THE NEW TRICK: MODULARITY, AUTOMATION, AND THE PLASTICITY OF PERCEPTION

by

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ABSTRACT

Jerry Fodor’s modularity theory holds that psychological processes behind basic perception have a property called informational encapsulation that preserves a consistency of experience across individuals and over time. Encapsulation keeps basic perception fixed, mechanical, insulated, and leaves it largely unalterable by the variability of higher-level cognition, as in acquired beliefs, knowledge, imagination, memory, and individual learning. However, encapsulation conflicts with mounting evidence that perceptual processes are sensitive to higher-level cognition under specific conditions. In this thesis, I will argue that modularity cannot adequately account for certain findings about perceptual experience. I will then propose an alternative theory of ‘holistic information transfer’, ‘cognitive information taps’, and ‘adaptive automations’ that accommodates the empirical literature behind observed cases of perceptual plasticity and accounts for the apparent implasticity that motivates modularity theory. Instead of encapsulated modules, we can conceive of perceptual systems as experientially reinforced cognitive subsystems amidst an informationally integrated cognition.

Keywords: cognition perception; modules; Fodor; Modularity; adaptive automation; perceptual plasticity

Subject Terms: Cognitive science; Cognition; Perception; Perception Philosophy; Constructivism (Psychology); Perceptual learning
Whether scientists or everyday people, the ability of individuals to communicate observational experiences to one another depends importantly upon the extent to which human experience is similar across those individuals. The greater the consistency of each individual’s experience across time and with the experiences of others, the more individuals can be confident that they refer to the same things in the discussion of those experiences. Jerry Fodor’s influential modularity theory of perception aims to explain both the psychological and neurological processes underlying sensory perception in a way that preserves this consistency across individuals and so quells these epistemic concerns about the commensurability of observation. Fodor argues that the processes behind perceptual phenomenology – our basic sensory experiences – have a property called informational encapsulation, which means that they are fixed, mechanical, insulated and largely unalterable by the variability of idiosyncratic learning. Our basic perceptual processes and the experiences these processes produce are closed to influence from higher-level cognitive processes, processes that involve acquired beliefs, knowledge, voluntary suppositions, imagination, memory, or other manners of learning. However, the limitations that modularity imposes on perception conflict with mounting evidence that our perceptual processes are sensitive to higher-level cognition under specific conditions. These shortfalls within modularity theory will point us, instead, towards a different way of understanding the relation between cognition and perception that promises to shed new light on both of these aspects of the mind.
In this thesis, I will begin with a brief description of Fodor's modularity theory. I will then present a combination of philosophical arguments and empirical evidence regarding our perceptual phenomenology from a number of fields of psychology that I believe are highly problematic for Fodor's modularity theory of perception. I will first question the limits of the informational encapsulation imposed by Fodor's model and argue that the concessions made by Fodor to account for empirical evidence stem from deficiencies in the comprehensiveness of his theory. A subsequent discussion of recent empirical studies that are troublesome for modularity will begin to yield an alternative picture of perception and cognition that better explains these aspects of perception. Finally, I will propose and argue for a theory of 'holistic information transfer', 'cognitive information taps', and 'adaptive automations' that accommodates the empirical literature behind observed cases of perceptual plasticity and also accounts for the cases of apparent implasticity that motivate modularity theory. In place of encapsulated modules, we can conceive of at least some perceptual systems as experientially reinforced cognitive subsystems amidst an informationally integrated cognition. A simple 'change of mind' allows us to account for perceptual penetration by learning and higher-level belief and still maintain enough commonality of perception to preserve fruitful communication between scientists and everyday individuals alike.
To my family for their unwavering support, and to its newest member, who came anew into my sister's world as this thesis neared its final revisions...
“You cannot depend on your eyes when your imagination is out of focus.”

-Mark Twain
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INTRODUCTION

At the very heart of epistemology, there stands a mysterious relationship between theory and observation. Philosophers and empirical researchers of many persuasions are utterly divided over how much one influences the other, whether the two are utterly separate, whether they are fundamentally conjoined or somehow intermixed. The elements that ground all scientific discussions depend in one way or another upon our attitudes towards this epistemological question: at stake is the very level of confidence we place in the veracity of our perceptions and — in turn — the level of individual experience we believe is shared between observers. Our understanding of this relationship also depends upon the empirical facts; in order to determine the impact of theory on observation, we must first understand the psychological and neurological mechanisms that underpin human observation and inference. This second, psychological question requires us to determine whether the mechanisms of human perception underlying observation are truly distinct from those behind higher-level human cognition of concepts, assumptions, beliefs, memories, and imaginings which make up our theoretical commitments about the external world. To answer to these two questions, we will need to explore developments in philosophy of mind, philosophy of perception, cognitive psychology, and neuroscience.

Theorists who study the nature of the cognition-perception relation are polarized along roughly two sides. One view argues that cognition and perception are fundamentally conjoined, that perception is therefore malleable to our beliefs and that observation contains an intrinsically idiosyncratic component. The opposing view argues that cognition and perception can be cleaved in some
principled manner. As this proposed dichotomy also prevents wholesale mixing of theory and observation, it avoids perceptual relativism and either preserves the objectivity of observation or at the very least maintains a basic commonality of phenomenology between observers. For these latter theorists, observation thereby provides a reliable, shared, and stable epistemic basis that disparate scientists with different theoretical commitments may draw upon as a starting point for consensus.

Jerry Fodor is one major proponent of the view that observation and theory are distinct. Throughout the 1980's, he advanced the argument that the psychological mechanisms behind the processing of observation and of consciously accessible theory are fundamentally different types of mechanisms. Fodor proposed a model of human perceptual systems as containing 'modules' or 'input systems' whose function it is to produce all pre-doxastic perception, or all perception that was unaffected by variable theoretical content, whose development is innately determined, whose internal processes are encapsulated from the psychological mechanisms responsible for processing the theoretical content of higher-level cognition, and whose operations are fixed and inflexible. The output of such modules are then uniform across individuals, and result in the neutrality of observation between all possible theoretical commitments that differing scientists might entertain. Modularity theory thus provides the empirical basis for a principled observation-theory distinction that preserves observation as a common theory-neutral ground for scientific consensus.

In recent years, a number of developments in the empirical literature cast doubt on aspects of Fodor's vision of encapsulated perceptual modules. In this
paper, I will present empirical evidence against the Fodorian thesis of encapsulated modularity in order to argue that modularity cannot sufficiently explain perception. This evidence will include empirical studies of hallucinations, mental imagery, and phenomena that blur the boundaries between sensory modalities and between lower-level and higher-level processes. We will see that alternate interpretations of the available facts are not only possible, but at times also explanatorily superior to Fodorian modularity. I will briefly weigh in on whether Fodor's arguments secure for him true theory-neutrality and then spell out an alternative conception of the relation between perception and cognition. This alternative, I believe, will satisfy the concerns that lead Fodor to propose modular encapsulation, and also account for observed levels of plasticity of perception to the processes of higher-level cognition. On this account, we will view the functions of input systems as specialised and reinforced subsystems of a cognition that is continuous with perception and propose new mechanisms that explain other cases of higher-level influence over perception. This account will allow us to preserve those aspects of Fodor's input systems that constrain perceptual relativism and yet produce a simpler, more holistic view of the mechanisms of human cognition.

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1 I would like to clarify that I do not intend a flat-out refutation of modularity, as I believe it is entirely possible and perhaps likely that some psychological mechanisms may be 'modular' in a way much as Fodor describes. However, I do not believe that this can account for all of our perceptual phenomenology and that some of the prohibitions it makes about the capacities of our perceptual architecture are wrong.
PART I: DISAMBIGUATING A TANGLED MESS OF ISSUES

The twin debates that surround the theory-neutrality or theory-ladenness of observation and the distinction between cognition and perception are exceptionally difficult to resolve in part because these two issues are so closely linked. If one attempts to propose a meaningful distinction between the mechanisms of cognition and perception, problems idiosyncratic to this matter will compound if unresolved, and will multiply the issues involved when we try to determine the theory content of observation. We will need to sift apart a number of the relevant aspects of each discussion before we dive headlong into the details of Fodor’s modularity thesis.

i. The Epistemic Issue in Detail

We have already briefly touched upon the debate in epistemology over the theory neutrality and theory-ladenness of observation. For observation to be theory neutral means that observation does not contain any hidden preconceptions or inferences that bias the information we get from it in any particular direction. For observation to be theory-laden means that observation contains built-in assumptions about the incoming information and that the information it provides is coloured by these hypotheses. This means that observation favours one theory of how the world works rather than merely providing basic information to the theorizing observer.

The level of impact that theory has on observation is important in epistemology because theoretical content can be highly variable, whether
Historically, between individuals, or even within a single individual across time. Theory depends upon assumptions, hypotheses, and inferences and any difference in these between individuals will result in a different theoretical framework of beliefs. In stark contrast to the variability of theory, any strong foundational view of the nature of observation, first, takes it to comprise the most basic experiences in individuals – non-inferential\(^2\), direct, and the surest form of knowledge about the outside world. Second, any foundational view of observation treats it as uniform between all observers, and therefore it is what allows the different theoretical frameworks across individuals (more importantly scientists) to track the same objective features of the outside world in the same way. An individual who views the same scene under the same conditions at different times, or even two individuals who view the same scene under the same conditions should invariably make the same observations. Their hypotheses, inferences, and interpretations from these observations, however, will differ according to their existing theoretical framework of beliefs.

It is important here to note that Fodor denies giving a special status to observation in the way of the foundationalist (1983, 88). Instead, he takes a ‘weak’ epistemic view of observation that does not require that observation be direct or non-inferential. Fodor argues only for the second condition — the commonality of observation to all observers. In fact, we shall later see that he adopts the view that observation actually contains theory and inference, but that

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\(^2\) I say non-inferential, but this does not necessarily mean non-conceptual, as argued by McDowell in *Mind and World*. I should also acknowledge that it is possible to hold a foundational view that has foundational beliefs supported by implicit and perhaps general but not explicit inferences; I mean only here to provide a rough sketch of the foundationalist position rather than a rigorous and comprehensive description of all possible foundationalist views.
theoretical content is somehow fixed across observers. Even if observation is coloured by theory in some form, so long as that influence is uniform between individuals such that observation is more or less common between individuals and scientists, then they have a requisite level of shared theory-neutral grounds for agreement to serve as the basic language for their theoretical discussions (1988, 189).

If, on the other hand, observation were not common between individuals but was somehow influenced by inferential content, and if the phenomenology of two scientists who observe the same set of stimuli could thus be altered merely by their differing theoretical commitments, then this presumably casts all of empirical science into doubt. This is how the epistemic dilemma has historically been debated between opponents such as Fodor and Paul Churchland. At the very least, an individual with a wildly non-standard theoretical framework may make observations that are utterly divorced from the distal object she observes. Even successful communication with this individual would be exponentially more difficult the more her framework departs from the norm and the less she shares a common observational frame of reference with others. This epistemic relativism would quickly invalidate observation as a foundational epistemic ground. Even scientists of different theoretical commitments would no longer be able to appeal to observation as a shared frame of reference for discussion: a physicist of a Newtonian persuasion may make observations totally incommensurable with the

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3 I shall have to apologise for the simplistic and incomplete nature of this history, but my intent here is only to briefly set the modern issues in some semblance of context.

4 I hesitate to say impossible, because this is – I believe – the predicament of individuals at progressive stages of psychosis and other such psychological disorders.
observations of a physicist of Relativistic persuasion. Theory-neutrality purports to save us from such an epistemic quandary.

We can see how the perceptual and cognitive realities of observation quickly become relevant to the concerns of epistemology. If pre-reflective perception is coloured by theoretical content due to its interaction with higher-level cognition, then observation is already intrinsically theory-laden. If that theoretical content can vary from one person to another, then the very process of observation in any individual cannot even be said to involve necessarily shared bodies of theory between observers and so, be theory-neutral to disputes of individual interpretation. The psychological problem is therefore deeply bound to the epistemological problem.

ii. The Psychological Issue

The psychological problem is generally described as the problem of the distinction between cognition and perception. Unfortunately for clarity, this description is complicated by the fact that our very concepts of what constitutes cognition and perception have evolved and the terms no longer circumscribe the same boundaries that they once drew. Where metaphysicians and philosophers of mind once spoke of perception in terms of the phenomenal pixels of qualia or sense data (and granted that even then, there was disagreement as to what

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5 As we will see at length, I believe these types of examples miss the most important and telling cases of higher-level cognition influencing the character of perceptual phenomenology, ones involving more basic and commonplace theoretical hypotheses such as of seeing faces or canals on the surface of Mars, or the increased detail of phenomenology that follows routine exposure to certain sets of stimuli as in faces of unfamiliar ethnicities (or even species).
6 Again, the history I shall provide for the psychological problem is admittedly simplistic, but my intent is only to provide a loose starting point from which to tackle these issues.
psychological elements qualified as sense data), the generally accepted view of perception has evolved to also include the beliefs derived from sensory data. Theoretical attacks such as those from Daniel Dennett’s “Quining Qualia” showed that qualia alone could not be all there was to perceptual experience, and perhaps that qualia as previously conceived were merely a theoretical fiction (1988). In the empirical literature, where once we saw perception as a purely physiological and non-inferential reflex, there was now new data suggesting that assumptions and knowledge somehow fed into our phenomenology. The rejection of forms of behaviourism in both philosophy and psychology – helped along in no small part by Fodor and Chomsky – added to this new understanding of perception as cognitive in nature (Baars 1986, 351). It was now safe to peer into the black box and ponder about cognition; this freed us to view perception as a rich, cognitive, knowledge-based phenomenon rather than merely a stimulus detector that made possible a response. However, once we saw perception as part of cognition, this entangled the two concepts and those who accepted this new understanding of perception could no longer rely upon the meaning of the terms ‘cognition’ and ‘perception’ to distinguish the ‘given’ from the ‘theory’. Theorists became divided between those who abandoned the distinction completely and those who attempted to forge a new empirical basis for the traditional observation-theory distinction.

Perceptual-cognitive continuity. Among psychologists, the group that totally rejected the observation-theory distinction briefly gained predominance in the 1950’s, under the banner of the ‘New Look’ movement. I should take a
moment to clarify that much of the history to this debate draws upon past approaches coming from psychology rather than philosophy proper. Fodor and Churchland – philosophers whose views on the present subject are diametrically opposed – take the import of the New Look and other past psychological approaches as their primary ideological battlegrounds and much of their disagreements stem from divergent interpretations of empirical findings.

According to Baars, the New Look was an approach that “advocated a view of perception in which biases and emotional factors would be taken into account as an inherent part of one’s perception of reality” (1986, 271). This view – primarily led by the research of Jerome S. Bruner and his colleagues – saw perception as highly malleable to an individual’s mental state, changeable in response to one’s beliefs and expectations. However, as it seemed to make “a mockery of validity and solidity”, many saw the view as excessively relativistic and it failed to sway most theorists and researchers (Wapner, in Baars 1986, 321). Although the New Look approach was itself ultimately rejected, a number of findings from related research had an important impact upon the understanding of perception. We will return at length to the studies of Bruner and Postman, the two major proponents of the New Look movement. Bodon credits the New Look movement for providing the first decisive challenge to psychological behaviourism by making it acceptable to study “perception properly so-called (i.e., not just sensory discrimination” (2008, 299). Furthermore, such research first demonstrated that the very act of perception contained inferential components necessary to the computation of perceptual values such as the perception of distance, the integration of retinal images into a unified three-
dimensional image, the apparent size of objects, and the processing of colour phenomenology from disparate sensory components. The raw data provided by our sensory receptors underdetermined the interpretation of its distal causes: there had to be intelligent features in the mechanisms of perception that resolved this informational deficit by making assumptions and hypotheses on the available data. The New Look took this revelation of “perception as problem solving” (Fodor 1984, 36) and extended it to the conclusion that perceptual processes — and by extension, their associated phenomenological content — are malleable to cognition⁷. Others rejected this thoroughgoing relativism, but had to admit that there was a genuine inferential component to perception that had to be integrated into their theories of the perceptual process.

*Fodor and perceptual-cognitive discontinuity.* As an adherent of the latter approach to cognition and perception, Fodor was among the theorists who attempted to construct a new model for the cognition-perception distinction. While Fodor considers perception in general to be a part of cognition, he also quite confusingly refers to his psychological basis for the observation-theory distinction both as the “cognitive impenetrability of perception” (1988, 188) and

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⁷ I would here like to make a few short clarifications. For purposes of clarity, whenever I herein use the term perception by itself, I shall mean as a whole the neural and psychological mechanisms that go into its processing as well as the phenomenological content that is their output and whatever higher-level cognitive processes that may be involved in identifying that phenomenological content. When I later speak of *mane perception*, I shall instead be speaking of phenomenological content that results from the information from external sensory stimulation and the neural/psychological processes underlying that content. Like Fodor, I will designate this term to exclude any higher-level cognitive processes (and the resultant outputs of those processes, such as those that result in perceptual belief) that operate upon that phenomenological (or rather sensory phenomenological) content. I shall take phenomenology as a general blanket term for phenomenological contents taken as a whole — if such contents do so exist — whether I speak of phenomenology in general (including here internally-generated phenomenology) or merely sensory phenomenology (the outputs of *mane perception*).
the as "perception/cognition distinction" (1983, 42). It is important for us to understand that he does so for the sake of convenience only. Perception for Fodor – as for many other modern cognitive scientists – involves all functions from sensation to belief formation, the former being merely the impinging of external signals upon receptor cells at the lowest levels of the sensory process and the latter being a higher-level cognitive function.

Accepting the modern concept of perception leaves Fodor with a problem of how to cleave perception and cognition to preserve epistemic objectivity, and us with the quandary of how to describe Fodor’s distinction. We cannot refer to Fodor’s cognitive impenetrability of perception as the separation between the perceptual and the non-perceptual since the act of perception itself includes higher-level mechanisms of belief fixation. Fodor himself agonises at length upon this aspect of the definition of perceptions; “I wish I knew what to call the ‘subsidiary systems’ that perform this function [of lower-level perception]” says Fodor (1983, 40), as he lists and rejects various candidates in turn before settling upon the term “input systems”. Furthermore, Fodor makes it clear that not only perceptual mechanisms, but also linguistic mechanisms are included in his inventory of modular systems. We also cannot refer to the cognitive impenetrability of perception as the separation between the cognitive and the non-cognitive; for Fodor, his modular and impenetrable perceptual input systems

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8 The term 'sensation' as used above has been taken by many psychologists and adopted by some philosophers such as Fodor to mean the initial stimulation and output of our sensory receptors. For modularity theorists, this is to be distinguished from 'perception' as the final product of perceptual modules and cognitive systems functioning within the brain.
are also fully cognitive processes. The scope of cognition thus includes perception, and this inclusion inserts a discontinuity between higher-level cognition and those processes that result in perceptual (and linguistic) phenomenology. Although the distinction is meant to be real, it is therefore imprecise to describe the issue qua Fodor as determining the boundary between cognition and perception.

In order to establish a new empirical basis for the cognition-perception boundary, Fodor presents his distinction as the separation between two different kinds of inferential processing: the modular input systems which produce our phenomenology and the holistic central processing systems which generate beliefs, choose actions, and underlie what we generally think of as the higher-level functions of the brain. These modules are the middlemen whose function is to make the inferences necessary to resolve the underdetermination of distal causes from receptor signals; “the inferences [that input systems effect] have as

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9 After all, as a modern cognitive scientist, Fodor must admit that his input systems are inferential mechanisms by which we learn about the world and so cannot avoid classifying them as cognitive. Presumably, the limits of cognition on Fodor’s view include the inferential input systems but neither sensory receptors – where the initial external stimulus is physiologically registered (physical transduction) – nor wherever down the line that signal is first converted into the language of the brain (pre-computational transduction, assuming the brain is actually computational). Both these stages of transduction occur prior to input system. In fact, Fodor expressly distinguishes the latter type of transduction from input systems – which he considers calling computational transducers (1983, 41) as the sense receptors and pre-computational transducers “preserve the informational content of their inputs, altering only the format in which the information is displayed” while input systems actually influence the signal’s informational content. Since both cognition and perception herein designate a heterogeneous collection of mechanisms, little hangs upon such initial stages unless these transducers ultimately turn out to be penetrated by higher-level cognition.

10 I refer to “perceptual phenomenology” here to make a naive distinction between phenomenology derived from sensory information and internally-generated phenomenology such as imagined objects. We will eventually see that these may not ultimately be so different.

