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THE MODULARITY DEBATE: ASSESSING THE CONSTRUCTIVIST/DEVELOPMENTALIST CHALLENGE

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1. INTRODUCTION

Some of the main questions that have been troubling philosophers, psychologists, and cognitive scientists alike for the last few decades are: What is the nature of human mind? Is there any difference between the "mind" of a robot and that of an intelligent scientist? Are human minds like a noisy parliament in which everyone competes with others to be heard (Dennett, 2001)? Are human minds nothing but thinking machines (Turing, 1950)? Does the notion of computation capture the essence of how our minds work (Searle, 1990; Dreyfus, 1992)? If yes, then what is the nature of these computations and mechanisms that subserve them (Pylyshyn, 1984; Flusberg & McClelland, 2014; Roberts, 2007)? It is the gamut of issues surrounding such questions that we need to situate very influential but equally controversial thesis of the modularity of mind that was first articulated by Jerry Fodor (1983). The proposal has elicited very extreme reactions ranging from extreme enthusiasm (Sperber 1994 & 2002; Pinker, 1998; Barrett, 2005; Barrett & Kurzban, 2006; Machery, 2007) to total rejection (Quartz, 1993 & 2002; Quartz & Sejnowski, 1997). Some other responses lie somewhere or the other between these two extremes (Karmiloff-Smith & Johnson, 1991; Karmiloff-Smith, 1992 & 1994; Elman et al., 1996). In my present essay, I wish to focus on constructivist/developmentalist response to the modularist proposal.

When we look at the work of constructivists and developmentalists, we find that one of the basic aims of their project has been to emphasise the distributed and interactive nature of cognition and mechanisms subserving such activities (Elman et al., 1996; Johnson, 1997; Karmiloff-Smith, 1998; Mareschal et al., 2007). They in fact have consistently raised many substantive issues affecting philosophy of mind and neuropsychology. It is perhaps also not out of place to acknowledge that these scholars have been at the forefront of offering critical evaluation of the wide spread idea of the "universal modular structure" of the cognitive system. They have also offered powerful arguments against static models of normal cognitive system that the modularist account of mind tends to legislate (Quartz & Sejnowski, 1997; Griffiths & Stotz, 2000; Grossberg, 2000 & 2019). Also, constructivists/developmentalists have also often accused their modularist opponents to be guilty of adhering to the "assumption of residual normality" (Thomas & Karmiloff-Smith, 2002a). Before undertaking an assessment of such responses, I want to begin my response by first highlighting confusions on the modularist side.

2. CONFUSIONS AND LACK OF CLARITY WITHIN THE MODULARIST CAMP

It is ironic that despite about four decades of intense debate over the nature and extent of modularity (Fodor, 1985, 1991, 1998, 2000 & 2005; Farah, 1994, Karmiloff-Smith, 1992 & 1994, Thomas & Karmiloff-Smith 2002a&b; Sperber 1994 & 2002; Pinker, 1998 & 2005; Carruthers, 2006; Coltheart 1999; Lyons 2001; Samuels 1998 & 2002; Elman et al., 1996; Robbins, 2017) there seems to be little clarity concerning even some fundamental issues, like, the nature of modules and how the modules let the information in[1]. Though modules are supposed to consult only what is in their proprietary database in producing a response (Fodor, 1983 & 2000), we still lack knowledge about such basic things as to what turns them on.

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[1]In a way while there seems to be some truth in Fodor's lament (Fodor, 1998) that modularity has come to mean different things on different tongues (for instance, massive modularists, like, Pinker, Cosmides & Tooby, Machery among others), such an accusation does not apply to developmentalists like Karmiloff-Smith (1994).

Or, how, for instance, a module decides whether a particular input belongs to its proprietary domain or not[2]. The lack of any details about how modules are individuated has also not been addressed by modularists. Consequently, there is little clarity as to whether they are individuated at the level of entire faculty or by the representations that they process (Fodor 1983 & 1985; Jackendoff, 1997). Lack of information about how modular mechanisms produce output in a format that it becomes accessible to other modules and or central systems, or how modules communicate with each other or the central systems is also very glaring[3]. Hardly any one seems to know whether top-down processing is possible within modules or not.

