules; mechanisms/systems/programs that trigger our emotional responses. The aim of this paper is to offer an explanation of how this is possible.

My argument, in a nutshell, is that we can accommodate the neurobiological variability of our emotions within a faculty psychology framework by thinking of emotions as the products of developmental modules: non-innate systems which behave like modules, but form as a product of ontogenetic development. If I am right, there are two important lessons to draw here. First, both constructionist and faculty psychology approaches to emotion are, *ceteris paribus*, on a par when it comes to explaining the variability of emotion. Subsequently, there is no need for such a

[1] See also Barrett (2006a, b, 2013, 2016, 2017a). Note: as a point of biography, Barret arrives at her constructionism for a myriad of reasons. For example, she is influenced by Russell's (2003) psychological constructionism, which in turn was a response to the methodology employed in Ekman's (1972) facial expression studies. She also adopts Mayr's (2004) Darwinian population thinking, where we treat biological entities (species in Darwin's case and emotions in Barrett's) as a population of unique individuals, i.e., instead of things which share certain essential properties. In that regard, Barrett can be seen to be employing the recent variability data not as a means to arrive at constructionism per se (which might be the impression you get from her book), but to discredit faculty psychology and to confirm her constructionism.

radical revision of our understanding of emotion. Yes we need a new version of faculty psychology but we needn't abandon such a psychology as an approach to emotion research completely. Second, what emotion research has so far got wrong is not an adherence to faculty psychology per se, but rather the nativist assumptions built into this approach. These are important lessons for emotion research going forward. But they also generalise. Insofar as we forgo nativism, neurobiological variability of a given domain needn't entail the absence of systems/mechanisms/programs specific to that domain. Rather, such variability, if anything, is to be expected.

2 The Problem of Variability

The problem of variability, very roughly, concerns the fact that empirical data do not support the existence of a coordinated set of biological markers, either in the body or the brain, which correspond to our folk emotion categories; categories like anger, happiness, sadness, disgust and fear (Scarantino 2015). The basic idea here is pretty straightforward. However, the precise sense in which emotions are variable, as well as why this actually poses a problem, is in need of clarification.

2.1 Getting to Grips with Variability

In a very general sense, the variability of emotion concerns the fact that our emotions are heterogeneous phenomena. They turn out to manifest considerable variability in their phenomenological, physiological, behavioural and neurobiological expressions. Loaiza (2020) calls this "the Variability Thesis" and goes on to argue that it is "problematically underdefined" (pg. 4). I am sympathetic to this claim and will therefore restrict our inquiry into only one aspect of this variability, viz. variability at the neurobiological level. More specifically, our target will be what Loaiza calls "NOC_{Neural}", i.e. that "there is no one-to-one correspondence between emotion categories and any pattern of neurobiological responses" (Loaiza 2020: 4).

This choice of variability rests on two reasons. First, while we have known about phenomenological, physiological and behavioural variability for a long time, what is most exciting and surprising about recent meta-analyses is that they demonstrate the variability of our emotional responses at the neurobiological level (Barrett 2013). Second, this is also what strikes me as the most significant form of variability at issue in the current debate. While various kinds of variability where previously known, there was also the hope of unifying emotions, and to think of some of them as basic emotions/natural kinds/modular systems, on grounds that these differences still stem from a stable set of underlying neurobiological causes (Griffiths 1997). This has now been called into question.

The question for us is how to best accommodate the recent empirical data that shows this sense of variability to be the norm. It strikes me that an adequate answer must do two things. First, it must accommodate, if not explain away, these data. Second, it must do so in a way that accommodates, if not explains away, the unity of emotion. That is, any response must explain why a set of instances are all instances

of the same phenomenon, i.e. emotion. This is what I consider to be the problem of variability. In the broadest sense, the problem concerns how to best account for neurobiological variability. But precisely why this poses a problem will depend on your view of emotion. Present theories of emotion face one of two problems. Either they grant the unity of emotions at the expense of denying what seems to be an empirical fact, i.e. the neurobiological variability of emotion, or they accept this variability at the cost of denying the unity of emotion.

2.2 Getting to Grips with the Problem(s)

To reiterate, why variability actually proves to be a problem depends on your view of emotion. Barrett, for instance, uses these findings to raise scepticism about the "topological/faculty/natural kind approach to emotion" (2013: 381). What Barrett means by this is a moving target, but it is fair to say that the views she often has in mind (e.g. that emotions are natural kinds, that some emotions are basic, that they are reducible to neural states) are Darwinian in conception: they tend to suppose that emotions are the products of systems/mechanisms/programs hardwired into our brains by evolution, and purpose-built to generate emotions.[2] In other words, there are the products of emotion modules. The problem for this view is that meta-analyses show that there is no one-to-one correspondence between our emotion categories and any particular neurobiological systems in the brain which we can identify as emotion modules.

Variability, however, also proves to be a problem for anyone who wants to deny this approach. This is because they have to offer not just a rival view of how emotions are produced, they also need to explain how they are produced in such a way that respects our emotion categories. Barrett responds to this challenge by arguing that emotions are both psychological and social constructs. The former is supposed to explain, in a general sense, how they are produced. They are produced, she argues, by domain general "core systems" instead of any purpose-built emotion mechanisms or modules. This is the psychological constructionism she gets from her mentor, Russell (2003). Moreover, they correspond to our folk categories because our everyday emotion-concepts play a role in how emotions form. On her account, our folk categories, like fear and anger, aren't just involved in how we categorise our emotions. They also literally figure in how our emotional experiences are constructed in the first place. This is her social constructionism, which heralds a departure from Russell.

