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Domain-General Operations in the Mind's 'Central Processing System'? A Test Case for Psycho-Ontology

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Psycho-ontology is the study of the basic features of reality in light of what we know about the nature of the human mind—and vice versa: It is also the study of the nature of the mind in light of what we know about the basic features of reality. In this paper, I will present an argument that moves in the "vice-versa" direction: I will seek to uncover features of the mind's central processing system by examining aspects of the objects of human cognition that seem to be present across most if not all cognitive domains. These general features of human ontology are then used as the basis for a sketch of a domain-general central processing mechanism capable of generating such an ontology, and of accounting for the rudiments of natural language without recourse to a specialized language module. Such a psycho-ontological method cannot, of course, conclusively settle questions about the structure of the human mind. But I will argue that it can give us something we could really use: A prima facie view of the operations of the mind's elusive central processing system.

I. Is "Central Processing" Needed in Our Model of the Mind?^

The question of whether the human mind can be said to possess a substantial "central processing system" is almost as old as contemporary cognitive science itself. Already in the early 1980s, when Noam Chomsky and Jerry Fodor offered the first formulations of the modularity thesis as a framework for thinking about mental architecture, they found themselves divided over the question of whether an architecture of domain-specific modules was likely to leave much room for an overarching central processing system that would apply a set of so called "higher" operations to the output of these dedicated modules. In Fodor's *The Modularity of Mind* (1983), the faculties or organs responsible for the domain-specific operations of perception and language cognition are considered to be "encapsulated," by which is meant that their operations are largely autonomous, and free from interference with one another and from other operations of the

mind.[1] But the autonomous modules that handle our perception of sights, sounds, smells, and language cognition aren't themselves all that there is to the mind. Beyond these, Fodor posited the existence of a domain-general processing "center" which is responsible for thought, belief, problem-solving, and other higher-level functions. This center receives processed information from the encapsulated faculties of perception and language, and generates thoughts, beliefs, and actions on the basis of this information.[2] In Fodor's presentation, this central part of the mind is seen as being difficult and possibly impossible to break down into distinct operations, and is unlikely to be located within distinct structures in the brain. The result is a description of the nature of the mind that has two parts or tiers: One that consists of discrete, domain-specific perception and language organs that are susceptible to empirical examination and description; and another, which remains resistant both to characterization in terms of operations, and to empirical study.[3]

Chomsky's view of modularity was more ambitious. Far from limiting the list of encapsulated organs to those that deal with processing perception, Chomsky's *Rules and Representations* (1980) suggests that the mind is comprised of a series of domain-specific modules whose business is the conduct of thought itself, each according to a grammar, or set of rules, specific to the particular area in question. On this view, the human mind looks something like a German research university, with each subject area being the domain of an independent faculty or department, whose expertise in treating its subject matter is largely detached from those of the department down the hall. Among the possible autonomous domain-specific modules mentioned in Chomsky's book are separate modules dedicated to thinking about common objects, language, mathematics, physics, understanding scientific theories, structured verbal discourse above the level of sentences, music, social structures, human personality, human facial recognition, and so on.[4] This list was expanded by subsequent scholars, so that, for example, Steven Pinker's *The Language Instinct* (1994) already names 17 possible domain-specific modules of the mind, one each for: Language, perception, physics (mechanics), biology (plants and animals), mathematics (number), maps, habitat selection, danger (fear and caution), food, contamination (disgust), monitoring current well-being (happiness and sadness), psychology (other people), a database of other individuals, self, justice (rights

[1] Jerry Fodor, The Modularity of Mind (Cambridge: MIT, 1983), p. 37.
[2] Jerry Fodor, Modularity of Mind, pp. 101-129.
[3] For the reasons "the psychology of thought has proved quite intractable" to cognitive science, and will probably continue to be so, see Jerry Fodor, Modularity of Mind, pp. 38, 126-129. Fodor returns to this subject in Jerry Fodor, The Mind Doesn't Work That Way (Cambridge: MIT, 2000), pp. 2, 5, 37-39, 41-53, 71, 78.
[4] Noam Chomsky, Rules and Representations (New York: Columbia, 1980), pp. 28, 38-39, 55, 94, 140, 180, 222, 241, 248-251. Chomsky's views on this subject may have changed in the intervening years. See Jerry Fodor, The Mind Doesn't Work That Way, pp. 96, 118.

and obligations, anger and revenge), kinship, and mating.[5] And other scholars have made additional suggestions.[6]

In principle, Chomsky's program for studying the mind's architecture is not limited to the exploration of the properties of such distinct domain-specific modules. Indeed, he argues that one must begin by means of the exploration of particular modules, with an eye eventually to being able to rise above these local explorations and see the overall architecture of the mind. As he writes:

> We might think about the less controversial task of studying the physical structure of the body. A rational approach would be to select some reasonably self-contained physical system of the body—some bodily organ—and try to determine its nature. Having done this in a number of cases, we might proceed to a higher level of analysis and ask how organs interact….[7]

Chomsky repeats this bottom-up description of how we are supposed to attain an overall picture of the structure of the mind time and again.[8] But so far as I know, his discussions of mental architecture—both then and since—never really attain such a "higher level" of analysis. Each time the possibility that the various mental modules may share significant traits with one another, or in any other way be similar or understood as parts of an integrated whole, Chomsky tends to shy away from this possibility. This reticence is visible, for example, in the following passage:

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[5] Steven Pinker, The Language Instinct (New York: Harper Collins, 1994), pp. 437-438.

[6] The argument for a mental architecture based on domain-specific modules is advanced, among others, in Leda Cosmides and John Tooby, "The Psychological Foundations of Culture" and "Cognitive Adaptations for Social Exchange," Jerome H. Barkow, Leda Cosmides and John Tooby, eds., The Adapted Mind: Evolutionary Psychology and the Generation of Culture (New York: Oxford, 1992), pp. 19-136, 163-228; Dan Sperber, Explaining Culture: A Naturalistic Approach (Malden, Ma.: Blackwell, 1996); Steven Pinker, How the Mind Works (New York: Norton, 1997); Randy Gallistel, "The Replacement of General-Purpose Learning Models With Adaptively Specialized Learning Modules," Michael Gazzaniga, ed., The New Cognitive Neurosciences (Cambridge: MIT, 2000), pp. 1179-1192; Peter Carruthers, The Architecture of the Mind (New York: Oxford, 2006). For criticism, see Jerry Fodor, The Mind Doesn't Work That Way; John Dupré, Human Nature and the Limits of Science (New York: Oxford, 2001); James Woodward and Fiona Cowie, "The Mind is Not (Just) a System of Modules Shaped (Just) by Natural Selection," Christopher Hitchcock, ed., Contemporary Debates in Philosophy of Science (Malden, Ma.: Blackwell, 2004), pp. 312-334; David J. Buller, Adapting Minds: Evolutionary Pyschology and the Persistent Quest for Human Nature (Cambridge: MIT, 2005); and the essays in Maxwell J. Roberts, ed., Integrating the Mind: Domain-General Versus Domain-Specific Processes in Higher Cognition (New York: Psychology Press, 2007), esp. Keith Stenning and Michiel van Lambalgen, "Explaining the Domain-Generality of Human Cognition," pp. 179-209; Graeme S. Halford and Glenda Andrews, "Domain-General Processes in Higher Cognition," pp. 213-232.

[7] Noam Chomsky, Rules and Representations, p. 227.

[8] Noam Chomsky, Rules and Representations, pp. 27, 39-42, 60-61, 90, 180. See also Jerry Fodor, The Modularity of Mind, p. 1.

