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Notes from the Editor

Dear colleagues,

I am sure that you have noticed the sparkling new format of this EPSIG Newsletter, which we have our two new associate Newsletter editors, Costa Savva and Sirous Golchinheydari to thank for!

Above you can see a photo of most of the chairs and speakers of the 5th International EPSIG conference in March 2023.

We are also pleased to let you know that Evolutionary Psychiatry continues to grow and that we have secured two speaker slots at the World Psychiatric Association congress in Vienna in September to speak about Evolutionary Mismatch and about how evolution can help us understand child abuse by mothers.,

Please pencil in the date of 5th April 2024 in your diary as together with the Philosophy SIG, we have invited the eminent psychiatrist Dr Iain McGilchrist to speak to us about the relevance of his work for psychiatrists. His magnum opus “The Matter with Things” expands and builds on his previous book “The Master and his Emissary”. As the new book is in two volumes and exceeds 1000 pages. You may want to consider it for your holiday read... Alternatively, watch this space and book one of only fifty places and hear what Iain says about how his work is relevant to psychiatrists.

In this Newsletter, we have a book review by Adam Hunt on the book by Mike Abrams titled “The new CBT: Clinical Evolutionary Psychology” which is well worth reading. We also include an essay by Costa Savva on “Modularity Theory”, which is well worth reading.

If you have time to spare over the summer and wish to hear interesting talks, please visit our YouTube channel https://www.youtube.com/c/EPSIGUK?app=desktop.

Wishing you all a lovely summer with at least some time to rest and recuperate!

Book review: Mike Abrams' "The New CBT: Clinical Evolutionary Psychology

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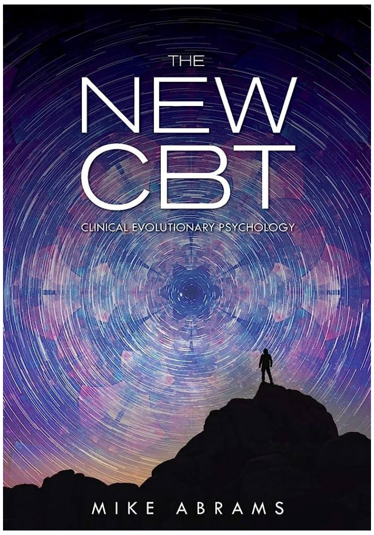

Mike Abrams is a clinical psychologist at New York University, and his book 'The New CBT: Clinical Evolutionary Psychology' is the most extensive attempt by any therapist to interweave evolutionary theory with psychological therapy. The book is large and comprehensive, with the first half dedicated to background in evolutionary theory and critical principles of evolutionary psychiatry (e.g. why distress can be adaptive), and the second half considering evidence and evolutionary hypotheses around the major mental disorder categories. The majority of this review is derived from the introduction to the book. For more specific details on how Abrams tackles each disorder, readers should refer to the book itself.

If there is one criticism I have of the book, it is that it takes heritability estimates as proof of fixed effects – the more heritable a condition is, the less Abrams believes you can change the individual (so antisocial individuals cannot be 'fixed'). This is a mistake – heritability estimates reflect genetic contributions to traits but are still dependent on environments – if you inherit a propensity to tan but are never exposed to sufficient sunlight, the genetic propensity never manifests in a phenotype. Similarly, the heritability of disorder-related phenotypes may lead to very different traits in different environments; if antisocial behaviour is 80% heritable, it doesn't mean an antisocial individual only has 20% of those behaviours which can be affected by environmental changes, or therapy.

Despite this problem, Abrams offers a solid and pioneering approach which offers something evolutionary psychiatry dearly needs – more contact with therapeutic change.

To briefly report Abrams' overall thrust throughout the book: Abrams proposes what he calls Informed Cognitive Therapy (ICT). ICT adds essential knowledge of evolutionary theory to CBT. Clinicians apply concepts from evolutionary psychology and behavioural genetics, helping to parse the historical nature versus nurture problem. Clinicians also need to recognise that modern environments are very different to the environment of evolutionary adaptiveness (EEA). This divergence leads to many psychological problems which superficially appear to be disorders, which would have been functional solutions. Mental health professionals will need to become conversant in the demands of daily life, not just today, but in past eons.

