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Making sense of the modularity debate

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A B S T R A C T

For several decades scientists and philosophers studying how the mind works have debated the issue of modularity. Their main disagreements concern the massive modularity hypothesis, according to which all (or most) of our cognitive mechanisms are modular in nature. Pietraszewski and Wertz (2022) have recently suggested that the modularity debate is based on a confusion about the levels of analysis at which the mind can be explained. This article argues that their position suffers from three major problems: (1) the argument is unsound, with untrue premises; (2) it glosses over important empirical issues; and (3) the guidelines it offers are not sufficient for avoiding future confusions. As these criticisms are developed, this article will provide a way of making sense of the modularity debate—with an eye for what really is at stake both conceptually and empirically—and, by identifying a false assumption often shared by proponents and opponents of the massive modularity hypothesis alike, it will sketch out some guidelines for moving the debate forward.

Evolutionary psychology is a relatively new discipline in the biobehavioral sciences that has been highly successful in generating empirically corroborated hypotheses about evolved psychological mechanisms in the human mind (Buss, 1995; Kennair, 2002; Buss, 2019; Buss, 2020, Lukaszewski et al., 2020). However, the discipline is controversial, in part because of its perceived commitment to a particular conception of how the mind works (Egeland, 2023; Fodor, 2001; Pinker, 1997). More specifically, evolutionary psychology is often presented, by both proponents and opponents alike, as involving a mandatory endorsement of the massive modularity hypothesis, according to which the human mind consists solely (or primarily) of different evolved modules (Symons, 1992; Tooby and Cosmides 1992, 2000). Due to the perceived logical link between evolutionary psychology and the massive modularity hypothesis, critics of the discipline often aim their *modus tollens* arguments against said hypothesis (see Goldfinch, 2015).

Recently, Pietraszewski and Wertz (2022) have argued that the debate about massive modularity is symptomatic a *category mistake*, making the different parties talk past each other. In order to support this claim, they rely on Dennett (1981) and Marr's (1982) insight that there are different levels of analysis, noting that commentators have conceptualized the notion of a "cognitive module" in fundamentally different ways, with the consequence that the explanations they provide cannot conflict with each other as they exist at different levels of analysis. In some sense, Pietraszewski and Wertz (2022) are right: "module" is a mongrel concept that has been used inconsistently in the decades long modularity debate. However, this is a Pyrrhic victory. As will be demonstrated in this article, Pietraszewski and Wertz' position suffers from three problems that make it less likely that progress on this issue will be made: (1) their argument is unsound, with untrue premises; (2) it threatens to gloss over important empirical issues that there are meaningful and persistent disagreements about; and (3) it does not provide good enough guidelines for avoiding future misunderstandings or conceptual confusions. As these criticisms are developed in the remainder of this article, an alternative position on the sources of disagreement and how they can be avoided will emerge. The goal is to provide evolutionary psychologists and others interested in the massive modularity hypothesis with some guidelines for making sense of the modularity debate and, hopefully, for making progress on important conceptual and

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Table 1
Three levels of analysis for understanding the mental processes underlying human behavior.

Levels of analysis	Entities
Intentional	A central agent and its various conscious and unconscious mental states (e.g., beliefs, desires, and emotions).
Functional	Functionally individuated mechanisms (e.g., cheater-detection, snake-detection, and male sexual jealousy).
Physical/implementational	Concrete physical objects and structures (e.g., neurons, glial cells, and neurotransmitters).

empirical issues that figure therein.

1. Levels of analysis

Before examining Pietraszewski and Wertz' argument, we will look at what the levels of analysis are that can be used in order to better understand the mental processes underlying human behavior. A complete understanding of some complex phenomenon usually requires knowledge about the different levels at which the phenomenon can be analyzed or explained. To use a simple example, consider water. Water can be analyzed in terms of the various ways in which it impinges on our senses (e.g., it appears as transparent and odorless at room temperature); it can be analyzed in terms of the properties it has under various conditions (e.g., it can exist as a solid, a liquid, and a gas); or it can be analyzed by focusing on its chemical composition (every water molecule has two hydrogen atoms attached to a single oxygen atom). Furthermore, it is considered a category mistake to confuse the different levels, for example by arguing that explanations offered at one level cannot be consistent with those offered at another level. Just because water is perceived as a transparent and odorless liquid at room temperature, it does not follow that we should expect any of these properties to exist at the molecular level.