> It remains an open question… to determine whether there really are significant analogies between the principles of mental representation and computation that seem to be well motivated in the study of language, and other mental operations, in other domains. Personally, I am skeptical; I see no interesting analogies in other cognitive domains….
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> In this connection, too, it seems to me that one must deplore the common tendency to insist that the mechanisms of language must be special cases of "generalized learning strategies" or general cognitive mechanisms of some sort…. [T]he principles of rule-organization that underlie the *wh*-island constraint are special properties of the language faculty, just as distribution of orientation specificities is a special property of the visual cortex. Similarly, it would not come as a great surprise to find that, in some respects, the human auditory system is specifically adapted to speech or that general principles of semantic structure and organization derive from or are specifically related to the language faculty…. *There seems little reason to suppose, for the moment, that there are general principles of cognitive structure, or even of human cognition, expressible at some higher level, from which the particular properties of particular "mental organs," such as the language faculty, can be deduced, or even that there are illuminating analogies among these various systems.*[9]

The supposition that there are no "general principles of cognitive structure, or even of human cognition, expressible at some higher level" is not peripheral to the nature of the human mind as it appears in Chomsky's writings. It is, rather, a consequence of his conception of modularity of the mind. For once one has posited the existence of a module that is responsible for language, and another different module that is responsible for mathematical thought, and yet another that is responsible for understanding scientific theories, and so on, it becomes quite unclear what is left for higher mental faculties to do that is not already being performed by the modules that are supposed to be responsible for thought in its respective domains.[10] Indeed, the picture of the mind that arises from this presentation is one in which human thought basically take place within the domain-specific module dedicated to the particular subject matter at hand. And if this is so, then the supposition of "higher faculties" that appears in Fodor's version of the modularity thesis is simply an unneeded hypothesis.

The modularity thesis has proved immensely fruitful in cognitive science research in the decades since it was originally proposed. And to a certain extent, the disagreement between Chomsky and Fodor over the existence and extent of a possible central-processing system in the mind has not been terribly important. Empirical research into the nature of the mind has had its hands full in establishing the nature of evidently encapsulated faculties such as the visual processing system, and the entire issue could therefore be deferred—as it for the most part has been—for a generation.

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[9] Noam Chomsky, Rules and Representations, pp. 214-215. Emphasis added.

[10] An exception may be human creativity. See Noam Chomsky, Rules and Representations, p. 222.

But this question cannot be deferred forever. If you swim upstream far enough in the process of recognizing visual objects, eventually you have to begin to wonder: Is the object that is at this point being processed merely a *visual object*—which is to say, an object of human thought only to the extent that it is an object within the context of the vision module? Or is the object visible *as an object* in part because of a downward imposition of some kind of an object-form from a central processing system that has not yet been taken into account? The more successful cognitive science becomes in untangling the secrets of the faculties of perception, the more pressing this question must inevitably become.

II. Domain-Generality and the General Qualities of Objects^

While Chomsky appears as a skeptic with regard to the existence of "general principles of cognitive structure, or even of human cognition, expressible at some higher level," he is, in fact quite a bit clearer than Fodor on what such general principles would have to be like if they did exist. The entire question, for Chomsky, pivots on the issue of whether it is possible to identify what he calls "illuminating analogies" between the operations of the mind as observed when it functions in one domain, and those that characterize the functioning of the mind in another domain. And this makes sense: If everything you encounter in one domain of the mind's operations looks entirely different from what you see in examining another domain (as the "*wh*-island constraint… of the language faculty" appears different, in Chomsky's account, from the "distribution of orientation specificities… of the visual cortex"), then the idea that both are functioning by grace of some higher system perhaps remains as a theoretical possibility, but one without any evidence for it. On the other hand, if one could find clear analogies between the characteristics of mental operations in one domain and those that appear in another, then this opens the door to the possibility that what on the surface appear to be distinct domains governed by independent modules are in fact particular instances of the operation of some higher system. By the same token, if one can identify characteristics of the mind's operations that are common to most domains of human thought or to all of them, then this would pave the way for the characterization of a central processing system whose operations are similar across all domains.

Of course this intuition need not be right. It is possible, to name another well-known scenario, that analogies across some or all domains are the result of duplication of functions within the respective domain-specific modules. For example, if one discovers that both natural language and mathematics function on the basis of sentences that are analogously structured, this is not in itself conclusive proof that this similarity results from the fact that natural language and arithmetic thought are both conducted by the same central processing

system. It may be the case that this only points to the fact that the language module and the math module are similarly structured internally. On this view, it is a redundancy in the structure of the mind that produces these analogies, not the presence of a central processing system.

I don't find this scenario particularly plausible. Since its inception, the modularity thesis has been built up from phenomenological evidence: The initial suspicion that the visual perception system is encapsulated rests on the fact that we do not experience leakage, even when this system is not functioning well, between the things that we see and the things that we hear. We don't ever mistake a sight for a sound, nor are we familiar with experiences that are in a grey zone between sight and sound. Nor does what we see seem to have a direct effect on what we hear. It is these facts drawn from the phenomenology of perceptual experience that make the modularity thesis initially plausible (and apparently correct) as far as at least some of the senses are concerned.[11]

But this same kind of encapsulation does not appear to be present in areas that Fodor associates with the higher-order operations of the mind: The emotions seem at times to have a direct effect on our reasoning. Mathematics and the physical sciences seem at times to advance on the basis of judgments that are clearly aesthetic in character. The forms of language, as I've already suggested, are not entirely distinct from those of logic and mathematics. And such concerns could easily be multiplied. None of this proves that the higher operations of the mind are not conducted by encapsulated domain-specific modules. But it does mean that the considerations that gave the theory of encapsulated domain-specificity its initial force and plausibility are attenuated or absent in the case of higher order mental operations, so that there is no prima facie reason to think such encapsulation exists.

This question will ultimately be settled by empirical investigation. But in the meantime, what I take away from this discussion is at least the following: If there is a central processing system of the mind that functions according to a unified set of operations, it seems highly probable that the presence of this system and this set of operations will be felt by way of common features that are visible in the mind's operations across many or all domains. So the search for a way of characterizing the mind's central processing system does, as Chomsky suggests, seem likely to begin with finding those common features.

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[11] Fodor's examples tend to focus on "vertical" aspects of encapsulation—the fact, for example, that if you push on your eyeball with your finger you perceive motion, and this despite the fact that you know the desk is not in fact moving. Here the phenomenological evidence suggests that the visual system is encapsulated against the influence on vision by higher-level beliefs: Explicit information about what is going on in the world, although well-known to the mind, "is *not* available to the analyzer in charge of the perceptual integration of your retinal stimulations…. Modularity with a vengeance." Jerry Fodor, The Modularity of Mind, pp. 64-73, esp. p. 67. My example, which focuses on the "horizontal" encapsulation that keeps vision separate from sound, is thus a bit different from the kinds of examples Fodor favors. Nevertheless, Fodor's examples are all built on phenomenological evidence just as this one is.