While Barrett's theory of constructed emotion has proved popular with psychologists and neuroscientists, both forms of constructionism assumed in this theory are also controversial. Barrett's social constructionism is a hard pill to swallow, for it entails that creatures lacking in emotion concepts lack emotional experiences. Moreover, as Scarantino (2015) observes, Barrett doesn't provide us with a story about

[2] She also targets the view that emotions have "physical essences" which show no significant physical variation across individuals. I doubt anyone in the present debate takes this view seriously and therefore will set it aside.

how we acquire our emotion concepts in the first place, thus making it mysterious how we ever acquire them as the obvious explanation, i.e. we acquire them by having emotions, isn't available to her.

Barrett also can't confirm her psychological constructionism in the way she assumes, as the evidence that supports variability underdetermines whether emotions are produced by core systems or domain-specific emotion modules. For example, as Scarantino points out, while there is a lack of evidence to show that there are hardwired mechanisms in the brain that correspond one-to-one with our folk emotion concepts, this doesn't preclude the possibility that there are hardwired emotion systems which outstrip such concepts. For instance, there might not be one specific emotion-generating mechanism for our vernacular category fear. But this doesn't rule out the existence of several distinct fear generating systems, ones which correspond to distinct fear categories, say fear1 and fear2.

Scarantino, in effect, provides us with an alternative response to the problem of variability. To give this some context, Scarantino himself is interested in defending a viable version of the basic emotion theory. According to the traditional version of this theory, there are specific emotion-generating mechanisms that correspond one-to-one with our basic emotion categories, e.g. fear, anger, sadness, happiness, joy etc.[3] This doesn't seem right in light of recent evidence, and constructionists are quick to conclude from this that there aren't any emotion mechanisms. But as Scarantino notes, the data are compatible with the existence of multiple emotion-generating mechanisms.

To elaborate, Scarantino offers us a new way of understanding the basic emotion theory. While he accepts that there is no one-to-one correspondence between our *folk* emotion categories and any pattern of neurobiological responses, he thinks there will be significant correspondence between our basic emotion categories, whatever they turn out to be, and our neurobiological responses. Subsequently, an instance of a basic emotion, say fear1, counts as fear1 because it is underlined by a specific neurobiological response that acts as a biological marker for fear1.

One problem with this view is that it doesn't offer us a story about how we are to think of non-basic emotions in the face of variability. More problematic for the view, the existence of emotion-specific programs also isn't something presently supported by the empirical data. To clarify, Scarantino envisions such programs as being concrete as opposed to abstract entities, for he claims that there will be "clusters of biological markers driven by hardwired neural programs" (pg. 364). The obvious benefit of this is that we would have neurobiological markers that could accommodate the unity of our basic emotion categories. But the downside of this is that whether we will actually find such markers or more variability is very much an open question.

I don't think the problems with either emotion constructionism or the new basic emotion theory are decisive, but I do think they are significant. What's interesting to take note is that such problems result from the way these responses to the problem of variability trade off between variability and modularity. Barrett accepts the

[3] Proponents of this view include Ekman (1999), Izard (1992), Panksepp (1998), and Levenson (1992).

neurobiological variability of our emotion-generating systems, and thereby denies their modularity, whereas Scarantino denies the neurobiological variability of a certain sub-category of emotions by upholding their modularity. Moreover, Barrett gets into a bind precisely because she denies modularity. She needs to explain the unity of emotion somehow, and it looks like on her view this is achieved via the contentious idea that emotions are built from our folk emotion categories.[4] Analogously, Scarantino's view ends up being controversial because he denies variability. In order to account for the unity of basic emotions, he posits the existence of certain emotion-specific modules, which isn't supported by the extensive empirical data presently on offer. I take as my starting point the observation that these choices don't exhaust all our options when it comes to the problem of variability. That is, instead of a tradeoff, I think we can grant both variability and modularity. In other words, I think we can accommodate variability within a framework of faculty psychology.

3 Faculty Psychology Revisited

How, then, should we accommodate neurobiological variability within such a framework? I think we can do so in two steps. First, we must forgo the nativist assumptions built into popular faculty psychology approaches to emotion. Second, we should replace these assumptions with certain developmental insights; insights that better accommodate environmental influences on cognitive-cum-neural development.

3.1 Cognitivism Nativism

Approaches to emotions within the framework of faculty psychology tend to be Darwinian in conception: they tend to suppose that emotions are the products of systems/mechanisms/programs hardwired into our brains by evolution, and purpose-built to generate emotions. Such nativist conceptions of faculty psychology are legion. Moreover, it is also a nativist conception of faculty psychology that Barrett takes as her primary foil: "Our emotions, according to the classical view, are artifacts of evolution, having long ago been advantageous for survival, and are now a fixed component of our biological nature" (Barrett 2017b: xi). I think Barrett is right to challenge this view on grounds of variability. But I also think she is wrong to infer from such a challenge that we need to radically revise how we think about emotion. In particular, that we need to forgo faculty psychology completely.