11 For much of this paper, I shall speak in similar terms in order to show how much Fodor’s modularity does or does not get on his grounds. However, this dichotomy between the phenomenological products of each stage of perception will become ever more elusive and arbitrary once we begin to break down the apparent barriers between lower-level perception and higher-level cognition.
their 'premises' transduced representations of proximal stimulus configurations, and as their 'conclusions' representations of the character and distribution of distal objects" (1983, 42). However, although they are inferential, unlike the central systems, modular systems do their work entirely autonomously, impervious to influence or 'impenetrable to' the rest of cognition. This cognitive discontinuity protects the perceptual modules' resultant observational content from the inherent variability of higher-order thought's beliefs, acceptances, and desires, and serves to maintain the epistemically important boundary between observation and theory\textsuperscript{12}.

For the sake of convenience, I will adopt Fodor's usage of the terms 'cognition' and 'perception', but since we have already seen how these terms are inappropriate for the discussion at hand, I will designate new terms to describe the distinction Fodor has in mind. I will use '\textit{mane} perception' – from the Latin for 'early' or 'morning' – as a placeholder for the perceptual functions filled by modular input systems in Fodor's mental scheme and 'mainstage cognition' as a placeholder for the cognitive mechanisms behind what Fodor calls 'central systems'\textsuperscript{13}. I add the qualifier 'mainstage' to cognition in order to distinguish such paradigmatically cognitive mechanisms from those that underlie Fodor's input system functions\textsuperscript{14}. Until we have an alternative understanding of the outputs of perceptual processing, I will also speak of the output of \textit{mane} perception as

\textsuperscript{12} As we shall later see, even Fodor's model is a compromise that does not guarantee that theory and observation remain totally distinct.

\textsuperscript{13} One could then identify 'secondary perception' with the belief-fixation processes that occur in higher-level cognition.

\textsuperscript{14} As the term 'higher-level' also comes with a lot of terminological baggage, I feel the term 'mainstage' will suffice for expressing the sense of cognition usually intended by both 'higher-level' cognition and Fodor's 'central' cognition without committing me to any particular picture at this early juncture. For more initial clarifications of these issues, see APPENDIX I.
‘sensory phenomenology’\textsuperscript{15} for reasons that shall become clear shortly, with the rider that in Fodor’s model, language perception is as much an output of \textit{mane} perception as less abstract forms of sensory information. Although it is by no means certain, I shall also accept language outputs as part of what I will call ‘sensory phenomenology’ for the purposes of our discussion; it will be understood that what applies to \textit{mane} perception will apply equally to the linguistic processes that Fodor also believes are modular. Our new terms will allow us to critically evaluate Fodor’s psychological arguments without committing to his ontology.

\textsuperscript{15} I add the qualifier ‘sensory’ to distinguish it – perhaps artificially, if it ultimately turns out perception is truly continuous with cognition – from internally generated phenomenology such as from thoughts, imaginings, visualisations, dreams, and hallucinations. This is so that we may speak of the outputs of \textit{mane} perception in the manner that Fodor requires, in exclusion from higher-level cognitive belief processes.
PART II: FODOR'S MODULARITY THESIS

Fodor’s model of perception breaks down into roughly three sequential categories: transducers, input systems, and central systems. At the lowest level of the perceptual chain, transducers are components that take initial sensory stimulation and convert that information into a form that cognitive systems can accept. The converted information is fed into modular input systems, self-contained cognitive systems that take the transduced information, fill in gaps and flesh out the raw data into perceptions of the external world using a predefined repertoire of interpretive inferences, and finally present that augmented information in the form of observation to the higher-level ‘central’ cognitive systems. In what follows, I shall briefly describe each level with particular focus on the input systems and their relation to the central systems.

i. Transducers

We all know of large global companies that have offices in a number of countries, and which must therefore do their business across different languages. We might see the human mind as one such international office. Within this metaphor, a transducer would be equivalent to a worker whose sole job it was to take documents – the sensory stimulations, for example – from the resident language of the local country and translate these documents directly into reports in the language of operation for the company. Transducers ideally “preserve the informational content of their inputs, altering only the format in which the information is displayed” (1983, 41), in order for that raw information from the
outside world to be compatible with the input systems. As we have touched on already – the term 'transducer' may refer either to the physiological transducers that convert energy (light, sound, chemical) at a receptor site into a neural signal or to the pre-computational conversion of this signal into Fodor's computational language of the mind. Transducers of these two types presumably include the sensory receptors and the mechanisms immediately beyond the sensory receptors – for instance, the ganglia immediately attached to those receptors – that extract information directly from the sensory stream without any modification of its content. Fodor never actually states at which point the sensory signal is converted into computationally accessible information and he alternates liberally between talk of both types of transducers\(^{16}\). Their raw output is understood largely or in full to be phenomenologically inaccessible (1983, 54), just as a company's board of executives may never see the lower-level forms and reports filed by its entry-level office grunts. Since transducers are incapable of anything other than the straight conversion of sensory stimulations to neural impulses without any alteration of the content of that data, and since their outputs pass solely to the lower-level processors in the input systems, these most basic systems – whether physical or pre-computational – are largely peripheral to Fodor's discussion of perception. Correspondingly, Fodor only briefly addresses

\(^{16}\) Fodor's reader is left to assume that symbolic transduction occurs at some point at or after physical transduction. For example, he often talks of the information passing through a transducer as beginning as "impinging energy at the transducer surface" (1983, 45), which clearly describes the operation of sensory receptors. Physical transducers in the visual system would therefore include (among others) cells such as photoreceptor rods and cones, retinal ganglia, and perhaps even center-surround cells since they function to detect regularities from the outputs of photoreceptors and report these regularities as-is to the higher visual centres. However, once he begins to talk of information formats – that is, the signal generated by physical reception is changed into a format useable by perception and cognition – we are left to assume that pre-computational symbolic transduction has also occurred.
their function when setting out his modularity thesis and quickly moves on to input systems and central systems\textsuperscript{17}.

ii. Input Systems as \textit{Mane} Perception

Input systems or 'modules' analyse and interpret sensory information from the transducers and output their results as experience to the mechanisms of mainstage cognition. The heart of Fodor's modularity thesis is concerned with specifying exactly how input systems function, and although Fodor believes that input systems are responsible for both \textit{mane} perception and early linguistic analysis (1983, 44)\textsuperscript{18}, he uses the term 'perceptual module' synonymously with 'input system'.

As stated, input systems take information formatted and pre-prepared for them by the transducers, analyse it, and present it in a vivid form that the central systems of thought can make use of (Fodor 1983, 40). They also function in a self-directed, self-contained, and fairly invariant manner. If we imagine transducers as workers translating descriptive reports from the language of sensory stimulation into the language of the brain, we might see input systems as engineers sealed into windowless soundproof cubicles whose job it is to take the reports from the translating workers and reconstruct perceptual graphics presentations from those original reports for the company executives. Just as

\textsuperscript{17} Of course, it is hardly a noncontroversial issue whether transducers have propositional or intentional content, but seeing as my intent at this juncture is to examine modularity from Fodor's grounds, I will not be pressing the matter herein.

\textsuperscript{18} Seeing as we are mainly interested in the role of input systems in the phenomenology of perception, and the functions of input systems are most evident in perception, we shall generally be glossing over their role in language in this paper. Suffice it to say the same characteristics apply whether they are responsible for processing the tone of an F sharp, the perceived lengths of two parallel lines, or a line of words spoken and heard in succession.

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there are different types of engineers for different types of job descriptions, the
documents from the transducers are divided amongst our input engineers
depending on the content of those reports and the specialty of the engineer.
Furthermore, these engineers are limited by company policy to use only an
approved, predefined list of allowable assumptions and hypotheses to carry out
their duties, whose use is specified by the character of the input they receive.
Because their cubicles are sealed to the outside and they are prohibited contact
from anyone else during their work, their actions are also deterministic; their
tasks and behaviour are entirely dictated by the content of the reports and the list
of allowable operations pinned to their cubical walls. We might even imagine that
their superiors are standardisation fanatics and have implanted high-tech neural
clamps into these engineers to prevent them from even thinking of changing how
they work. The upshot to curtailed operational freedom and having only to
analyse documents suited to their expertise is that they can perform their tasks
extremely quickly. Thus is the life of the Fodorian perceptual module.

Our office metaphor demonstrates a number of the characteristics of input
systems. The sealed cubicle represents the informational encapsulation at the
very heart of modularity. The internal workings of the engineer in the cubicle
contain theoretical assumptions and hypotheses, but are inaccessible to the
outside employees and the goings-on outside the cubicle are inaccessible to the
engineer inside. Just as engineers come in a variety of expertises, modules
come in a variety of ‘domain specificities’, the specialisations of each particular
module to a particular well-defined range of tasks. The list on the wall of
allowable actions represents the rigid and inflexible operations of each module.
The speed of the engineer is the quick action of the module, and the neural clamps are the (neural) hardwiring of each module's processes.

Fodor lists ten characteristics of modular systems in total, but these ten largely reduce to six requirements a cognitive system must fulfil to be modular. To address every condition of modularity that Fodor lists and do justice to the immense scope and detail of his theory would be prohibitively lengthy for the purposes of this paper; I will instead focus on only the six properties most central to the modularity thesis. As introduced by Fodor (1983, 37), the first five general properties of modularity are that they are (1) domain specific, (2) innately (or endogenously) specified, (3) neurally hardwired, (4) autonomous, and (5) not assembled. To these five general properties, I shall add the final property that modular systems are (6) informationally encapsulated. Fodor introduces this property later and it is given particular emphasis among his expanded list of modular properties. This last property is the most important of the six; Fodor, after all, holds that informational encapsulation is at the very heart of modularity.

(1) Domain specificity. Fodor's perceptual modules might be described as short-sighted and boring in temperament. The various input systems are each built to look in only a specific type of inputs (a single sensory modality, for example) for a very well defined and specific type of problem to solve and they will only deal in these specific areas for which they are built. Unlike what Fodor calls "horizontal faculties" – psychological mechanisms such as imagination, memory, and reasoning, which function generally across multiple domains and over all sensory modalities – typical of central systems, input systems are
"vertical faculties" specialised for their particular functional niches. An input system that effects the analysis of colour or of distance perception in vision will do only that job, and only in that visual modality for which it is tailored. This idea of 'domain specificity' is summed up by Fodor's motto "specialized systems for specialized tasks" (1983, 52). There are as many different input systems as there are specific domains of perceptual problems that need solving and information that needs integrating into sensory phenomenology. Examples of domains over which specific input systems may operate are facial recognition, colour, size, and shape constancy processing, vocal recognition, linguistic processing, and speech processing (Fodor 1983, 47).

As support for the existence of domain-specific input systems, Fodor argues from the general plausibility that where there are highly idiosyncratic 'eccentric' cognitive tasks with computational demands that differ from tasks of other domains and modalities, it is likely that there are specialised systems that compute these tasks (1983, 49). Although he admits that this argument is not definitive, he proposes that it accounts for there being linguistic universals across

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19 A perceptual module determines whether or not the input data falls into its target domain by relying upon contextual cues in the sensory input from the transducers to determine whether or not the information falls into its domain of operation (Fodor 1983, 49). If these cues are unsatisfied, the module remains inactive and produces no phenomenological output. For example, Fodor cites studies that show that auditory contextual cues suggesting a sound is speech will result in the phenomenal perception of speech-related sounds, while cues suggesting a sound is non-speech will result in non-speech sounds (1983, 49). It should be noted that evidence of contextual influence in itself does not necessitate modularity; a New Look theorist could just as easily take this as evidence that the context is a higher-level determination which influences or predicts incoming audition in a top-down manner. If this were so, this psychological operation would be domain specific merely in Fodor's 'trivial' manner of an instantiation of a general process operating in a particular and regular subject domain (1983, 48). However, Fodor argues that the study also shows that only a specific number of predetermined auditory cues will automatically "flick the switch" that induces domain recognition (1983, 49), and therefore it is not the case that just thinking of a particular domain will result in contextual recognition and produce phenomenal perception as speech.
all human languages. Fodor contends that language processing is an eccentric computational task quite unlike general visual or auditory object recognition. If this task were handled by the same domain-specific input systems common to people across all languages, this would account for the inherent similarities in the structures of those languages (1983, 51).^{20}

The specialisation of input systems has several beneficial consequences. First, it allows these commonly occurring and well-defined types of tasks to be run as quickly as possible by having a dedicated processing system highly focused on a small array of tasks (Fodor 1983, 61). Second, because such dedicated systems for specific cognitive tasks run autonomously, this minimises the processing load for the higher “central” cognitive systems in the same way that autonomic or reflexive blinking saves computational resources for other tasks (Fodor 1983, 64). Third, for the same reasons, this helps isolate perception from the influence of higher cognitive systems, protecting the consistency of our sensory phenomenology. We shall delve further into the details of the second and third consequences a little later.

(2) *Endogenous specification.* Although Fodor originally proposes endogenous specification as one of his primary five qualities of input systems, he ultimately has surprisingly little to say on this topic. Fodor’s input systems may be cognitive in nature, but unlike other cognitive systems they do not depend upon learning for their development. In Fodor’s highly nativist conception of

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^{20} For this argument to really go through, though, Fodor also needs a number of the other properties in our list of input system characteristics, namely those of endogenous (and mandatory) specification, autonomy, and developmental completeness. Without these other properties, there would not be anything necessarily common from the outputs of even domain-specific computational processors.
modules, their development is predetermined and more or less unaffected by differential experience. That is, except to say that they may at stages rely upon "environmental releasers" (Fodor 1983, 100), types of experience that act only as catalysts for that development rather than directing that development in any way. Fodor does not say what exactly dictates the development of input systems, but it is an easy leap to assume that these deterministic factors are genetic in nature. Therefore, input systems unfold in a characteristic and regular manner in childhood much like a mechanical flower unfolding according to a predetermined design. Endogenous specification is necessary if Fodor is to show that input systems produce common theory-neutral sensory phenomenology by design, as it provides a more or less uniform starting point for all human perceivers. Furthermore, in contrast with exogenously influenced development, it provides a foundation for both completeness and informational encapsulation, as the nascent input system comes pre-packaged with everything it needs for normal development without the need for experiential influence for direction. The trouble, as Fodor notes, is that there is insufficient evidence to show definitively that the childhood development of psychological mechanisms are endogenously specified and not exogenously influenced. Fodor, however, cites several studies as preliminary evidence suggesting that certain stages of language development are relatively uniform across all children, even those with handicaps of specific sensory modalities (1983, 100).

(3) Neural hardwiring. In addition to the development of input systems being endogenously fixed, Fodor also argues that the manner in which they operate is also fixed by their physiology and that the internal computations of the
Input systems are physically cut off from any interference caused by mainstage cognition. Fodor notes that among those psychological functions whose operations we can localise to specific brain areas, perception and language are first and foremost. Since perception and language processing — or to put it more accurately, *men's perception* and language processing — are roughly synonymous with input systems on Fodor's model, input systems and their internal operations are dictated by the existent neural architecture within these areas. Fodor suggests that certain rules apply for all 'hardwired' systems. For one, hardwiring restricts the possible range of operations to a specific number for which there exist connecting pathways; this speeds up operations while preventing outside interference. Just as neural connections that allow for information transfer can exist between particular processing systems, where there is no connection, there is also no possibility for causal influence (Fodor 1983, 98). Hardwiring provides a physiological basis — and a computational basis, since Fodor holds that a module’s computational structure is actually isomorphic with its neural structure (1983, 37) — for the further claims that input systems are autonomous and that they are informationally encapsulated.

(4) Autonomy. Given that input systems are specialised, that their development is fixed by genetics (their developmental process is self-contained), and that their operations are self-contained by neural hardwiring, the only external factor that determines the behaviour of a modular system is the very input information it is designed to analyse. This means that input systems are necessarily computationally self-reliant and are therefore autonomous in nature. To make this point explicit and clear, by an input system being autonomous,
Fodor means that it does not “share horizontal resources (of memory, attention, or whatever) with other cognitive resources” (1983, 37). It depends only on the incoming information and its own self-contained resources for its operation. Autonomy, like domain specificity and hardwiring, allows the functions of a specialised system to be streamlined so as to operate in a quick and efficient manner without being bogged down by considerations from other (higher) cognitive areas. For Fodor, this autonomy is also a necessary prerequisite for the automation of these functional tasks; autonomy and automation take the ‘thinking’ out of *mane* perception and make the operation of the input system mandatory. This allows the input systems to perform as quickly and easily as a reflex (1983, 64). Hardwiring allows Fodor a basis for his claim that input systems operate in a fixed, rigid, and inflexible manner physiologically isolated from other cognitive systems. As autonomous – isolated – systems, input systems do not depend in any important way upon other cognitive systems – especially attention – for their operation; this enables the entirety of an input systems’ activity to be automatic. Therefore, not only the operation, but the activation, and the manner in which input systems operate are ‘mandatory’ and insensitive to higher-level control. Once a perceptual module detects its requisite sensory input domain, its operation is unavoidable and unalterable (Fodor 1983, 53). This provides Fodor with a few easy leaps from the restricted connections of hardwiring, to autonomy of input systems, to their automation, to mandatory operational character, and finally to informational encapsulation (1983, 98).

(5) *Completeness.* Fodor holds that not only is the development of an input system innately specified, the input system also unfolds and matures as a
whole unit. Input systems are developmentally unassembled; that is, their
cognitive architecture is not constructed or built up from other more basic
cognitive components by learning or by any other constructive method (1983,
37). Fodor credits this completeness to the endogenous specification that directs
the module to unfold according to plan (1983, 35), as well as to hardwiring.
Modules are not 'assembled' because an input system's "virtual architecture
map[s] relatively directly onto its neural implementation" (37). This connection
between developmental completeness to the identity of computational structure
and physical realisation may not be immediately apparent to most readers, since
the physical maturation of the brain itself depends on the constitutive process of
connection-making between neural components. Fodor surely does not mean
that we are born with fully developed input systems since he has already stated
that they develop in an innately specified manner. His intention, instead, is that
any neural connections added to existing input systems during childhood growth
will be minor additions that do not constitute either genuine processing sub-units
or significant doxastic neural structures. If the modular perceptual functions
completely take up the sensory areas to which their functions are localised, and
there are no functional connections existent or added during growth between
these sensory areas and those that subserve the higher cognitive functions
(wherever those may be), then the neural structures and their associated
computational processes can be considered to come 'complete', unassembled by
learning, and merely grow in capacity rather than compositional complexity.\(^{21}\)

\(^{21}\) I should remind the reader that Fodor is not a believer in the view that all individuals'
developmental environments contain the same features necessary for an incomplete module to
(6) **Informational encapsulation.** The hardwired segregation of an input system from other cognitive systems and the mandatory character of its operation lay the groundwork for Fodor's most important and characteristic of modularity, a property he considers to be "the essence of [an input system's] modularity" (1983, 71). To be an input system, a cognitive system must have the property of informational encapsulation, meaning that the module only has access to a certain range of information (templates for visual, auditory, or lingual comparison for example) to perform its internal computations, and all other information – including much of what one knows – is cut off from the module's operations (Fodor 1983, 70). The range of this accessible information is presumably dictated by hardwiring and endogenous specification; Fodor provides no definitive formula to determine the accessible information for any particular module except to say that a module may make use of a segregated quantity of information located in the horizontal 'central' memory stores in order to perform its tasks (1983, 64-65; 70-72), or it may operate entirely in exclusion of such information (66). However, the important point to note is that its access to information – particularly higher-level conceptual information – is restricted and non-comprehensive, unlike the higher-level central systems.