Since so little is known about functioning of modules, I am not sure the extent to which acceptance or rejection of modular imagery will really have as wide spread repercussions as is usually made out to be by the modularists. What is even more surprising is the fact that very little has been done to address such issues by designing experiments that aim at gathering such details. As Fodor himself laments, “most of the discussion has been about whether there are modules and, if there are, whether they are innate. For better or worse, the point of view in the book [Fodor (2000] isn’t the one that has guided research on these issue” (Fodor, 2000, personal communication). But who is to be blamed for such a state of affairs given the wide spread disdain amongst philosophers towards incorporation of findings of rigorous empirical work in their cogitations? Even more surprising fact is that even most neuropsychologists still tend to implicitly rely on the doctrine of modularity or what has come to be referred as the assumption of “residual normality” (Thomas & Karmiloff-Smith, 2002a). That such a grim situation should inspire some modularity enthusiasts to make extensive use of modularity thesis in their explanation of such complex human behaviours as language (Pinker, 1994), marriage, love, misplaced investment in bringing up of children and neglect of one’s own parents (Pinker 1998), cheating (Cosmides & Tooby, 1992), religion, art appreciation or lack of it (Mithen, 1996) is quite unfortunate. If nothing else, loss of rigour through such attempts tends to bring a bad name to scholarly pronouncements.

3. THE DEVELOPMENTALIST CHALLENGES

One way, among others, to demonstrate the plausibility of modularist assumptions is to examine the influence of background information on perceptual processes. This can be attempted by testing how the former affects the computations performed by the latter. Provided of course that the background information in question falls outside the proprietary database of the module and is perceptual in nature[4]. In my view it is one of the chief merits of effort of constructivists/developmentalists is to face the modularist challenge by focusing on basic issues surrounding modularity. That they have been very successful in this endeavour is obvious not only from the wealth of data examined by them over the decades but soundness of their position/arguments has been demonstrated through results of computational models designed by them, models that have specifically aimed at bringing into sharp focus how modular structures could developmentally emerge without being innate. Such attempts pose a formidable challenge to the modularist orthodoxy when they direct their energies at inquiring whether the rest of the cognitive system would develop normally if some of its components are not allowed to develop normally? Or, what would happen if developmental processes were disturbed as in the case of developmental disorders? Would such unusual scenarios affect final outcome or end state?

In the context of controversies surrounding modularity, the basic problem appears to be that the modularity thesis has never been precisely formulated for it to be refuted (Lyons, 2001). For instance,

[2]For details of attempts by scholars who tend to make use of the concept of a ‘module’ in a relatively less strict manner, see, Pinker (1997/8; Cosmides & Tooby (1992), Sperber (2002) and Robbins (2017). For Fodor’s critical response to these efforts, see, Fodor (2000).

[3]As the situation is already complicated enough, I have restrained myself from complicating it any further. Accordingly, discussion of issues like whether cognitive systems are endowed with ‘interface modules’ or not, though important enough in its own right, has not been taken up for consideration here (Jackendoff, 1997). Such a proposal is problematic because while the existence of such entities is usually justified on the ground that we need ‘something’ that affects translation operations between modules or modules and central systems, no ompelling ground have been provided for accepting the requirement of preservation of informational content through such translation operations This is problematic as contra interface modules, as we are used to understanding modules following Fodor (1983), are often thought of as not preserving informational content.

[4]See, Hunt (1985) for some details on context priming studies.

modularists have never specified necessary and sufficient conditions for modularity. Even evidence for violation of some of the central features like innateness, domain specificity, and informational encapsulation has not been of much help because modularists insist that to show the truth of "nonmodularity, you have to show that a capacity is affected by information that is external to the module by independent criteria" (Fodor 1985, p. 36). Also, modularists usually embrace some kind of nativism or the other in articulation of their position though all nativists are not strict modularists (Spelke & Newport, 1998). Now, the extent to which nativists agree in some of their sober moods with nonnativists (eg, Cowie, 1999) that nativism is a "largely negative doctrine" based on "notoriously vague and slippery" notions like triggering (Samuels 2002, pp. 248 & 247 n 21), one is at a loss to understand what to make of some of their larger claims.