At a first glance, why nativism is incompatible with variability isn't entirely obvious. Barrett's main charge is that emotions lack "biological fingerprints"; roughly, neurobiological profiles that can act as markers for each emotion type.

[4] For both Barrett and Russell, the affective phenomena we call emotion will be similar in the sense that they are grouped together because they fit our emotion prototypes/scripts/concepts. The difference is Barrett, unlike Russell, goes further in supposing we won't actually experience emotions unless we categorise these phenomena under such prototypical concepts.

Cognitive nativism, in comparison, is a view about innate content and innate cognitive architecture:

> I want to emphasize that, qua modularity theory, the kind of nativism we're imagining thus postulates features of innate cognitive *content* as well as features of innate cognitive architecture. Each module comes with a database that is, in effect, what it innately believes about its proprietary computational domains. (Fodor 2000: 91)

Thus construed, there is no explicit requirement that innate content or inherited architectures be, more or less, the same across individuals. This has to do with the adaptationist assumptions built into such a nativism. As Fodor contends, "Just as Classical computation needs modularity, modularity needs adaptationism" (pg. 79). According to such an adaptationism, most of our cognitive traits are adaptations, and *ergo* the most significant factor in evolution is natural selection. Now, if modules are adaptations, in particular, adaptations to the Pleistocene environments of our ancestors, we would expect any inherited modules — baring genetic mutations, defects and other outliers — to be the same across individuals. In this way, adaptationism suggests that emotion modules hardwired by evolution should, more or less, remain stable. In other words, there should be biological markers for such emotions.

We find a similar relationship between adaptationism and nativism at more granular levels of modularity. To clarify, a module, in a very basic sense, is a functionally dissociable system. For example, in asking what it means to say that emotions are modular, Faucher and Tappolet observe that this would "mean, minimally, that emotions are cognitive capacities that can be explained in terms of mental components that are functionally dissociable from other parts of the mind" (2008b: vii). According to Fodor (1983), that modules exist in this very minimal sense isn't really controversial. What is controversial is whether there are systems that also bear certain "hallmarks" of modularity. This controversy carries over to the domain of emotion as well. For example, champions of emotional modularity, e.g. Charland (1995), Griffiths (1997) and Prinz (2004), argue for the existence of emotion-specific modules precisely because emotions bear such hallmarks. Griffiths, for instance, notes that a certain class of emotions, viz. basic emotions, possess the Fodorian hallmarks of being fast, mandatory, opaque, domain-specific and informationally encapsulated.

Out of the Fodorian hallmarks, two features deserve a special mention, for the question of emotional modularity has typically hung on whether emotions bear these features. First, modular emotions are supposed to be informationally encapsulated. To say that a cognitive system is informationally encapsulated, roughly, is to say that the function it computes is insensitive to what is going on elsewhere in the mind. More specifically, it is sensitive to incoming information and information already stored in the module but nothing else. Second, modular emotions are also supposed to be domain-specific. A cognition system is domain-specific, roughly, if its responses are restricted to a certain class of stimuli. If it, say, triggers in response to some stimuli but not others.

Some of our emotions seem encapsulated and domain-specific. For instance, consider recalcitrant emotions: emotions that run contrary to your judgements, e.g. being afraid of flying even if you rationally judge it to be safe; being angry at your

partner even though you know they haven't done anything wrong etc. (D'Arms and Jacobson 2003). These emotions are typically taken to be evidence for emotion-generating systems being (at least on occasion) informationally encapsulated.[5] In an analogous fashion, our emotions also (sometimes) appear domain-specific. We seem to have fear responses to specific cues, e.g. heights, loud noises, objects that look like snakes etc.[6] Whether any emotions actually bear such hallmarks of modularity is a source of contention. But the point is, both of these traits are typically construed as being innate, which given adaptationist assumptions have implications for variability.

It is worth being careful here as 'innatenes' is a notoriously ambiguous term. To say that our emotions are innate, in a very broad sense, is to say that we have "innate knowledge" of the domain of emotion. This tends to mean two things. First, it means that our emotion-generating systems are domain-specific in the sense that they are pre-programmed to trigger in response to specific *innately-specified* triggering properties. This is explained by the fact that they also have *inherited* proprietary algorithms. Second, it means that our emotion-generating systems are informationally encapsulated in the sense that they are only sensitive to incoming stimuli and *inherited* proprietary algorithms stored within the modules themselves. Moreover, it also tends to mean that these encapsulated systems are things we are either born with, or at least develop in a genetically pre-determined way, with minimal input from the environment.

As before, it isn't entirely obvious why this proves to be incompatible with variability. But looking at adaptationism makes this plain. The whole rationale for committing to innate systems is premised on adaptationist assumptions. For instance, the reason why our emotion systems are (allegedly) preprogrammed to trigger in response to specific cues is that this was adaptive. If such inherited traits are genuine adaptations, we would expect them to remain, more or less, constant in our species. Likewise, the reason why our emotions can (allegedly) be triggered in a way that is insensitive to background information except a small class of inherited proprietary algorithms, again, has to do with the fact that encapsulation was supposed to be an adaptation. If it genuinely was an adaptation, we would not only expect most members of our specifies to share such encapsulated modules, but also the proprietary algorithms that govern how such modules function. So though the notions of information encapsulation and domain-specificity don't, in and of themselves, entail the existence of any stable biological markers for emotion, adaptationist assumptions built into discussions of modularity suggest that there must be such markers.