III. Ontology Across Domains^

I've suggested that if there are features of human cognition that persist across multiple domains, or even across all domains, these would be a reasonable place to start in seeking insight into the nature of higher-level mental operations. Are there any such features? Recent cognitive science has begun to revive this question,[12] and in fact there seem to be more than a few such features. I'll quickly mention a number of them:

a. Objects

In every domain of human thought, our understanding is met with *objects.* By an *object* I mean *a discrete entity that can be given a name and reliably distinguished from other entities in the same domain.* According to this definition, an object can be any concrete particular including, for example, a particular apple or bird, but also a war, the sky, or a mirror image.[13] But abstract and even fictitious entities are, by this definition, to be recognized as objects of human cognition within their own domains, so long as we have a good shot at identifying them and distinguishing them from other distinct entities in the same domain. Thus the number *five* is a mathematical object, in that we can identify it and distinguish it from the numbers *six* and *seven*; *Anna Karenina* is an object within the domain of literature; and so on. Understood in this sense, the object can be seen as a central feature of our ontology that appears to be perfectly universal. Indeed, we can propose as a law of human cognition: *No domain of human cognition without objects of human cognition.*

b. Sensation and Meaning

Across all domains of human understanding, the objects of human cognition are recognizable as composite entities, analyzable into two distinct aspects or parts: On the one hand, objects consist in part of present or recalled *sensations,* which are qualities detected originally by means of the senses, both external and

[12] Steven Pinker proposes four basic features of human ontology across domains: Space, substance, time, and causality. See Steven Pinker, The Stuff of Thought: Language as a Window Into Human Nature (New York: Penguin, 2007), pp. 153-233.

[13] See Hilary Putnam, "Sense, Nonsense, and the Senses: An Inquiry into the Powers of the Human Mind," The Journal of Philosophy (September 1994), pp. 449-450. Compare Donald Davidson, "The Individuation of Events," in Essays on Action and Events, (New York: Oxford, 2001), pp. 164-165.

internal;[14] but sensation alone appears never to be sufficient for the recognition of an object in any domain. In addition to sensation, every object of our experience includes a certain *meaning*, which provides, at a minimum, the object's identity as a *bird* or the *moon* or my son *Binyamin;* and probably much else as well.[15] We can tell that the meaning of an object is not intrinsic to these sensations because of the ease with which certain sensations can be interpreted first in light of one meaning (or concept) and then in light of another, so that one and the same sensation is "seen as" first one object and then a different one.[16] Moreover, the imposition or infusion of the meaning within the perceived sensations in the construction of the object is an experience distinct from the experience of sensation—an experience that has been called an "understanding experience,[17] and which, according to some scholars, can be detected in measurements of brain activity as phenomenon distinct from the experience of sensation.[18]

It might be suggested that there are domains of abstract thought, such as mathematics, in which objects exist as *meanings* alone, without sensation. But this does not seem to be right. It is true that the human mind *can* engage in thought concerning a given cognitive object in the absence of sensation or images. However, even in a discipline as abstract as mathematics, the objects in question very often consist of a meaning imposed upon, or infused in, sensation. For example, the mathematical object *five* is frequently recognized together with sensation: Either the sensations associated with an array of five items (such as five apples); or those associated with the symbol *5;* or that associated with the sound that is made when someone says the word *five*. That we can do without sensation of any kind in thinking of the mathematical object *five* only serves to underscore the composite nature of this object, which is first learned by children

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[14] I am here following Jesse Prinz in understanding sensation very broadly. As used in this paper, *sensation* includes not only the reports of the canonical senses, but also of internal senses such as proprioception, hunger, and thirst, emotions, and motor schema. See Jesse J. Prinz, Furnishing the Mind: Concepts and Their Perceptual Basis (Cambridge: MIT, 2002), pp. 120-122.

[15] What I am calling *meaning* is not to be confused with mental images, which would appear to be a form of sensation. By *meaning* I have in mind content that is not in any respect sensory, such as knowledge of the identity of an object or person. This distinction between sensation and meaning is roughly parallel to Jerome Kagan's division between *schematic* and *semantic* content. See Jerome Kagan, Surprise, Uncertainty, and Mental Structures (Cambridge: Harvard, 2002), pp. 96-97.

[16] Ludwig Wittgenstein, Philosophical Investingations, G.E.M. Anscombe, trans. (New York: MacMillan, 1953), pp. 193-208. See also Charles Taylor, "Theories of Meaning," Human Agency and Language (New York: Cambridge, 1985), p. 283; Howard Margolis, Patterns, Thinking and Cognition: A Theory of Judgment (Chicago: Chicago, 1987), p. 39; Stephen Kosslyn, Image and Brain, p. 336.

[17] See Galen Strawson, Mental Reality (Cambridge: MIT, 1994), pp. 4-13. For earlier discussion, see, among others, Husserl, Logical Investigations, vol. 1, p. 214; Gottlob Frege, Der Gedanke, quoted in Michael Dummett, Origins of Analytic Philosophy (Cambridge: Harvard, 1993), p. 95.

[18] Jerome Kagan, Surprise, Uncertainty, and Mental Structures, pp. 96-97. Kagan's N1 corresponds to what I have called *noticing;* his N2 corresponds to my *recognition.*

as a combination of sensation and meaning, but which can later sometimes be manipulated even in the absence of sensation.

And this too can be regarded as a law governing objects of human understanding across all domains: *No objects of human cognition that are not in principle composites of sensation and meaning.*

c. Normativity

As far as I can tell, every instance of a given object is either a *better* or *worse* instance of its kind. We can easily say whether something is a good example of bottle or a table; award prizes for the best specimens of breeds of horses or wines, of musical or athletic performances; and so on. But this is no less true for linguistic objects: We can tell a word that is better pronounced from one that is less so, and a sentence that possesses clarity of expression from one that does not. Even in arithmetic, we can distinguish a better example of a triangle from one that is less good; and a better from a worse example of five of any kind of thing. Indeed, there seem to be few objects in any domain that cannot be understood in terms of the degree of their goodness with respect to their kind. The Platonic conception of objects as striving to attain a certain ideal type can thus be given a cognitive interpretation, with the particular array of sensations interpreted in light of a given meaning being sensed as being "nearer" or "farther" away from the standard or prototype established by the meaning or concept applied to it.[19] If this is right, then cognitive objects can be seen as possessing normative characteristics, with the normativity supplied by the meaning or concept of what the object "ought to be."

In sum: *No objects of human cognition that are not intrinsically normative in character.*

d. Motives for Action (Rudimentary Plans)

Similarly, every object, once it is judged a better or worse example of its kind, can be readily analyzed in terms of its flaws. Thus the judgment of an object results not only in an abstract rating of its degree of goodness, but also in a kind of "criticism" of the object, which is directed, in the first instance, at those aspects of the object that are most discrepant with respect to the standard or prototype in

[19] See, for example, Eleonore Rosch and C.B. Mervis, "Family Resemblances: Studies in the Internal Structure of Categories," Cognitive Psychology (1975), pp. 573-605; Eleanor Rosch, "Principles of Categorization," Eleanor Rosch and Barbara L. Lloyd, eds., Cognition and Categorization (Hillsdale, N.J.: Lawrence Erlbaum, 1978), pp. 27-48; Philip N. Johnson-Laird, Mental Models (Cambridge, Harvard, 1983), pp. 187-191. For an updated discussion, see Jesse J. Prinz, Furnishing the Mind, pp. 51-74.

question;[20] and which can be progressively more refined. These areas of discrepancy can be understood as constituting judgments, in that they furnish *reasons* for the judgment that the object is flawed. But they are also potential *motives* for action directed towards the improvement of the object, and can in fact be understood as rudimentary plans for action. For example, where the leg of a chair is broken, this will fact will typically be the first to draw one's attention once the object has been recognized as a chair. The broken leg constitutes a discrepancy, which can serve as a basis for judging the quality of the chair, but also as a motive for action directed toward the improvement of the chair.

In sum: *No objects without motives for potential action directed to their improvement.*

e. Parts and Neighbors (Hierarchies)

Nearly all objects, in every domain, can be understood as having an *inside* and an *outside,* both of which can be seen as containing additional objects. An object outside of another object can be said to *co-exist* with it, to be its *neighbor;* an object inside of another object is its *part* (unless we have reason to define it as foreign). And very nearly all objects in all domains have neighbors and parts. Even in a domain such as music, which initially appears to be inherently non-spatial, investigation of musical sensations gives birth to theory and notation in which musical tones are understood to have neighbors and parts. There are very rare exceptions to this rule: In geometry a point is defined as that which has no part; in theology, God is defined as having no neighbor. But such idealizations only serve to underscore the extent to which human understanding, if its regular course is not artificially restrained, operates as though all objects of cognition have both neighbors and parts.