Following Tinbergen's (1963) influential claim that different explanations of animal behavior belong to four distinct categories (mechanism, ontogeny, phylogeny, and adaptive function), Dennett (1981) and Marr (1982) have argued that scientific explanations of human behavior usefully can be partitioned into different levels of analysis (see Table 1).[1] At the *intentional* level the mind is populated by an *agent*—the "I" or the "self" that is experienced as a unitary and persistent being that makes you the same person today as you were in the past, despite all the physical and psychological changes that "you" have been subject to—and a number of conscious and unconscious mental states and processes that the agent "has". At this level, it is common to talk about someone, an agent, who has beliefs, desires, emotions, and intentions, who decides to pursue certain lines of action, and who may be in need of psychological therapy if his or her well-being is compromised by some sort of mental disorder (Dennett, 1981, 17). This is Dennett's (1991) *homunculus*, the little cranial inhabitant who watches the sensory inputs displayed at the *Cartesian Theater*, and who pulls the physiological levers that result in appropriate behavioral outputs.

At a lower level of abstraction, we find the *functional* level. At this level the intentional agent disappears, as the mind is assumed to be populated with a fundamentally different kind of entity: *mechanisms* with functionally individuated algorithms that are if-then rules determining cognitive or behavioral outputs from certain kinds of input that activate and interact with the associated mechanisms (Bechtel, 2008). Human behavior, in other words, is no longer explained as a consequence of a central agent and its various (conscious or unconscious) mental states, but rather in terms of *computation* (Marr, 1982). Consider a cognitive system containing a mechanism with the function of adding numbers. If the mechanism is provided with information about two numbers as input, then, due to the fact that its algorithms contain the rules of addition (such as associativity and commutativity), it will map them onto a single number. This and other outputs found in the function's range can then be fed as inputs into other causally linked mechanisms, with the eventual result that certain cognitions or behaviors are produced (Dennett, 1996). At the functional level it is often argued that form follows function, since the form or structure of any information-processing mechanism is determined by its evolved function, and full knowledge about this structure requires insight into *what* problem the mechanism was "designed" to solve, and *why* it was "designed" to solve that, rather than some other problem (Al-Shawaf, 2024; Burke, 2021; Cosmides & Tooby, 1995; Marr, 1982).[2]

Lastly there is the *physical* or *implementational* level, where the workings of the mind are understood in terms of the physical constitution of its various systems (Dennett, 1981; Marr, 1982). The researcher operating at this particular level of analysis is concerned with figuring out the physical structure and physiology responsible for certain behaviors or cognitions, what the physical laws are that govern them, how, for example, the different neural circuits communicate with each other chemically and electrically, and what kinds of neuromodulary molecules figure in the process of neurotransmission. Higher-level psychological phenomena, such as algorithmic mechanisms or the mental entities found at the intentional level of analysis, are here either eliminated altogether, or they are explained *reductively* in terms of their concrete physical implementation.

2. Pietraszewski and Wertz' on *the modularity mistake*

Pietraszewski and Wertz' (2022) argument that the different parties in the modularity debate are talking past each other can be reconstructed as follows:

1. Human psychology can be described at different levels of analysis—intentional, functional, and implementational—and confusing the different levels is a category mistake.
2. Critics reject the massive modularity hypothesis because some psychological mechanisms don't have the intentional-level properties that Fodor associates with the notion of modularity, which means that they operate at the intentional level and rely on a Fodorian conception of modules.
3. Proponents of the massive modularity hypothesis, including most or all evolutionary psychologists, understand modularity simply in terms of *functional specialization*, which means that they operate at the functional level of analysis.
4. Hence, the critics of the massive modularity hypothesis invariably make a category mistake since the "modules" of evolutionary

[1] Although there are different ways of characterizing the levels, Dennett and Marr being cases in point, they are here described in the same manner as in Pietraszewski and Wertz' paper. An implication of this is that Marr's computational and algorithmic levels are collapsed into a single functional level of analysis (Pietraszewski & Wertz, 2022 fn. 1).

[2] This paper follows Pietraszewski and Wertz by assuming a computational conception of the mind. It should, however, be noted that there are some who claim that the idea that the human mind consists of innate computational cognitive mechanisms that are products of natural selection reflects a form of genetic determinism and is outdated (Narvaez, Moore et al., 2022). Nevertheless, this criticism is only applicable to certain versions of evolutionary psychology (depending on how its theoretical basis is cashed out), and there are other versions that explicitly take developmental factors into consideration and reject the idea that humans are born with fully functioning and inflexible psychological mechanisms (Geary, 2005; Bjorklund, Ellis et al., 2022).

psychology simply are defined in terms of function and without reference to any of the intentional-level properties invoked by Fodor.

Pietraszewski and Wertz refer to the confusion of different levels that critics of the massive modularity hypothesis are guilty of as *the modularity mistake*. In order to better understand how their argument works, let's look more closely at how exactly they motivate each of the argument's premises.