This is an important lesson for us. Accounts of emotional modularity do seem to be in tension with variability, but only when seen through the lens of adaptationism. My question is, since adaptationism is generally thought to be problematic, why should a modular framework continue to retain its adaptationist premises?

[5] E.g. see de Sousa (1987) and Griffiths (1997). Also see Faucher and Tappolet (2008b) and Majeed (2019) for a discussion.

[6] E.g. see Tooby and Cosmides (1990).

In other words, why can't a modular framework make do without any claims about innateness?

Adaptationist explanations, in general, are thought problematic because they are neither verifiable nor predictive.[7] Such explanations, within the domain of emotion, are especially problematic. For one thing, as Deonna and Teroni (2012) observe, besides shop-worn examples, such as an innate fear of snakes, it is hard to come up with cases where emotions respond to specific classes of stimuli. Another significant issue is that adaptationist explanations tend to have a hard time accommodating emotional plasticity: that emotions can be shaped and reshaped by socio-cultural factors (Faucher and Tappolet 2008a). As Tomasello observes, "innate modules are supposed to unfold relatively independent of specific experiences, and they are not supposed to interact in meaningful ways with one another or with other domains of psychological development" (2019: 82). If that's right, it remains mysterious why we have emotional responses to stimuli radically different to those encountered in our evolutionary past, e.g. why we fear not only dangerous animals, but things like stock-market crashes and Brexit (Jones 2008).

To be clear, these challenges to adaptationism are compatible with the existence of systems in the brain that have evolved due to selection pressures. The trouble is, adaptationist explanations put forward in evolutionary psychology, in general, are poor guides when tasked with determining which traits are genuine adaptations. Moreover, when it comes to emotion more specifically, the kinds of adaptationist explanations on offer aren't just empirically underdetermined, they often run contrary to the available evidence itself. This is not the place to offer a full-blown critique of adaptationism. The question is, insofar as we are convinced that adaptationism is a problematic research program, why can't we strip a modular framework of its adaptationist assumptions?

One *prima facie* worry is that since its inception, the Fodorian notion of modularity has been so deeply enmeshed with nativism that it would be hard to disentangle them. I think there is something to this worry. But at the same time, it is also worth bearing in mind that it isn't as if things in cognitive science have remained static since Fodor introduced the notion of modularity. There are now a whole host of ways of thinking about modularity. Some of these, I take it, might provide clues as how to retain modularity *sans* cognitive nativism, and crucially, in a way that would be compatible with variability.

There is already some precedence for disentangling nativism and modularity within the domain of emotion. For example, Griffiths notes that "While the structure of the adaptive responses is innate, the contents of the system which triggers them are largely learnt" (1990: 175). I think this is a step in the right direction, but it doesn't go far enough. That is, if there are still innate structures, we would, *ceteris paribus*, expect to find them at the neural level. In other words, we would expect to find some neurobiological markers for emotion; something which is called into question by the evidence for variability. Nevertheless, it is my view that the very

[7] See Tooby and Cosmides (1990) and Cosmides and Tooby (2000) for examples, and Griffiths (1997) and Sterelny (2003) for critiques.

idea of innate structures itself can also be challenged. Instead of thinking of cognitive architecture as being fixed, we can suppose that this is something that develops, with variation, throughout an agent's lifespan. As we shall see, thinking of emotion development in this way will prove crucial to how we can accommodate variability within a faculty psychology approach.

3.2 Cognitive Development

My argument, simply put, is that we can accommodate the neurobiological variability of our emotions within a faculty psychology framework by thinking of emotions as the products of developmental modules: non-innate systems which behave like modules, but form as a product of various ontogenetic developmental processes.

To elaborate, the phylogenetic development of emotion concerns the evolutionary history of emotions in our species, whereas their ontogenetic development involves the development of an individual's emotional responses during their lifespan. Thus understood, ontogenetic development is a broad category. It captures both intrapersonal and interpersonal emotion development, respectively developmental changes in an individual's emotional responses over the course of their lives and changes in the development of emotional responses across individuals. Moreover, it also captures the development of an individual's ability to regulate their occurrent emotions (i.e. the emotions they experience at a given occasion), as well as the development of their ability to influence their emotional dispositions over time. Though phylogenetic development is an important issue for a theory of emotion, I am of the view that to explain variability, we need to focus on the broad spectrum of phenomena relating to ontogenetic development.

So how should we think of ontogenetic development? One way to think of such development is as the unfolding of a genetically pre-determined program. This is the nativist position. Nativists typically accept that the infant mind does not come equipped with a fully-fledged emotional repertoire. Nonetheless, it is a tenant of nativism that some emotions, e.g. the basic ones, develop with minimal input from the environment. What this means is that, although nativists can accept that certain emotions, e.g. guilt and Schadenfreude, are (partly) socio-cultural, they posit a set of emotions that develop, more or less, independent of experience and context. As we have seen, adaptationist assumptions built into nativism suggest that the development of such emotions will remain relatively stable across individuals. And this proves problematic because such stability implies the existence of a stable set of biological markers, which runs counter to neurobiological variability.