Just as we used to portray mental health problems in terms of fighting demons, Abrams suggests that modern people feel liberated when their demon-like despairs are explained in scientific terms – it can be explained that their brains contain circuits designed by evolution at cross-purposes to their own desires. These circuits will make them feel wrong, and let them down, and always be there. In coming to learn this ICT explanation of their suffering, people can be better motivated to change, understanding this is the best scientific explanation of their problem. Anyone can improve – not infinitely – there are heritable or evolved barriers – but those people with vulnerable genomes, if they're willing to work har-

Book review: Mike Abrams' "The New CBT: Clinical Evolutionary Psychology

der and more persistently, can still change. Abrams asserts that ICT requires a thorough examination of strengths and weaknesses – the ICT clinician notes that genetic tendencies cause suffering, but other genetic abilities allow healing.

Abrams suggests that attributing a person's failings to evolutionary adaptations can be liberating. It moves blame away, and points to potential positives in adversities. It does not impugn a person to note some essence of their being as causing the problem, nor does it imply it can't be changed, although it appropriately indicates that change may be more difficult for some individuals. In contrast, falsely attributing psychological problems purely to social or cultural factors carries that risk, blaming others, parents, society.

By applying the evolutionary perspective to psychotherapy, Abrams believes we disentangle the defect from the distress. By providing substantiation that much human anguish is the result of natural selection, we destigmatize the afflicted and find new ways to better functioning. Recognising evolved psychological mechanisms is not dehumanising, as some suggest – it is realistic, and is not blaming. While exploring the genetic foundations of traits, we can also develop an understanding of environmental influences on them and learn to create environments that foster psychological well-being and productivity.

Abrams provides a vignette: Sam, who is antisocial, has violent tendencies and enjoys aggressive encounters, gets into fights often, sees it as defending his honour, and is told by the ICT clinician that clearly his behaviour was rational for a cave dweller, but is asked to take an economic view of his behaviour: was the increasing cost (criminally) of his encounters worth the brief high of winning a fight? He is told he has a unique and valuable talent, but is undermining it by using it foolishly. It is offsetting its benefits. He is not told to avoid fights because of normative modern values – he is informed of aggressive tendencies in the evolutionary past, and made to see his behaviour is maladaptive and now hurting him rather than helping him. Not only is Sam helped by this explanation, but the therapist who learns evolutionary principles can also be more compassionate and understanding of his antisocial tendencies, which enriches the therapeutic relationship.

Abrams notes that before the introduction of an evolutionary approach, applied psychology had no single unifying or organising principle; textbooks set forth a series of contradictory theories, clinical psychology texts advocate therapies based on three or four standard acclaimed figures, and applied psychology made divergent recommendations contingent on the author's affiliation.

On a more technical psychological note, Abrams suggests that almost all psychological suffering can be reduced to internal conflicts – ICT applies the techniques of CBT, but with three fundamental principles guiding interventions. i) a substantial proportion of psychological conflicts arise from innate or evolved factors ii) the therapist needs to be mindful of that fact whilst conducting psychotherapy iii) this must be persistently imparted to the client when encouraging them to adhere to prescribed changes in thinking and behaving. Abrams notes that CBT is most effective when persistently and forcefully applied – he believes that ICT can help by encouraging this.

In summary, Abrams emphasises that clinicians must understand the principles of evolution – the brain evolved as much as any other organ. He believes that psychotherapists who are aware of the evolved mechanisms that guide thinking, feeling, and actions will have a more realistic view of human inclinations to anger, jealousy, fear, despair, and aggression. Appreciating that all human strengths and failing have origins in genes and evolution allows a better conceptualisation of a client's problem. It is far more productive to look to genes and evolution for explanations than to make a futile quest into a client's childhood. The next step in clinical psychology may indeed be something like what Abrams suggests in The New CBT.

Has the sun set on "Modularity Theory"?