The first premise is motivated by providing a detailed description of the intentional, the functional, and the implementational levels of analysis, and by showing how they can be used to better understand various psychological and non-psychological phenomena—similarly to the preceding section above. Doing this, they note that:

> (a) all three levels are complementary […], (b) the higher level gives meaning or significance to the next lower level, and (c) all three levels are important for a complete medical (or, in our case, scientific) account of what is happening. (Pietraszewski & Wertz, 2022, 469)

The second premise is motivated, first by offering an extended discussion of Fodor's *Modularity of Mind* (1983), and then by claiming that opponents of massive modularity follow Fodor in conceptualizing modules with reference to properties or entities that only exist at the intentional level of analysis (Pietraszewski & Wertz, 2022, 470–475). In their excellent discussion of the historical background that Fodor's work is a reaction to, Pietraszewski and Wertz note that *information encapsulation* is an essential property of any Fodorian module, and that information encapsulation is defined as a restriction on the flow of information into a certain system.[3] Fodor argues that his prototypical modules, namely input systems involving perception and language, are a *natural kind*—i.e., a grouping of certain particulars that reflects that actual structure of the natural world—and the reason is that they essentially are informationally encapsulated (Fodor, 1983, 71, 98–99). To say that a module must be informationally encapsulated means that there is some information internally represented by the organism that the module does not have access to (Fodor, 1983, 69, Fodor, 1987). Moreover, for Fodor this implies that there also are "non-modular" systems that are not informationally encapsulated: "Mechanisms that operate as modules *presuppose* mechanisms that don't" (Fodor, 2001, 71).[4] These "central systems" can access information that is represented by other systems, and they are therefore "isotropic" and "Quinean", in the sense of being epistemically interconnected and "sensitive to properties of the entire belief system" (Fodor, 1983, 105–107).

A phenomenon that often is used to illustrate Fodor's distinction between modules and central systems is visual illusions (Fodor, 1983; Pinker, 2005). In the Müller-Lyer illusion, for example, a viewer is presented with arrows where it clearly appears as if one is longer than the other, even though they are equally long. And this illusion persists even if the viewer comes to know that the arrows in fact are of equal length. This shows that perceptual systems are modular and, hence, informationally encapsulated, since "the data that can bear on the confirmation of perceptual hypotheses includes, in the general case, considerably less than the organism may know" (Fodor, 1983, 69). Furthermore, since the existence of such modular systems implies that there also must be some central system where, at least in principle, all the information in some sense known by the organism can come together, it follows that Fodorian modules exist at the intentional level of analysis. Such central systems (or agents) only exist at the intentional level, since the mind is assumed to be entirely decomposable into functionally individuated mechanisms or their physical implementation at lower levels of analysis. In other words, it is only at the intentional level that we find Fodorian modules that are informationally encapsulated from the goings on in other modular or central systems; modular systems cannot "see" all that goes on elsewhere in the mind, including at the Cartesian theater.[5]

Having (let's suppose) established that Fodor's modules exist at the intentional level, Pietraszewski and Wertz claim that critics of the massive modularity hypothesis rely on a Fodorian conception of modules. To support this, they focus on a debate between Chiappe and Gardner (2012) and Barrett and Kurzban (2012) that is supposed to exemplify the modularity mistake in action: whereas the former rely on a Fodorian conception of modules in their criticism of the massive modularity hypothesis, the latter operate with a different conception that rather exists at the functional level of analysis. Specifically, discussing what they call "the problem of novelty", Chiappe and Gardner (2012, 679) write as follows:

> [S]ometimes we have to deal with novelty by engaging in problem solving. Sometimes we actually have to think about a problem and gain insight into it so that we can improvise a solution. We can't rely on a prepared response produced by natural selection. This can require considerable effort and ingenuity.

Given their repeated references to the "we" who have to gain insight in order to solve evolutionarily novel problems, it should be clear that their analysis operates at the intentional level. Since insight is a property of a central agent (or system) that is not limited with respect to the kinds of information it has access to in the same way that encapsulated modules are, it must be the case that Chiappe and Gardner's modules are Fodorian in nature.

Pietraszewski and Wertz' third premise—that proponents of massive modularity conceptualize modules at the functional level—is motivated by referencing a large number of evolutionary psychologists stating that they understand modularity in terms of functional specialization, and also by claiming that the idea that the mind is functionally specialized logically follows from Darwin's (1859) theory of natural selection (Pietraszewski & Wertz, 2022, 475–478). Let's begin with the first line of motivation. Many evolutionary psychologists argue that the mind is modular, in the sense of being functionally specialized (e.g., Barrett & Kurzban, 2006; Barrett & Kurzban, 2012; Pinker, 1997; Symons, 1992; Tooby & Cosmides et al., 2005; Tooby et al., 2005). Pietraszewski and Wertz (2022, 475) define functional specialization as the claim that "the mind is composed of many different mechanisms, each of which can be described according to its function." (As will be shown in the next section, this is not how all evolutionary psychologists they cite define

[3] It should be noted that modular systems, according to Fodor (1983, 47–101), typically have other properties besides being informationally encapsulated. They are: domain specificity, automatic processing, limited central accessibility, fast processing, shallow outputs, fixed neural architecture, characteristic and specific breakdown patterns, and characteristic ontogenetic pace and sequencing (see, e.g., Robbins, 2017, for a detailed description and analysis of these properties). Moreover, since these properties can come in degrees, one can meaningfully talk about our cognitive mechanisms being more or less modular in nature (Fodor, 1983, 37).