A consequence of encapsulation is that the internal processes of input systems are insulated from any influence by mainstage cognitive systems. This is more than the claim that a perceptual module is autonomous and independent
develop in the same manner. In a variable developmental environment, elements like completeness, hardwiring, and endogenous specification guarantee to Fodor that – barring genetic anomaly or physical ailment – all human perceivers will end up with roughly the same compliment of perceptual modules.
of input from other cognitive systems in development or operation. Since an input system's internal operations – the inferences, assumptions, representations, and hypotheses that make up its theoretical or 'informational' components – are insensitive by design to most if not all information contained in the mainstage cognitive systems that subserve one's main body of theoretical knowledge and beliefs, one cannot alter one's sensory phenomenology by simply changing what one believes (Fodor 1983, 70, 102; 1988, 191). A module's operations will not respond to or change due to any learned information, nor can an individual wilfully alter the (mandatory) operations of their perceptual modules (and by extension, the character of their sensory phenomenology). I say insensitive by design to the majority of background information because informational encapsulation buys the perceptual modules speed and efficiency (Fodor 1983, 71), as well as the consistency of content over time. Fodor argues that "Implicit in the trichotomous architecture [of transducers, modules, and central systems] is the isolation of perceptual analysis from certain effects of background belief and set; and, as we shall see, this has implications for both the speed and the objectivity of perceptual integration" (1983, 43). As modular development is also generally uniform across humans due to endogenous specification and completeness, this consistency over time ensures that the theoretical content of the perceptual modules is uniform across humans regardless of our individual cognitive expectations of the forthcoming sensory data. Encapsulation thereby provides Fodor with his empirical justification for the theoretical neutrality of mane perception.

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22 Fodor calls this the "veridicality of perception given that the world doesn't always prove to be
To support this bold claim of informational encapsulation, Fodor presents a number of empirical arguments. One of Fodor's favourite examples is that of the Müller-Lyre arrows (1983; 1984; 1987). In this illusion, one of two parallel lines of identical length always appears longer than its partner depending on which line has the 'arrow tails' at both ends and which has the 'arrow heads' at both ends. It is generally accepted that the illusion is due to some psychological mechanism in the visual system that interprets the inward or outward line ends as indicators of distance or length (Howe and Purves 2005).

![Figure 1: Müller-Lyre arrows](image)

The moral that Fodor takes from this example is that no matter how much one believes or knows that the arrows are, in fact, the same length, the perceptual illusion of differential length persists phenomenologically despite our knowledge that the difference is illusory. A process is either encapsulated or unencapsulated; Fodor often presents the contrast as the difference, respectively, between a process that has clear and definite restrictions on its informational access and a process that is "conservative... [and] uses everything you know" (Fodor 1984, 40). A prototypically unencapsulated process is thus fully penetrated by cognition, meaning that it has unrestricted access to any and the way that we would prefer it to be" (1983, 102), although I hesitate to describe it thus given that even Fodor would agree that perception can be systematically fooled as happens in the Muller-Lyre illusions.
all of one's information. If the module that produced this phenomenological result were not encapsulated, it ought to have access to one's knowledge of the illusion and be able to correct its phenomenological output. That this does not happen, and we seem to be unable to force it to happen shows that the module's operation is fixed and informationally encapsulated.

iii. Central Systems as Mainstage Cognition

Fodor's 'central systems' are what we typically call 'higher-level' cognitive processes. These are all cognitive processes that either make use of or are capable of using all of an individual's knowledge and beliefs to perform their functions, and as such include the traditional 'horizontal' faculties of creativity, imagination, conceptualisation, recall, and other such general (in contrast with domain-specific) cognitive functions. They include the processes responsible for creating new beliefs from observation and revising existing beliefs, and of correcting for illusions during belief-formation by comparing with previous experience – a process Fodor calls the "fixation of perceptual belief" (1983, 102). They have full access to memory, and they are also responsible for making decisions in accordance with our motives and intentions that result in action (Fodor 1983, 103). Conscious and volitional processes fall neatly into the category of 'central systems'. Fodor argues that central systems stand in marked

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23 Fodor's mistake in this, as I shall argue shortly, is that he conflates a number of independent states: 'unrestricted' and 'free' access need not imply unimpeded access or instant informational reconciliation depending on how you carve up the concepts 'unrestricted' and 'free'. Somewhat impeded access also does not imply the impenetrability of encapsulation that Fodor will require to make his case for theoretical neutrality.

24 This is not to say that non-cognitive systems such as reflexes cannot result in action, but rather to say that action-guidance is primarily a function of the 'central systems'.
contrast to the hardwired modular systems in both form and function, since central systems are general in operation and fundamentally neurally non-localised (1983, 119). That they are general and unencapsulated allows them to have easy access to any knowledge one has from experience and that they are non-localised accounts for the difficulty in the neurosciences of understanding the physiological structures responsible for higher-level processes.

As we have seen, Fodor has a number of main reasons for proposing modularity theory’s tripartite division of perception and cognition. There are the intuitive concerns, the epistemic concerns, and the empirical concerns, each of which Fodor takes as evidence for modularity theory and the mainstage cognitive impenetrability of sensory phenomenology. Each of these concerns also has implications for the form that modularity theory takes.

It just seems intuitive that there is something consistent and uniform about perceptual mechanisms across different individuals; this thought is at the root of Fodor’s intuitive and epistemic concerns. After all, the very proposal of invariably detectible first-order sensory properties that began modern empirical science is a product of such an intuition. This consistency is part of our notion of scientific objectivity; unlike subjective impressions, objective observation is unaltered by our individual cognitive biases. Consistency is at the very heart of our ability to communicate effectively with one another. As it is increasingly unlikely that perception is non-inferential, something must explain why scientific consensus is possible at all, and why inferential content does not lead to wildly fluctuating and inconsistent perceptions from wildly variable opinions. If we presuppose theory
neutrality and inferential perception, then Fodor holds that the only solution is a sharp delineation between observations and belief fixation/central systems as we have in modularity theory (1984, 36). If we accept informational encapsulation, this "is tantamount to insisting upon a perception/cognition distinction" (Fodor 1983, 42), and has "implications for both the speed and objectivity of perceptual integration" (43). Not only does modularity provide the empirical basis for separating mane perception and mainstage cognition along traditional lines, but it also explains observational language usage: why some terms such as 'red' intuitively fall into the category of observable while terms like "proton" do not (Fodor 1984, 38). To Fodor, this shows that information about colours lies within the encapsulated boundaries of background information available to the input systems, while information about protons does not and cannot.

I must make two points of clarification at this juncture. First, while Fodor believes that the outputs of the input systems are epistemically special, he also maintains that his approach is non-foundationalist since there is no infallibility in the basic levels of experience. The level of sensory phenomenology "does not correspond to the distinction between what we infallibly know and what we merely justifiably surmise" (Fodor 1983, 88). It is not the job of the modules, but of the central systems to correct, or 'fix', the errors in our mane perception by comparison with past experience. The point of modularity and theory neutrality is not to provide infallible foundational experience, but a common frame of experiential reference – and presumably (Fodor does not explicitly state this) an adequate modicum of perceptual veracity – necessary for scientific consensus (41-42).
Second, modularity and encapsulation may be thought of in two ways: as a theory of phenomenology and a theory of informational exchange. Phenomenological content is, in essence, a matter of information exchange – phenomenal content from input systems is segregated from outputs of central systems because encapsulation prevents information from central systems from influencing the processing of input systems. In much of this thesis, I will speak in terms of phenomenology; this is because Fodor often describes his model in phenomenological terms: physiological and computational transducers output pre-phenomenological information inaccessible to observation, the outputs of perceptual modules consist of a level of ‘basic’ sensory phenomenology which functions as the basis for further analysis, and central systems further process this information that is somehow patched on top of sensory phenomenology. This hierarchical phenomenological picture is mostly consistent throughout his writings on modularity and I have adopted it for the purposes of analysing modularity. However, it is important to note that Fodor refers to informational encapsulation as the hallmark of modularity; routes of information flow that are privileged or restricted are the basis of many of his arguments for modularity. We will return near the end of this thesis to discuss perception and cognition in terms of information flow, at which point we will see that this phenomenological hierarchy may not be the best model of perception to handle the evidence at hand. The separation of observation in terms of sensory phenomenology from the processing of mainstage cognition may turn out to be increasingly artificial and arbitrary. We will discuss this issue in more depth at a later point.
Fodor’s empirical motivations for modularity primarily center on evidence for implasticity in sensory phenomenology and in other cases where background knowledge fails to penetrate *mane* perception. As long as there is any impenetrable or inflexible sensory phenomenology, Fodor believes that this constitutes evidence for an informationally encapsulated module in action. We have already seen one example of encapsulation in persistent optical illusions such as the Müller-Lyre illusion. Fodor’s other empirical motivations for modularity theory stem from the apparently non-intuitive implications of cognitively penetrable *mane* perception. To Fodor, the alternative to encapsulation is the type of excessive theory-relativity that the New Look proposed, where an unencapsulated system has full continuity with mainstage cognition and is comprehensively penetrated by all beliefs and background knowledge. Fodor argues that in this type of system, a visual or language system would have a very hard time dealing with unusual stimuli; “a New Look parser tends to hear just what it expects to hear... [however] Background beliefs, and the expectations that they engender, from time to time prove *not to be true*” (1984, 38). If one’s higher-level expectations of objects or events were allowed to influence the course of *mane* perception, those perceptual processes would be confounded by or may flat-out ignore atypical sensory stimulations – a result that might prove fatal were it to conceal warnings of impending danger (1983, 70).

Fodor is careful to acknowledge that while encapsulation prevents synchronic mainstage cognitive penetration of modular functions, there is a real possibility that there may be *diachronic* penetration of input systems. That is, although there may not be any instantaneous or short-term influence of
mainstage cognition and background information across encapsulated boundaries, some aspects of modular functions may be sensitive to higher-level influence over long periods of time. Even the information available to the encapsulated modules may have to be learned, especially in the case of language; to claim that “all the background information that is accessible to modular perceptual systems is endogenously specified... is viewed as implausible even by mad dog nativists like [Fodor]” (1984, 39). However, Fodor maintains that the empirical evidence simply is not available or adequate to draw significant conclusions concerning theoretical neutrality. As long as our perceptual systems turn out to be largely diachronically encapsulated, Fodor asserts that there will be enough consistency between the perceptual systems of individuals for theoretical neutrality and thus, scientific consensus (1988, 192-193).
PART III: PICKING UP THE TRAIL TO A MIDDLE GROUND

Before I go on to address newer empirical studies, I'd like to see how far Fodor's picture of modularity covered thus far actually gets us. In this section, I will raise some prima facie objections to modularity theory as described and open up some room for doubt to suggest that modularity is not the only possible interpretation for at least some of the evidence at hand.

Fodor is keenly aware that the fate of modularity theory is at the mercy of future experimental results. In response to contrary empirical evidence, he is often forced to weaken the force of his assertions and dilute his theory so as to be as open as possible to new data. At the outset, he states that all of his arguments for modularity may apply in different cases to different degrees; by saying that a system is modular, Fodor does not intend this as a categorical statement but rather that the system is modular "to some interesting extent" (1983, 37). Unfortunately, this and other similar statements leave his theoretical commitments open to the charge of being vacuous as he tries to present both strong and minimalist positions on a number of his core criteria for modularity. While I'd like to also explore the contrary evidence to which Fodor provides weaker versions of his thesis, I think it is more revealing at this juncture to address the concessions he is willing to make. What exacerbates this potential problem is that at times, the strong versions of his modularity criteria are

25 Although trying to lay out criteria for input systems as a natural kind, he also makes it clear that he does not believe in definitions for theoretical terms. "I am not, in any strict sense, in the business of 'defining my terms,'" Fodor proclaims (1983, 37). Fodor may or may not be correct about theoretical terms having definitions, but it certainly makes pinning down his theoretical commitments a far more difficult task.
necessary if his theory is to be able to affirm a truly robust conception of theoretical neutrality\textsuperscript{26}.

The results of concessions to potentially contrary evidence are most clearly apparent when we examine informational encapsulation. Fodor continually asserts that encapsulation is central to the entire concept of modularity. However, he is somewhat inconsistent with regards to the extent to which encapsulation is present in different modules and the strength of informational access restriction. This implies that the level of encapsulation in any given module may vary with respect to its individual function, perhaps even to the extent of being nonexistent.

At some points, Fodor seems to argue the strong thesis that this encapsulation is universal to modules and total or near total with respect to higher-level informational penetration. At other times – such as when considering the possibility of higher-level informational feedback into an input system's computations – he provides a minimalist approach with the weak thesis that “at least some input analyzers are encapsulated with respect to at least some sorts of feedback” (67)\textsuperscript{27}. However, such a weak conception of encapsulation absolutely cannot be the case if Fodor is to maintain that encapsulation is at the very core of modularity. If encapsulation is fundamental to modularity, then all

\textsuperscript{26} Of course, this charge is only as effective insofar as the contrary evidence turns out to genuinely militate against the strong conceptions of the modularity thesis. If the contrary evidence is specious then no doubt Fodor would prefer modularity to explain as much as possible about the operation of the mind.

\textsuperscript{27} If there turn out to be some such things as input analyzers, I would have no problem accepting that some of these employ some means of restricting their informational access such that their access is not system-wide. As I shall later argue, this does not determine the argument as to whether sensory phenomenology as a whole is impenetrable to higher-level cognition, nor does it necessarily guarantee theory-neutrality for sensory phenomenology.
input systems must have encapsulation, and they ought to always have it in a manner essential to their individual primary functional roles. It is insubstantial to claim that encapsulation is satisfied by any minor restriction or a missing pathway of information flow, even if this weak encapsulation is universal or widespread among modules. Even Fodor’s paradigmatically non-modular and unencapsulated central cognitive systems do not have access to initial receptor outputs or pre-computational transducer outputs. Fodor can only claim that sensory phenomenology is impenetrable to mainstage cognition – and so, consistent and theory-neutral – when informational restriction prevents all contact between the internal contents of perceptual modules and higher-level information that is sensitive to learning. Indeed, Fodor only intends this weak thesis as a “first blush” (1983, 67) attempt to establish the beginnings of encapsulation, but we must be careful to establish that he may not fall back upon this weak thesis if evidence contradicts the strong one.

Let us look at the relation between encapsulation and autonomy. Fodor wants to argue that sensory phenomenology as a whole is resistant to theory penetration. However, when this strong argument is contradicted by empirical data he falls back upon the weaker assertion that sensory phenomenology is only mostly encapsulated. The strong argument requires that the module contains all of the theoretical content upon which it relies (in the active sense of preventing informational seepage as well as the passive sense of having such content within); otherwise, it would then have access to a horizontal resource – information in central memory stores – something strictly prohibited by autonomy.
Autonomy is threatened by access to horizontal resources, whether that informational access is partially restricted or freely roaming. However, even Fodor must admit that language resources cannot be totally self-contained (from innate specification) or else we would each be born already programmed with a full grasp of language (1984, 39). In response, Fodor is forced to reject this strong conception of encapsulation and to alter and disown this original stance on autonomy. The condition of autonomy must be weakened, therefore, from complete self-sufficiency to a cap on the level of informational transfer – a ‘constraint on information flow’ – available to any particular module (Fodor 1983, 73). This discards Fodor’s original modular criteria prohibiting the sharing of horizontal processing resources. With autonomy merely a function of informational encapsulation, this places even greater importance on the primacy of encapsulation: if encapsulation is not fundamentally necessary to the primary functioning of all input systems then modules also need not be autonomous. Even as it is, any module that uses horizontal resources (most of the linguistic modules, for instance) can no longer be said to be fully autonomous. With the modules now able to rely upon an external higher-level theoretical resource, encapsulation is no longer a matter of barriers but of sanctions on the specific higher-level theoretical content by which a module may be penetrated.

Fodor’s 1988 exchange with Paul Churchland provides another case where he again weakens the criterion of encapsulation. Churchland had claimed that the capacity of human subjects to re-orient their perceptual phenomenology

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28 By ‘contained’, I mean that the module does not do any ‘exterior contracting’ of resources of other cognitive systems – that everything it relies upon is fundamentally a part of that module and its operation. Again this is, I believe the original intention of autonomy.
when wearing spectacles that vertically invert their visual information constitutes a failure of encapsulation. In response, Fodor retorts that this is not a case that threatens modularity, but merely shows that there are modular mechanisms of sensory recalibration that can respond to changing stimuli. It is therefore compatible with encapsulation that one would “find specific perceptual plasticity pretty much where you’d expect to find it on specific ecological grounds” (1988, 193). However, since Fodor has already stated that functions that depend on use are unencapsulated central processes (1983, 102), and these mechanisms of sensory recalibration depend upon use for their functioning, Fodor has here agreed to even greater amounts of higher-level penetration in perception than he had previously. This in effect also concedes the case for inflexibility of modular function by allowing there to be plasticity anywhere it might be useful while concurrently conceding the case for diachronic penetrability.

In response to Churchland, Fodor finally retreats to a position that encapsulation is only violated if one finds plasticity where one would not find it immediately useful, i.e., “that you also find perceptual plasticity where you wouldn’t expect it on specific ecological grounds” (1988, 194). He then points to the inability of our knowledge of physics to alter the content of what we see, to make us ‘see’ atoms and forces rather than objects and effects (Fodor 1988, 194). This statement is tantamount to his position that for encapsulation to not be the case, a cognitive system must have access to any and all information that the subject holds and that the mere presence of any restriction or inaccessibility qualifies as encapsulation. Unfortunately, this position weakens encapsulation even further and seems to beg the question against theory penetration. Even
mainstage cognition is limited by the efficiency of memory recall, and mainstage 'central' cognitive processes certainly do not always have access to all information within the system, as in transducer outputs or when one holds conflicting or inconsistent beliefs. The question instead, is whether physics may somehow penetrate perception in the first place; the jury is still out on the very matter of theory-penetration of technical information. To use intuitions that physics does not penetrate to perception as the very evidence that perception is encapsulated and cannot be penetrated by theory is to argue from circular reasoning.

Although not all of Fodor's characteristics of modularity are necessarily reduced like autonomy to aspects of informational encapsulation, the import of modularity on theory neutrality clearly necessitates a rich theory of encapsulation. Endogenous specification cannot produce all information within the encapsulated limits of modular access and since genetic programming cannot know what specific information will fill the central stores, it can only guide a module's access to information in those stores. Endogenous specification's significance to whether a module is penetrable to mainstage cognition is thus limited to skewing encapsulated informational access favourably towards general types of information rather than specific data points. Hardwired, domain specialised processors may help ground the idea that privileged or restricted information is enshrined on a physiological level, but if some encapsulated modules can share informational stores with horizontal central processes, then this also detracts from the encapsulation-supporting argument that input systems and central systems
are fundamentally segregated by hardwiring. As far as completeness, there is no genuine completeness as long as some component of encapsulated informational access requires learned information. This will be the case with almost all language processors that require central storage language access, and since language modules are meant to reflect other perceptual modules we can assume that other modules may be similar in their dependence upon learning.

Even when one ignores Fodor’s ‘first blush’ at the prevalence of encapsulation and takes as Fodor’s position, that there is some encapsulation fundamentally involved in all input systems, Fodor still requires a clear account to explain the varying degrees of encapsulation (as restricted informational access) available to different individual modules, especially with encapsulation as vital to modularity as it is. Let us look at the picture so far.

As we recall, Fodor claims that the degree of informational encapsulation in any particular module may vary: some input systems may have total encapsulation in which their functions are computed completely in isolation from all centrally stored background information (Fodor 1983, 66), while other input systems may rely upon tightly restricted and endogenously specified access to information in those central stores (64-65; 70-71; 72). It is exceedingly unlikely that all inputs are totally encapsulated for exactly the same reasons that make it

Furthermore, if it turns out that the centrally located higher-level information to which they have access may be altered synchronically, one really cannot call them genuinely encapsulated. We will revisit this point at a later juncture.

It is important for us to keep it clear that Fodor does not intend that encapsulation may be so open so as to include synchronically alterable higher-level resources. Even in the case where a module’s informational access includes some piece of information – about language, perhaps – that may be synchronically altered, this case would not be representative of perceptual modules in general, and the module is penetrated only because it is so designed. It would not be penetrated by higher-level cognition, for example, by one willing that its output be altered, but only because the specific information it operates on has altered.
implausible that a language could be fully pre-programmed. On the other hand, the Müller-Lyre illusion would not be as illuminating for Fodor if that type of thorough encapsulation were not presumed to be representative for all input systems. What is more, encapsulation cannot just be any restriction or reduction in informational access, as this in itself does not in any way necessitate modularity as Fodor intends. Even a primarily isotropic system may have safeguards here or there without any of the other main characteristics Fodor lists for modularity. The restriction must be vital, comprehensive, and central to the module in question; it must necessarily exclude at least all higher-level information that may be synchronically altered by higher-level processes. Only then may it maintain the impenetrability of sensory phenomenology and begin to ground theoretical neutrality. However, Fodor gives no such formula to explain the variation in degrees of encapsulation across input systems. Without thorough criteria by which the degree of the fundamental property of modularity may be gauged in any particular module, the danger is that modularity theory may explain too much. Encapsulation really cannot merely be any restriction of information, as this would allow Fodor to claim an ad hoc encapsulation pretty much wherever he sees it in the data.