A critical overview of one of evolutionary psychology's most controversial theories

About the author

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Over the last 50 years, a debate has been raging between academics on the overall functional organisation of the mind. Central to this debate has been a concept about the structure-function of the mind popularised by philosopher Jerry Fodor– the "modularity theory of mind" (Fodor 1983). In this essay, I would like to highlight the important features of Fodor's original theory, its evolutionary implications and psychological enhancement, subsequent scientific findings that have seemingly provided evidence in favour of modularity, and also some of the critiques that are still being levelled at it. In order to do so, it is my contention that a rudimentary understanding of the historical background of these complex developments will help colour these ideas.

Historical underpinnings

The 20th century saw substantial advancements in theorising about the mind; the first half dominated by *behaviourism* –the idea that all animal behaviour, including human, can be explained in terms of conditioning, without an appeal to internal mental states such as thoughts– and the second half by *cognitivism* –the notion that internal cognitive processes work similarly to a computer program, underscoring the vital importance of mental states in behaviour and learning. It is in this latter context, within the area known as *faculty psychology*, that Fodor was thinking about the structure of the mind as being separated into sections, each assigned to certain mental tasks. In his original 1983 paper, Fodor delves deep into some of the historical projects in faculty psychology, for example in referring to Franz Joseph Gall's formulation of *phrenology*, the idea that brain areas are localised according to their function and can be empirically measured by quantifying various bumps on the skull. Gall's work is nowadays considered racist, sexist and pseudoscientific, but Fodor draws particularly on Gall's theorising about *localisation of function*.

Other examples of early localisation of function were demonstrated by Carl Wernicke and Pierre Paul Broca, whose eponymous cortical areas are associated with language comprehension and language production respectively. Furthermore, neurosurgeon Wilder Penfield's seminal electrical stimulation experiments elucidated the underlying relationship between structure and function (Penfield 1937). It is clear, therefore, that the overall functional organisation of the mind can't be purely homogeneous. However, this was in contrast to early British *associationist thinkers* (who provided the intellectual foundations for later behaviourism), whose view was that there is no internal specialisation, and that the brain was functionally undifferentiated, with the same basic operations taking place everywhere.

The brain as Fodorian modules

In rejecting full homogeneity, and accepting a degree of specialisation, Fodor seeks in his modularity theory to embrace heterogeneity, and to understand how this *functional specialisation* works. He starts by discussing the two types of architectural theory of cognition: "vertical" and "horizontal" organisation (Figure 1). The former involves the mind being divided into modules according to the *content* processed (*"domain-specific"* e.g. visual stimuli, faces, speech), and the latter organising the mind according to the *kinds of processes* it carries out (*"domain-general"* e.g. learning, memory, perception). Fodor then posits a three-tiered taxonomy of cognitive systems consisting of "transducers" that translate physical stimuli into usable computational code, and "input systems" such as the sensory systems and language that transfer this code to the "central processor". The candidates for "modularity" that Fodor focuses on are the "input systems", and he arrives at nine criteria for modu-

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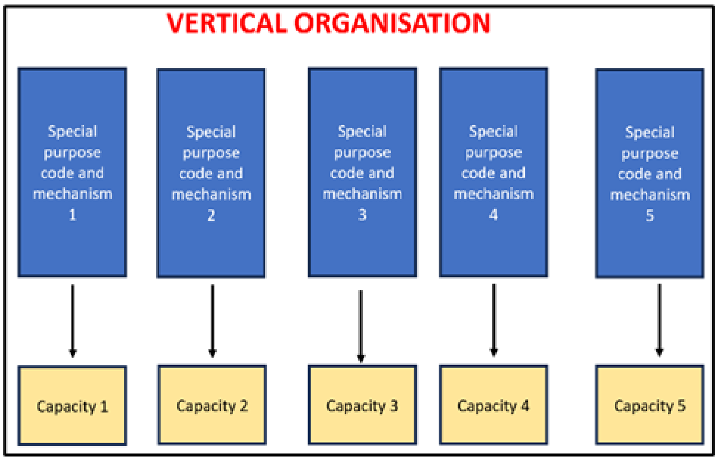