But this isn't the only way to think about ontogenetic development. A non-nativist way of thinking about development comes from the Developmental Systems Theory (DST), championed by Griffiths and Gray (1994). The DST is "a general theoretical perspective on development, heredity and evolution. It is intended to facilitate the study of interactions between the many factors that influence development without reviving "dichotomous' debates over nature or nurture, gene or environment, biology or culture." (Griffiths and Gray 2004: 417). When we look at emotion development from this perspective, the emotional phenotype, *contra* nativism,

is not preprogrammed into our genes, but rather depends on a whole host of factors, i.e. physiological factors (e.g. locomotion), social factors (e.g. parent reactions) and cultural factors (e.g. emotion concepts), as well as genetic factors (Faucher and Tappolet 2008a). If that's right, while there are still biological constraints on development, such constraints don't necessarily channel development in a direction programmed into the genotype. As Griffiths and Gray stress, "The role of the genes is no more unique than the role of many other factors" (1994: 277).

A similar idea can be found in neuroconstrucivism. The basic idea here is that cognitive development is constructed not innate, but such development is constrained by our brain, body and social environment. Like the DST, neuroconstructivism is best viewed as an overarching framework which can be applied to various developmental phenomena. As Westermann et al. contend:

> Neuroconstructivism is a theoretical framework focusing on the construction of representations in the developing brain. Cognitive development is explained as emerging from the experience-dependent development of neural structures supporting mental representations. Neural development occurs in the context of multiple interacting constraints acting on different levels, from the individual cell to the external environment of the developing child. Cognitive development can thus be understood as a trajectory originating from the constraints on the underlying neural structures. (Westermann et al. 2007: 75)

As far as I can tell, the exact relationship between the DST and neuroconstructivism has yet to be articulated. (The main difference seems to be that the DST has its inception in evolutionary biology, whereas neuroconstructivism was originally a view about neurobiology). What is salient is that both take a very similar approach toward cognitive development, and thereby prescribe very similar ways of thinking about emotion development. For example, on a neuroconstructivist approach to emotion, experience plays a key role in wiring the emotional brain, but in contrast to constructionism wholesale, the way experience wires the brain is still subject to certain biological constraints.[8] Likewise, according to the DST, while there are genetic factors that shape emotion development, these are to be thought of as just one amongst the many factors that shape such development. Without looking at concrete examples, what these frameworks actually prescribe for emotion development can appear rather abstract. But the crucial point for us is that, contrary to nativism, we have ways of construing emotion development that no longer guarantee that emotions will develop along a pre-specified trajectory. Which means there is no reason to suppose that emotion development will result in a set of biological markers unique to each given emotion type.

What does all this hold for faculty psychology? As we have seen, both the DST and neuroconstructivism provide us with ways to think about ontogenetic development which are markedly different from that prescribed by nativism. In particular, both approaches warn against positing innate modules. But crucially, both

[8] This, of course, is an over simplification. The brain on this approach is wired through "multidirectional" interactions between our genes, brain, cognition and environment (Karmiloff-Smith 2009).

approaches also employ the notion of developmental modules. The key insight here is that modules form as a product of development. That is, rather than think of modules as things we are born with, or unfold in a genetically pre-determined manner, modules form because of the sorts of developmental processes outlined above.[9] For example, as Karmiloff-Smith observes, "neuroconstructivism maintains that if the adult brain contains modules, then these emerge developmentally during the ontogenetic process of gradual modularization" (2009: 59).[10]

It is helpful to think of this process of modularisation in terms of the previously discussed hallmarks of modularity, viz. domain-specificity and information encapsulation. The process of modularisation departs from the nativist picture of how modules form in two ways. First, we are not born with domain-specific systems. Rather, we come equipped with certain "domain-relevant" systems: systems which are relevant but not innately-specified for processing certain kinds of inputs.[11] Second, nor are we born with informationally encapsulated systems. Rather, a limited set of domain-relevant biases act as a constraint on development, which in turn (sometimes) leads to the development of encapsulated systems. A general outline of this process goes as follows.

The domain-relevance of certain cognitive systems, along with various sociocultural factors, bias us towards processing certain kinds of inputs over others. Such biases in turn can lead to the gradual development of brain circuits progressively selected to process inputs of that kind. Such information is processed more often, but also more quickly and automatically. This specialisation, however, comes at the expense of these processes becoming less accessible to central cognition and also less sensitive to what is going on elsewhere in the brain. In other words, the specialisation comes at the expense of systems becoming more and more informationally encapsulated (Karmiloff-Smith 1992).

On this picture, the domain-relevance of a cognitive system, then, doesn't entail that there is such a thing as an encapsulated module for that domain. Rather, encapsulated systems, if they develop, are products of a process of modularisation, where cognitive systems become more and more specialised for processing certain kinds of information, at the expense of being less sensitive to other kinds of information. The overall lesson, then, is that instead of thinking of encapsulated modules as the starting point of development, here we see them as the endpoints of certain ontogenetic processes.

This pushes us away from the nativist position that we are born with emotion-specific systems (e.g. ones that are homologous across species) towards something closer to Russell's psychological constructionism, where emotions result from domain-general core systems. I don't mind the constructionist label, but it is

[9] E.g. see Greenfield (1991), Karmiloff-Smith (1992, 1994, 2009, 2015), Mithen (1996), Lopez (2015), and Karmiloff-Smith et al. (2018).

[10] See Griffiths and Stotz (2000) for a discussion of developmental modules within the framework of the DST.