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31 At this point, one begins to wonder how much conclusions about the purported language modules can apply to sensory-perceptual ones, and the level of centrally stored information to which the non-linguistic perceptual modules really have access.

32 Just as interesting is the fact that Fodor states that Central Systems, like modules, may vary in their degree of unencapsulation or conversely, of modularity (1983, 111). This adds credence to the idea that central systems and the mechanisms that subserve primary phenomenology may not be quite as separable into Fodor’s trichotomous architecture as he would like. If encapsulation or free access may vary by degrees, then these systems may be more similar than modularity theory gives them credit for.
While I grant that Fodor is only providing the beginnings of a theory with modularity, there are many more key aspects of encapsulation that are lacking of explanation. Fodor requires an account of how endogenous specification pre-determines the level of encapsulated access to central systems, and how this does not qualify as the module's higher-level resources being 'assembled'. If encapsulation involves restricted access of modules to central stores, Fodor also needs to show us how encapsulation of a central resource is accomplished, if the access of central systems to the same general resource is concurrently free or 'isotropic'. This is to be distinguished from cases where the theoretical content of a module is actually contained within the module and not part of a horizontally shared central store. Finally, the very idea of initially general, universal, and modular linguistic mechanisms that are later adapted for idiosyncratic use in different languages – this intuitively seems best suited to a fundamentally unencapsulated learning process, an intuition that conflicts with Fodor's criteria of completeness. It is doubtful that such elaboration and development of the modules would not be dependent somehow upon use and practice over time, and Fodor states that at the very least language production (i.e., use) as opposed to its processing and comprehension is a horizontal and non-domain-specific process (1983, 102). Even Fodor is forced to accept the ontological possibility of diachronic penetration of mane perception by mainstage cognition no matter how adamantly he disavows synchronic penetrability (1983, 82).

I'd like to take a moment to say a short word about theoretical neutrality. We already know that Fodorian perception taken as a whole is not theory-neutral as it includes not only Fodor's modules but also central mechanisms of belief
fixation. By the same token, phenomenology in toto is also not theory-neutral. Fodor would agree with the lack of theory-neutrality in both cases. Instead, he aims to show that (that which I have called) sensory phenomenology is theory-neutral, or if not that, at least some significant proportion of sensory phenomenology is theory-neutral enough to allow us the requisite basic shared experience upon which to communicate. I have no real problem with the second weaker conception of theory-neutrality except to state with Paul Churchland that I do not believe this can truly be called theory-neutrality. Certainly, one cannot make the claim that mane perception is theory-neutral if diachronic penetration can influence even a small portion of sensory phenomenology. If it takes advanced science to sift out the portion of mane perception that is tainted by theory and the portion that remains in common with humanity in general, then this is not theory-neutral perception as originally intended. Even if Fodor is correct in his suspicion that diachronic penetration is illusory (1988, 193), what we would then have is merely universal bias or “universal dogmatism, not an innocent Eden of objectivity and neutrality” (Churchland 1988, 170). The moment a module modifies the information it receives in a consistent manner, our perception favours a particular theory about the external world and biases do not theoretical neutrality make!

To return to modularity theory, we have shown that there are just enough gaps in modularity theory that a similar but possibly parallel theory may answer some of these questions better. Modularity may admit of degrees, but at this point it seems to admit of a few too many degrees. We have pointed out doubts about the extent of hardwiring, of endogenous specification, completeness,
autonomy, and encapsulation in *mane* perception. Modularity is also less cohesive as Fodor would like: the requirements of modularity seem an excessive solution to the concerns of preserving the epistemic value of observation. There is no theoretical reason that domain specific psychological mechanisms must also be encapsulated, inflexible, or hardwired. Hardwiring also does not necessitate strong encapsulation; as we shall see, there is a certain amount of evidence that even hardwiring may change over time in response to changing sensory environments. These points and Fodor’s vacillation over the extents and details of his criteria for modularity both suggest that there could be and likely are a range of other possible psychological mechanisms at play that are not covered by the architectural divisions within modularity theory. To say that *mane* perception is totally modular is to hit the nail with a sledgehammer: overkill. In addressing certain perceptual problems, it leaves other problems in its wake and those problems are what we have so far detected.

What we require in order to satisfy Fodor’s concerns and address gaps in the explanatory picture is a type of cognitive system that need not be fundamentally encapsulated, but is still somewhat stubborn to change in order to preserve experiential commonality for communication. It ought to be a system that acts and reacts quickly and is not caught up in complex processing for regularly occurring processing tasks. It should also be responsive and adaptive to important changes and novel stimuli in the perceptual environment in a manner

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33 What these other factors are will hopefully become clearer later on. Suffice it to say, if there are a range of other phenomena lumped in with modularity, they will have to fulfill somewhat similar functional roles of Fodor’s modules and they ought to address many similar empirical and epistemic concerns to the ones that Fodor seeks to address with modularity theory.
that seems problematic for Fodor's inflexible modules. However, it should react
to these changes in a way that is consistent across all perceivers and that
maintains important connections with stimuli that persist across environments.
We will have to look to the empirical literature to see if such a picture can indeed
be painted from the evidence at hand.
PART IV: FUEL TO THE FIRE, RECENT EMPIRICAL STUDIES

In this section, I would like to present a number of recent empirical trends and consider their impact on modularity. Eventually, this new data will coalesce into a new understanding of cognition and perception. However, before we use these studies for the purpose of theory construction, we will need them to help show aspects of the perceptual system where Fodor’s modularity theory is currently wanting of explanation. We have already introduced some preliminary theoretical arguments that raise doubts about the adequacy of modularity; here we will see some of these doubts – particularly about encapsulation – amplified by the empirical data. As there is much empirical data on relevant areas, my treatment of each study will necessarily be as brief and as general as is possible, focusing more upon the general trends in the findings rather than the details of each study. Most of the studies I present will focus upon the visual and to a lesser degree auditory modalities, as these are the two sensory modalities most examined. Presumably, results from these modalities should transfer to a greater or lesser degree to other modalities.

I will first present data on cross-modal influence where psychological mechanisms that operate in one sensory modality also influence processing that occurs in other modalities. This, I suggest, shows that manifold perceptual functions have greater connectivity than is supported by the rigid encapsulated of modularity theory. Next, I will review evidence that suggests that higher-level functions such as memory can actually influence sensory phenomenology as in the case of colour constancy. Following this, I will present a number of findings
from the neurosciences that suggest that *mane* perceptual functions may be activated in a 'top-down' manner by higher-level processes of memory recall, imagination, and visualisation. Some of this will rely on findings in studies of hallucinations and dream imagery. These types of studies, I believe, will show that not only do higher-level mainstage processes and *mane* perception share processing resources and hardwired links that fly in the face of encapsulation, but that mainstage processes may actually cause false sensory phenomenology in hallucinations and in the more familiar case of dreams. Finally, I will then present data that should fill in some gaps about the ontogeny of some perceptual systems, that will address relatively quick changes in the neural hard wiring and introduce us to the operation of the perceptual systems that resemble modularity, but are in fact induced by learning tasks. With the introduction of this empirical data, we will then have everything we need to propose and enhanced understanding of perception and cognition.

i. Intermodal Effects on Sensory Phenomenology

   The effects of perceptual mechanisms that interact across sensory modalities – whose outputs feed into each other’s analyses – has important consequences for modularity theory. These and other studies blur the boundaries between the modalities and between the encapsulated, simple, and inflexible input systems of modularity theory. For one thing, perceptual information for each sensory modality is processed within largely dedicated lobes of the cerebral cortex; the processors for different modalities should be the very archetype for encapsulated and hardwired collections of psychological
mechanisms. However, there is mounting evidence for inter-modal processing influence. In one recent study, Ro et al found that visual cues could induce illusory tactile sensations (2004). Ro et al presented their subjects with a visual cue via a mirror that contradicted both the subject’s tactile evidence and knowledge: in the mirror, a brush appeared to stroke the subject’s left hand, while only the subject’s right hand was stimulated. Subjects were also told that only their right hands were stimulated. Ro et al found that a significant number of the subjects reported that they felt their left hand being stroked by the brush. Surprisingly, Ro et al also found that the subjects had increased tactile sensitivity in their left hand for several minutes afterwards. If we can trust the psychophysical reports, we have a case in which sensory phenomenology of one modality — touch — was altered by information from another modality, vision. Fodor might reply that this experiment only shows encapsulation in action: the subjects’ knowledge that only their right hand was stimulated did not penetrate to their sensory phenomenology. On the other hand, if encapsulation’s purpose is to prevent external information from interfering with the regular functioning of a module, then encapsulation has failed here to perform its proper task. Furthermore, Ro et al repeated the study, this time applying transcranial magnetic stimulation (TMS) interference to the parietal lobe — the lobe typically thought to govern integration of signals from various sensory modalities. The result was that no increased tactile sensitivity accompanied the illusory visual

34 Of course, it is to be expected that we believe what is before our eyes before what we have been told to be true. In the normal course of perceptual life, we rely upon our senses for every waking moment and they are usually quite reliable in allowing us to successfully navigate our world. Encapsulation or otherwise, recently learned knowledge holds less cognitive weight than our normally reliable sensory information, made worse by our natural propensity to conflate pragmatic reliability and genuine veracity.
phenomenology. Ro et al concluded that the multi-sensory parietal lobe enhances the false alarms from vision and modulates the tactile signal for up to 4 minutes after the stimulus. Here, we have an automatic and seemingly complex higher-level effect of vision on a somatosensory phenomenology that involves visual hand-object identification and transposition – an effect that is not prevented but in fact facilitated by hardwired systems.\textsuperscript{35}

In another study, Kayser et al used functional magnetic resonance imaging (fMRI) to detect what they take to be intermodal convergence of information early in the macaque auditory cortex by visual signals (2007). In contrast to Ro et al, Kayser et al showed that not only could intermodal effects occur due to late-stage parietal lobe signals, but that they also occur early on within the specific sensory cortices. Among the numerous test conditions, Kayser et al mapped out the functional areas of the macaque auditory cortices and then imaged macaque subjects subjected to audio only stimuli, visual stimuli only, and combined stimulus conditions. They then repeated the tests under both anaesthetised and alert conditions\textsuperscript{36}. In the visual stimuli only condition, they reported that activation occurred in the auditory cortex, most evidently in the caudal auditory fields. In the combined condition, they detected increased activity in the auditory cortex over the audio stimuli only condition. Furthermore, they confirmed that not only

\textsuperscript{35} Fodor might also argue that multisensory modulation by the parietal cortex is merely an observation of higher-level post-modular processes at work, but if this were so it would be precisely what Fodor denies – a case of higher-level processes penetrating into the perceptual modules, altering sensory phenomenology. Furthermore, this would be in contradiction to Fodor’s belief that higher-level central processes are fundamentally delocalised and isotropic.

\textsuperscript{36} Interestingly enough, they, like other studies report a certain level of difficulty in localization of auditory fields due to variations across individuals. If such variations are widespread, one may speculate that they could be symptoms of learning or of neuroplasticity, or at least detract from the case for endogenously specified hardwired homogeneity between individuals.
were there activation effects, but enhancement or 'modulation' effects much as reported in Ro et al. The anaesthesia conditions were intended to eliminate or at least decrease the effects of attention and higher-level (mainstage) cognition, and the same effects above were found in both anaesthetised and alert conditions. However, since these effects are strongest in the alert condition, Kayser et al conclude that there are higher-level cognitive effects that feed backwards into early sensory processing\(^{37}\). Kayser et al also report that these intermodal or multisensory effects of visual input on the auditory cortex involved not only the enhancement of existing auditory signals, but also the introduction of 'a spatially distinct pattern' (2007, 1830). Finally, Kayser et al report a confirmation of Stein and Meredith's 1993 'principle of inverse effectiveness', that the "effect of multisensory integration is highest when both unisensory stimuli are minimally effective" (Kayser et al 2007, 1831). This means that multisensory integration will be most useful to the perceptual systems when the incoming input is ambiguous or otherwise deficient in quality. Kayser et al presented their subjects with visually and auditory degraded stimuli and found enhanced activation in audiovisual stimuli\(^{38}\).

\(^{37}\) One might even speculate that these higher-level effects may be related to the parietal signals found in the Ro et al study.

\(^{38}\) Kayser et al also mention in passing the increasing evidence for 'feed-forward' neural pathways in connections routing visual information to the auditory cortex from the thalamus, and directly between auditory to visual cortex (2007, 1832-1833). Churchland also cites similar studies in the earlier empirical literature as examples of inter-perceptual and higher-level to early perceptual connectivity (1988, 178), to which Fodor replies that there is no data showing proving the function of these neural structures, so "if there is no cognitive penetration of perception, then at least 'descending pathways' aren't for that" (1988, 194). However, if studies like Kayser et al and Ro et al are correct in showing very late stage enhancement of early stage processing, we might have more evidence that these pathways serve as Churchland believes they do.
Kupers et al reported similar results in their study using transcranial magnetic stimulation (TMS) on the visual cortex to create tactile phenomenology in trained blind subjects (2006). In their study, they trained blind and sighted subjects to perform visual discrimination tasks using a tongue display unit (TDU), which represented the visual information tactilely on the surface of the subject’s tongue. The team found that after a period of training, when the blind subjects’ visual cortices were stimulated with TMS, the subjects reported feeling tactile sensations associated with the TDU use, and that these sensation activations were somatotopically organised. That is, the receptive fields of the activated neurons in the visual cortex were arranged in a corresponding manner to the tactile receptors on the tongue. Normal-sighted subjects reported no tactile sensations from TMS, but rather experienced visual phosphenes (illusory visual experiences of points of light). Kupers et al’s results show what seems to be a genuine case of not only diachronic perceptual plasticity to learning tasks, but neuroplasticity in the underlying hardwiring that allows for visual architecture deprived of visual stimulus to be appropriated by somatosensory use. This radical reconfiguration should not be possible under a strict interpretation of Fodorian modularity theory. Furthermore, Kupers et al suspect that the cross-modal activation observed is a symptom that there were pre-existent neural connections between the somatosensory cortex and the visual cortex that were merely strengthened by the training and the protracted lack of visual stimuli (2006, 13258). We have here another likely case of hardwiring that violates autonomy and encapsulation. That the normal-sighted subjects reported no tactile sensations does not prove that their recently-used visual mechanisms
were impenetrable to change, but merely suggests that these architectural features had been used recently enough – continuing to reinforce their visual use – that they had insufficient impetus to rewire (we will revisit this point in Part V).

The Kupers et al and Kayser et al studies suggest that these effects may occur not only in the parietal lobe, but in the early perceptual processing of the lobes previously thought to be dedicated to specific modalities rather than being involved in sensory integration. Although inferences from psychophysical correlations are still uncertain at best, this strongly suggests that functions that would be modular under Fodor's picture – as opposed to higher-level integration functions – are penetrated by information from other sensory modalities. It also suggests that connectivity in the brain is far more widespread than would be inferred by modularity theory alone.\textsuperscript{39}

ii. Memory Colour & Colour Processing\textsuperscript{40}

Colour constancy is one of the prime examples of a collection of "problem-solving" perceptual processes relying upon assumptions to resolve sensory ambiguities. Through the inferential mechanisms that give us colour constancy, the human perceptual system is able to identify the chromatic surface reflectance properties of objects around us consistently across illuminations. The problem fuelling colour constancy is the near impossibility of settling ambiguities of external objects' original distal surface reflectance profiles solely through the

\textsuperscript{39} It also confirms the intuition that sensory phenomenology is penetrated more so in cases of uncertainty such that a system typically errs on the side of false positives.

\textsuperscript{40} This section is largely excerpted from a previous (unpublished) paper of mine from Fall 2006 titled "The Shifting Colours of Plastic Perception", which is the direct precursor to this current thesis.
reflected wavelengths incident upon our cones and rods. The perceptual system must rely upon assumptions about three-dimensional shapes, specular reflectance, illuminant wavelengths, computational heuristics, and a wide range of other properties in order to arrive at an approximation of the objects' original surface reflectance.

Ewald Hering first suggested colour memory in 1920 in *Grundzüge der Lebre vom Lichtsinn* in his attempt to work out the factors involved in colour constancy processing. Memory colour was a proposed effect wherein the colours of remembered object prototypes could transfer to and influence the perceived colouration of objects identified with these prototypes. Hering dismissed colour memory as a trivial effect at most when taken alongside other mechanisms for colour constancy (Duncker 1939, 258), but two later studies in particular have found significant empirical evidence for this phenomenon.

In 1939, Karl Duncker’s team tested the influence of object shapes upon the colour perception of two images made of the same material. In their primary experiment, they produced two image shapes made from artificial green leaves—one, an uncut artificial leaf and another made from cut artificial leaf fragments glued together to resemble the shape of a donkey. Both shapes were of the same size (for the initial trials) and since both shapes were produced of the same material, they both had the same surface reflectance. Subjects were presented

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41 I will make one short point here to explain my usage of the differing terms 'colour memory' and 'memory colour'. Duncker and other studies typically call this effect of memory influenced colour perception 'colour memory', although I find that this tends to connote both the phenomenon observed here and the capacity of humans to recall hues from memory – a capacity that does not necessarily involve the altering of *mane* perception from memory. Therefore, to pick out the specific case of phenomenology being enhanced or altered by the colours of memory prototypes, when I refer to the phenomenon later on, I will typically speak of it as 'memory colour' or 'memory colouring' rather than 'colour memory'.
with each shape in a repeating sequence under a red illuminant such that, a circle of the same material under the same illuminant would appear grey with the slightest green tinge. In each trial, the subjects reported the object’s perceived colour by comparison with a colour wheel presented to their left under normal illumination.

Just over half of Duncker’s subjects reported a statistically significant increase in the perceived “greenness” (presumably, a hue and saturation determination) of the leaf shape over the green of the donkey shape. An additional two subjects reported the leaf as slightly greener – than the donkey shape, but under the range of significance. The remaining subjects reported no difference. Interestingly, Duncker speculates that for those subjects reporting no difference, cognitive considerations could have played a corrective role in counteracting the phenomenon:

It is interesting that of these ‘negativists,’ one was a painter (a painter is used to abstracting from objective connotations), another was a psychologist who knew the problem and moreover was ‘distinctly uninterested in and poor on colors,’ and the third was a medical student, also more sophisticated than the majority of Ss.

(Duncker 1939, 260).

I shall have more to say about this potential ‘negative’ condition of the experiment at length. Finally, Duncker reports that where there was an observed effect, the leaf was also perceived to be greener than the circular control shape and that neither donkey nor circle were ever perceived as greener than the leaf.

A newer study was conducted in 2006 by Hansen et al to improve upon the Duncker study by providing a measure of perceived hue from memory colour that did not rely upon remembered comparisons between the object and a
separately presented colour scale. For the 2006 study, Hansen et al presented
their subjects with pictures of fruit objects whose hue and saturation in two
isoluminant dimensions of (L-M) and (L+M)-S the subjects could directly control
through a keyboard. In the primary example – an image of a banana – the
subjects were told to adjust the image until the yellow banana appeared an
achromatic grey. The subjects were also asked to adjust an unnaturally coloured
banana image until it appeared a natural yellow. As a control, the subjects
viewed random clouds of colour or uniform spots of light and were asked to
perform the same colour adjustment task.

Hansen et al’s study revealed that in all fruit object cases, all 14 subjects
adjusted the yellow banana image beyond the achromatic grey point (as
determined in reference to the control) and towards the blue colour-opponent
channel of yellow. The effect was statistically significant across all fruit objects,
suggesting that in all cases the memory prototype for the fruit object increased or
maintained the perceived colour of the object even when the image was actually
achromatic. This result is problematic for Fodor. Colour processing would be a
mane perceptual process computed by perceptual modules on Fodor’s account.
It relies upon inferences and assumptions about environmental conditions to
determine the best chromatic representation of the external world; this colour
experience cannot easily be altered synchronically by mainstage cognition simply
by willing it so. However, colour processing also cannot be fully encapsulated, as
we have here a case of memory – a feature of mainstage cognition that depends
fundamentally upon learning – directly influencing the sensory phenomenology of
a mane perceptual process. We will return to this point shortly in more depth.
Another aspect of colour constancy that Bloj et al tested (1999) is the effect of three-dimensional shape interpretation and reflected light on perceived object colour. Bloj et al proposed that the visual system infers the presence and composition of inter-reflected light from its interpretation of an object's three-dimensional shape as well as that of nearby objects. In the same way it discounts light composition from a visible illumination source, the visual system would then discount the inter-reflected light from the apparent surface reflectance of the object to determine the object's original surface reflectance properties.