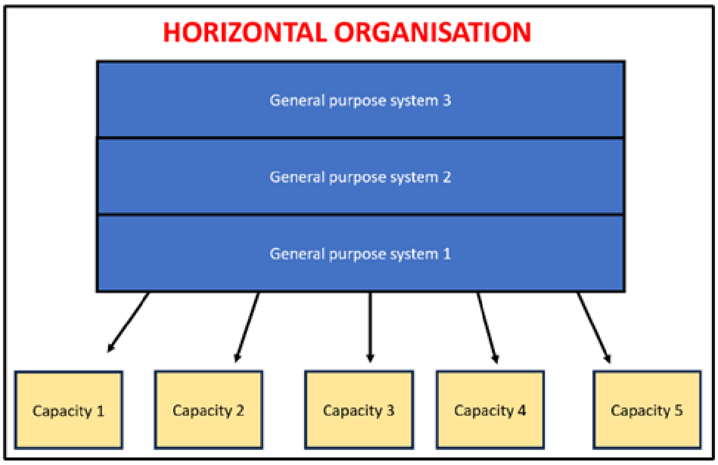

larity, which we will now consider. Interestingly, Fodor considers the “central systems” as not fulfilling criteria for modularity, and thus being beyond the reach of future empirical science.

Two important features, ***informational encapsulation*** and ***central inaccessibility*** are two sides of the same coin, referring to the character of information flow across a module. The former refers to the restriction of flow of information into the modules, whilst the latter refers to the restriction of information out of it. Therefore, informational encapsulation means that a module processing some specific information (e.g. incoming sensory data) can’t access information stored elsewhere; all it has to go on is the incoming information and any information stored within the system itself. Similarly with central inaccessibility, whilst the module is doing its processing prior to output, the central system, or consciousness, doesn’t yet have access to it. Linked to these ideas of encapsulation is the notion that the module processes information within it in a ***fast*** and ***automatic*** way – your visual sensory systems can’t choose not to see something presented to them; your auditory cortex can’t not hear a word that is uttered by someone else. Furthermore, the module generates ***shallow outputs*** whereby a mere sketch, rather than an elaborate picture, is produced and presented to the central processor (i.e. outputs are computationally-cheap and informationally-general).

In addition, the classic Fodorian module, when damaged or impaired, will have little to no effect on the operation of other systems. Ideally, it will also have a fixed neural architecture. Together, these features are known as ***dissociability*** and ***localizability***, respectively, and they go together; evidence from neuroscience has demonstrated that selective lesions of certain areas will produce very specific functional impairments – fusiform gyrus (prosopagnosia), area V4 (colour vision), area MT (motion detection), parahippocampal gyrus (spatial scene recognition), and so on. To this end, Fodor recognises that the modules may display ***domain-specificity***, which has to do “with the range of questions for which a device provides answers…”, as he himself puts it. Domain specificity is to do with the *content* that is being analysed as input, and allows modules to act as autonomous, dedicated, special-purpose systems for specific tasks. The narrower the range of inputs a module is designed to process and compute, the more domain specific it is, and Fodor cites systems for colour perception, visual shape analysis, voice recognition and others as potential candidates, in doing so recognising these modules as components that are *vertically-organised*.

The final module feature that Fodor characterises in his seminal 1983 work is the idea of ***innateness***, or put differently, that the “input systems” Fodor is considering have an ontogenetically characteristic pace and sequencing. His primary example is that of language acquisition, and here Fodor alludes closely to work central to linguist Noam Chomsky, and his theory of “Universal Grammar” – a nativist theory that posits innate constraints on what the grammar of a possible human language can be. Related to this, it has been demonstrated that language acquisition occurring in normal individuals of all cultures follows a quite rigid schedule: single words (12 months), telegraphic speech (18 months), complex grammar (24 months) (Stromswold 1999).

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Further, though not offered as evidence by Fodor, work on the cognitive development of children by Jean Piaget, and how all children seem to follow discrete stages as their neural circuitry develops, seems to support this hypothesis that modules are innate. From an evolutionary perspective, multiple mechanisms may be hypothesised to be at play, but, in part, Fodor's modularity theory seems to rest on the idea of *path dependence*; the modular structure of the brain develops irreversibly as determined by the drives and constraints of both genetics and the environment.