Therefore, if modularists want their thesis to be taken seriously, then they have to clarify whether their thesis is applicable to a cognitive system, and if yes, then they are also required to explicate what it is for something to be a cognitive system. This is important as nonnativists have argued that functional discreteness of cognitive systems in no way entails acceptance of innateness, informational encapsulation or domain specificity (Lyons 2001). Also, there is considerable evidence to believe that the localisation of function could as well be resulting from competition between different neuronal groups than being genetically determined. A considerable number of prominent scholars have, for example, tried to successfully demonstrate how input itself could be serving as a kind of bias for functional specialisation (Edelman, 1987 & 1993; Jacobs 1999; Johnson, 1999; Neville, 1995; Sur, Pallas & Roe, 1990). As Lyons points out, "with the exception of neural localization, none of Fodor's nine diagnostic features are necessary conditions for system hood...there is nothing in the definition of cognitive systems that requires that they be innately specified, introspectively opaque, fast, or subject to characteristic breakdown" (Lyons 2001, p. 296).

In this regard, even if it is conceded to the modularists that no reduction of the mental to the physical has so far been realized or is not even in sight and we have to live with some kind of graded conception of reality where different resultant properties retain their functional autonomy without being reducible to the underlying base (Elpidorou, 2018; Melnyk, 2020; Stoljar, 2021), they still cannot indefinitely postpone giving answer to the question of how modular systems are individuated[5]. This is unavoidable because neural architecture is, by everyone's admission, the substrate in which modular systems are realized. Also, there seems to be no justifiable reason for pessimism concerning the science of nonmodular cognitive systems. There appears to be no principled objection to our continuance to look at the mind as a cognitive system that is implemented through "functionally isolable subsystems" (Shallice, 1984 & 1988) without accepting the modularity thesis. Such a possibility cannot be easily dismissed as the actual details of brain circuitry involved in different perceptual processes is largely plastic, interconnected, parallel and makes use of elaborate re-entrant pathways (Edelman, 1987; Grossberg, 2000 & 2019). It is very unlikely that such a substrate will not affect the nature of computations that such networks perform in subserving different cognitive tasks. Therefore, in so far as objective of advancing our knowledge of nature and cognitive capacities of living beings is concerned, designing of more and more powerful computational systems is likely to be of very little consequence.

This appears quite natural as all information is eventually represented through neuronal activity. As has been argued by many neuropsychologists, even the existence of "so-called pure syndromes" does not prove that a "cognitive system is modular in nature (Shallice, 1984 & 1988; Hinton & Shallice ,1991). Whatever we know about the nature of brain structure does not appear to rule out that the functional architecture cannot be interactive in which different systems are influenced in their activity by activation patterns of other connected neuronal networks. In fact, empirical facts about neuronal structures across different life forms favour quite the opposite. The issue that is yet to be settled in sufficient detail is thus more about the nature of influence. If modules can be thought to be resulting from developmental processes as has been argued for by developmentalists like Karmiloff-Smith,

[5]Here by supervenience, following Kim, |mean that "for each mental, biological, or other 'special' property M, there is a physical property P such that M must occur if P occurs". The supervenience thesis thus entails nomological dependence of M upon P (Kim, 2000, pp. 247 & 256).

Thomas and their other co-workers, then different cognitive systems may involve varying degree of encapsulation as a function of developmental processes (Karmiloff-Smith, 1994). However, this in no way amounts to vindication of the other extreme that argues for equipotentiality of the cortex (Quartz & Sejnowski,997). In this regard, Shallice's advice appears quite reasonable when he proposes that "cognition may involve more than Fodorian modules and equipotential systems" (1984, p. 246).

I consider it important to emphasize this point as given the acrimonious nature of the debate between modularists and developmentalists, arguments run the risk of being totally misunderstood might remain less effective if developmentalists are not careful the level at which they are pitching their arguments against what has been at the centre of modularist discourse[6]. Lack of such a clarification would also make it difficult to assess the extent to which their proposal affects modularity thesis. For instance, reflexes are ideal type examples of modular systems for Fodor. They are thought to be oblivious to our beliefs, interests, and life objectives. Given their proximal stimulus, they produce their effects. Similar is the case with perceptual illusions. Modulartsts explain these phenomena by taking recourse to restrictive availability of information to modules; modules by definition are supposed to consult only what is in their database to produce a response.