The fact that objects in all domains possess an inside containing parts and an outside containing neighbors appears to dictate that all domains of human knowledge will be *hierarchically organized* at least in potential, with every object of human cognition containing other objects as parts; and coexisting with other objects within a larger object of which they are themselves parts.

Thus we may say: *No domains without parts and neighbors; and so no domains that cannot be understood in terms of hierarchies of objects.*

This would appear to be a basic law establishing domains of human cognition as necessarily organized as *spatial* structures.[21]

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[20] On *discrepency,* see Jerome Kagan, Surprise, Uncertainty, and Mental Structures, pp. 41-44. The inadvertant movement of one's attention toward discrepant regions is described by Max Wertheimer, Productive Thinking (New York: Harper and Row, 1959), pp. 47-49; Jerome Kagan, Surprise, Uncertainty, and Mental Structures, pp. 43, 64.

[21] Until now, I have not used the term *space.* But note that any cognitive object containing parts can be interpreted as a *space*; and any cognitive object co-existing with neighboring cognitive

f. Causation

We are accustomed to thinking of physical causation as being unrelated to logical causation. For example, fire is experienced as causing smoke, and this is usually thought to be an instance of *physical necessity*; whereas the fact that bringing two objects together with another two gives us four objects is considered to be a matter of *logical necessity*. Yet in terms of their phenomenology, the two kinds of causation are experienced as being somewhat similar. Both involve a sensation of compulsion linking objects that are otherwise experienced as being independent of one another—one in domains containing physical objects, and the other in domains containing mathematical or logical objects. But as Hume correctly argued, it would seem that the sensation of compulsion we experience in the case of physical objects is not intrinsic to the reports of the senses, but seems to be "an internal impression of the mind, or "something, that exists in the mind, not in objects."[22] And if this is right, then physical necessity may not be quite so different from logical necessity as we often suppose. The very fact that we are naturally inclined to use the very same terms (*causation, necessity, compulsion*) in describing them deserves attention. And if it is the case that the two kinds of necessity can be considered sub-categories of a single phenomenological form, then causation, too, can be recognized as a feature of the objects of human cognition across all domains. Thus in addition to being related to one another either as *parts within wholes* or as *co-existing,* the case can be made that objects in all domains of human understanding are able to stand in relations of *cause and effect* with respect to one another.

In sum: *No domains in which objects are not causes of other objects.*

This may be recognized as a basic law establishing domains of human cognition as necessarily organized as *temporal* structures.[23]

g. Qualities and Predication

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objects can be interpreted existing within a larger object or (what amounts to the same thing) a larger *space*. I'm not in fact sure there is much point in maintaining a distinction between cognitive objects and the spaces established by cognitive processes. These items are extremely similar and probably identical. But note that in Section IV.2.2, I do use the term *space* to describe a structure that is not an object yet because no concept has been imposed in it.

[22] David Hume, Treatise of Human Nature, L.A. Selby-Bigge and P.H. Nidditch, eds. (New York: Oxford, 1978), p. 164-166.

[23] A great deal obviously rides on the definition of the word *temporal*. My assumption is that what is called *time* in many domains of human cognition is a constructed net of causes, as argued by Hans Reichenbach, The Direction of Time (New York: Dover, 1956), p. 37. If this is right, then there is no need to introduce *time* as a feature of human ontology distinct from causation.

In all domains, the objects of human cognition appear as possessing *qualities* that are intrinsic to them. For example, a coat may be said to possess the quality of being red; the number five the quality of being odd; and so forth. By *predication* I mean the cognitive ability of bringing an object of human cognition together with another object (that is, its quality) in such a way as to produce a sentence-like thought, as when the object *cat* and the quality *fat* are brought together in the thought expressed by the sentence *The cat is fat.* This susceptibility of objects to being predicated of one another appears to be universal, suggesting another law: *No objects that cannot be predicated of qualities describing them.*

h. Representation

In addition, objects of human cognition across all domains appear to be susceptible to being *represented.* By *representation* I mean the intentional use of a scheme of sensations in a given domain to invoke a meaning (or concept) that is familiar from another domain, where it is associated with a different scheme of sensations. Thus a bronze statue may represent a man or a bird by means of a certain isomorphism or similarity between its form and that of the object represented. Due to this isomorphism, the domain of inanimate materials is made to host a cognitive object that is more commonly recognized in the domain of living things. But in domains such as language and mathematics, representation most frequently takes place in the absence of any such isomorphism. For example, the word *sun* bears no resemblance of form to the actual sun, just as the word *bird* bears no resemblance to an actual bird. It would appear that the human mind has the capacity for generating an infinite number of systems for the symbolic representation of objects in any domain.[24]

In sum: *No domain whose objects cannot be represented in other domains.*

IV. Sketch of a Domain-General Cognitive Mechanism^

I've proposed a number of features characteristic of the objects of human cognition that can be seen as applying across most or all domains. No doubt every reader can come up with counter-examples. But even after all the counter-examples have been taken into account, I suspect the picture will not be very different from the way I've described it: The distinct cognitive domains that

[24] This fact seems to militate against the Chomsky-Fodor position which sees language as a candidate for a domain-specific module along the lines of vision and sound. Instead, it seems worth exploring the possibility that the symbolic representation at the base of language, logic and mathematics is derived from a more basic representational apparatus that functions across all domains.

recent cognitive science has often interpreted as pointing to the existence of dedicated domain-specific subject modules in the mind, are in fact characterized by a great many of what Chomsky calls "illuminating analogies" between them and the other domains of human knowledge. In fact, many of the fundamental features of every domain of human knowledge are shared with all or most other domains. As discussed above, it is *possible* that the existence of so many common characteristics could be a consequence of a mental architecture consisting of a large number of domain-specific modules that are in many respects redundant—with each module duplicating in its internal structure the mechanisms that are also found in its neighbors. But this possibility becomes less plausible as the similarities that are found to persist across domains become more extensive.

By this point, I think we've already seen enough examples of ontological features persisting across domains to make plausible the suggestion of a domain-general central processor that handles higher-order operations of the mind; and which is responsible for the similarity that we see across domains of human cognition. In this section of the paper, I will to try to make this possibility significantly stronger by taking the disordered shopping list of domain-general features I presented in the previous section and trying to describe a plausible mental mechanism,[25] or a series of mechanisms, that can be seen as generating some of these features. If such a mental mechanism can be described, then on the grounds of parsimony alone, we should consider it a viable alternative, and perhaps even the preferred one, to the supposition of a system of massively redundant domain-specific modules.

I now turn to proposing a mental mechanism that can plausibly be seen as being responsible for the universal ontology we've been looking at.