Evolutionary psychologists and the "Massive Modularity Hypothesis"

Whilst Fodor didn't commit to modularity in the "central systems", evolutionary psychologists in recent decades have gone as far as to assert modularity throughout the mind, including the parts responsible for high-level cognitive functions like problem-solving, thus giving rise to the "Massive Modularity Hypothesis". Importantly, these psychologists haven't committed themselves to modules as defined by the Fodorian criteria necessarily, but rather to the concept of "functional specialisation"; the logic being that structure follows function in biology, and that the modules should be defined by the specific operations they perform rather than a list of necessary and sufficient features (Pinker 1997).

The key to understanding how the evolutionary psychologists view modules is to conceive of them as adaptive "Darwinian modules", a notion substantially different from Fodorian modules, since the former are well-designed to fulfil a specific function and are acted upon by natural selection. In this case, Darwinian modules may overlap with Fodorian modules in their constitution if, and only if, the aforementioned criteria are a property of their evolved design. It may also be the case that Darwinian modules may refute most, or all, of Fodor's criteria, whilst remaining consistent with "functional specialisation"; for example a module might not be localised in a fixed neural circuit, but rather distributed throughout multiple areas. Examples of uncontroversial Darwinian modules are rare, but may include Tooby and Cosmides' hypothesised "cheater-detection module" that fulfils the specific function of identifying individuals who've broken contracts and norms, and is speculated to be a *distributed* rather than fixed neural system (Cosmides 1989, Cosmides and Tooby 1992).

Before we discuss some of the underlying scientific findings, we must familiarise ourselves with the case for Massive Modularity (of both Fodor's "input systems" and also the central systems). The most famous, the "argument from design", is firmly grounded in evolutionary reasoning – the human mind is a product of natural selection; in order to survive and reproduce, human ancestors had to solve a number of recurrent adaptive problems; modular systems are able to solve adaptive problems more quickly, reliably and efficiently; thus natural selection will have favoured evolution of a massively modular architecture (Cosmides and Tooby 1992, Carruthers 2002, 2006). This reasoning has been attacked as a just-so story in the literature; a common line of argumentation against adaptationist reasoning. The second argument, "argument from animals", relies on the fact that if we can empirically demonstrate massive modularity in many other animal species, that would lend phylogenetic evidence to the hypothesis in humans.

Allometry and the neurobiological foundations of modularity

If we, for argument's sake, presuppose the existence of multiple, functionally-specialised, Darwinian modules, we must then examine how these modules may have evolved phylogenetically. It could be the case that each module has a "semi-independent evolutionary account" (Quartz 2002), whereby each module may have been under selective pressure independently of other modules and thus evolved differently, to fulfil their specific functions – aka "mosaic" evolution. Or, it could be the case that these modules evolved in a "concerted manner", whereby they have evolved dependently on one another (and, of course, there's no reason to presume both mechanisms

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aren't at work). These two modes of evolution can be modelled mathematically through the concept of "allometry".

Allometry refers to the proportional relationship between a quantity (e.g. volume) of a part of an organ, and its whole (or of an organ, and the whole body), often described mathematically by a power law. Different types of allometric relation can be studied: during development (ontogenetic), across individuals (static), across environments (plastic), and across species (evolutionary allometry). Allometric relations are found at many levels of organisation, including of volume relations between parts of the brain and the brain itself. The more closely allometric relationship is demonstrated, the greater the suggestion of concerted evolution.

It may be the case that, if allometry can be demonstrated between parts of the brain, and the whole brain itself, in humans and in other species, then this discrete empirical evidence may shed light on the nature of modular evolution – whether mosaic or concerted. This was exactly what neuroscientists Barbara Finlay and Richard Darlington sought to investigate, when they mapped the logarithm of the volume of 11 adult brain parts (e.g. cerebellum, striatum, neocortex etc), as a function of the logarithm of the volume of the brain across 131 species, include *homo sapiens* (Figure 2). Their data shows a clear allometric relationship across mammalian species between brain parts volume and brain volume, providing, on the surface, compelling evidence for concerted evolution of Darwinian modules, defined functionally as embryologically-distinct brain structures.