Bloj et al constructed a card folded in half, painted magenta on one half, white on the other. They then presented the subjects with the card folded in a concave “corner” manner (with fold farther away from the subject than side edges) and asked the subjects to compare the perceived colour of the white side with a set of paint chips to determine perceived colour. The light source was hidden, but as the subjects could see that the card was folded in a concave manner, their visual system was able to determine the presence of inter-reflected light from the magenta side onto the white. In the comparison condition, the subjects viewed exactly the same apparatus through a pseudoscope – an optical device that switches the images coming into each eye with the image of the other eye and thereby tricks stereoscopic vision into inverting the depth of the perceived image. In this condition, the card was perceived as convex “roof” (with the fold closer to the subject than the side edges), eliminating the apparent possibility of inter-reflected light.

Bloj et al found that under the corner condition, the white side was perceived as a desaturated pink rather than magenta. This was presumably
because the visual system discounted the reflected illumination from the magenta side and corrected the colour back to the original white. However, in the pseudoscope roof condition, there was a significant difference in the perceived colour of the white side of the card: in the convex condition, there was no possibility for inter-reflections and the white side of the card was perceived as a saturated magenta. The study thus showed that the perceived colour of objects is highly sensitive to the visual system’s interpretation of three-dimensional shape.

It would seem that the existence of memory colour and shape sensitivity in colour constitute clear cases where the phenomenology of the perceptual system is synchronically sensitive to new beliefs.

In the case of memory colour, the newly acquired belief is one of object identification: “x is a” where x is the stimulus before us and a is the classification of object described by the memory prototype. The act of seeing the stimulus as a leaf or a banana colours the image slightly as colour constancy responds to memory when the spectral content is impoverished, as in the banana image once it has been tuned to achromatic grey, or the red lighting revealing only a slightly green leaf. Both cases show a phenomenological effect on observation that increases the chromatic content anywhere from two to five orders of magnitude above the threshold of discrimination (Duncker 1939, 261; Hanson et al 2006, 1368). Furthermore, while the ‘negative’ condition in the Duncker study – where knowledgeable subjects did not report an effect – has not been rigorously examined (and could be quite difficult to confirm), Duncker suggests that the memory colour effect itself could be penetrable to and therefore subject to
background knowledge about the viewing conditions of the image (1939, 260). If Duncker's observations are correct, then not only can one synchronically increase the chromatic content of our perceptions, but one can also synchronically cancel out the effect in a way we cannot for the Müller-Lyre illusion. As we shall later see, there may also be a diachronic explanation for memory colouring, but the negative condition – if confirmed – shows that there must be at least some synchronic component to memory colour examples that allows background information to cancel out the effect. In a system where perception is totally encapsulated, neither effect suggested by memory colour should be possible\(^42\).

In fact, having attempted to replicate certain aspects of the Hansen et al study myself, I find that at the achromatic point of uncertainty, it seems almost possible to "flex" our phenomenology back and forth a few degrees. I ask myself whether there is any yellow left in the image and begin to wonder whether I am genuinely seeing faint traces of colour in the image; the experience is somewhat like performing very fine adjustments to the signal gain of an old radio. This possibility requires testing (again, it is not entirely clear how such testing might proceed), but it could turn out that the uncertain flexibility of colour perception falls within the same range of colour attenuation that Hansen et al found for the influence of memory colour on perceptual images. If confirmed, it would

\(^42\) Another possible explanation for the memory colour effect observed in the Hansen et al study is that the visual system interprets the achromatic background of the image as a night-time scene, in which colours are naturally chromatically impoverished, and then artificially colours in the banana at the achromatic point in order to compensate for the interpretation of night-time lighting. However, this would still require the visual system to access a memory prototype for the banana (whether from a long-term memory store, from simple priming – made unlikely due to Hansen et al's reverse-colour control condition – or from some other form of memory) in order for it to colour in the banana to the proper hue.
constitute a paradigm case of cognition synchronically and consciously altering perception.

The case of the sensitivity of colour perception to inter-reflections and three-dimensional shape recognition also supports the influence of synchronic perceptual plasticity. It is typically assumed that colour is determined early in processing and shape at a later point, but the results from Bloj et al suggest that here this paradigm may in fact be in the opposite direction (Gegenfurtner 2006, 856). Bloj et al posit that their study shows “a top-down influence of surface recognition on colour perception” (2006, 879, italics mine). Here, we have a case where the visual system’s intuitive understanding of the physics of reflection is synchronically penetrated by a consciously accessible interpretation of an object’s three-dimensional shape and orientation.

At this point, I should remind the reader that whether we consciously will the perception-influencing interpretation or not is unnecessary to synchronic plasticity. All one needs is an example where a new piece of background information – the orientation of the folded card – causes an immediate perceptual change, as in a dramatic alteration of the hue and saturation of the “white” half of the card. Furthermore, the mere act of believing or consciously willing that something is so does not automatically make us perceive it thus. Churchland and Duncker both state that there must be evidence in the sensory stimuli to support this perceptual belief (Churchland 1988, 182; Duncker 1939, 262). In the memory colour tests, the perceived effect is an amplification of the slight green of the leaf through the red illumination, the remembered colour of the prototypical banana, or the recent perception of yellow in the banana image from the
experimental adjustment process\textsuperscript{43}. In the inter-reflection case, the interpretation of three-dimensional shape derives its evidence from the stereoscopy of the incident retinal images. The colour constancy cases do not support Fodor's charge that continuity of cognition and perception implies an utter relativism of perception to belief. What they do support, is the contention that perception is not modularly encapsulated, but plastic to perception in different degrees relative to the utility of such plasticity in settling ambiguities and – in the more inflexible cases – to the amount of experiential support behind the particular perceptual assumptions in question.

iii. Mental Imagery

Mental imagery is a category under which I include ‘self-generated’ phenomenology such as imagination, vivid visualisation, vivid memory recall, hallucinations, and dreams. Most of these functions are paradigmatically mainstage in nature; they draw upon any of accumulated information that an individual possesses and they are subject to voluntary control. While the latter two examples of mental imagery – hallucinations and dreams – are involuntary in nature, there is evidence that they, too, draw upon the individual’s remembered experiences and depend upon other mainstage cognitive resources.

An ever-growing body of empirical evidence from studies into mental imagery suggests that there are neurophysiological links between pathways

\textsuperscript{43} There may be good reasons for why object identification affects colour constancy in this way. Memory colour may help an identified object “pop out” of its surroundings and remain in our attention. It may also aide scene segmentation that we can enhance the perception of recognised objects in order to better identify other objects in the visual field.
involved in higher-level mental imagery and those that facilitate sensory
phenomenology, and that these functions often share physical resources within
the brain (I will provide examples shortly). This sharing of physical resources
constitutes a violation of Fodor’s assertion that higher-level cognitive and lower-
level modular resources are physically encapsulated by hardwiring, especially
when this close link between higher-level and sensory perceptual functions
appears widespread and pervasive. In fact, it is interesting that despite Fodor’s
commitment to functionalist computationalism, he makes comments on
perceptual modules that sound almost as what one would expect from a type-
identity theorist. To review, Fodor believes that a major difference between input
and central systems is that the former is localized and the latter non-localized,
and that their operations are associated with a “fixed neural architecture” (1983,
98). “Neural architecture... is the natural concomitant of informational
encapsulation” and hardwired neural connections in modular systems
concurrently mean encapsulation from other – Central – systems (Fodor 1983,
99). On the subject of autonomy, Fodor also believes right from the outset that
modules do not “share horizontal resources (of memory, attention, or whatever)
with other cognitive resources” and that they are complete (non-assembled),
rather than “having been put together from some stock of more elementary
subprocesses” (1983, 37). Modules are selfish – they do not share of themselves
– and are not the types of systems where we might find internal physiological (nor
functional) systems overlapping with those involved in higher-level mainstage
cognitive processing, even for a selfless equipotent non-localized mainstage
cognition. The further conditions that modules are fast, mandatory, automatic,
hardwired, localized, that they are encapsulated “in the way that reflexes are, but also computational in a way that reflexes are not” (Fodor 1983, 72), and their outputs are informationally shallow (Fodor 1983, 86) all suggest that input systems are quick, dirty, and relatively simple ways of analysing perceptual information. The empirical literature suggests a very different picture of *mane* perception.  

As I have mentioned, empirical studies have found hardwired connections between neural resources which are supposedly module-internal (in a physiological sense) and the neural resources used in operations of mainstage cognitive functions. Furthermore, a growing body of such studies also suggest that imagination and mental imagery in fact share neural processing resources with *mane* perception. The prospect of shared neural resources between mental imagery and perception has received evidential support from numerous functional neuroimaging studies, such as those exploring visual imagery or visuo-spatial relations (Kosslyn et al 1999; Aleman et al 2002; Formisano et al 2002; Aleman et al 2005a, Cui et al 2007, to name a few), vivid recall (Wheeler et al 2000;  

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44 This ‘selfish modules’ picture of input systems is exactly one point which prompts Fodor to weaken his thesis on autonomy to the point of contradiction. Whereas he had previously stated that modules are not assembled from subunits and computationally autonomous (1983, 37), he later admits that empirical evidence otherwise would be a counterexample to autonomy and instead suggests that this is not the type of autonomy he has in mind. Fodor then reinterprets autonomy as ‘restricted access to information’ that is not violated by shared functional resources (72). Encapsulation as restricted information access has very little to do with the existence of module-internal resources shared with mainstage cognition and even less to do with his stance that hardwiring prevents this type of violation of physical encapsulation, or the completeness condition that prohibits processing subunits or external processors from being part of module-internal operations. Seeing as we have informational restrictions throughout cognition – contrary to Fodor, even central systems do not always have access to all information it contains – this altered and reduced criteria for modularity again allows Fodor to see encapsulation pretty much anywhere he wants. There is one interesting consequence of this Fodorian stance on encapsulation, however, that because encapsulation is controlled by endogenous specification, what is informationally restricted should never be capable of becoming unrestricted for Fodorian encapsulation of *mane* perception to be the case. More on this later.
Nyberg et al 2000; Slotnick 2004), and heard and imagined spoken words (Aleman et al 2005b). These studies are alike in that they have found a significant overlap between neural areas of the sensory cortices used in perceptual processing – in many cases, physiologically early areas typically found to be associated with psychologically low-level functions\(^45\) – and neural resources used in mental imagery. The existence of shared physiological resources (and perhaps also of the psychological functions they process) runs contrary to the conditions of autonomy, hardwiring segregation, and completeness that should apply to input systems. However, I should note that even Fodor glosses over hardwiring, autonomy, and completeness and spends little time on these conditions of modularity after their initial introduction. Whether he senses that they are contentious or whether he takes them to be decisively shown, they merely constitute a background to informational encapsulation. The same physical and psychological machinery may be used in processing two sets of data and remain encapsulated as long as one train of processing does not influence the processing of the other. Therefore, the mere sharing of physical resources is not decisive against Fodorian modularity unless this physical overlap also corresponds to a functional overlap: that is, where the demands of 'higher' and 'lower'-level compete for the same computational resources that are both physically processed at the same neural site. The empirical literature is not without examples, too, where mental imagery results in

\(^{45}\) These are functions that would be modular on Fodor's picture. The assumption is that, whether legitimate or not, this reactivation of physiologically 'low-level' resources also constitutes the reactivation of psychologically 'low-level' resources.
the violation of both Fodorian physical encapsulation (hardwiring) and functional encapsulation.

Fodor's modularity does not have a principled explanation for the operation of these types of 'self-generated' or 'internally generated phenomenology'. To account for it, we will have to propose additions to his theory that modularity was never intended to accommodate. These are additions to which I believe Fodor would object, and which will become increasingly implausible until we have an adequate theoretical alternative to replace modularity from the ground up.

**Vivid visualisation & imagination.** Vivid visualisation is a special case of imagination where an individual generates an internal image that is as rich in detail as they can manage. Imagination, unlike the sensory perceptual centres involved in intermodal effects, is a psychological faculty that should be a prime example of horizontal, isotropic, central, and unencapsulated mainstage cognitive processes. We can imagine almost anything we can remember, and we can use remembered experiences to imagine things that we have never encountered in actuality. As such, visual imagery should also be precisely the type of thing that modular hardwiring insulates from the processing of *mane* perception. Certainly, imagination should not be able to bring about the top-down activation of presumably modular perceptual mechanisms.

It turns out – contrary to the hardwiring and informational encapsulation conditions of modularity – that visual imagery is actually an important case where hardwiring and encapsulation are violated. In one particular study, Cui et al
imaged blindfolded subjects with functional magnetic resonance imaging (fMRI) and found that when the subjects performed a vivid visualisation task, they showed activity within the primary visual cortex even though there was no external visual stimulus (2007). Furthermore, the localised activation level – determined from the amount of blood oxygen flow – correlated directly with subjective measures of a subject's subjectively reported vivid visualisation ability measured by standardised questionnaire. The team also reported subjective findings that subjects with higher visualisation ability had greater difficulty identifying colour words in black when these words were presented atop background colours corresponding to the words' meanings. Presumably, they reason, greater visualisation ability causes interference during reading and word recognition that actually hampers the subject's discrimination of the text from the congruently coloured background (Cui et al 2007, 477). The moral of the Cui et al study is twofold: first, higher-level processes such as vivid visualisation share neural processing resources with visual perception – violating Fodor's requirement of hardwired autonomy – and second, that the concurrent use of the same resources for both sensory perception and higher-level visualisation actually interferes with one another⁴⁶. It is this second finding that requires a breakdown in both physical and functional encapsulation.

⁴⁶ Another case which violates both hardwired autonomy and completeness involves faces. O'Craven and Kanwisher report in their own functional neuroimaging study that the fusiform face area (FFA) of the brain – which is specialised for perception and recognition of faces – is also activated during the imagination and visualisation of faces (2000). The FFA has long been thought of as a module as it is both localized and specialized; like language it requires external input to populate its processing inventory but certain features of face recognition are relatively universal. We can draw two inferences from the evidence that FFA is shared by both perception and visualisation. First, if FFA is purely mainstage cognitive (and therefore subsequent to mane perception in Fodor's processing heirarchy), the study is evidence of localization of Fodor's
Cui et al note that their observed effect is actually the opposite of the Stroop effect, in which colour words printed in incongruent colours to the words' meaning cause interference in word identification (2007,477). In Stroop interference, the colouring of the text overrides the semantic content of the text and slows down word identification. In this case, a background colour that matches the meaning of the colour word results in a delay in holistic access to the text information. There are two possible explanations for this effect. First, the background and colour name combination result a 'masking' effect that slows down word identification: the semantic content of the word induces a visual experience that blends the word into the background and makes discrimination difficult. Second, Cui et al suggest that the sharing of physiological resources between vivid visualization and perception causes interference between the competing processing demands for congruent colours that slows down processing. Both possible explanations imply a concurrent mainstage and parallel perceptual activation of the same (presumably modular) functional resources. This causes a functional breakdown in encapsulation that results in a degradation of normal performance. If Cui et al are correct and higher-level purportedly non-localized central processes. Second, if FFA activation is a genuine parallel perceptual process – as is likely from the specialization, hardwiring, automatic and rapid functioning of face recognition – then we have further evidence of a purportedly modular system either being shared with or reactivated by a higher-level processing in absence of external sensory stimulus. This violates modular autonomy and completeness. To make a further point about the violation of functional encapsulation would require a study which demonstrates that the recognition of a visually presented familiar face is disrupted by the visualization of a remembered face. Conversely, if one can show that cognitive strategies enhances face recognition – and perhaps modulates FFA operation under neuroimaging – then we would also have a case where functional encapsulation is violated.

47 The researchers point out that this explanation – if true – could have implications for similar cases in synaesthesia studies in which a similar effect is observed. 48 Cui et al briefly note that their findings have implications for research into memory interference, where greater visualization capability decreases accuracy of veridical recall of witnesses in
considerations can actually interfere with the operation of normal perceptual functions, we have good evidence for synchronic perceptual penetration by higher-level processes.

Taken together with the memory colour study, the results of Cui et al and Hansen et al provide important evidence that colour processing – an important basic element of visual processing is importantly penetrated by mainstage cognition. There is no reason why colour should be privileged over language or spatial processing (or other perceptual functions of similar complexity), so it stands to reason that other perceptual functions may be similarly penetrated.

_Hallucinations._ Hallucinations are typically defined loosely in the psychological community as “any false perception” (Braun et al 2003), or more specifically “perceptions experienced in absence of external stimuli” (Adler 1997). I shall take the latter as a working definition. Hallucinations come in a variety of forms with a likely variety of causes; they can be as complex as illusory objects, figures, and/or voices, or as simple as points of light seen after pressing one’s hands to one’s eyes (Braun et al 2003, 433)\(^49\). They can arise commonly as a result of schizophrenia, after lesions of the brain (Braun et al 2003), in some individuals under hypnosis (Szechtman et al 1998), or in mentally healthy individuals when falling asleep or waking up (Adler 1997). When we view forensic reconstructions (2007, 477). The more vivid the imagined fictions, the greater the possibility of conflation with genuine memory, and the more pressing is the need to take into account the individual visualization capacity of witnesses.

\(^49\) Not all hallucinations are necessarily caused by higher-level cognition; indeed the simpler ones are very likely not. However, the focus of our interest is that some hallucinations – the more complex and vivid ones – are very likely to be the result of the same types of higher-level cognition that were active in the imagination and visualisation studies.
hallucinations in light of Fodorian modularity, we must keep in mind that in a strong conception of modularity, where the physical resources, functional resources, and informational databases of modular systems and mainstage cognition are radically segregated, hallucinations should not occur. The fact that there are many possible causes for hallucinations tells against radical segregation; the fact that there are pathways which allow this to occur should the proper traffic control safeguards be negligent shows that there may be situations when it is beneficial to the system for traffic to flow down these pathways. To make an analogy: a computer will not display a video file on a display monitor unless there is first a cable connecting the two and the information passing through that cable is of the correct formatting to interface with the monitor. For a system as complex as the brain, the more structured the hallucination, the greater the chance that there is more going on than merely physical short-circuiting and missing computational code. What is important for our purposes is that at least one of these causes produces genuine and vivid phenomenology of a type that violates encapsulation; if this cause also involves the activation of 

mane perceptual neural structures, then all the stronger for our case. If this vivid phenomenology is entirely the result of mainstage processes, then we have a curious redundancy of representational capacities between mainstage cognition and mane perception that calls for explanation.

Our criteria for genuine and vivid phenomenology – what I will call 'salient phenomenology' – will be prima facie qualitative indistinguishability from the
typical outputs of *mane* perception\(^{50}\). We have already seen evidence in studies of cross-modal effects that not only are connections between *mane* perceptual processors not encapsulated, but that there actually exist hardwired connections between sensory processors of differing modalities. Vivid visualisation studies indicate that internally generated phenomenology may actually share the same physical and functional processors as *mane* perception. Hallucination studies take these conclusions one step further in suggesting that in certain conditions such as hallucinations (and in the more common case of dreaming), the sensory cortical activations of internally generated higher-level phenomenology\(^{51}\) may actually intensify so as to be more or less subjectively indistinguishable (salient) from *mane* perceptual phenomenology (Bentaleb et al 2002; Braun et al 2003; Stephane et al 2005; Szechtrnan 1997)\(^{52}\).

\(^{50}\) By this, I mean the subjective nature of the phenomenological content, rather than the phenomenological content itself. Braun et al note that in certain 'release' types of vivid and rich hallucination, these hallucinations may be distinguished from sensory perception by being recognized as a scene or an image from memory (2003, 434). Because it is the content itself that allows it to be distinguished, this type of hallucination could also very well qualify as 'salient phenomenology'.

\(^{51}\) I must here note that when I speak of 'internally generated' or 'self generated' phenomenology, or of the 'generation' of phenomenology, that I do not mean to say that there is some screen upon which homunculus central systems watch this phenomenology. To do so would fall into the same trap as I believe Fodor has; I mean only that these are the outputs of some psychological levels which reach conscious availability in some manner similar to the outputs of *mane* perception. Exactly how this conscious availability looks, I'm not sure anyone truly knows at the current stage in our sciences.