1. Object Recognition, Evaluation and Action

[25] Fodor points out that while the term *mechanism* appears frequently in the cognitive science literature, many scholars, including Chomsky and Fodor himself, in fact use this term to refer to systems of propositional content that can be transformed into other propositional content through deductive operations much like those of a computer. He distinguishes such a use of the term from reference to an actual mechanism—"a piece of hardware, one might say, whose structure somehow imposes limitations upon its capacities." Such a conception would make the proposed mental organs "analogous to a hand or a liver or a heart." Jerry Fodor, The Modularity of Mind, pp. 7-10. This latter notion of *mechanism* as a way of understanding the operations of the mind has been gaining traction in recent years. See, for example, Robert Cummins, "'How Does It Work?' Vs. 'What Are the Laws?': Two Conceptions of Psychological Explanation," Frank C. Keil and Robert A. Wilson, eds., Explanation and Cognition (Cambridge: MIT: 2000), pp. 117-144; Carl F. Craver, Explaining the Brain: Mechanisms and the Mosaic Unity of Neuroscience (New York: Oxford, 2007); William Bechtel, Mental Mechanisms (New York: Psychology Press, 2008). Jerome Kagan's argument concerning the preoccupation with mental functions over the psychological forms and structures that can explain these functions is closely related as well. See Jerome Kagan, Surprise, Uncertainty, and Mental Structures, pp. 16-18. This paper is concerned with mental mechanisms and structures in this non-Chomskyian sense of the term.

Let's suppose that object recognition takes place in a manner that is a modified version of accounts already available in the writings of early modern philosophers such as Hume and Kant. On this modified view, object recognition involves the construction of a composite object that is built up out of sensation and meaning, in accordance with a two-step procedure, as follows:

(i) *Noticing* is a primitive cognitive mechanism that fixes upon a certain aspect of the field of sensation. What is *noticed* need not be, for example, the shape of a bird as a whole. I can notice the shape of the beak alone; or the fluttering of a wing; or the tugging on a worm.

(ii) *Recognition* is the subsequent imposition or infusion of the meaning or concept *bird* in the sensual field encompassing the sensation that has been fixed upon in (i). This imposition or infusion often affects a much larger area than that which was originally noticed. Where successful, the operation of *recognition* assigns meaning to many additional sensations not originally noticed, thereby establishing the object as a whole (e.g., a particular bird) as present before the mind.[26]

These two steps of *noticing* and *recognition* can thus be seen as a unified mechanism—in fact a cycle—whose purpose is establishing the objects of human cognition before the mind.[27]

Now let's consider how the normativity of the object might fit into this picture. If an object is composed of sensation and of a concept that has imparted meaning to this sensation, how do we account for the normative character of the object—the fact that the object is a better or worse instance of its kind? What makes the object a member of a kind is, of course, the meaning or concept. Sensation by itself would seem to be normatively inert. What makes the object better or worse is the "distance" (whether more or less) of the sensory field from the standard set by the concept, which is establishes the expectation of what the object "ought to be." With this in mind, we can posit a tension within the cognized object, which is greater or less where the field of sensation in which the concept has been imposed is farther from or closer to a good "fit" with the standard set by the concept. This lets us see the mental mechanism involved in object recognition as having the following features:

(iii) The *meaning* or *concept* is a normative entity, constituting a standard against which the field of sensation is compared. The meaning or concept is the mind's conception of what the bird "ought to be." Thus

[26] The distinction between noticing and recognizing can be usefully compared to the terms *recognition* and *identification*, respectively, as these are used in Stephen M. Kosslyn, Image and Brain (Cambridge: MIT, 1994), p. 72.

[27] Note that the objects here under discussion are those in what psychologists often refer to as the "foreground" of the cognitive field.

the "is" of every object of human cognition in the first instance derived from a conception of what the object "ought to be."

(iv) *Tension*. With the imposition of the concept in the field of sensation, a tension—apparently a measurably physical quantity—is established, which is less as the "fit" between the concept and the field of sensation is better; and greater where the field of sensation is more discrepant with respect to my concept of what the object ought to be.[28] Where the tension is on the whole too great, the object collapses; and the recognition of the object will be seen to have been "mistaken."

(v) *Evaluation* of the object, whether it be a *better* or *worse* instance of its kind, can therefore take place immediately, without discursive thought, by way of an assessment of the degree of tension present within the object. Where the field of sensation is of greater discrepancy, the tension is higher and the object is judged to be a worse instance of its kind; where the field of sensation is a better "fit," the tension is less and the object is judged to be better.

In this way, the normative qualities of the object are introduced directly into the familiar structure of the object as composed of sensation and concept. By stipulating that the concept is intrinsically normative and positing a real physical tension that reflects the "degree of fit" between the field of sensation and this norm, we can see how object-evaluation can take place even without any kind of analysis conducted by way of discursive thought. The tension is apparently real and something that can be sensed—so that a child can immediately tell you which instance of type is better or worse, even though he doesn't know how to explain "why." What we call *intuition* is a direct report of the degree of tension internal to the cognitive object, which the child can feel.

The relationship between the objects of human cognition and human action with respect to them also begins to become tractable as soon as one posits a real physical tension in the cognized object. If we suppose, as is reasonable, that this tension is greater in those parts of the object that are particularly discrepant with respect to the concept, then we have a ready explanation for how at least certain kinds of "motives" for action (and perhaps all motives for action) arise directly from the regular operation of the mental mechanism for object cognition:

(vi) *Motives.* The physical tension arising in every object of human cognition, as described in (v) above, is distributed throughout the object in proportion to the degree of discrepancy between a given point in the

[28] For the role of *fit* in judgments, see Nelson Goodman, Languages of Art (Indianapolis: Hackett, 1976), p. 264; Hilary Putnam, Reason, Truth, and History (New York: Cambridge, 1981), pp. 55, 64; Stephen Kosslyn, Image and Brain, pp. 120-122; David Lowe, Perceptual Organization and Vision Recognition.

> field of sensation and the standard of what the object "ought to be" at this point as defined by the concept imposed upon this same field. A *motive* (or *reason*) is a physical tension in at least one part of the object that provides cause for a change of behavior aimed at reducing such tension.

As described above, a simple example the way in which discrepancy between the field of sensation and the concept imposed in it creates motives without need for discursive reasoning is the broken chair: One's eye is immediately drawn to the broken leg of the chair, and the tension in the discrepant limb constitutes a motive to repair the chair. But this same model can be applied much more widely: When I bend down to pick up toy my child has left on the stairs, it the discrepancy of the object's placement that serves as the motive, and I pick up the toy to reduce the tension it creates simply be being on the stairs. Similarly, when dancing or driving a car, the shifts of one's body or of the position of the vehicle relative to other cars on the road are undertaken consciously but without discursive thought. The motive for these shifts is a felt discrepancy between the position of one's body or one's vehicle and the concept that serves as the normative standard against which the array of sensations is being compared.

2. *Representation, Space and Hierarchy*

To this point, I've described a domain-general mental mechanism (the two-step cycle of noticing and recognition) capable of accounting for a number of the observed features of objects across domains of human knowledge—including the persistence of objects in all domains, the composite character of these objects, their normativity, and the role played by cognitive objects in providing motives for human action. I will now introduce a small number of additional mechanisms (I'll call them "upgrades") that refine and improve the functioning of the domain-general mental mechanism I described in Section 1. These upgrades are: (1) A mechanism enabling *representation* across domains; (2) a mechanism for the rapid construction of *spaces*; and (3) a mechanism for assembling *hierarchies* among spaces.

(1) The first upgrade I wish to introduce into the mental mechanism of Part 1 concerns the internal structure of the concepts imposed in the field of sensation in the construction of objects. The internal structure of concepts is a crucial subject, but for lack of space I'll have to bypass it almost entirely for now, touching only on one important aspect of it. As discussed above, an object can be represented by a set of sensations that are unaccustomed to it, as in the example of a bronze statue of a man. In this example, as in many others, the representation is isomorphic with respect to the object represented. This makes sense, since the operation of *noticing* that begins the process of object recognition

fixes only on sensation that is reminiscent of an aspect or part of the whole, and so there is no need for a bronze statue to resemble a man in every way for it to be recognized as a man. However, nothing we have seen so far can account for symbolic representation, in which there is no aspect of the representation that resembles any aspect of the represented object. To account for symbolic representation, I introduce the assumption of that the internal structure of concepts is branch-shaped, involving not one but multiple prototypes, each of which is capable of being deployed in object recognition. The presence of multiple prototypes permits the same concept to be associated with a multiplicity of forms:

> *(vii) Branch-Structure of Concepts.* I assume that concepts are internally branch-shaped, with different branches used to project different norms or prototypes of what an object of a given type "ought to be."