[4] Cf. Fodor (1983, 101–103): "the representations that input systems deliver have to interface somewhere, and the computational mechanisms that effect the interface must ipso facto have access to information from more than one cognitive domain […] central systems are, in important respects, *un*encapsulated, and that [is why] they are not plausibly viewed as modular."

[5] It must be noted that there is another reading of Fodor, where he argues that central or isotropic systems don't entail a commitment to the intentional level of analysis, but rather that they challenge the very idea of a complete cognitive scientific understanding of the mind in purely functional terms. There are certain passages in Fodor's writings (e.g., 1983, 127–128) that appear to support this reading and, if it is correct, this would provide another source of criticism of premise 2, since Fodorian modularity simply does not imply a commitment to the intentional level of analysis. For more on this, see The Mind Doesn't Work That Way (2001), where Fodor quite clearly seems to operate at the functional level, and Samuels (2005). However, this text does not pursue the issue further in order to avoid getting bogged down on exegetical issues.

functional specialization.) From an evolutionary perspective, these functional mechanisms are usually called *adaptations*, since natural selection is the only known natural process that can produce complex functional mechanisms—whether psychological or physiological (Tooby & Cosmides, 1992; Buss, 1995; Buss, Haselton et al., 1998; Kennair, 2002).,[6],[7] Other traits are either by-products of adaptation, or random effects (also called "noise") produced by stochastic processes, such as genetic drift. As explained in the previous section, functional mechanisms are characterized by abstract if-then algorithmic rules, the nature of which depend on how selection acted on the mechanisms in the ancestral environment.[8]

Moreover, given that selection is the only known natural process that can produce functional mechanisms, Pietraszewski and Wertz claim that if we adopt a functional understanding of modules, then the massive modularity hypothesis must be a logical consequence of Darwinian theory. This is how they put it:

> Of course, viewed within the correct functional level of analysis, evolutionary psychology's claims of so-called massive modularity are not radical at all. If anything, they are boringly axiomatic. The claim is simply a logical entailment of Darwin's theory of natural selection […] Therefore, the mind must also be composed entirely of modules—if by "modules" one means evolved functions (i.e., mechanisms)—by-products of their operation, and noise (Pietraszewski & Wertz, 2022, 478).

In other words, their idea is that the massive modularity hypothesis cannot be false if the theory of evolution by natural selection is true, since the former is entailed by the latter.

3. Facing up to false premises

One problem with Pietraszewski and Wertz' argument is that it has false premises. Premises 2 and 3 are false for essentially the same reason, which is that both opponents and proponents of the massive modularity hypothesis often share the view that modularity primarily is about *domain-specificity*—another property that Fodor associates with modules (cf. footnote 3). It is true that *some* opponents may be committed to the Fodorian position that modules invariably are informationally encapsulated (e.g., Clarke, 2021), which implies that there must a central system or agent that is not modular, and it is true that *some* evolutionary psychologists do define modularity simply in terms of functional mechanisms. However, this is not enough for the argument to go through. For that to be the case, *everyone* involved in the modularity debate must define modules in either of these ways. As we will see, most commentators do not operate with either of these narrow definitions.

A cognitive system or mechanism is domain-specific if it takes as inputs and operates on information from a very specific and narrow content domain. Fodor (1983, 103) says that "domain-specificity has to do with the range of questions for which a device provides answers (the range of inputs for which it computes analyses)". Domain-specificity is in other words a *continuous* variable—the narrower the range of information it functions to operate on, the more domain-specific a system is—and Fodor contends that modular systems will tend to be relatively domain-specific (cf. Carruthers, 2006). Now although critics of massive modularity tend to draw quite heavily on Fodor, most of them do not actually claim that information encapsulation or other properties that imply the existence of a central agent are essential aspects of modules.