\(^{52}\) The articles I will make mention of in this section are primarily neuroimaging studies, but for the interests of simplicity I shall refrain from going into any more detail regarding exact neurophysiological loci of hallucination than is absolutely necessary, as excessive detail will only distract from our goal. Furthermore, likely due to the heterogeneous nature of hallucinations and difficulty in exact localization of specific brain areas such as Wernicke's area and Broca's area (Stephane et al 2006, 399), or perhaps due to variations in the stimulus conditions between studies, individual thought patterns, or other factors, neuroimaging results are unfortunately somewhat inconstant regarding activation locations found. Some studies indicate activation in Broca's area, while others do not, and so forth for a number of other proposed neural loci. To put it simply, I believe these studies do show us cases where phenomenology — that may or may not share the same physical processors as those of *mane* perception — is qualitatively mistaken for sensory phenomenology, that such phenomenology is generally thought to be caused by internal and higher-level processes, and therefore that we have cases of failure of encapsulation.
The greater majority of the proposed causal explanations for hallucinations draw upon one or both of two primary suggestions: either these non-veridical perceptions arise from some manner of misattribution regarding the source of certain types of self-generated mainstage cognitive functions or they arise from some atypical self-generated activation of the sensory cortical lobes which normally process external stimuli. My interpretation of these results will take the form of an inference to the best explanation and do not constitute a deductive refutation of Fodorian modularity or a conclusive support for a particular picture of cognition and perception. If it turns out that the first explanation – that of misattribution – is the case, then we have an example of indistinguishability where mainstage mechanisms are capable of feeding into the production of phenomenology that is qualitatively the same as sensory phenomenology. As stated, this type of redundancy would require explanation whether or not maine perception and mainstage cognition were distinct. If it turns out that hallucinations arise from atypical activation of maine perceptual resources, and it is shown that a hallucinator's mainstage systems have some level of control over the content\textsuperscript{53}, then it is likely that there are genuine pathways of information flow present rather than simply short circuits. In either case, these are grounds that

\textsuperscript{53} Furthermore, unless individual researchers are failing to accurately pinpoint their observed areas of activation, it seems that observed activations (even if not observed in every study) – that under some specific conditions have been shown to occur – are sometimes more telling than unobserved activations, as long as they have been replicated in more than one study. Inconsistently observed activations at least make grounds for the possibility of a hypothesis to be the case given the complexity of the systems involved and an incomplete understanding of their operation, even if such inconsistency is not sufficient to prove the hypothesis. I make a distinction here between the hallucinator’s mainstage systems rather than the hallucinator herself as the locus of control since even mainstage processes are not all voluntary (as in the case of compulsions).
there is not such a radical separation as Fodor would have us believe, and that there may be a purpose for such connections or capacities.

In most of the studies into hallucinations, researchers image the brain of a hallucinating subject through the use of functional magnetic resonance imaging (fMRI), magnetic resonance imaging (MRI), or positron emission tomography (PET), and then observe areas of activation or of differential blood-oxygen flow as compared with non-hallucinating control conditions or subjects. Auditory verbal hallucinations (AVHs) – the illusory hearing of voices – are largely thought to be the result of the failure of some manner of internal monitoring mechanism (known as 'corollary discharge') that results in normally non-pathological internal speech – “thinking in words” (Stephane et al 2006) – being unrecognized and attributed to an external source. I will point out here that internal speech is a mainstage cognitive auditory phenomenon. Braun et al also note that perioral activity (involuntary mouth movements) is often found to occur during some schizophrenic AVHs and they theorise that this may be due to some form of subliminal echolalia (2003, 433), or the occasionally delayed repetition of remembered heard speech, rather than internal speech as was famously proposed by Frith and Fletcher (1995). Studies such as Szechtman et al involving PET scans of hypnotic hallucinators have found a decreased activity in the auditory association cortex when compared to non-hallucinators and an activation in the right rostral anterior cingulate where there is none in the non-

54 Braun et al come to this conclusion as in their studies of lesion-caused auditory hallucinations, factors make it unlikely that these hallucinations arise from the subject’s own motivations, that “the content of the hallucinated speech does not correspond to any apparent emotional or moral obsession of the patient… the speech is often a conversation among several people known to the patient or singing by a person heard previously by the patient, and the speech is often of a person of the opposite sex” (2003, 433).
hallucinators (2006), and that this latter area is active during normal hearing and hallucination but not during commonplace imagination. Szechtman et al then posit that this is a possible locus for the misattribution of internally generated phenomenology, that the activation of this extra area makes the difference between imagination as such and imagination heard as an auditory stimulus.\textsuperscript{55}

Adler et al cites studies implicating other possible neural loci for misattribution of internal speech (1997), such as abnormalities in the language centres of the left hemisphere during hallucination causing auditory deficits in the normal right ear hearing dominance. Stephane et al show that schizophrenic patients demonstrate an unusually strong activation in Wernicke's area – an area of the auditory cortex that, along with Broca's area, is involved in the processing of speech – when the subject experiences auditory verbal hallucinations (AVHs) (2006). In their PET studies of schizophrenic patients with and without AVHs, Stephane et al also found an abnormal reversal of activation in the supplementary motor area (SMA) of hallucinators versus activation patterns in non-hallucinators, where hallucinators showed greater activation in the right over the left SMA (2006, 403). Finally, they connect these results with other studies that found that lesions in SMA may result in alien limb syndrome and conclude

\textsuperscript{55} Interestingly enough, Szechtman et al also report that other studies suggest hallucinators are more likely to actively and vividly fantasize in the course of daily life (2006, 1958). This further reinforces the connection between higher-level internally generated imagination and the phenomenology of hallucination. Furthermore, the study found a far broader activation of the auditory cortex and of other areas for hallucinators during normal non-hallucinatory hearing (Szechtman 2006, 1958). One possible explanation I might suggest for this greater activation – if neuroplasticity turns out to be possible – is that if it is true that certain types of frequent and vivid hallucination co-opt mane perceptual mechanisms, this data may indicate a rewiring of systems for normal hearing to compensate for the drop in available resources.
that SMA abnormality is the locus for the failure of attribution of self-generated functions as in AVHs (404)\textsuperscript{56}.

Studies such as Bentelab et al (2002) and Braun et al (2003) suggest some combination of failure of corollary discharge with an abnormally uninhibited activation of the primary sensory cortices (or other such \textit{mane} perceptual mechanisms) as the source for hallucinations. Bentelab et al studied a schizophrenic patient under fMRI whose AVHs were disrupted by auditory stimulation by loud external speech. Although they found no activation in Broca's area, they found activations in superior temporal gyrus (BA 41) and right middle temporal gyrus (MTG) (112). Furthermore, they found that temporal lobe activity of the hallucinating patient matched activity of healthy individuals listening to external speech, but that when the hallucinatory subject listened to external speech, these areas were then deactivated (114)\textsuperscript{57}. This correspondence of activation demonstrated to the researchers that both phenomena of AVH and external speech in healthy individuals share neural resources. Finally, they found that the left primary auditory cortex (PAC) and right MTG were activated during hallucination, and conclude the possibility that it may be a combination of defective corollary discharge in the left PAC that allows for this release of

\textsuperscript{56} It is perhaps important to note that many of the studies into imagination and perception – specifically those examining auditory stimuli such as Aleman et al's study into perceived and imagined spoken words (2005b) – also reported activation of the SMA in both imagined and perceived conditions.

\textsuperscript{57} A potential and purely speculative explanation for this odd deactivation is that this auditory area is normally used in both external and internal auditory processing, but that in the hallucinating patient, the area has become so hyperactive that external speech processing has been rerouted elsewhere. An alternative explanation is that due to the constant activation, the brain requires fewer resources to use the area for processing external speech and so, the external speech input 'focuses' the activation in this area. It would be interesting to see if external speech can also silence hallucinations in these individuals.
activation (115). A review study by Braun et al of post-lesion single-modality hallucination studies came to a similar conclusion that a failure of dampening of the intensity of internally generated phenomenology results in the phenomenological salience of hallucinations (2003). Braun et al note that in cases such as Charles Bonnet syndrome, it is thought that neural damage early in the perceptual chain removes visual sensory input and that this reduction of “competition with endogenous representation (imagination)... lower[s] the threshold for hallucination” (2003, 434). They add that many post-lesion hallucinations occur during twilight or night time when sensory input is lowered, in further support of this theory. Braun et al also note other auditory hallucination studies that show abnormal pathway activation (436), and conclude that “the most likely mechanism [for auditory hallucinations] is [the] release of inhibition of the auditory cortex by other cortical auditory neural assemblies” (436). In the same way, primary somatosensory and posterior parietal cortex activations are observed during imaging studies of somatic hallucinations (those related to touch) (441). Braun et al observe that single-modality hallucinations in individuals with lesions are “nearly always in the primary sensory pathway of that modality in the brain” (442), and they suggest that such lesions remove inhibitory neurons designed to prevent the greater release of internally-generated phenomenology and other “complex sensory representations, which would be presumably cortical” (443)\(^{58}\), that “in the visual pathway, neurons and neuronal

\(^{58}\) As for cortical representations, we shall return to this a little later. Braun states that “it is well established that cortical cell assemblies (occipital, inferotemporal and parietal) are repositories of fully formed dynamic images and are extraordinarily specialized for this function” (2003, 444).
assemblies specialized for waking vision and for voluntary visual imagination are responsible for the hallucinosis... as well as visual aspects of normal dreams" (444). If this is true, not only are there hardwired connections between mainstage cognition and mane perception, but they share processors and even have their own 'traffic signals' governing their function. Fodor might argue that such a 'traffic signal' is encapsulation in action, but the non-autonomous nature of such systems reduces modularity to a level that I believe, is inconsistent with the original spirit of modularity theory.

In any case, it is important to reiterate that hallucinations appear not to be limited to those with psychological disorders or neural damage. While the empirical literature on hallucinations in healthy individuals is scant, it is common to hear of non-veridical perceptions in everyday life being written off as the result 'overactive imagination'. A recent newswire article discusses the common case of 'phantom vibrations' being felt by users of cellphones (Simon 2007), who sporadically feel vibrations in their pant pockets as of the vibrating notification of an incoming call on their mobile phones and then are surprised to find out they are not even wearing their phones. If the phenomenon were likened to the non-

However, this specialized storing of information – I will argue is in a manner somewhat different from what Fodor has in mind when he speaks of domain specificity.

One may raise the issue that the capacity of processors to multitask – of visual imagination and visual perception to occur concurrently – suggests that even if mainstage and mane perceptual processing occur at the same physiological sites with the same processors, as long as these traffic controllers exist this constitutes encapsulation in action. The pathological nature of most hallucinations would then constitute an atypical and thus irrelevant violation of such encapsulation. However, I would suggest that even if there is the possibility of encapsulation breakdown producing phenomenology conflation, this possibility suggests a suspiciously poorly guarded pathway between mainstage and mane perceptual processing occurring in the same processor. The likely existence of non-pathological hallucinations, as we shall see, suggest that these pathways exist in healthy individuals as well.

I must say, this is a phenomenon that I have personally experienced in the past and it very much feels as if my phone is genuinely receiving a call when in fact it is set to silent, off, or
veridical phenomenology induced by the colour memory experiments, we may infer that this is the operation of a somatosensory system having become accustomed to detecting the cellphone vibration, which misinterprets some borderline or ambiguous sensory stimuli as of originating from a mobile phone’s vibration. We will return to the topic of learned or conditioned sensory detections and reduced sensory criteria for phenomenological representation at the end of this section as I believe this has interesting implications for modularity and learning.

Dreams and lucidity. If dreams have a similar physiological root as hallucinations, then they are even more telling against encapsulation than hallucinations: dreams occur frequently during the normal course of life for humans, and not only in disordered neural systems. Most models of dreaming, as in that of Cicogna and Bosinelli, suggest that dreams result from a mix of activations by lower-level and top-down higher-level mechanisms which draw upon the dreamer’s knowledge, experiences, and memories to generate a unified narrative (2001, 34). A third model – which I will not discuss but only make mention of here – makes an explicit link between the higher release of dopamine as compared to other neurotransmitters observed during both dreaming and in schizophrenic hallucination as a common source for both phenomena.

actually in a different pocket than the apparent source of the phenomenology. There is no question in my mind that this is salient phenomenology whether or not the phenomenology is actually generated by mainstage cognitive processes. At the very least, the fact that we cannot possibly have been born with a module that involves ‘cellphone vibration detection’ shows that any purportedly modular processes generating this phenomenology cannot be endogenously specified, rigid, and encapsulated to learning/training.
(Gottesmann 2006). Each model has its own divergent story to explain the phenomenological salience\(^{61}\) of dream imagery.

However, there is even more disagreement in the dreaming sciences community – mainly between models offered by Hobson et al (2000) and arguments by Mark Solms (2000) – over the neural loci of such dream imagery. Hobson had advocated the ‘activation synthesis model’, which suggests that dream imagery is fundamentally linked to rapid eye movement (REM) sleep and originates from the pontine brain stem mechanisms and disordered neural firings within the cortical regions (Solms 2000, 843). Solms attacks this model and shows in his study that dreaming is not necessarily the result of REM sleep and but can occur during non-REM (NREM) conditions, and also that dreaming may continue even with lesions to the pontine brain stem (845). Furthermore, he argues that in much of the research literature, lesions to the parieto-temporo-occipital (PTO) junction removed dreaming in a subject (846). Finally, Solms notes previous studies in which he showed lesions to the primary sensory cortices - such as lesions to V1 and V2 in the primary visual cortex – did not result in loss of dreaming, while lesions to the visual association cortex (V3) and higher other visual areas such as V4 resulted in loss of associated capacities – as in facial and colour imagery – in both wakefulness and dreaming conditions.

\(^{61}\) At this point, it will be useful if I introduce the terms ‘phenomenological salience’ and ‘salient phenomenology’ to designate any phenomenological contents (sensory or internally-generated) that are of such vividness so as to be indistinguishable from sensory phenomenology to an untrained subject. This is not to say that salient phenomenology from, say, dreaming may not as a whole exhibit distinguishing tendencies from wakeful sensory phenomenology as this is a matter of some debate (Hobson et al 2000), but rather to say that it is of such a nature that we may be “duped into believing we are awake” (Hobson et al 2000, 799).
It is this last point that is interesting for us as – if true – it finds contrarily to imagination studies that at least physiologically, dream (and possibly hallucination) activation of the visual cortices does not become salient phenomenology through activation of the early mechanisms of visual perception. In contrast, it suggests that activation of late processing can indeed result in salient phenomenology, a peculiar feature of the cognitive system if mainstage cognition really has nothing to do with sensory phenomenology. Even in light of this fact, we still see that some purportedly modular functions – such as face recognition and colour processing – are activated during dreaming by higher-level generative processes: Solms takes the identical deficits in dream and wakeful imagery due to V3 lesion as a sign that "visual imagery of dreams is produced by activation during sleep of the same structures that generate complex visual imagery in waking perception" (848). Solms' findings remain compatible with the model of dreaming and hallucination that mechanisms responsible for self-attribution of internally generated phenomenology are inactive, and also partially with the theory that mechanisms inhibiting the level of cortical activation – perhaps not within the primary cortices, but within physiologically higher areas – are rendered inactive during sleep and hallucination. Once again, the fact that

62 Italics mine. Solms also implicates lesions in the anterior thalamus, basal forebrain, anterior cingulate, and mesial frontal cortex in causing "excessively vivid and frequent dreaming, a breakdown of the distinction between dreaming and waking cognition, and other reality-monitoring deficits" (2000, 848) and suggests that these structures may be inhibited during sleep. As a reality-monitoring deficit, it may be interesting to examine whether the left parietal lobe (P3) – responsible for self-awareness – is also affected by such lesions as in the cases of lucid dreaming that we shall see momentarily. Solms also notes that discharging lesions in the medial and anterior temporal cortex may result in both nightmares and "unpleasant hallucinatory experiences during waking life" (848).

63 This is one juncture where the distinction between mainstage cognition/mane perception may not precisely map onto the distinction between physiologically lower or higher perceptual structures.
higher-level internally generated imagery can achieve phenomenological salience can itself be taken as an indication that higher-level and sensory phenomenological processes may not be as distinct as is suggested by modularity theory. Lucid dreaming further distorts this distinction.

Lucid dreaming is a case of especially vivid dreaming where an individual has control her own salient phenomenology – the awareness of being in a dream state comes with an ability to direct events within the dream. This is potentially significant if the dreams – like hallucinations – are the result of internal trains of thought or imagination being amplified during the dream state by a neural release of activation-inhibiting mechanisms. If this is so, then the difference between lucid dreaming and regular dreaming is that in the former, a neural state allows the dreamer to attribute the dream’s underlying train of thought to herself, allowing for imaginative control (and by extension, the phenomenology generated) instead of the dreamer being carried along like the phenomenon of being ‘lost in thought’.

Among the studies into lucid dreaming, Blagrove & Hartnel are typical, showing that lucid dreamers demonstrate a higher level of imaginativeness rating\(^6^4\), a higher need to engage in cognitively demanding activities, a higher level of self-assessed creativity, as well as a greater belief in their own ability to

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\(^{64}\) Blagrove & Hartnell cite Berstein & Belicki (1995-96), who show that individuals who more frequently experience lucid dreams score higher on measures of imaginativeness. This is interesting, as we have already seen how greater vivid visualization ability (imagination) also translates to greater activation of the primary visual cortex during voluntary visualization. This is what we would see if dream imagery and imagination are fundamentally related, as greater control over imagination would translate to greater control over the internally-generated and phenomenologically salient sensory cortex activations during lucid dreaming. We could then conceptualise lucid dreaming as an explicit case of higher-level control over salient phenomenology.
control the conditions of their environment, over non-lucid dreamers on standard tests (2000, 43). Holzinger et al also report that during lucid dreaming, there was increased activity in the parietal regions of the brain of a specific type known as the beta-1 frequency band (13-19Hz), especially in the left parietal lobe (P3), implicated in semantic understanding and self-awareness (2006). Self-awareness, is after all very much the difference in the way of Harry Frankfurt between the first order of thoughts and the meta-level of control over such thoughts\textsuperscript{65} and is also implicated in the hallucination studies as the cause for misattribution of internally generated phenomenology\textsuperscript{66} as external. We might also recall that in the Ro et al studies, the parietal lobe was also implicated in the intermodal transferring of sensory information between sensory cortices, but any conclusions beyond this would be premature and merely speculative.

Whether or not a dream is lucid, one point of general agreement from dream researchers is that dream phenomenology is highly penetrable to mainstage cognition. Hobson et al describes an observation by Pylyshyn (1989) that many features of the dream narrative, imagery, and contents are highly plastic to the dreamer’s goals and beliefs (Hobson et al 2000, 802). Furthermore, the use and training of imagination and visualization can increase the lucidity of dreaming; these observations are likely due to involvement of these higher-level processes in the very act of dreaming (2000, 802). Hobson also notes Pylyshyn’s observation that in “the case of beliefs, the meaning of a dream experience while

\textsuperscript{65} I should note, however, that Frankfurt himself talks of first order desires and second order volitions, which may not be the same as other mere thoughts, as I have put things.

\textsuperscript{66} We shall later see that this concept of ‘generation’ may not be the best way of conceiving of phenomenology. At this point we can extremely liberally stretch ‘generation’ to mean the initial cause that results in the experience, whether by external stimuli or internal mainstage processes.
it is occurring is highly dependent upon the dreamer's personal (and changeable) philosophy of what dreaming is (e.g., a message from a deity, a psychopathomimetic experience, 'travel outside the body,' etc.)" (2000, 802). Dreams would therefore constitute a prime case of salient phenomenology, easily conflated with external sensory phenomenology, that is highly cognitively penetrable.

*The state of the argument so far.* From the research reviewed so far on intermodal connectivity, colour memory, and mental imagery, we can now extract several interim morals for modularity and encapsulation:

(i.) In internally-generated phenomenology, there is an absence of external stimuli supporting that phenomenology. These signals must come from somewhere: our evidence so far suggests that they originate from higher-level mechanisms such as memory and imagination, which appear to share neural and functional mechanisms with some stage in *mane* perception. If this is so, this counts as a failure of hardwired autonomy and informational encapsulation of at least some *mane* perceptual mechanisms. Without hardwired autonomy and completeness, there is no physiological reason that precludes *mane* perceptual processing from penetration by mainstage processes; like software, with the right kind of programming (or mechanism for creating such programming), perceptual processing may be facilitated by mainstage processes as in memory colour.