Thus for example, the concept of an *A* may be successfully recognized where a number of different forms are present in the field of sensation: It can be recognized in the visible form **A** ; the visible form **a** ; the visible form *a* ; the audible form *e'i* the tactile Braille form ⠁ ; and so on—each of which corresponds to a normative form that is something like a branch within the larger concept of what an *A* ought to be. The same will be the case for all other concepts. My concept of my wife *Yael* includes a branch not only for the way she looks today, but another, gleaned from photographs, of her form as a child, and yet both branches are a part of my concept of *Yael*.[29]

The internal structure of concepts is an important subject, but I won't go further into it here. I raise the subject here because the assumption that concepts are internally branch-shaped, sustaining multiple prototypes that can vary greatly in terms of their form, is by itself sufficient to account for the human capacity for symbolic representation across all domains of human ontology. The argument is straightforward: If concepts are established by way of a domain-general system then all concepts can possess this same quality of being internally branched, so that at least in potential, every object of human cognition can be recognized by means of multiple forms, some visible, some audible, some tactile, and so on. If this is right, then there is no reason to suppose that the number of such branches is limited, and the path is opened for an endless number of different cues and symbols that can be recognized as an object that is a bird or

[29] Prototype theory in cognitive science usually involves only a single ideal example used in recognition of the object, and this is in fact one of the central objections to the theory. Jesse Prinz, Furnishing the Mind, pp. 51-52, 66. The "multiple-prototype" theory I am proposing here is not intended as a rejection of other theories of concept structure. I agree with Prinz that a good theory of conceptual structure will have to combine elements from the different theories advanced so far.

the sun under one or another circumstance—or in one or another domain. In this way, the object itself made to transcend all domains, appearing in the guise of a given form in one domain, and in the guise of another form entirely in another, without limit.

(2) That's one upgrade to the domain-general cognitive mechanism I described before—one that accounts for the appearance of symbolic representation as a universal feature of human ontology. Here's a second such upgrade, whose implications I'll return to presently:

(viii) Glance. Let's say that a *glance* is a mental sweep of the field of sensation, involving a series of consecutive acts of *noticing* unbroken by the operation of recognition.[30] In a single glance, one may notice three or four (and perhaps five) aspects of the field of sensation, resulting in a static shape that can be called a *space*.[31]

(ix) Serial Recognition in a Space. A space constructed at a glance may then be interpreted by several consecutive acts of recognition, one for each noticed aspect of the field of sensation. The limit on the number of such operations of recognition before the space is cleared and the cycle begins again apparently four (or perhaps five), in keeping with the number of distinct noticing operations possible in a single glance.

Thus while the human mind apparently cannot engage in multiple acts of recognition simultaneously, it is nevertheless the case that one may, as suggested by Bergson, construct a kind of "freeze frame" montage of noticed sensations, which may be recognized as distinct objects one after another immediately thereafter. This means that a single cycle of noticing and recognition, before it is has run its course and must begin again, can produce not merely a single object, but a space containing multiple coexisting objects with distinct identities (or, what is much the same thing, the co-existing parts of a single object).[32]

(3) A third upgrade permits the object-bearing spaces constructed by means of principles (viii) and (ix) to be assembled into hierarchies. This is an operation of the mind that establishes an *interior* to any object of human cognition:

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[30] My discussion of the *glance* roughly parallels what psychologists sometimes call the "attention window." See Stephen Kosslyn, Image and Brain, pp. 87-94, 360; Jerome Kagan, Surprise, Uncertainty, and Mental Structures, pp. 39-40.

[31] I use the term *space* here, as opposed to *object,* because an object has been defined as sensation that has been given meaning after the imposition of a concept. The space first established in a glance consists only of noticed effects prior to their having received meaning.

[32] On mental freeze-frames, see Henri Bergson, Creative Evolution, (Mineola, N.Y.: Dover, 1998), p. 302. The importance of multiple noticed effects in object construction appears in the psychological literature with the studies of G. Johansson, beginning with Configurations in Event Perception (Uppsala, Sweden: Almqvist and Wiksell, 1950).

(x) *Object interior.* The operation that establishes an *interior* to any object of human cognition is experienced phenomenologically as a "push" on a given object. This push establishes the extant boundaries of the object itself as a bounded field of sensation, which can then be reconstructed as an object-bearing space using the same *glance* and *serial recognition* operations described in (viii) and (ix) above.

I have here posited that the construction of hierarchies of spaces internal to other spaces (or of objects internal to other objects) proceeds from the combination of the space-constructing mechanism described in (viii) and (ix) above, together with one other primitive mental operation, which serves to "open" any object of human cognition, permitting the field of sensation discovered within the bounds of the object to become itself a space bearing multiple objects. This operation of "opening" an object is a bit reminiscent of the double-click feature familiar from recent computer software, but with a significant difference—it is the double-click on the object that for the first time *creates* the interior field of sensation in a given object.

3. *Qualities and Predication*

Together with the "upgrades" introduced in Section 2, the model of a domain-general central processing mechanism presented in Section 1 is able to account for most of the general features of human ontology across domains described in Part III of this paper. Those I haven't discussed yet are predication and causation. I will here say a few words concerning these features of human cognition, which I believe can be accounted for by the domain-general mechanism I have described without needing to introduce additional modifications.

First consider predication. In classical philosophy, predication was supposed to involve qualities inhering in a substance, so that, for example, *fat* was understood to be a quality of a substance such as *cat,* as in the sentence *The cat is fat.* But as recent thinkers such as Quine have suggested, the distinction between substances and qualities is largely a matter of the customary grammatical forms of a given language—and not a reflection of a root ontology to which such parts of a sentence are intrinsic. We can as easily treat *is cattish* as the quality and *fat-thing* as the object in which it is discovered (adopting Quine's nomenclature) as in the sentence *The fat-thing is cattish.*[33] The two sentences, once you get used to them, can easily be seen to be describing the same static picture of reality. As far as the operations of human cognition are concerned, then, we use the concept *cat* to recognize a cognitive object that is a cat in a certain field of sensation; just as we use the concept *fat-thing* to recognize a cognitive object that

[33] See W.V.O. Quine, Word and Object (Cambridge: MIT, 1960), pp. 96-97; W.V.O. Quine, Pursuit of Truth (Cambridge: Harvard, 1990), pp. 29-30.

is fat in a certain field of sensation. The operation of recognition appears to be the same in each case, although the concept applied is different.

If this is right, this clears the way to a straightforward understanding of the operations of the domain-general central processor that are involved in predication. Cognitively, a *cat* and a *fat-thing* are two different objects, and there is no reason why they should be identified one with the other. But we know that a given field of sensation can be re-cognized in terms of first one concept, and then in terms of another different concept. This is the same cognitive phenomenon often referred to as "seeing as," which has become so famous in philosophical circles thanks to Wittgenstein's interest in it. We recognize a cat in a certain field of sensation, and then we see a fat thing in this same field of sensation. What holds the bundle of these two qualities—*cat* and *fat-thing*—together, and prevents them from being coexistent objects, side by side in given space, is the fact that it is the same sensations that are first seen as a cat, and then seen as a fat thing. Or, to adopt the terms I've proposed just now, the object that is the cat is held together by our recognition that the meaning of certain sensations is the concept (normative standard) *cat*. If these same sensations are immediately recognized as having the concept (normative standard) *fat* as their meaning as well, the quick change of aspect that lets us see a *fat-thing* in the *cat* (or vice versa) is itself, I propose, just the kind of concatenation that is then the basis for predication in natural language sentences.