Though modularists treat reflexes to be ideal type cases for demonstration of their thesis (Fodor 1983 & 1985), evidence points to a very involved role for input in development of motor and sensory systems (Konczak et al., 1997; Pearson, 2000). For instance, maturation of walking and head bobbing behaviour is shown to be dependent on locomotor experience (Muir & Chu, 2002). Studies have also emphasised the dynamic nature of organisation of motor cortex as evidenced from large scale reorganisation of representational maps for movements in both humans and animals. Motor plasticity is also revealed through the ease with which new motor skills can be learned and retained in the form of automated skills. Pearson (2000) in his work, following studies by Durkovic & Damianopoulos (1986), has reported wide spread changes in reflex pathways following lesions in both humans and animals, whether they happen owing to accidents and/or in experimental settings (Whelan & Pearson, 1997; Pearson, 2000). In this regard, work of du Lac et al. (1995) is very noteworthy in providing evidence for learning and memory in the vestibulo-ocular reflex (VOR) pathways of the awake and behaving monkeys by identifying anatomical structures involved in learning in the VOR. Moreover, while activity-dependent reorganisation of cerebral cortex is well documented, there is substantial increase in evidence that points to marked reorganisation in subcortical structures, like, brainstem and thalamus as well (Jones 2000). McAllister, Katz & Lo (1999) in their review of literature likewise report studies that have identified specific neurotrophins as mediators of different forms of plasticity.

Notwithstanding such encouraging empirical findings, it may be more rewarding for the developmentalist alternative to systematically examine stock in trade examples that are all the time marshalled by the modularists in support of their thesis. For instance, how to deny the fact of persistence of visual illusions is not input driven? It would be interesting to see how developmentalists would account for such happenings within their proposed framework. If not anything, these issues have been at the centre of modularist discourse. Some clarifications may also be required as to what all is treated as being modularized and detailed trajectories of such processes. Are they referring to modularisation of perceptual mechanisms or cognitive systems[7]. This is important as modularity thesis in its strict formulations is more about perception than cognition (Fodor, 1985). As has been often pointed out by innatists, existence of innate and domain-specific knowledge does not entail existence of innate and domain-specific processing mechanisms (Samuels, 1998).

The other aspects of the modularist approach that have occupied developmentalists attention are their refutation modularists poverty of stimulus arguments and a particular version of modularity, namely,

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[6] For the sake of readability and descriptive elegance, I have tended to include amongst modularits their over enthusiastic massive modularist followers as well. They are known in the literature under the umbrella terms of "new synthesis nativists" and/or "massive modularists". However, this convenience has been adopted only in contexts where commonality between these camps is more important than their familial quarrels vis-à-vis their common developmentalist opponents.

[7] Since modularity thesis is more concerned with perceptual mechanisms than higher cognition, developmentalist arguments would hold only to the extent to which modularity thesis is extended to cognitive systems.

massive modularity[8]. That Fodor as the real proponent of the modularist thesis does not approve of extension of his thesis to include higher cognitive processes is well known and is in itself a topic of very acrimonious debate within the modularist camp[9]. At the centre of the disputes between Fodor and his massive modularists opponents has been the problematic nature of simplistic gene-behaviour mappings that are implicitly presupposed by many massive modularist accounts (eg., Pinker, 1998; Cosmides & Tooby, 1992, 1995 & 1997; Sperber, 1994). Often this gets tagged on to the vagueness that surrounds the functioning of modules within modularist camp. For instance, even in the case of modular systems damage to a component does not entail that the behaviour of other components will not change. If damage to a module means change to its computational ability, then the change in its output is likely to affect input/output of other modules and hence behaviour. Even within some versions of modularist accounts, it is possible to believe that any damage to a subsystem can have cascading effect on performance of other systems. Because modularists have themselves for long argued that while modules are insensitive in their operations to those of others and work on their own, this fact, for them, cannot be taken to mean that the output of modules cannot be affected by action of others. The damage to a module can affect both computations and function performed by a module in question. Also, computations may remain intact though behaviour may change due to changes in the input (Grodzinsky & Hader, 1994).