[11] In earlier work (e.g. 1992), Karmiloff-Smith posits the existence of domain-specific systems, which she later replaces with the notion of domain-relevance (e.g. 2015).

important to recognise that the present view is different from Russell's constructionism in two important respects. First, on our view emotions result not from domain-general systems but rather domain-relevant ones. Second, these domain-relevant systems, through modularisation, can become emotion-specific. This means that though we might have something akin to psychological constructionism, we have a view that, unlike Russell's, vindicates a form of faculty psychology.[12]

Why should we believe this view? The most compelling evidence seems to come from neural plasticity: "knowing what we do about the brain's plasticity, progressive modularization, rather than prespecified modularity, is more plausible. By definition, precoded encapsulated modules could not reconfigure themselves. By contrast, modularization is a function of multiple levels of environment/organism interactions" (Karmiloff-Smith 1994: 733). If modules do form, the gradual process of modularisation provides a better explanation of their formation than the unfolding of a genetically pre-determined program.

Now, I appreciate that I have not said enough here to give a thorough exposition, let alone defence, of the idea of modularisation. The devil is really in the detail. The point for us though is that this process of modularisation is ripe for explaining why emotions can be modular and still show significant variability at the neural level. Module-like emotion systems may form in the course of development, via certain dynamic interactions between agents and their environment, which is constrained, but not determined, by their genes. Such developmental processes also give us a way of explaining interpersonal emotional differences. Differences in the emotional dispositions across individuals can be explained by differences in their developmental setting. The development of emotional modules, though constrained by our biology, can be shaped, and reshaped, by socio-cultural factors. The important point for us is that developmental modules show variability, i.e. both in their developmental patterns and in the outcomes of these patterns. Moreover, this is important because if cognitive development shows traces at the neurobiological level, we would expect the neurobiological realisers of these developmental processes and outcomes to manifest variability as well.

One downside of appealing to domain-relevant instead of domain-general systems is that we might, inevitably, still commit to some overlap in the neural correlates of emotion across individuals. According to Barrett, "Brain regions like the amygdala are routinely important to emotion, but they are neither necessary nor sufficient for emotion" (Barrett 2017b: 19). This is a controversial claim but suppose she is right. Doesn't our account suppose that some regions will be necessary for emotion? Not necessarily. I think we can understand domain-relevance along the same lines as something being "routinely important" in Barrett's sense. That is, there might several distinct emotion-relevant systems but this is not to say that any

[12] Note: while we get a view that results in distinct emotion systems, this in itself does not entail the existence of an overarching emotion faculty as such. While neurobiological variability makes the existence of an emotion mechanism which is common across all instances of emotion unlikely, we might still differentiate emotion from other psychological phenomena, e.g. perception and cognition, because of their functional profile. See Section 4.3.

one of them is shared across all instances of emotion or even an emotion type such as fear. If we are to understand domain-relevance in this non-essentialist sense, it need not be incompatible with neurobiological variability.

In summary, I think variability can be accommodated within a faculty psychology paradigm by treating emotions not as the products of innate modules, but rather as developmental modules: modules which form due to various ontogenetic processes. Both the DST and neuroconstructivist frameworks are useful in that they help us understand ontogenetic emotion development in a way that is crucially different from nativism. In particular, we see that the development of emotion modules can show significant variation across individuals on account of the multitude of factors that constrain development.

Here it would be remiss not to mention that Barrett herself is sympathetic to neuroconstructivism:

> The theory of constructed emotion incorporates elements of all three flavors of construction. From social construction, it acknowledges the importance of culture and concepts. From psychological construction, it considers emotions to be constructed by core systems in the brain and body. And from neuroconstruction, it adopts the idea that experience wires the brain. (Barrett 2017b: 35)

The difference between Barrett's view and the ideas developed here is that she takes neuroconstructivism to be solely about neural development, whereas here we take the view to also be an overall framework that can be applied to cognitive development more broadly. Barrett stops short of this, and thereby seems unaware of the possibility that we can apply this very framework to accommodate variability. The take home message, then, is that if you are happy to accept neuroconstructivism, you don't need to also commit to Russell's psychological constructionism and Barrett's social constructionism to accommodate variability. This isn't to claim that these additional forms of constructionism are false, but that if you want to embrace them, *contra* Barrett, you need to appeal to something other than variability to justify your commitments.

4 Implications and Limitations

Thus far we have seen how certain developmentalist frameworks used to explain cognitive development can be utilised to explain the neurobiological variability of emotion without forgoing the need to abandon faculty psychology. In this final section, let me fill in some detail so that we may distinguish the present proposal from others in terms of the specific predictions it makes about the neurobiology of emotion, and in turn see what these imply for other forms of emotional variability (e.g. physiological variability) and the unity of emotion.

4.1 Neurobiological Variability

The primary "hallmark" of faculty psychology approaches to emotion is that there are emotion-specific centres in the brain (Barrett and Satpute 2013: 362). From a contemporary neurobiological perspective, the claim is that our brains contain emotion-specific neural circuits or networks, e.g. a network for fear, a network for anger, etc. Barrett's discussion of the neurobiological data, in particular, focuses on "neuroanatomical structure", measured via neuroimaging methods such as PET and fMRI scans (Barrett 2006a: 45). At this level of analysis, a faculty psychology approach to emotion predicts that there must be emotion-specific networks in the brain, which can be individuated at the level of neuroanatomical structure.