Notice that this means that the second operation of recognition results in the construction of a structure that is molecular in its shape. In **Figure XX,** we see what the molecular thought that is being represented by the sentence *The cat is fat* looks like once it has been built. The fact that the operations of the domain-general processor, prior to being modeled in language, seem to produce such molecule-shaped structures in the mind—rather than the linear structures we are used to from written and spoken language—is significant in many ways. It explains, for example, why metaphysics conceives of objects as bundles of properties.[34] It clarifies, too, why the sentences *The cat is fat* and *The fat-thing is cattish* possess what is in effect identical cognitive content, since these two different sentences are both descriptions of the same molecule-shaped spatial construction. Or, in other words, they both represent one and the same thought.

4. Causation

[34] The difference between a metaphysics in which properties inhere in a substance and one in which there is no underlying "substrate" is here seen to be an argument over whether there is any ontological difference between a cognitive object established first and those other cognitive objects that are subsequently predicated upon it.

Finally, let's look again at causation. Relations of cause and effect can also be accounted for by returning to the *cycle of noticing and recognition* introduced in Section 1, and re-interpreting the operations of this mechanism as follows:

(xi) Effect. The term *effect* is another name for any aspect of the field of sensation, whether present or recalled, that is fixed upon in the operation of *noticing*.

(xii) Cause. The term *cause* is another name for *that concept which is recognized as imposing a meaning within the field of sensation.*

This redefinition does not, I admit, reflect a standard view of what is meant when we speak of causation. I am here following Searle's reconstruction of standard relations of cause and effect, which lays bare (correctly, I believe) the fact that "every experience of perceiving or acting is precisely an experience of causation,"[35] and then uses the more fundamental form of causation (Searle calls it *intentional causation*) discovered in this way as the basis for an account of more traditional relations of cause and effect. According to the adaptation of Searle's view I propose here, there is no case of object recognition that does not also involve, at the same time, the establishment of a relation of cause and effect, for each case of object recognition begins by (i) noticing an aspect of the field of sensation, which is to say, noticing an *effect*; and ends with (ii) the assignment of a *cause* to this effect in the form of a concept that supplies the meaning to this effect and to other sensations in the same field. Thus, for example, upon hearing a certain barking sound I have noticed an effect, whose cause is then assigned when I impose the concept of a *dog* on the sound—thereby creating a cognitive object that is a dog as recognized by way of its audible form or prototype.[36]

If this is right, it means that the more traditional examples of the causal relation—as when one billiard ball bumps into another—are apparently causal only to the extent that the noticed effect (the motion of the second ball) finds its cause in the imposition of the concept of the first ball. In this way, even traditional examples of the causal relation can be recognized as being, at bottom, descriptions of a single cognitive object (call this single cognitive object a *bumping*), wherein the relation of *cause and effect* holds together the sensation and the concept that together form the object.

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[35] John Searle, Intentionality: An Essay in the Philosophy of Mind (New York: Cambridge, 1983), especially pp. 112-140, esp. pp. 123-124.

[36] We usually prefer to say that what I have recognized is a *dog barking,* which is to say *a dog causing a barking sound.* In my view, this does not more accurately describe the cognitive object in question than simply to call it a dog. Why, after all, should the visible form of a dog be any more the dog itself than its audible form? For the barking sound is the audible form or prototype of the dog, just as the wagging tail and panting tongue are aspects of the visible form or prototype of the same object.

This discussion is obviously far too brief. But it does suggest a conclusion that I believe requires further discussion: It does give us a first indication that the basic higher-order mental mechanism I've described as the *cycle of noticing and recognition* may have to resources to account for the presence of causation across all domains of human cognition as well.

V. NATURAL LANGUAGE FROM A DOMAIN-GENERAL COGNITIVE MECHANISM^

I've now sketched a domain-general cognitive mechanism that can be seen as generating all eight of the general features of objects I pointed to in Part III of this paper. There are, to be sure, plenty of loose ends in my description, which I can only hope to fill out in a longer discussion. Nevertheless, I think the sketch I've offered drawn clearly enough to give a sense of how a domain-general cognitive mechanism could in fact be responsible for the basic features of human ontology across subject domains. In this final section I'd like to further test the explanatory power of the domain-general cognitive mechanism I've described by seeing whether it can shed light on the relationship between the mind's central processing system and the human capacity for language. If my model can account for known features of natural language, this will be strong additional evidence for the existence of a powerful domain-general central processor such as we've been discussing.

Few assumptions are so well entrenched in the cognitive science literature on mental architecture as the supposition that the grammar of natural languages is too distinctive to be governed by, or derivable from, the operations of a general-purpose higher-level processor. This assumption is a cornerstone of Chomsky's theory in *Rules and Representations,* in which the "language module," with its highly articulated grammar, in effect becomes the paradigm for what an innate, domain-specific mental module must be like.[37] But the encapsulated, domain-specific language module also appears as a central hypothesis in Fodor's *The Modularity of Mind,* despite its argument for the existence of a massive domain-general central processor operating above the level of language processing.[38]

The view I will present here suggests that the assumption that natural language cannot largely be the work of a domain-general higher-level processor has been adopted too hastily. I will show that there are strong indications that a domain-general processor such as the one I've described can in fact account for at least the rudiments of natural language. In particular, I will suggest that when analyzed in terms of the basic mental operations needed for its construction,

[37] "As I have tried to show in earlier lectures, it makes sense to think of other cognitive systems on the model of the human language faculty…." Noam Chomsky, Rules and Representations, p. 180.

[38] Jerry Fodor, The Modularity of Mind, pp. 44-45, 49-51.

natural language seems to depend only on a limited number of such operators: namely, *predication, representation,* and the *hierarchical construction of spaces* – all of which already appear in my model for a domain-general central processor.

Let's begin with *representation.* I've described the way in which the supposition that concepts are internally structured so as to permit recognition of a given object using many different possible forms accounts for the mind's capacity to represent its objects using arbitrary visual, audible, and even tactile symbols across all subject domains. This, of course, is precisely what words are: A *word* is a cognitive object in which a familiar concept is recognized as supplying the meaning of otherwise arbitrary visible or audible sensations such as the written mark *sun* or the sound we hear when the word *sun* is spoken aloud. A word is, in other words, a representation in the domain of written or spoken language of objects familiar from other domains.

The capacity of the mind to understand and generate such symbolic representations of objects in domains quite different from those in which they are originally encountered is sufficient for the creation of words. But it is not sufficient for establishing the kind of relationship between cognitive objects that underlies sentences in natural language. One is able to hook them together by engaging in the operation of *predication* described in Section IV.3 above. To have a thought of the kind expressed, for example, by the sentence *The cat is fat*, the cognitive object that is the *cat* must be predicated of the second, otherwise entirely distinct, cognitive object that is the *fat-thing.* As discussed above, the underlying mechanism that makes such predication possible is the recognition of the second cognitive object (in this case the cognitive object *fat-thing*) in the same region of sensation that also serves as the basis in sensation for the first (the cognitive object that is the *cat*). The two cognitive objects in the sentence *The cat is fat* are thus moored together by the fact that each is anchored in one and the same sensation.