For example, Bolhuis and Macphail (2001, 426–427) conceptualize modules as "distinguishable cognitive mechanisms", noting that they also tend to be "domain specific", "species specific", and "located in specific brain regions", in their argument that learning and memory mechanisms are not modular. Reader, Hager et al. (2011) explicitly understand modularity in terms of domain specificity, and they argue that what we know about the structure of primate intelligence and its evolution is inconsistent with a model of the mind as massively modular. Another example may actually be provided by Chiappe and Gardner's (2012) work, even though Pietraszewski and Wertz use it as a prototypical example of Fodorian modularity. Chiappe and Gardner are careful to define modules as "specialized psychological mechanisms" (2012, 669), and although their appeal to dual-process theories of learning perhaps does involve a commitment to the intentional level, they also raise other criticisms against the massive modularity hypothesis, without taking on any such commitment (2012, 671–673).[9]

Moreover, proponents of massive modularity, including many evolutionary psychologists, also tend to conceptualize modules in terms of domain-specificity. Here are some examples:

> [H]uman psychological architecture contains many evolved mechanisms that are specialized for solving evolutionarily long-enduring adaptive problems and … these mechanisms have content-specialized representation formats, procedures, cues, and so on. These richly content sensitive evolved mechanisms tend to impose certain types of content and conceptual organization on human mental life. (Tooby & Cosmides, 1992, 34, cf. Cosmides & Tooby, 2002)

Having thus presented their position, Tooby and Cosmides explain that these "content-specialized" mechanisms are "modules", and they go on to provide several examples, including "a face-recognition module", "a tool-use module", "an emotion-perception module", "a child-care module", "a sexual attraction module", and many more besides (1992, 113).

Similarly, Barrett and Kurzban (2006, 629) first define modularity as

[6] Henrich (2015, 113–114) notes that this statement, although common, ought to be amended since cultural evolution also can produce complex adaptations. Moreover, it is also worth mentioning that selection can lead to non-functional outcomes as well (Wakefield, 2015, 884–885).

[7] Complex functional mechanisms bear the mark of apparent design. This was first pointed out by natural theologians, like Paley (1802), who used the appearance of design in nature to strengthen the case for God's existence. Evolutionists, like Darwin (1887) and others after him, tend to hold Paley in high regard for showing that the appearance of design does call for some sort of explanation, although they argue that natural selection does a much better job than theism. Indeed, selection is the only natural process that can explain the appearance of phenotypic design, and such appearances are still appealed to as evidence in favor of adaptationist explanations. For more on this, see Williams (1966), Godfrey-Smith (2001), Gardner (2009), and Ågren (2021).

[8] Evolutionary science has made great progress in successfully explaining and predicting animal behavior (Parker & Smith, 1990), often by relying what Grafen (1984) calls the phenotypic gambit, which is the assumption that adaptive phenotypic evolution is unconstrained by genetic architecture. Moreover, the earlier sociobiology of Wilson (1975) and contemporary behavioral ecology often adopt an additional assumption, which has been called the behavioral gambit (Giraldeau & Dubois, 2008), and which says that adaptive behavior is unconstrained by psychological mechanism. However, this is problematic, because animals' evolved psychological mechanisms sometimes prevent them from behaving in an optimal manner, and because selection does not directly favor or disfavour behaviors, but rather the underlying psychological mechanisms that produce them (Fawcett, Hamblin et al., 2013). One of the biggest strengths of evolutionary psychology is therefore the fact that it rejects the behavioral gambit and explicitly acknowledges that psychological mechanisms are the proper target for evolutionary analyses of behavior.

[9] It should also be noted that just because one writes using personal pronouns (e.g., "we", "I", "you"), it does not follow that one necessarily is committed to seeing things from the perspective of the intentional level. Evolutionary theory has a long history of anthropomorphizing using agential vocabulary, even though no one thinks that evolutionary biologists are committed to the idea that genes literally are scheming and strategizing in order to make sure that the organism in which they reside should function or behave in a way that is likely to maximize its genetic representation in future generations (see, e.g., Okasha, 2018; Ågren, 2021; ch. 3).

functional specialization, but then continue to claim that modules invariably also are domain-specific:

> What matters, functionally, is *how modules process information* in the service of regulating behavior, because this is what impacts fitness. As a direct and inseparable result of this evolutionary process of specialization, modules will become *domain specific*: Because they handle information in specialized ways, they will have specific *input criteria.* Only information of certain types or formats will be processable by a specialized system […] Thus, domain specificity is a necessary consequence of functional specialization. (Barrett & Kurzban, 2006, 630, cf. Barrett & Kurzban, 2012, 685)