What form should such specificity take? What, in other words, does specificity predict in terms of neuroanatomical structure? A common assumption found in faculty psychology approaches is that such a structure should be inheritable and (thereby) consistent amongst all instances of the category, including across individuals and also potentially across some species. For example, while the traditional basic emotion theory assumes this of our folk categories, Scarantino's new basic emotion theory takes this to be true of some of their sub-categories. What's more, this is also how Barrett herself interprets such approaches (2013: 387, fn 1). In forgoing nativism in favour of a developmental approach, however, I have tried to tease apart the claim that there are emotion-specific neural networks from the claim that they are inheritable and consistent in the aforementioned sense. The lesson being, we needn't treat a lack of inheritability and interpersonal consistency as evidence for a lack of specificity.

For instance, a neuroconstructionist approach to cognitive development replaces the notion of domain-specificity with domain-relevance (Karmiloff-Smith 2015). In terms of the domain of emotion, this means we do not inherit emotion-specific networks. Rather, insofar our brains contain emotion-specific networks, these are products of ontogenetic development. In particular, they form when domain-relevant systems interact with a multitude of other developmental factors, including an individual's body, their physical and socio-cultural environments, their genes, etc. Since these factors can be highly variable from individual to individual, there is no reason to think that the emerging networks should be consistent across individuals, let alone homologues across (some) nonhuman animals.

What about specificity? A neuroconstructivist approach leaves room for there to be specificity within individuals, even if there is none to be found across them. In fact, certain versions of neuroconstructivism make intrapersonal emotional specificity quite likely. For example, according to Karmiloff-Smith (1992), the process of modularisation is both recursive and conservative. The recursively of the process means the development of emotion-specific networks needn't be fixed to a particular developmental "stage" such as early childhood. Individuals can undergo changes in their emotion networks throughout their lifespan. But the fact it is also conservative means that once emotion-specific networks form, they remain relatively stable from moment to moment. So for any two instances of an emotion category that occur relatively close together in time for a given individual, we wouldn't expect there to be significant variability between these instances.

If we understand our developmental approach to emotion in this manner, the difference between the present proposal and Barrett's will really be a matter of degree. Neither approach is committed to the discovery of stable neuroanatomical structures for any of our emotion categories when such stability is measured across individuals or across species. However, in claiming that emotion-specific networks can arise as a product of ontogenetic development, the present approach predicts that there will be a degree of stability in instances of certain emotion categories within individuals. This is in contrast to psychological-cum-social constructionist approaches which allow for more variability in instances of an emotion category, even within the very same individuals.

To elaborate, both constructionist and neuroconstructivist approaches allow for the context-dependent nature of emotion. For example, neither approach assumes that all instances of the folk category fear are underpinned by the same neural networks. A person's arachnophobia might be due to networks very different to those responsible for their fear of more abstract events, e.g. the long-term economic consequences of a pandemic. (From a developmental perspective, these fears develop under very different developmental conditions). But in denying specificity and emphasising the context-dependent nature of our neural networks, Barrett's constructionism predicts that the neural networks responsible for an arachnophobic's fear of spiders can itself vary significantly from context to context. By comparison, neuroconstructivist approaches, especially those that employ the notion of developmental modules, predict that there should be significant consistency in such networks, especially if we compare instances that aren't temporally too far apart. For example, if we compare the neuroanatomical structure of a given individual when they feel afraid of spiders within the span of years, not decades. This difference, I submit, will need be worked out more thoroughly if it is be properly operationalised. But for now, I think it is an empirically tractable difference that gives us a preliminary handle on how these two approaches compare when it comes to any possible neurobiological data.

So which approach is right? As is hopefully clear by now, we will need a lot more data, culled from new longitudinal studies, to really answer this question. For instance, we will need to make intrapersonal comparisons in neuroanatomy spanning a range of contexts and temporal durations, in addition to the sorts of interpersonal comparisons we make at present. These are important avenues for future research. The overall point I have argued for in this paper is more modest: both approaches can accommodate the neurobiological data highlighted by Barrett herself to lend credibility to her emotion revolution.

4.2 Physiological Variability

Suppose I am right. What does this hold for other forms of variability? In particular, what does it tell us about physiological variability? Physiological activity associated with emotion is typically understood to concern changes in our autonomic nervous system (ANS). More specifically, they involve changes along the following autonomic variables:

> First, there is activity related to the cardiac system, which includes heart rate variability, blood pressure, cardiac cycles, and the like. Second, we find variables regarding respiration, e.g. respiratory cycles, respiration period, amplitude, etc. Lastly, there are variables concerning electrodermal activity, i.e. skin conductance levels, responses, resistance, etc. (Loaiza 2020: 337-338)

Standard faculty psychology approaches assume we should be able to find biological "fingerprints" in the form of specific ANS patterns for our emotion categories. But as Barrett notes, this isn't empirically born out. Meta-analyses of various studies that try to identify such fingerprints support what Loaiza dubs "$NOC_{Physiological}$: There is no one-to-one correspondence between emotion categories and any pattern of physiological responses" (2020: 332).[13]

What does our developmental approach tell us about such variability? To my mind the approach inspires a similar response to physiological variability. That is, various developmental factors could be utilised to explain why there is ANS variability across individuals all the while leaving room for there to be ANS specificity within individuals. While such a response is, I think, *prima facie* plausible, it is important to recognise that explanations of cognitive development, concerning neurobiological changes to the developing brain, might not carry over to physiological development.