(ii.) If hallucinations/dreams occur as a result of failure of mechanisms keeping internally generated stimuli distinct from externally generated stimuli (as in misattribution), this shows that the two can be phenomenologically
indistinguishable, especially if they indeed share physiological circuitry. We have reason to believe that these processes function in both internally-generated and in *mane* perception. As it is possible to control the operations of these shared mechanisms in dreaming, this means that it may be possible for such control or influence to exist during wakefulness as is the case in memory colour. This would constitute a failure of encapsulation. Where the phenomenology is indistinguishable and yet circuitry is not shared, we have evidence that suggests that either different systems can generate phenomenology, or that they both output something in the manner of information to which whatever process that facilitates phenomenology is sensitive. This proposal of course, would be unacceptable to Fodor on his original picture of modularity.

(iii.) If hallucinations/dreams occur as the result of failure of mechanisms preventing spreading activation in-cortex (as in the case of release), this also presumes that certain higher-level functions share physiological mechanisms with *mane* perceptual functions and therefore are importantly networked. In this and in (ii.), the existence of lucid dreaming constitutes a case of synchronic penetration of salient phenomenology, paving the way for the possibility that higher-level functions may perform similar functions in aiding wakeful *mane* perceptual processing. Without reflection, we would never know the difference. *Mane* perception turns out to be importantly penetrated by mainstage cognitive systems through its physiology and quite possibly by function.
iv. Plasticity and Top-Down Changes in Early Processing

There is a growing body of literature regarding changes – both synchronic and diachronic – to early sensory processing by task or goal dependent top-down processes. Most of these neuroimaging studies either examine alterations of blood flow during sensory stimulus tasks in the synchronic case or changes over time in the processing regions and receptive fields responsible for a specific type of sensory stimulus in the diachronic case. The former indicates that attention may influence the operation of early sensory processing areas (Shulman et al 1997), while the latter involves neuroplastic adaptation to stimulus conditions by experiential learning\(^67\) (Sigman et al 2006).

Shulman et al gathered data from previous studies they had performed in which they had imaged test subjects under PET scan while the subjects performed higher-order directed sensory discrimination tasks (1997). They reasoned that if these scan sessions should show no change in blood flow to areas of the early sensory perceptual pathways in response to goal-oriented tasks, then this would show early perception (specifically of task-irrelevant areas) to be impenetrable to mainstage cognition. However, if change or ‘modulation’ in the blood flow were observed in these early perceptual processing areas, then we would have physiological evidence of higher-level goal-directed processes affecting lower-level functions in a top-down manner. What they found were modulations increasing blood flow in the early visual cortex areas (BA 17/18)

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\(^{67}\) When I speak of learning here, I will primarily mean non-propositional skill learning or learning by experience. It may turn out that learning as ‘the internalization of propositional knowledge over time’ will have interesting correlations with non-propositional learning – and I strongly believe there will be at least some parallels as far as the internalization and use of propositional knowledge – but that remains to be studied and demonstrated.
gathered around the calcarine sulcus, as well as replicable decreases in blood flow in the auditory areas in response to attention being directed to visual tasks (BA 41/42)\textsuperscript{68}. While they did not observe the decreases in primary somatosensory cortex, they did observe decreases in an 'insular region' they believed could be a somatosensory association area (1997, 193)\textsuperscript{69}. These decreases indicate a "suppression of neural activity in task-irrelevant modalities", as in cortical activity in the auditory cortex during focused visual tasks (Shulman et al 1997, 203), and may be evidence of selective attention in action (193).

Schulman et al also argue that activation differences observed during their studies indicate that not only do tasks alter blood flow in early sensory areas, but this modulation may depend upon "the nature of the analysis demanded by the task, as opposed to a non-specific process" (1997, 202). Altogether, they conclude that their observed results are "not consistent with a model in which the precortical input to task-irrelevant sensory cortical areas is broadly suppressed" (Shulman et al 1997, 205), that top-down effects can cause changes in the early processing of any sensory modality.

One more item of interest should be noted from the Shulman et al study: in one of their experiments, they conducted a visual language practice task in which the PET imaged subject was required to perform a linguistic task in response to

\textsuperscript{68} In their study of scans of vivid visualisers in absence of visual stimuli, BA 17/18 was one of the early visual areas in which Cui et al observed activation (2007); Slotnick et al also implicated higher-level activation of this early visual area during the course of unconscious memory retrieval (2004).

\textsuperscript{69} Especially if higher-level thought involving sensory content shares processors with sensory perceptual input, it may be very hard to observe deactivations of such areas. This may explain random or unexpected activations observed in imaging studies. In this particular case, I suspect they simply could not factor out the somatic sensory stimulation of the PET restraining apparatus from activating the somatosensory cortex.
reading lists of nouns. In this experiment, there were three primary conditions: naïve (in which the subject first sees the noun list and first performs the task), practice (in which the subject repeatedly performs the task with the same noun list), and novel (in which the trained subject performs the task with a new noun list). Shulman et al study note that there is a significant increase in blood flow near or along the calcarine sulcus in the occipital lobe particularly in the practice conditions over the naïve and novel conditions (1997, 197-198), but it is apparent also from their scan images that the coronal activation also observed in the left hemisphere frontal lobe as well as the visual cortex activations are smaller and more localized in the novel (post-practice) conditions over the naïve conditions (199). This apparent change in activation within the visual cortex following practice is particularly interesting, as a recent and important study by Sigman et al found that processing in the visual pathway – particularly in the visual cortex – actually changes and reorganizes after training in response to top-down task-dependent influence (2006).

Sigman et al used whole-brain fMRI to further image the visual pathway and their results suggested that “highly trained stimuli, which prior to training are represented as combinations of basic features, may, as a consequence of training, shift their representation toward earlier, retinotopically mapped cortical areas” upon which decrease of attentional control and the automation of the task are concurrently observed (2006, 2)70. This conclusion indicates that learning

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70 Retinotopic organization occurs in the visual pathway when neurons particularly in the primary visual cortex (V1) are organized and grouped together by the location of their receptive fields of sensitivity on the retina. Sigman et al note that the traditional view of visual processing is that early stages in visual processing are associated with neurons with very small and specific
and a degree of neuroplasticity – the reorganization of neural processing locations – are linked and that processors early in the visual pathway are plastic to and penetrated by task-oriented learning, suggestions that are in direct opposition to the rigid, inflexible, encapsulated view of *mane* perception espoused by Fodor’s modularity theory. Sigman et al imaged their subjects while the subjects performed a shape identification task, picking out a shape from distractors; and the subjects were trained on the task for 3-6 days with imagings before and after the total period of training. Prior to the training, they observed – as with Shulman et al – activations in the occipital cortex and the parietal, prefrontal, and frontal cortices, whereas after training they observed an increase in the early visual areas of the retinotopic cortex (RC) (as in V1) and decreased activations in the higher-level visual areas such as the lateral occipital complex (LO) (2006, 3). Interestingly enough, they also found post-training decreases in activation in the bilateral posterior parietal cortex (PP) and the supplementary motor area (SMA). We might recall that defective activation of the latter area is also implicated in faults in self-attribution and in hallucinations (Stephane et al 2006), suggesting a possible link between the results of automation and the occurrence of hallucinatory perceptions. Sigman et al also confirmed that these modulations of blood flow corresponded with increases in learning; by correlating activation changes with performance, they found RC/V1 activity correlated with

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receptive fields but high retinotopic order detecting simple visual characteristics whereas successively later stages of processing are associated with processing of visual features of higher complexity and neurons with large receptive fields but low retinotopic or stimulus positional order (2006, 1).
better performance, and the opposite for LO (2006, 4)\textsuperscript{71}. They conclude that "visual modules do not have fixed functional properties and enhances the importance of large-scale network changes resulting from learning", as in Gilbert's earlier finding of plasticity after "lesions and to relevant and persistent changes in the visual environment" (Sigman et al 2006, 8)\textsuperscript{72}.

The Sigman et al study indicates that the process of higher-level learning is integrated into the neural circuitry that underlies the processing of \textit{mane} perception, i.e., that these neural components develop in an at least partially exogenously specified manner and in response to environmental conditions. It also indicates that neuroplasticity is an important part of higher-level learning, and that learning is (at the very least) closely associated with the process of the automation of perceptual tasks. Other studies have shown that sensory cortices such as the somatosensory cortex may also reorganize their receptive fields in a neuroplastic manner (Joublin et al 1996), especially in response to prosthetics such as bone-mounted dental aides (Calford 2005). As we saw in the Kupers et al study, sensory cortices chronically deprived of input from their associated

\textsuperscript{71} Furthermore, Sigman et al argue that their results cannot be misinterpreted as indicating the mere perception of their target changing in a bottom-up manner, having performed a second control experiment involving a greater number of scans and trials in which the target stimulus was inconsistently present to factor out this possibility (2006, 7). They conclude that the observed modulations are a result of top-down visual search mechanisms being automated.

\textsuperscript{72} These entrained changes to the early visual pathway may be associated with Slotnick's 'non-conscious memory' activations, as often-used functions become automated with use and activated as necessary "as repetition-related increases in activity -- as opposed to typically observed repetition-priming related decreases in activity" (2004, 217). Combined with Sigman et al's conclusion, repetition-priming related decreases in activity would signal transfers of blood flow away from task-irrelevant areas. Slotnick et al's findings that conscious memory recall -- the "subjective experience of 'remembering' " (2004, 217-218) -- is associated with activation of later visual processing regions also fits with the studies we have seen on complex hallucinations, imagination, and lucid dreaming and 'neural release' theories of these phenomena. Taken together, these findings suggest a significant link between higher-level processing and the production of sensory phenomenology.
modality may be neuroplastically rewired to process input from other modalities after an extended period of training, and that transcranial magnetic stimulation of such neural areas can induce sensations in the trained modality (2006). This supports Sigman et al's contention that neurons in sensory modalities are not necessarily functionally rigid, that their functions are at least partially governed by exogenous and top-down pressures, and that firing of these trained processors may even cause internally generated salient phenomenology.

Still other studies, such as Toni et al (2007), have laid the groundwork for neuroplasticity in the adult brain by showing cases where neurons continue to be formed into adulthood and are integrated into existent mature processing pathways. While it was once widely thought that neuroplasticity exists only in children and that new neurons or neural connections are not produced in adults, research is gradually changing that preconception about the brain. The Toni et al study observed the continuing birth of neurons in the hippocampus of adult mice, that these new neurons integrated fully into synapses of the hippocampus and that they then continued to mature normally (2007, 5). Toni et al also observed that the continuing survival of these new neurons was regulated by activity in the hippocampus and depended upon the synaptic connections they made governing the excitatory input they each received as part of the neural circuitry (2007, 6). The reinforcement of pathways used and the deactivation of ones unused are basic to neural life on both the cortical level of perceptual learning and on the level of the individual neuron. However, while unused single neurons may end up simply pruned away, systems at the cortical level continually have new tasks to learn.
with novel and unfamiliar stimuli to analyse even given the presence of learning-induced deactivations.

This cycling of neurons – particularly the cycling out of unused ones – does not make sense unless the cycling in of new neurons fulfils a purpose greater than maintenance of pre-programmed functions. That is, unless the brain is capable of wiring new and potentially superfluous functions, the deactivation of unused neurons would lead to an accelerated degeneration of the brain.

v. Learning and Perception

Given our working paradigm of learning as entraining73 as non-propositional and by repeated experience – and set amidst the backdrop of automation over time, it is imperative for us to explore some of the consequences and characteristics of this manner of perceptual plasticity. The studies we have covered have opened up the grounds for plasticity in perception and connectivity between purportedly modular processors. However, it seems that there must be something right about the limits of information flow which motivated the encapsulation thesis. Even in clear-cut cases of higher-level learning, particularly visuomotor skill learning, entrained skills are typically narrow and non-transferable between differential contexts unless those contexts are relatively similar74. For example, learning to ride a bicycle (and gaining the balance

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73 As I earlier stated, this does not and is not meant to cover all forms of learning (such as propositional learning). I only mean here to demonstrate the existence of exogenous pressures upon the development of purportedly endogenously specified ‘modular’ systems and particularly upon the *mane* perceptual generation of sensory phenomenology on the modularity account.

74 This detour to behaviour is relevant to our discussion on perception as perceptual discriminations – whether innate or learned, autonomic or mainstage cognitive – are, in a sense, skills and behaviours. If you will forgive the somewhat behaviouristic formulation, skills and
required) does not guarantee a person ease in the skill of ice-skating. Seidler conducted a study where subjects were to perform different motor tasks on joysticks in response to different types of visual stimuli. She found that although there are very specific conditions in which an adult human can learn general visuomotor skills, during the normal course of our lives, we are not always in the cognitive state maximally conducive to generalised skill learning (Seidler 2004). Following a course of adapting to a number of new motor skills in succession, however, these ‘multiple motor learning experiences’ place subjects in a state of enhanced plasticity for a period of time in which they are better able to adapt to new skills (2004, 66). Seidler observed that when subjects were in this state of enhanced generalized learning, the performance of their tasks was more easily disrupted by randomized changes in the stimuli. She proposes that this disruption may better facilitate adaptation of behaviour and learning but that it is detrimental to normal performance of skills once the skill is learned and hence, we are not constantly in a state of maximal adaptivity.

Seidler’s results are consistent with what we have learned from Sigman et al about the automation of learned visual tasks: once we have learned and trained the necessary steps to perform a particular task, successive reinforcement of this task pares down neural resources unnecessary to task performance and the behaviour becomes automated, streamlined, involuntary, behaviours are all capacities of a system to perform an operation in response to certain stimuli. They are all causal connections that are formed to allow us to interact with the world. It is little wonder that logical behaviourists and psychological behaviourists believed they could get such considerable mileage from this idea while ignoring the cognitive substrate that often performs such response actions. Whether stimulus and response, input and output, functionalists are still mining the very same inspirations today. As a result, I will be playing somewhat fast and loose with my terminology in this section around the terms ‘skill’, ‘task-performance’, and ‘behaviour’.

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quick, and somewhat inflexible. The more this behaviour is reinforced and the more eccentric the task, the more this process becomes seemingly encapsulated. However, these are learned tasks and Seidler’s results show that we are also capable of transferring such skills under specific conditions of repeated multi-contextual adaptation, hence when the combination of our goals and our environmental conditions make that a useful capacity to have. If these conclusions transfer to perceptual learning, then it means that our capacities for perceptual discriminations may be expanded over time, and that such learning is integral to the trimming away of perceptual unknowns and cognitive demands. Automation would allow us to make ever greater and more detailed sense of the sensory world in which we live.

vi. Automation Gone Awry

In order to make sense of modular functions as automated learned functions, it will be helpful to explore a case that shows how even an uncontrovertibly mainstage cognitive function may over time and use become automated to such an extent that its functions appear modular. Addictions of habit are one obvious example; certain phobias or aversions built up over time rather than trauma may be another. Both are automatic, inflexible, quick, resistant to voluntary control and thus somewhat cognitively insulated, but both can be overcome over time with the proper training. Even memory strategies may be built up over time to such an extent that they become involuntary and automatic. Parker et al reported a case of what they have termed ‘hypertymestic syndrome’ after examining the case of AJ, a woman whose
memory for exact dates and events operates in a manner that is "non-stop, uncontrollable, and automatic" (2006, 35). What differentiates AJ from other documented cases of superior memory is that AJ does not apply mnemonic strategies in the operation of her memory and in fact has great difficulty in doing so (Parker et al 2006, 36). Her memory appears to be an innate faculty that has been with her since the age of eleven, is not under her conscious control, may be cued by any manner of stimulus and then strung along by "spreading activation" (46) of cognitively salient events in the narrative with other memories in a continuous recollective chain (Parker et al 2006, 39)\textsuperscript{75}, and often involuntarily intrudes upon her conscious waking life. Parker et al also report that AJ’s memories appear to be “vivid, like a running movie and full of emotion” (39)\textsuperscript{76}. AJ has kept a diary of noteworthy events for nearly every day between the ages of 10 and 34, written in a “micrographic” manner into “various forms of scheduling calendars with small entry areas, some just one inch by one inch” (2006, 38). She tells of a traumatic event at the age of eight when the decision of her family to move from the east coast from the west, after which she began documenting and organizing her memories and her past and spending considerable time thinking about the past (37), and that her memory became “clearer” thereafter.

\textsuperscript{75} Parker et al note that this is a characteristic of semantic memory (2006, 39).

\textsuperscript{76} It would be interesting to see whether and to what extent AJ might show evidence of the same automation effects reported by Sigman et al. Parker et al report that AJ has “significant deficits in executive functions involving abstraction, self-generated organization and mental control” (2006, 47), which they attribute to possible prefrontal cortex abnormalities; however, taken in the context of automation, it may be the case that aspects of her memories have been parcelated and made autonomous by a process of automation to the extent where they have been more or less disconnected with her executive control. We have already seen in Cui et al that vivid imagination may actually interfere with memories and with perception; if these three functions are related, it seems likely that a vivid memory can interfere with other higher-level functions that share similar neural resources.
AJ began keeping a diary at age ten and her first awareness of her “detailed memory” occurred at the age of twelve (38). What is important about AJ’s case is Parker et al’s suggestion that AJ’s mental calendar “can be thought of as a mnemonic that has become automatized with extensive use” (2006, 48). That we are not always in generalized learning mode as shown by Seidler, combined with AJ’s continuous and involuntary use of her specific form of memory explains why – although her memory is likely to be at least partially a result of an automated strategy – she cannot consciously transfer this ability to learn information artificially by rote memory or word lists (36, 48). Over time and use, this strategy has become so reinforced, eccentric, specialized, and automated that it has become a more or less ‘modular’ capacity.

We now have everything we need to synthesize these trends in the empirical data into a theory of cognition and perception that fills in the gaps between the capacities available to modularity theory and the numerous mental phenomena that fall outside Fodor’s explanation of input systems and central processors. Studies into intermodal effects, colour memory, and mental imagery have already widened the cracks in Fodor’s encapsulated modules, and studies of skill learning have given us grounds to talk about module-like capacities arising from mainstage cognitive functions. As I have stated, the theoretical approach we take in the next section will attempt to accommodate some of the concerns that lead Fodor to propose the requirements of modularity theory while integrating

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77 I say ‘at least partially’ as Parker et al also state that other members of AJ’s family have also reported having good memories, although “nothing like hers with her phenomenal memory for dates” (2006, 37).
the interconnected reality of cognitive systems as we have seen above. The basic skeletal structure of this theory should already be fairly visible in the research covered; I do not expect to be saying anything fundamentally new, only distilling notions – especially as proposed in Sigman et al – already present in the literature into a collected and coherent form.
PART V: INTEGRATION & IMPLICATIONS

The picture of the cognitive system that has begun to coalesce from our menagerie of empirical examples is one that involves a dynamic array of interactions between mainstage cognition and mane perception and contains both synchronic and diachronic connections between these two levels of cognition. Just as there is a wide variety of complex functions that the brain must process, there are likely to be a variety of psychological mechanisms that accomplish the tasks of perception. These mechanisms operate on a continuum of levels of interaction between the more or less involuntary processes typically thought to be responsible for mane perception and the processes of mainstage cognition that are malleable to beliefs and to voluntary control. At one extreme, there may indeed be Fodorian modules, but if the studies above and their implications are compelling to our fair reader, modules cannot be the final word on mane perception and sensory phenomenology. At the other extreme of perception are the belief-fixating mainstage cognitive processes typically thought to be distinct from sensory phenomenology and also types of mechanisms that effect a certain degree of mainstage cognitive influence over the character of sensory phenomenology. In between, are a range of mechanisms at different stages of involuntary or voluntary operation which bridge the gaps between purely sensory and purely cognitive functions. Some of these would appear to be automated systems, systems which are similar in certain respects to modules but also deeply connected with mainstage cognition.
However, with the level of interconnectivity that now appears to exist within the processing of cognition at large — and by this I include perceptual processes — we are faced with the question of whether cognition and perception are truly two distinct processes. At this point, it becomes more useful to speak of cognitive and perceptual interactions in terms of information flow rather than the generation of phenomenology: if cognition is really one unified and interconnected system, then there are not separate systems of *mane* perception and mainstage cognition that each produce distinct phenomenological outputs (the latter through internally-generated phenomenology). Instead, there are differential subunits of cognition that all concurrently feed *information* into a single perception and these different sources of information are reflected in a unified phenomenology. This will ultimately become the basis for a model of cognition that I will refer to as 'phenomenological unity and holistic perception'.