These are just some of the evolutionary psychologists that Pietraszewski and Wertz cite as supporting their definition of functional specialization (i.e., as functionally individuated mechanisms), even though it is evident that these commentators operate with a narrower conception whereby domain-specificity is a necessary aspect—other examples include Symons (1992), Pinker (1997, 2005), Tooby and Cosmides (2005), Ermer, Cosmides et al. (2007), Boyer and Barrett (2015). Indeed, there is a plethora of other commentators, on both sides of the issue, that understand modularity primarily or solely in terms of domain-specificity (e.g., Bolhuis, Brown, Richardson, & Laland, 2011; Buller, 2005; Burke, 2014; Carroll, 2015; Carruthers, 2008; Egeland, 2023; Frankenhuis & Ploeger, 2007; Gigerenzer & Hug, 1992; Kaplan & Gangestad, 2015, Forthcoming; Burkart; Schubiger et al., 2017; Nairne, Thompson, & Pandeirada, 2007; Stephen, 2014; Sterelny, 2003; Villena, 2023; Zerilli, 2017). Why is this important? Because, as Pietraszewski and Wertz (2022, 474) point out, a mechanism can be domain-specific without implying that there is a central agent that its workings are encapsulated from (cf. Boyer & Barrett, 2016). But if many (if not most) of the commentators involved in the modularity debate conceptualize modules in terms of domain-specificity (rather than information encapsulation or just functional mechanisms), then premises 2 and 3 above cannot be true, and the conclusion that the decades of debate about the massive modularity hypothesis is due to a simple category mistake, of people talking past each other, becomes unsupported.

4. The questions that matter

The second problem with Pietraszewski and Wertz' argument is that it threatens to gloss over important empirical issues that there are meaningful, important, and persistent disagreements about. Domain-specificity is one of them. Some mechanisms are plausibly highly domain-specific, in that their adaptive function is to operate on information from narrow content domains. Mechanisms for dealing with information about social exchange, including the detection of cheaters in social situations, is one famous example (Cosmides, 1989; Cosmides et al., 2010; Cosmides and Tooby 1992, 2015). Other examples may be mechanisms for mate choice, food choice, and predator avoidance (see Buss, 2019 for discussions of these, and other, examples). On the other end of the information-processing spectrum are domain-general mechanisms—i.e., mechanisms that are sensitive to and that operate on information from broad content domains (Geary, 2005; MacDonald, 2008). Are there any such mechanisms in the human mind? This is an important and (arguably) unresolved issue that is at danger of getting swept under the rug by equivocating between understanding modularity in terms of function and in terms of domain-specificity, as I believe Pietraszewski and Wertz do.

On the one hand, they argue that the massive modularity hypothesis trivially follows from Darwinian theory, since it says that the mind consists of functionally individuated mechanisms that have evolved. In a paragraph quoted above, they claim that the hypothesis in question is "not radical at all", but rather that it is "boringly axiomatic" and "simply a logical entailment of Darwin's theory of natural selection" (Pietraszewski & Wertz, 2022, 478). However, following other evolutionary psychologists that endorse the massive modularity hypothesis (e.g., Buss, 2020; Tooby & Cosmides, 1992), they also want to insist that our evolved modules must be domain-specific, in the sense that they function to operate on information from very specific and narrow content domains:

> In particular, evolutionary psychologists constrain themselves to positing only biological mechanisms for dealing with inputs that would in principle have been recurrent over evolutionary time (and therefore cannot propose mechanisms that take as inputs evolutionary novelties, unless these inputs are taken in as a side effect or by-product of the mechanism's evolved structure) […] When one's goal is to address these problems in a computationally adequate way one quickly realizes the inadequacy of logistic, content-neutral (i.e., "domain-general") architectures. Or positing that high-level abstractions such as "memory," "attention," or so can adequately describe how these problems are solved. (Pietraszewski & Wertz, 2022, 477)

This is highly problematic since the claim about domain-specificity is empirical in nature and not a logical consequence of the theory of natural selection.[10] To see why, consider an example of what one might consider such an entailment. The Price equation (Price, 1972) gives a mathematical description of how a trait changes in frequency over time due to selection or genetic drift. Supposing we have an unstructured population and that a trait, referred to as z, is subject to directional selection, then the mean trait value, $\bar{z}$, will change over time in accordance with the following equation:

$$\Delta\bar{z} = \frac{Cov(w_i, z_i)}{\bar{w}}$$

where w_i is the fitness of the ith organism, $\bar{w}$ is mean fitness, z_i is the trait value of the ith organism, and Cov is the covariance function.[11] From the Price equation (and other minimal assumptions) interesting theorems can be derived, such as Hamilton's rule (Okasha, 2016), which asserts that under conditions in which a trait's benefit to others, multiplied by relatedness, exceeds the cost to self, selection will affect the trait so that it increases in the population. However, the claim that the human mind is massively modular and consists of numerous domain-specific mechanisms cannot similarly be derived from the Price equation, or from any other typical statement of the theory of natural selection. Although the claim may be true, it simply is not a logical consequence of Darwinian theory.[12]