For one thing, any variability or consistency at the neural level won't entail those at the physiological level. As Barrett notes, while there is an assumption in faculty psychology approaches that any observed consistency in ANS patterns stem from similar underling mechanisms, the reality of degeneracy means that distinct neural activity can give rise to the same ANS patterns (Barrett 2017a). This is important because it tells us that any individual-specific modularisation in the brain that happens as a result of ontogenetic development needn't be reflected in any individual-specific ANS patterns. Such patterns may remain unaffected, in which case we would need a separate body-centred explanation for the observed interpersonal variability of ANS patterns, as well as for any speculation about their intrapersonal consistency.

For another, any variability or consistency manifest at the neural level might be very different to those found at the physiological level. In fact, we tend to expect there to be less plasticity in physiological development than there is in neural development. A developmental approach would, I take it, leave room for such differences. For instance, according to the DST, the development of a trait is influenced by numerous factors, however, nowhere does it state that these factors must act equally regardless of the nature of the trait. One would expect social influences on ANS development, for example, to be significantly less than that which is observed with neural development. But this would also mean the precise ways developmental factors shape the ANS variables concerning emotion will have to be worked out separately from those that shape our neurobiology. In particular, we will have to take our

[13] E.g. see Barrett (2006a, b, 2013, 2017a, 2017b) and Siegel et al. (2018).

cues not just from developmental psychology and cognitive neuroscience but fields such as developmental biology.

What does this tell us about emotional variability more generally? I think the lesson is that a developmental approach might help explain other forms of variability, but this should be argued for independently, on a case-by-case basis, with a lot more input from the relevant fields. For now, any optimism should be cautious.

4.3 The Unity of Emotion

Finally, let me briefly mention what the present proposal holds for the unity of emotion: why a set of instances are all instances of the same phenomenon, namely emotion. According to Barrett's constructionism, the things we call emotion can form a unified category, but not because similar emotion "prototypes" exist in nature but because they are constructed from prototypical emotion concepts by us. In effect, this means that which things do and don't count as emotion is a matter of social construction, not scientific discovery as such.

While the present proposal does not suggest an answer to the question of emotional unity itself, it is compatible with plausible ways of maintaining such unity which don't rely on social construction. For instance, both Griffiths (1997) and Loaiza (2020) suggest that we can still give functional analyses of emotion in the face of neurobiological variability. Griffiths, in particular, argues that while there is no specific mechanism shared across all instances of emotion, we can still understand emotion as "a putative psychological category of motivational states that exhibit passivity" (1997: 246). This gives us a way to main the unity of the category emotion in the face of neurobiological variability.[14] What's more, it does so in a way that is compatible with the developmental approach I have outlined in this paper. Very briefly, certain modularised systems, which manifest neurobiological variability, might still count as emotion because they share the same functional profile.

There is much more to say about the unity of emotion, but the important point is that the present proposal leaves these issues empirically open, unlike Barrett's constructionism which rules them out a priori.[15] This I take to be a strength, instead of weakness, of the present proposal.

[14] Of course, whether there is actual functional unity is an empirical issue. One could argue that the sorts of developmental factors (e.g. environmental inputs) that account for neural and physiological variability might also render the functions associated with emotion variable across individuals as well. This is a possibility, but neural degeneracy means it is also possible that distinct neural structures might implement the same functions. So in the absence of any relevant data, for now we can note that both functional unity and functional variability are possibilities left open by our developmental account.

[15] For example, the question of how we can have "projectable" emotion categories suitable for a science of emotion is not addressed simply by appealing to functional analyses, as such categories are supposed to be explained by a shared mechanism (Griffiths 1997). I think modularisation might just be one such mechanism but a full exploration of this idea will have to wait for a future date. For now, let us just note that our account, unlike Barrett's, is compatible with such explanations.

5 Conclusion

The problem of variability concerns the fact that empirical data does not support the existence of a coordinated set of biological markers, either in the body or the brain, which correspond to our folk emotion categories. In this paper I have argued that while Barrett is right that this variability poses a challenge to a certain kind of faculty psychology, namely one that takes emotions to result from innate modules, she is wrong to suppose that it undermines faculty psychology completely. In particular, I have argued that variability can be accounted for by a new version of faculty psychology that takes emotions to be products of developmental modules: non-innate systems which behave like modules, but form on the basis of various ontogenetic processes. If I am right, both constructionist and faculty psychology approaches to emotion are, *ceteris paribus*, on a par when it comes to explaining the variability of emotion.

This point should not be understated. The plausibility of Barrett's new emotion revolution, as summarised in her hugely influential work *How Emotions Are Made*, to a large extent rests on her use of neurobiological variability to lend support for her social-cum-psychological constructionism. It is hard to argue with the empirical data which shows that there is an absence of biological markers for any of our folk emotion categories. But the plausibility of this data should no longer be conflated with the plausibility of Barrett's overall constructionism. The latter, as we see more clearly now, remains a matter of contention. Subsequently, whether future emotion research is best served by an approach that aligns itself with radical constructionism or a new version of faculty psychology is still very much up for grabs.

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Declarations

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