Initially, the idea that these discrete brain regions evolved in a concerted manner may provide evidence against a "massive modularity": might we not expect more mosaicity if different structures have evolved for different functions, with an evolution to some degree independent of one another? Philosopher Steven Quartz contends this is the case, and argues against massive modularity based on the allometric findings of Finlay and Darlington. However, one important

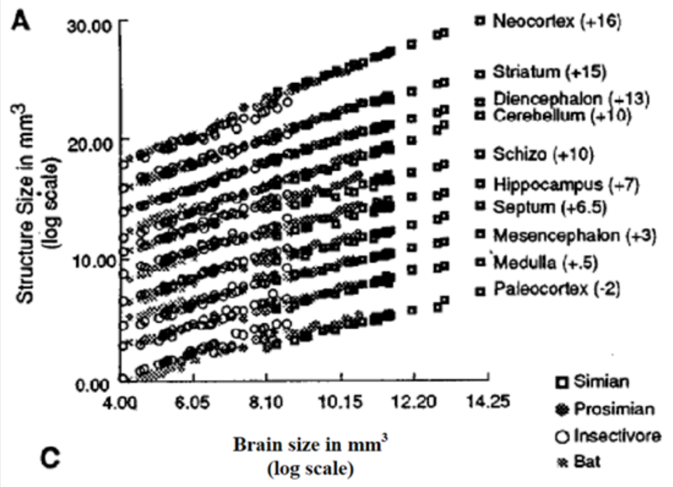

Figure 2: Allometric Relations between the Volume of the Brain and the Volume of Brain Parts (from Finlay, Darlington, & Nicastro, 2001, 266)

problem Quartz' argument faces is that the empirical data discussed doesn't show whether there may be mosaicism within the *neocortex itself* (Machery 2007). In fact, there is a wealth of evidence that suggests that the human neocortex displays intrinsic mosaicity, despite the concerted evolution of the neocortex in reference to whole brain volume. For example, whole-brain MRI studies have demonstrated the human prefrontal cortex is significantly more convoluted than expected for our brain size, and significantly larger than expected for a primate of our brain size (Rilling 1999). Furthermore, the many structural differences between the visual cortex of humans and of macaques suggest a divergent and mosaic neocortical organisation (Preuss 2004). Additionally, the human insular cortex, significantly greater in relative cortical size than in other primates, contains specialised "Von Economo Neurons" that are involved in social processing, and found in much lower proportions, or not at all, in other mammals (Bauernfeind 2014, Banovac 2021).

Therefore, I propose that modularity is present on at least two levels neurobiologically:

- Between embryologically-derived brain structures and the brain itself, concerted evolution acts to ensure that these structures evolve co-dependently, and incrementally.

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- Between cortical divisions of the neocortex, mosaic evolution is likely to act to induce the functional development of "Darwinian modules". This is demonstrated by inter- and intra-species differences in the allometric relationship between neocortical subdivisions and the neocortex itself.

To complicate matters further, separate to evolutionary environments, adaptive responses to local conditions of an individual, ontogenetically-speaking, may result in substantial degrees of neuroplasticity within Darwinian modules, further distorting what we mean by the concept of "module". In this sense, culture may be able to influence, via epigenetics, the modular structure of any one individual's mind (and for that matter a population also).

<u>Concluding remarks</u>

The modularity literature is vast, riddled with confusion, and epitomised by often unintelligible and parochial arguments. The ceaseless debates that have raged over the last few decades have been unproductive, stultifying the development of further thought. In particular, the terminology around the word "module" has been ill-defined, with behavioural scientists arguing for "Fodorian modules" and evolutionary psychologists arguing for "Darwinian modules", each debating at cross-purposes, and on different explanatory levels (Pietraszewski et al).

To clear up the confusion, and set an agenda for subsequent work, it's worth considering the three levels of analysis that are pertinent to psychological entities, each with their own ontology and level of reduction (Figure 3).