Moreover, in the context of the modularity debate, claims concerning massive modularity or domain-specific information processing also cannot be considered as "axiomatic" without begging the question. That would be to assume the correctness of one's conclusion, rather than adducing reasons supporting it. This is problematic because there is a lively and ongoing debate about whether our psychological adaptations all are modular in this sense of the term, or whether a subset of them

[10] Nettle and Scott-Phillips (2023) have forcefully argued that claims like this are made because some evolutionary psychologists assume that "the scope of psychological mechanisms correspond one-to-one with mid-level evolutionary theories", such as reciprocal altruism theory (Trivers, 1971). However, they note that there is no reason to assume that the problem space of fitness must be carved up in a way that isomorphically corresponds to how the computational space of mind is carved up.

[11] This is a simplified version of the Price equation, where the transmission term has been excluded.

[12] Although it is erroneous, the claim that it follows from basic Darwinian theory that any evolved psychological mechanism in any species must be domain-specific is nevertheless popular among evolutionary psychologists (Koenigshofer, 2017). It is, moreover, worth noting that the claim is absent, and sometimes rejected, in for example behavioral ecological approaches to human and non-human animal behavior (Burkart, Schubiger et al., 2017; Kaplan & Hill, 2017), and it is inconsistent with certain lines of empirical and modelling evidence (Richerson & Boyd, 2000).

rather are domain-general by taking as inputs and operating on information from broad content domains (e.g., Bolhuis et al., 2011; Chiappe & Gardner, 2012; Frankenhuis & Ploeger, 2007; Geary, 2005; Geary, 2007; Geary, 2024; Geary, Nicholas, Li, & Sun, 2017; MacDonald, 2008). As mentioned, this is an important *empirical* issue that cannot be settled from the armchair, using purely conceptual reasoning or argumentation (cf. Sperber, 2001). So, by equivocating between understanding modularity in terms of functional mechanisms and domain-specific processing, one runs the risk of missing out on opportunities for making progress on getting an adequate empirical understanding of how the mind works.

Moreover, since other, somewhat similar empirical issues sometimes are discussed using the term "module", these also risk being swept up under the rug as symptomatic of a simple category mistake, when in reality they too must be settled on the basis of observation or experiment. An example of this is that part of the so-called modularity debate is about yet another of Fodor's properties (cf. footnote 3), namely whether a certain mechanism or system has a *fixed neural architecture*, in the sense that the neural circuitry in which it is implemented is circumscribed and dedicated to the realization of that system alone (cf. Robbins, 2017). This is for example what Anderson and Finlay (2014) and Kelkar and Medaglia (2018) seem to have in mind in their discussions of whether the mind is massively modular. It is empirical issues of this kind that really matter in the modularity debate, and disagreements about them cannot be dismissed as simple conceptual confusions.

5. How to make sense of the modularity debate

Conceptual misunderstandings arising from the confusion of different levels of analysis are no doubt big problems, and such confusion has certainly played a part in the modularity debate. Pietraszewski and Wertz (2022, 483–484) argue that this is the biggest problem facing current psychological research, and in order to make progress on the massive modularity hypothesis (in evolutionary psychology and beyond), they suggest that researchers discussing the issue of modularity always should specify the level of analysis they are using. This is a very helpful first step that researchers should take to heart in order to avoid unnecessary future confusions. As we have seen, the term "cognitive module" is used in many different ways, and some of these clearly involve commitments to *different* levels of analysis. However, the modularity debate is not just about people talking past each other; there is more to it than that. There are meaningful, important, and persistent disagreements about various issues that manifestly are empirical in nature. Examples include whether some of our psychological mechanisms are domain-general (and if so, how they might have evolved), and whether every mechanism has a fixed neural architecture. It is disagreements about fundamental issues of this kind that have led to the proliferation of different perspectives and approaches within evolutionary psychology (Egeland, 2023, Woodley ofMenie, Peñaherrera-Aguirre, Sarraf, Kruger, & Salmon, 2023), and this may have had the unfortunate consequence of making some researchers skeptical of the discipline (Burke, 2014).

Why did this happen? Plausibly, as Stephen (2014) has noted, because its theoretical underpinnings were formalized sometimes as a simple logical extension of Darwinian theory in evolutionary biology, without reference to conclusively supporting evidence (cf. footnote 2). The massive modularity hypothesis is a case in point (Laland & Brown, 2011). And, contrary to the supposition that it logically follows from the theory of natural selection, all that strictly is necessary for evolutionary psychological science to thrive is that there was heritable variation in behavior and cognition that contributed to fitness outcomes in the ancestral past (Burke, 2014).[13] Seen from the functional level of analysis, the mind is composed of functionally individuated mechanisms. Are they all domain-specific? Maybe, but whether the mind is massively modular in *this* sense of the term can only be settled on the basis of empirical data. With this in mind, three concrete suggestions for making progress on the issue of modularity can be offered.