The molecular object I sketched in **Figure XX** above was intended to present a likeness of the actual structure that is built by our central processing system in any domain when one cognitive object is predicated of another. But this successive recognition of two cognitive objects within the same constricted field of sensation is *thought,* not *language.* It is not at all the same as the written or spoken sentence *The cat is fat,* which would appear to be the equivalent, rendered in natural language, of this operation of predication. What, then, is the relationship between the molecular structure depicted in **Figure XX** and the sentence *The cat is fat?*

My proposal is that language at the level of sentences is means of using the nested hierarchies of spaces that the domain-general central processor is so good at for constructing *in order to represent the operations of the mind involved in the building up a thought such as the one we've just looked at.* On this view, language at the level of sentences is an entirely new kind of system of representation in which the objects of human cognition are no longer what is represented by

individual words. Instead, what is represented in a sentence is something entirely different: *What sentences represent is the operations of the mind.*

Consider this for a moment. If I have a reasonably accurate representation of the sequence of operations that my friend's higher-order processor has just carried out, I can use this sequence of operations to reconstruct in my own mind this same sequence of operations, and therefore know with a degree of precision just what he is thinking. And that is, I believe, just what language does: It permits us to know to a high degree of precision what someone else is thinking by representing for us the order of their thoughts.

How, then, does language represent the precise operations of the mind?

Let's go back to operations involved in prediction, as in the sentence *The cat is fat*. Recall that in the hierarchy construction of the domain-general central processor, cognitive objects can have other objects *interior* to them (as parts); and *co-present* with them in the same space (as neighbors). Thus if we understand the sentence *The cat is fat* as a cognitive object, we can easily discern that this object contains two objects interior to it:

{ [the cat] [is fat] }

But each of these objects is itself an object with an internal structure. What is that structure?

Look more closely at the linguistic object constituted by the expression *the cat.* If it is true that this expression is in fact a representation not of objects but of operations of the human mind, what do the two words that make up this expression represent? We know that the construction of a cognitive object involves the imposition of a concept in the field of sensation. Let's suppose, therefore, that the word *the* represents the concrete sensation in which the object is anchored, whereas the term *cat* now represents only the concept of the cat imposed in sensation. On this understanding, the expression *the cat* models the operations of the mind, which first fixes on a certain noticed sensation (*the*) and then imposes a concept within the field of sensation surrounding this noticed sensation (*cat*). The complex *the cat* thus represents a single cognitive object by representing the two steps in the construction of this object.

If language uses nested hierarchies of objects to represent the operations of the mind, what is the relationship between the object *the* and the object *cat* in the expression *the cat?* Here's a proposal: This expression is an object in which the term *the* represents a sensation that is then, after the imposition of the idea, *interior* to the object recognized. For example, if it is the cat's whiskers or paws that are noticed, then the *the* represents this noticing. The object that is the cat thus has something interior to it, which is modeled by the interiority of the object *the* within the larger object, as follows:

[(*the*) cat]

The operation of recognition is thus modeled in English by placing one word that represents the field of sensation (*the*) inside another object that represents the concept imposed in the sensation (*cat*). The resultant structure actually looks quite a bit like the cognitive object that is produced by imposing the concept in the field of sensation.

Looking now at the second part of the sentence, we see that the expression *is fat* functions in a manner that is similar to the expression *the cat*. The word *fat* here is parallel to *cat,* meaning not the object that is a fat-thing, but only the concept of it not yet applied to sensation. The operator *is,* on the other hand, models the imposition of the second concept in the same material already represented by the *the.* That is, it indicates the imposition of a second concept—the concept *fat-thing*—in the same sensations in which the concept *cat* has previously been imposed, thus creating a sentence that has modeled the mental operations involved in predication.

The internal structure of *is fat* parallels that of *the cat,* with *fat* being the concept and the term *is* standing in for the same sensation that has already appeared represented by the term *the*. So a linear analysis of the internal hierarchy of the sentence can look like this:

{ [(*the*) cat] [(*is*) fat] }

The notation I'm using here is quite similar to the tree-structures normally used by linguists for parsing sentences. And from the point of view of linguistics, there shouldn't be much that is new here. But from a cognitive science perspective, what I've proposed is a description of a domain-general cognitive mechanism that can serve as the underlying cause of the tree-structure of natural language. Specifically, the suggestion is that:

1. The tree-structures used to parse sentences in linguistics point to something that actually exists in the mind when it is processing language: They point to the structure of nested hierarchies of cognitive objects that natural language is built out of in the mind.

2. These nested hierarchies of cognitive objects are themselves language, which is used to represent something. But what they represent is not "the world," as is commonly suggested. Instead, what is represented in language is the operations of the domain-general central processing system, which involve the construction of molecule-shaped structures out of noticed sensations and concepts.

3. The nested hierarchies used in natural language to represent thoughts appear to rely on three fundamental operations—predication, representation, and hierarchy construction—that are in any case needed by a domain-general

processor to generate the basic features of human ontology across all domains. Natural languages does not, therefore, appear to require any additional cognitive abilities beyond those in any case required for cognition in all other domains.

On the basis of the evidence presented thus far, then, there seems to be no need for the Chomsky-Fodor hypothesis of an innate and domain-specific language processing module. An innate domain-general processing system of the kind I've described may be able to handle language processing just fine.[39]

VI. CONCLUSION^

It has now been nearly thirty years since the Chomsky-Fodor debate launched a cognitive science in search of domain-specific modular structures that were supposed to characterize the architecture of the human mind. The research agenda created in the space established by this debate has been extraordinarily successful in advancing us toward a detailed understanding of the workings of certain dedicated domain-specific modules, especially in the areas of sensory processing. But this research agenda has not shed light many of the questions Fodor himself admitted in *The Modularity of Mind* that "we would most like to know about"[40]—namely, those associated with higher order operations of the mind, which Fodor supposed would have to be conducted by a domain-general central processing system. Chomsky's bet that most of human thought takes place within domain-specific modules has led to a voluminous but highly speculative literature about the identity of these modules and the unique "grammar" operating inside of them. Meanwhile, Fodor's hypothesis of a massive domain-general central processing system has suffered from relative neglect—principally, as it seems, for want of way of moving forward toward even a sketch of what this central processing system could be like.

In this paper, I've suggested that psycho-ontology, the study of human thought processes in light of the fundamental ontology of the world of human experience, may well be the road we need to be able to begin thinking carefully about the possibility of a domain-general central processing system. In this paper, we've seen that an exploration of the ontology of the objects of human cognition can lead rather quickly to the construction of possible models of what a domain-general central processing system that could be responsible for these ontological features might look like. A carefully constructed catalogue of the features of human ontology that recur across domains was shown to be a fruitful

[39] In this case, language will in fact be like bicycle-riding—it will be a skill that takes advantage of native abilities, but which is nonethelss acquired. Compare Chomsky, Rules and Representations, p. 102.

[40] Jerry Fodor, The Modularity of Mind, p. 38.

basis for proposing domain-general mechanisms that are capable of producing these features across domains. And while such a model must at this stage be no better than a hypothesis, we can take it more seriously if we can demonstrate its explanatory power by setting it to work dealing with other familiar problems in mental architecture. Here I've provided one important example, suggesting that a domain-general central processor of this kind is also capable of serving as the basis for natural language—apparently making the Chomsky-Fodor proposal of a robust language-processing module unnecessary. The vulnerability of the supposition of a domain-specific language module to counter-arguments deriving from psycho-ontology should make the potential importance of this discipline plausible even to those whose commitments to a thoroughgoing domain specificity remain strong.

Due to space limitations, the argument of this paper has been sketchy. But even so, I think it maps a clear route from where we are to a systematic inquiry into the nature of the mind's central processing system. Psycho-ontology seems to provide the opening move we need.