The intentional level, where Fodorian modules reside, is where a unitary agency ("you") resides, what philosopher Daniel Dennett calls the "Cartesian theatre" (Dennett 1987, 1991). Philosophers most associate this level with first-person phenomenological research, and it is the terminology most associated with lay-use conceptions of mental abilities.

The next level down, the functional level, is where the object of focus for evolutionary psychologists resides; the "Darwinian module". This level corresponds to a *computational* or *representational* level of analysis; there is no "you" or "I" or "central system" but rather a series of abstract "if/then" causal relationships between mechanisms.

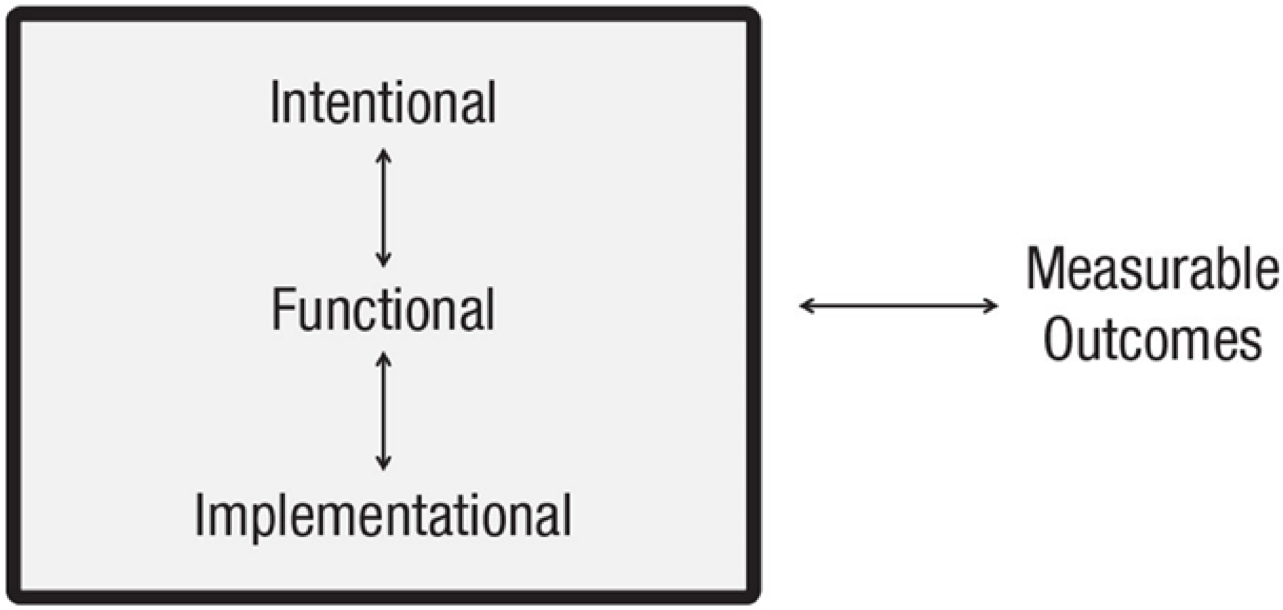

Figure 3: Causal processes within the mind responsible for producing measurable outcomes can be understood at three different levels of analysis, from least reductive (*intentional*) to most reductive (*implementational*). Reproduced from Pietraszewski et al (2021).

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The final level of analysis is the most reductive, and seeks to ground higher levels in discrete neuroanatomical features and electrochemical interactions; some of the work we have touched on apropos allometry may serve the purpose of conceptualising modules at an implementational level. To take the implementational level of modularity to a new level, I contend that the existence of discrete neuroanatomical structures that are functionally linked in "networks", such as the well-encapsulated *default mode network* (involved in the resting-state intrinsic connectivity of the brain), the *latero-frontoparietal executive network* (involved in the higher-area top-down control of attentional resources), or the *salience network* (consisting of the anterior insular and cingular cortices, and involved in the regulation of the previous two networks in response to a "task" or a "salient stimulus"). These functional networks are studied in the academic field of *systems neuroscience*, and are clearly-delineated brain areas that have separate roles, but can be co-activated ("coupled") to perform particular functions. Here, the "network" being activated is the module, that ostensibly has an evolutionary origin.