4. CONCLUDING REMARKS

In the context of the modularist thesis examined in the present essay, it appears that the developmentalists are justified in focusing on the problematic nature of the assumptions about the nature of cognitive systems that most neuropsychological accounts seem to unquestioningly assume the thesis of “residual normality”. But the important question that both modularists and developmentalist have to face is to answer whether functional nonmodularity entails anatomical nonmodularity. And if yes, then how is the former instantiated? After all it is not easy to establish that the distributed nature of neuronal implementations is inconsistent with computational modularity (Chater & Oaksford, 1990; Oaksford & Chater, 1991; Oaksford, 1994). Accordingly, the alternative of developmental modularization as articulated by Thomas, Karmiloff-Smith and their co-workers (Karmiloff-Smith, 1992; Karmiloff-Smith, Scerif, & Thomas, 2002; Thomas & Karmiloff-Smith, 2002a&b; Dekker & Karmiloff-Smith, 2010; D'Souza & Karmiloff-Smith 2016) can serve its intended purpose only after the nature of relation between cognition and neural substrate that subserves cognition is settled because cognitive systems are describable at different levels of abstraction (Marr, 1982; Farah, 1994). In my opinion a great deal of confusion in neuropsychology seems to result from neuropsychologists’ tendency to constantly shift between neural and cognitive levels of description in their explanations. This seems to result from their uncritical acceptance of the fairly widespread structure-function correspondences in the brain, a fact that often misleads many researchers in their theorisations by implicitly supposing as if these correspondences are one-to-one and direct.

As opposed to modularist accounts, the developmentalists seem to entail a kind of many-to-many mapping across different levels. It appears to me that the damaged components are likely to affect behaviour of nondamaged ones whether the imagery that we use in our explanations is of modular systems or of the connectionist variety, a fact reiterated by Semenza when he points out that the “nondamaged components of the architecture continue to function as they did before damage does not follow from the modularity assumption…[as] under the modularity assumption, the working of nondamaged modules may undergo considerable modification” (Semenza, 1994, p. 80). If this is possible without giving up modularity thesis, then Thomas, Karmiloff-Smith and their co-workers’ charge that their opponents mistakenly believe that despite damage to a particular component the nondamaged parts of the system may still be thought to work normally (the hypothesis of “residual

[8] However, for a more recent and detailed rehearsal of poverty of stimulus arguments and the kind of challenge that such arguments pose to developmentalist approaches, see, Laurence & Margolis (2001), Pullum & Scholz (2002) and Scholz & Pullum (2002).

[9] For a detailed critique of such an approach from within the modularist camp, see, Fodor (2005, 2000 & 1998) and Pinker (2005). In fact, Fodor may even be in agreement with some developmentalists in believing that the mapping between genes and cognition are many-to-many, see, Fodor (2000, Chs 4&5) for details. At the other end of the spectrum, clubbing together modularists like Fodor with other neuropsychologists like Shallice amounts to overlooking subtle but important differences in their approach.

normality") would not hold at least in some cases. It is however not clear to me what these alluded to changes could eventually turned out to be. Are the changes computational, algorithmic, or implementational? In my opinion, the details in each case are likely to have wild variations. More so when we keep in mind large-scale redundancies in the brain.

Also, the contribution of environment cannot ever be eliminated, but can merely be changed from one that is species typical (Johnston, 1988, p. 622). As has been often emphasised by interactionists, like, Bateson (1979), Gottleib (2003), and Oyama (2000) among others, all behaviour arises as a consequence of dynamic "interactions within and between the organism and its environment" (Johnston, 1988, p. 624). So, the interaction is always between organism and the environment and not between genes and the environment. What is inherited is not merely genes but "gene products, hormones, patterns of neural activity, nutrients, anatomical structures (both neural and nonneural), physical variables (such as temperature, salinity, ph, and gravity), self-produced stimulation, sensory experience, social interactions [, etc.]" (Johnston, 1988, p. 625). Given such a scenario, the influence of genes is not the only influence that we have to deal with in our theorisations, As Johnston & Edwards (2002) point out, "genes appear as one among many contributors to a complex network of interactions" (p. 26). As researchers like Schaffner and Lewontin have asserted, "The relation between genes and organism is 'many-to-many'" and extremely indirect (Schaffner 1998, p. 212; Lewontin, 1995; Karmiloff-Smith, 2006). In a scenario like this and given developmentalists' emphasis on developmental modularisation, they may not be averse to acceptance of the existence of modules that are assembled by building upon certain 'inherent' biases. That is, a scenario in which perceptual illusions and reflexes would fall at one end of the spectrum, higher cognitive processes like belief fixation would fall at the other extreme. However, whether this would entail end of the road for the modularist camp is hard to ascertain. But it is beyond doubt that their approach has suffered considerable damage given the accumulation of evidence against their intuitions.

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