First, in addition to marking one's level of analysis (as suggested by Pietraszewski and Wertz), researchers should specify which Fodorian properties they have in mind (if any) when talking about modularity. This will not just further reduce the chances that future contributions to the research literature are talking past each other, but it will also help to clarify whether empirical issues are being discussed, and if so, what they are.

Second, having specified the set of properties one associates with modularity, one should strive to derive testable predictions from one's hypothesis—regardless of whether it is a version of the massive modularity hypothesis or not. To give just one example, there is a gap between how most intelligence researchers understand human intelligence and how many evolutionary psychologists do so. Whereas the former group tend to view it as a domain-general ability that, in conjunction with more specialized cognitive abilities, contributes to people's performances on many different kinds of cognitive task (Snyderman & Rothman, 1988; Reeve & Charles, 2008; Rindermann, Becker, & Coyle, 2020), the latter tend to favor the idea that there are multiple, independent intelligences in the human mind, and that they primarily are constituted by domain-specific mechanisms that function (more or less) like cognitive "instincts" (Tooby & Cosmides, 1992, 113–123, Cosmides, Barrett et al., 2010; Buss, 2019, 744–745).[14] These positions are clearly at odds with each other, and depending on how they are articulated, they yield different predictions, for example about whether performances on different cognitive tasks should be positively correlated with each other—a phenomenon usually referred to as the *positive manifold* (Carroll, 1993; Egeland, 2022).

Third, by explicitly stating that the epistemic fate of evolutionary psychology as a discipline *does not* depend on the truth value of the massive modularity hypothesis since the latter does not logically follow from basic evolutionary theory, one can avoid the controversy over whether evolutionary psychology might be undermined if conclusive evidence against the massive modularity hypothesis were to be presented. Critics are wrong to present *modus tollens* arguments of this kind, and evolutionary psychologists do *not* need to defend said hypothesis for fear that their discipline might be undermined. Nothing of the kind would follow. Perhaps the mind is massively modular, but even if it isn't, our cognitive mechanisms can still be given evolutionary explanations that are fully in line with Darwin's theory of natural selection.

6. Conclusion

Evolutionary psychology is about using evolutionary theory to better understand the mechanisms of the human mind that are responsible for our cognitions and behaviors. To do this, some have argued that the massive modularity hypothesis, which asserts that all (or most) cognitive mechanisms are modular, must be correct. Those who disagree with said hypothesis sometimes invoke evidence against it to demonstrate the falsity of evolutionary psychological thinking in general. They do this because it is often assumed that there is a logical relationship between the two: if human psychology is a product of evolution, then the mind

[13] Any psychological theory that does not contradict this basic evolutionary claim is in principle consistent with evolutionary psychological thinking about the human mind (Nettle & Scott-Phillips, 2023).

[14] This latter position is in certain ways quite similar to that of Franz Joseph Gall, who argued that "there are as many different kinds of intellect as there are distinct qualities", and that these intellects or intelligences are species-specific "instincts" (Gall, as cited in Fodor, 1983, 15–21).

must be massively modular. This is an assumption found among both critics and practitioners of the discipline. But it is false.

Pietraszewski and Wertz (2022) have recently undertaken the ambitious project of arguing that the whole modularity debate rests on a simple category mistake (what they call "the modularity mistake"), whereby the different parties are talking past each other because they focus on different levels of analysis. Their contribution to the literature is highly valuable, showing that the notion of modularity often is used in fundamentally different ways. However, their position suffers from three major problems: (1) the argument has untrue premises; (2) it glosses over important empirical issues; and (3) the guidelines it offers are not sufficient for avoiding future confusions, in part because it too takes for granted the claim that the massive modularity hypothesis is a logical consequence of Darwin's theory of natural selection. In pointing out these problems, this paper has presented an alternative way of making sense of the modularity debate. Because the debate has to do with unresolved issues about the workings of the human mind, some of which are empirical in nature, and it is shaped to some extent by conceptual confusions, progress can only be made by focusing our attention on the former, while at the same time being mindful of avoiding the latter. Three suggestions were provided for aiding in this project: specifying which properties one takes to be characteristic of cognitive modules and marking one's level of analysis; deriving testable predictions from one's hypothesis; and noting that regardless of whether the massive modularity hypothesis is true or not, nothing follows concerning the epistemic status of evolutionary psychology as a discipline.

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Significance

This article demonstrates that the modularity debate in psychology involves important empirical issues that, contrary to recent arguments, cannot be dismissed as conceptual confusions. It provides concrete guidelines for moving the debate forward.

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No data was used for the research described in the article.

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