For Pietraszewski then, it is clear: academics have been arguing for a concept of modularity at different levels, without fully realising it. He repudiates neither the work at the intentional level, nor at the functional level, but rather argues for an integration of ideas across levels in order to revitalise the field. Finally then, has the sun set on modularity theory? Categorically the answer is no; it has the potential to realise truly groundbreaking discoveries about the nature of the mind (as long as we are able to stop using the word "module" without qualification!).

Costa Savva, July 2023

Post-scriptum: Pietraszewski uses a famous comedy sketch (Abbott and Costello – "who's on first?") as an analogy to the debates in the field of modularity theory. It's well worth a watch:

https://www.youtube.com/watch?v=kTcRRaXV-fg&t=373s&ab_channel=NYYGehrig

References

Banovac I, (2021). Von Economo Neurons - Primate-Specific or Commonplace in the Mammalian Brain? Front Neural Circuits. 2021 Sep 1;15:714611. doi: 10.3389/fncir.2021.714611. PMID: 34539353; PMCID: PMC8440978

Bauernfeind AL, (2013) A volumetric comparison of the insular cortex and its subregions in primates. J Hum Evol. 2013 Apr;64(4):263-79. doi: 10.1016/j.jhevol.2012.12.003. PMID: 23466178; PMCID: PMC3756831

Carruthers, P., (2002). The cognitive functions of language. *Behavioral and Brain Sciences*, 25: 657–725.

Carruthers, P, (2006). *The Architecture of the Mind*, Oxford: Oxford University Press.

Cosmides, L (1989), "The Logic of Social Exchange: Has Natural Selection Shaped How Humans Reason? Studies with the Wason Selection Task", Cognition 31:187-278.

Cosmides, L., Tooby, J. (1992), "Cognitive Adaptations for Social Exchange", in John Barkow, Leda Cosmides, and John Tooby (eds.) The Adapted Mind. New York: Oxford University Press, 163-228.

Dennett D. (1987). *The intentional stance*. MIT Press.

Dennett D. (1991a). *Consciousness explained*. Little, Brown.

Finlay BL, Darlington RB. (1995) Linked regularities in the development and evolution of mammalian brains. Science. 16;268(5217):1578-84. doi: 10.1126/science.7777856. PMID: 7777856.

Fodor, J. A., 1983. *The Modularity of Mind*, Cambridge, MA: MIT Press.

Machery, E (2007). Massive Modularity and Brain Evolution. Philosophy of Science 74 (5):825-838.

Penfield W et al (1937) Somatic motor and sensory representation in the cerebral cortex of man as studied by electrical stimulation. *Brain.* 1937;60:389

Pinker, S (1997). How the mind works. New York: Norton

Pietraszewski, D., & Wertz, A. E. (2022). Why Evolutionary Psychology Should Abandon Modularity. *Perspectives on Psychological Science*, *17*(2), 465–490. https://doi.org/10.1177/1745691621997113

Preuss, T,. (2004), "Specialisations of the Human Visual System: The Monkey Model Meets Human Reality", in Jon J Kaas and Christine E. Collins (eds.). *The Primate Visual System*. Boca Raton, FL: CRC Press, 231-259.

Quartz, S (2002), "Toward a Developmental Evolutionary Psychology: Genes, Development, and the Evolution of the Human Cognitive Architecture", in Steven J. Scher and Frederick Rauscher (eds.) Evolutionary Psychology: Alternative Approaches. Dordrecht: Kluwer.

Rilling JK, (1999). The primate neocortex in comparative perspective using magnetic resonance imaging. J Hum Evol. 1999 Aug;37(2):191-223. doi: 10.1006/jhev.1999.0313. PMID: 10444351

Robbins, P, "Modularity of Mind", *The Stanford Encyclopedia of Philosophy* (Winter 2017 Edition), Edward N. Zalta (ed.)

Stromswold, K., 1999. Cognitive and neural aspects of language acquisition. In E. Lepore and Z. Pylyshyn, eds., *What Is Cognitive Science?*, Oxford: Blackwell, pp. 356–400.