Holistic perception uses pertinent information from multiple levels of processing, but its operations are also constrained by cognitive obstinacy (what I will later call 'cognitive inertia'), specific evidential criteria, and certain features of the environment. Each level outputs information that is then used to make conclusions about the sensory information and about the environment. This information can sometimes be contradictory or complementary, just as traditional higher-level cognition can contain conflicting or inconsistent beliefs and still be holistic, but need not always be phenomenologically given. When they are given, informational conflicts will appear as non-standard phenomenology (as occur in many optical illusions) and confluences of information may sometimes appear as peculiar or unexpected alterations in perceptual functions (as in
memory colour). The question becomes whether we can make sense of a continuous, unencapsulated picture of cognition that preserves the requisite consistency of observational content in order to allow individuals and scientists to share grounds for communication. I will come back to this issue at length, as its solution will only be clear once we have examined the types of psychological mechanisms that likely exist given our empirical data.

For the time being, I shall use our familiar terms of mainstage cognition and *mane* perception to try to describe some different forms of psychological systems involved in perception and the manners in which they interact, although as we proceed this dichotomy will begin to break down into a single internally networked cognition. In what follows, I will explain the two main types of interaction between different levels of perception that occur in the empirical literature – roughly diachronic and synchronic interactions between mainstage cognition and *mane* perception – by way of the types of cognitive processes I believe to be involved. While I will first present them in the familiar terms of phenomenology that we have used to address Fodorian modularity, I will subsequently reformat these categories in terms of our new informational framework for perception.  

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78 However, I want to make it clear that by continuing to use these terms, by no means do I preclude the existence of perceptual systems that are a mix between these two categories, that I believe would very likely exist if there is indeed a continuum of processes between the modular and the paradigmatically cognitive.
i. Synchronic Mane Perceptual Interactions

The hallucination, dream, imagination, cross-modal studies, and the ‘negative’ condition of the Duncker colour memory study (cancellation of effect by knowledge of conditions) that we have explored all suggest that hard-wired connections exist between those neural systems that govern internally-generated imagery and those representative of the external world. Atypical functioning of these systems can result in involuntary non-veridical sensory phenomenology; this shows us that salient phenomenology need not be externally caused, but rather that the balance of informational resources that become incorporated into salient phenomenology lays on the proximal end of object-observer relation. Furthermore, if these systems make possible salient phenomenology without external stimulation – that is, circuitry already exists that allows internally generated information flow to replicate or mimic the patterns of information flow that occur during mane perception, and that can be tripped as easily as falling asleep or by disabling self-recognition – this also suggests that there is some useful, important, and regularly employed function for salient phenomenology from mainstage processing. As we have seen from the Toni et al study on neuroplasticity or the Sigman et al blood flow modulation results, there are basic neural pressures for paring away or at least minimising the resource-demands of vestigial mechanisms, which suggests that connections that persist typically retain some useful function.

79 For any that have concerns that our perceptions do not necessarily represent the external world in a veridical manner, I am not opposed to the alternative, “those systems representative of our specific relation to the external world” (or something to that effect).
We know that our perceptual constancy mechanisms – such as colour constancy – do not always operate under ideal sensory conditions and require inferences in order to 'fill in the gaps' of our sensory input. This is especially so in cases of ambiguous stimuli, as in dim-light conditions (similar to viewing fruit or other commonly seen objects in the spectrally impoverished conditions of the evening), where higher-level capacities for object identification are most useful in aiding mane perception. Conditions under which the mane perceptual system finds itself information-impoverished require the system to become more receptive to any sources of relevant information it can find; as we have seen, this can occur by transferring or combining information between sensory modalities or by increasing sensitivity of perceptual systems to internally visualised hypotheses. This is a view that Christopher Frith also adopts – he claims that "perceptions are fantasies that coincide with reality [and] if no sensory signals are available, then our brain fills in the missing information" (2007, 135). Frith’s reasons for his position consist of fairly well-known cases, such as where perception fills in the blind spot in one’s visual field or corrects for body motion. However, Frith proposes that hallucinations also function as a cognitive utility for filling in blind spots, as evidenced by the types of errors they may produce:

A striking laboratory experiment is to present people with visual stimuli, such as letters of the alphabet, so rapidly that the sensory signals can only just be detected. If you are strongly expecting to see the letter A, you may sometimes be convinced that you saw this letter when, in fact, the letter B was presented.

Frith 2007, 135

Frith points not only to the 'unreliability' of sensory signals as prima facie support for greater involvement of higher-level cognition in perception, but also to
the advantages of having perception respond to our intentions. This responsiveness would allow us to focus perception where we want, much as we do when we have a conversation in a crowded room (2007, 136).

I like to think of the process through which perception responds to increased internally-generated (mainstage) influence as ‘opening up the information taps’. This is a process that occurs regularly, in the course of our everyday lives, without our even noticing. It allows connectivity between sensory modalities or between what we think of as higher and lower levels of psychological processing to bleed through in certain situations. We need not have Charles Bonnet syndrome for our eyes to play tricks on us at night, especially if we are prone to fearing objects that go bump in the night, i.e., the higher our capacity for vivid imagination or susceptibility to fantasy. Brewer and Lambert also argue this case in a recent article (2001): they examine a number of studies of apparent synchronic penetrability of maine perception by mainstage cognition and conclude that ambiguous, degraded, or overly complex stimuli will lead our mechanisms of sensory phenomenology to incorporate higher-level information. Put simply, in situations where “the stimuli were either ambiguous, degraded, or required a difficult perceptual judgement... weak bottom-up

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80 Fodor may object that hallucination-type cases may constitute mere garden-variety short circuits of modular encapsulation, that they do not pose a threat to modularity because they are simply instances of pathology rather than genuine functions (I am indebted to Kathleen Akins for this objection). To this, I respond that we have good reason to believe – namely in the form of Stein and Meredith’s ‘principle of inverse effectiveness’ as confirmed in Kayser et al (2007) that they serve a genuine function, and that they fit within the larger picture presented herein. This is a picture that accommodates not only hallucinations or dreams but also the types of synchronic interference found in the Cui et al (2007) and the negative colour memory condition from Duncker (1939). In fact, we might revise the principle of inverse effectiveness to read as follows: “When available information from usual sources is impoverished or when demands on perception are heightened, information from other cognitive sources becomes most useful to the system as a whole”. Here, I propose a perceptual system that takes this advice to heart and makes use of holistic sources of information in such situations.
information allowed the top-down influences to have a strong impact on perceptual experience” (Brewer and Lambert 2001, S179)\(^8\).

Memory colouring may be an example of such a synchronic mechanism in action. While I do not rule out the possibility that it occurs due to a diachronic – what I will call an ‘automated’ – association process, in which yellow colour experiences gradually come to be associated with banana shapes (or even some sort of combined effect), it is much more likely that this is a case of synchronic plasticity. As Duncker had noticed in his experiment, the subjects who did not report memory colouring effects consisted of a painter, a psychologist versed in the issue, and a medical student, each of whom had a sophisticated understanding of colour perceptions of visual illusions\(^8\). Therefore, for the effect to occur, the subject “should not know the issue and thereby be led to adopt an unduly critical or abstract attitude” (1939, 262). Foreknowledge of or scepticism about the experimental conditions will often lead the subject to correct for and dispel the memory colouring effect. The influence of attitude\(^8\) on the presence and function of an aspect of phenomenology might be considered the hallmark of a synchronic effect.

\(^8\) One might ask why there should be any roadblocks to informational integration within the perceptual-cognitive system if integration is so helpful. To this question I respond that there is still something important to Fodor’s call to perceptual consistency. If any mere thought or theory could radically change perception we could hardly rely upon perception to negotiate the world. As we shall see, even an integrated system is subject to a certain amount of necessary stubbornness to change, accountability to evidence (as in memory colour), and environmental constancies that keep an individual ‘tracking’ features of the external world.

\(^8\) The sample size in this study is admittedly small, but for the purposes of this discussion, it suggests an important avenue for future testing.

\(^8\) By attitude, I mean either as a relaxed threshold for false positives from memory or imagined hypotheticals (the perception of frightening shadows or illusory colours) or a tightened threshold for such false positives (correcting for such false positives).
Imagine looking about a dimly lit room trying to find a flashlight. You see an indeterminate, roughly spherical blob before you and some level of mainstage cognition advances the hypothesis that this is likely a soccer ball on the ground. Your perceptual system involuntarily takes that hypothesis and places a ‘soccer-ball stamp’ over that indeterminate blob, allowing it to extract more information from the stimuli in support of that hypothesis and to distinguish that blob from the indeterminate blob behind it. From the apparent size, mainstage cognition, at some level or other, develops a hypothesis that the second blob is a set of drawers, a hypothesis that is concurrently supported by background information about the nature and distribution of the room’s contents. This in turn allows the identification of a ‘glint’ of specular reflectance, which is oriented in a manner consistent with a smooth vertical surface, a finding that further confirms the hypothesis. All of this information helps to resolve your perception of the object as a set of drawers. The same process now reoccurs, helping you to find the individual drawer containing the flashlight. The process of hypothesis resolution continues as you open the drawer and search within, only now the identification is aided by the tactile input from your hand rummaging through the drawer’s contents, all until you are able to find the desired flashlight.

Depending upon your individual propensity for vivid visualisation, the degree of immediate evidential support behind the perceptual hypothesis, or perhaps the degree of immediacy behind the need for identification (even a false positive) as related to your level of physiological arousal—fear and adrenaline, as we know, often plays tricks on the mind—this ‘soccer-ball stamp’ may even penetrate through to your ‘sensory’ phenomenology to varying degrees.

This model of hypotheses helping to collapse the perceptual probability space in sensory-impoverished environments should be familiar to proponents of Bayesian models of observation and perception; in fact Frith introduces the Bayesian model of the brain as an introduction to his talk of perception as controlled fantasy (2007, 135). Of course, the hypothesis here occurs at the same time as the brain searches for further information to confirm or disconfirm the hypothesis, so it is difficult to distinguish temporally between the information search, and the hypothesis, and the determination of the conclusion that confirms or disconfirms the hypothesis.
While this process of synchronic ‘opening of information taps’ suggests that mainstage processes and mane perceptual functions are importantly networked, I will not attempt to suggest a physical mechanism for the operation of these information taps. However, the fact that mainstage cognition and mane perception share resources and the fact that the brain has the ability to modulate blood flow as a possible physical correlate of attention may both play some part in this process. A more complete explanation awaits further empirical findings.

ii. Adaptive Automation and Diachronic Perceptual-Cognitive Penetration

The other manner of mane perceptual interaction with mainstage cognition involves the supplementation or alteration of our sensory phenomenology over time. This is what I have been talking of thus far as ‘automated processes’ or ‘automations’, and which I will also refer to more fully as ‘adaptive automations’ for reasons that I will go into shortly. While I realise that all manner of involuntary or autonomic processes may be called ‘automated’, I use the term here to refer to a very specific type of process that begins as a function of or sensitivity to mainstage cognition and gradually becomes streamlined, refined, and made successively more involuntary and autonomous over time.

Automations can begin as either effortful tasks or they may take place with relatively little consciously directed attention\(^8^6\); the automation process can also either occur either over the long-term or happen relatively quickly as

\(^8^6\) I say that they may occur with relatively little consciously directed attention to include psychologically lower-level compensatory mechanisms within the scope of automations. On the other hand, our capacity for multi-tasking may even allow for sustained attention without our realising it and this may well be enough for an automation to occur – whether it is sufficient is an empirical matter.
compensations for changing stimulus conditions to maintain perceptual constancy. In fact, all automations are in some respects compensatory, but they are more accurately described as fundamentally adaptive: adaptation is the basic function of this manner of cognitive-perceptual interaction. Through automations, our cognitive systems reorient in response to continuous or repeated pressures – either to environmental pressures (as in adjusting balance in response to waves on the ocean), to cognitive pressures (as in task-specific functions such as in visual learning), or to some combination of the two (as in motor learning)\textsuperscript{87}.

Relatively fast short-term automations do not necessarily produce long-term neuroplastic changes unless, perhaps, they are routinely repeated. As mentioned, one kind of short-time scale automation is the motion adaptation of vision and balance to the motions of being on the sea, and the accompanying illusory motion perceived upon coming ashore. The longer a person is subjected to real waves, the longer the illusory waves will generally persist once on dry land (although this need not be a direct mirror relation, as the effects of a week on sea usually wear off in a few days). Wapner (Baars 1986, 322) talks explicitly about this type of habituated adaptation to persistent ocean-going motion and the counter-adjustment that occurs upon going ashore as a result of ‘neural habituations’, which roughly map onto what I have herein called adaptive automations. This differs from Wapner’s understanding of habituation. On his view, habituations function together as a context or ‘frame of reference’. On my

\textsuperscript{87} Bike riding requires automation of both cognitive tasks and compensation for the changing perceptual conditions as the bike moves.
view, automations may function relatively independently of one another. A similar effect occurs when watching a scrolling visual stimulus as in a feature film's end credits and then averting one's glance to a stationary scene, upon which one will perceive the stationary scene appearing to 'sink'. On the other hand, the sailor who routinely goes to sea will likely find it easier to adjust to the rolling of the waves than the average landlubber. In this way, the repeated or extended use of similar short-term automations may eventually produce what I call long-term diachronic automation.

Long-term diachronic automations are, I believe, the story behind much of what we call learning, and likely one way in which many of our perceptual capacities may be gradually built up over time by exogenous and mainstage cognitive pressures. Norman suggests that "'Cognitive' behaviour is perhaps

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88 To Wapner, the case described is evidence that the sailor "integrates, as context, the movement of the ship and the water and the like, and when he functions with that as a stable, predictable ground" (1986, 322). Although I do not believe this 'contextualisation' is necessary for automation — and I think even Wapner will agree there — there is no reason why there cannot be an emergent frame of reference of some sort or some way that automations can be informed by other automations or higher-level conditions in some specific manners or conditions. The point of this entire paper has been to show that such penetrations of autonomous systems are theoretically possible under at least some conditions. Indeed, if sailors do get accustomed to changing back and forth between 'sea' conditions and 'land' conditions as Wapner suggests and are able to eventually make the change without persistent effects simply by the higher-level knowledge of the proper context (Baars 1986, 322), then this frame of reference may itself be an automation of the system to changing conditions. Wapner's contexts would then be automations by the consolidation of other automations. However, the fact that this process does not typically happen synchronically suggests that the neural system puts more emphasis on the automation/habituation component of the process than on the higher-level 'context' component.

89 Another note of interest with regards to Wapner's views on perception is that the context is more than merely compensatory: the wave motion that the sailor adjusts for is not simply ignored by his "neural habituation" (Wapner in Baars 1986, 319), or automation as I call it, but continues to be attended to by the system to some degree (320). If the stimulus being automated is complex enough, I see no reason why this cannot be part of the automation process for the same reason that Wapner points out that "habituation cannot be inhibition, because if the system is going to filter by inhibiting, then it's going to need every bit as much information to inhibit with precision, as it would to deal with the information in the first place" (Baars 1986, 320). Automation rather than inhibition might just be more resource-efficient.

90 While I refer primarily to skill learning, I believe it very likely that this is similar to what happens in propositional learning except that the mechanisms and memory stores responsible for
the less skilled behaviour [that] is important for learning or for dangerous situations or acquiring ill-learned concepts" (Baars 1986, 392), a view that fits nicely into our view of the relation between mainstage cognition and automation. It suggests that mainstage cognition is the testing grounds for new types of stimuli, highly variable situations, and perhaps even for those conditions under which we have ambiguous stimuli – conditions that require the most flexibility and are prior to the process of automation of functions into 'skilled' functions.

Automated processes begin as functions that are regularly used, either by voluntary mainstage cognitive tasks or in response to the regular occurrence of an event in the environment. A novel cognitive task – especially a mainstage cognitive task – uses up greater amounts of psychological and physiological resources than a task that has already been entrained91. As this new task's operation becomes more regular – as in the 'practice' condition in the Shulman et al study – the brain devotes other resources to figuring out how best to streamline this operation. Eventually, the process becomes more and more autonomous (and involuntary as a result), quicker, and less resource-intensive as the psychological resources required to accomplish this task are 'emparcelated' or packaged together and made successively more self-sufficient92. Automation

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91 Novel tasks may be more mainstage or more perceptually-based tasks, but even where they are perceptual tasks, a novel function usually requires an effortful voluntary integration of new information that was not previously integrated concurrently with routine perceptual processing. This requires both greater and more extensive psychological and physiological resources than an entrained (or even a 'modular') task.

92 As in the Sigman et al study, one possible mechanism by which this may be accomplished in the visual system could be that it consolidates the minimum physiological resources to
may explain the ease of hallucinatory perceptions, since the emparcelation of the resources that identify the source of a stimulus means that there is less stimulus content and less higher-level analysis required for its representation. This is perhaps what happens in the case of phantom cell-phone vibrations and similar hallucinatory experiences – the expectation of a cell phone vibration at a particular tactile location on the body has become so reinforced that any receptor twinge (say, a vibration of the car in which one is travelling) or perhaps stray neural signal is enough to trigger an automated perceptual identification.

If any of this sounds familiar vis-à-vis Fodor’s arguments in favour of encapsulation and modularity, it should. An automation ought to be able to do pretty much the same things as a Fodorian module. It works rapidly and has both domain specificity and autonomy – as well as being potentially neurally localised in the earlier case of visual learning. Unlike modules, automations do away with the requirements of endogenous specification, completeness, and most importantly, they are not fundamentally encapsulated either cognitively or by hardwiring. Many cognitive and behavioural phenomena such as compulsions, phobias, and non-chemical (habituated) addictions also bear striking similarities in their operation to what Fodor describes as modules, but are not endogenously specified, and – like the automations I describe – often depend upon a combination of external and mainstage cognitive conditions for their ontogenesis.

accomplish this processing function and shuffles it up to the retinotopic cortex for quick and easy operation.

93 All the same, phantom cell phone vibrations may also be a case of our cognitive system’s preference for false positives; the anticipation of an incoming call increases the cognitive information taps such that a stray vibration or sensory signal is visualised and then saliently felt as a genuine vibration.

94 I would not rule out the possibility that a susceptibility to such disorders may not be at least partially genetic and as such, endogenous predispositions.
The phenomena I have just listed are all highly resistant to change, involuntary to some extent, more or less synchronically impermeable to beliefs (irrational), but they may all be altered gradually over time depending upon the level to which the particular phenomenon is entrenched with time and use.

A similar process to the formation of an adaptive automation may occur in the alteration of a previously automated (or a habituated) cognitive task. This alteration occurs when one tries to either change a pre-existing automated process so that it accomplishes its task differently, or when one tries to create a new — more complex — automation whose processing relies on previous automations but whose output supplants the informational outputs of those prior automations. At first, both the existing automation and the cognitive resources dedicated to accomplishing the new task are concurrently active. Great effort, repetition, and reinforcement are then required to automate the new task as its function overlaps with that of the prior automation. An example of this might be cognitive therapies that avert phobias, e.g. exposing an arachnophobic individual to spiders over time. Over time, as the new task is further automated, resources are pruned away from the old circuitry in favour of the new one patched atop it, but perhaps often not entirely: this explains the predisposition of altered

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95 I have a personal example of this type of alteration. When I was a child I had perfect pitch — I could see a note and hear the tone in my head as if played. I later began playing instruments tuned to different keys than my primary instrument (the violin) and the piano to which I had tuned my violin was gradually going flat. The result was that eventually the tones I mentally heard when reading sheet music consistently became a full semitone under what I expected. When I realised this, it took a great deal of cognitive effort to ‘re-train my ear’ to hear the tone I desired. Of course, in simply learning to play the violin I had done the same task of automating and re-automating many times over. This type of process occurred when I learned to play sustained tones with vibrato, and then again when I learned to refine my control over that vibrato so that it would not occur without my intention. As I shall later discuss, this alteration of automations may not always be possible in practice depending upon the degree to which the existing automation has already been ingrained. Ingrained automations, such as occurs when processing Muller-Lyre illusions, may be extremely difficult if not practically impossible to alter.
habituation to relapse. The more a cognitive task is ingrained over time by use, the more resistant this task is to alteration.

Consider again, for example, the Müller –Lyre illusion, consisting of two arrows that appear to be different lengths depending upon whether the arrow tips point inwards or outwards. On one proposed explanation for the Müller –Lyre illusion (Howe and Purves 2005), the visual system regularly employs specific probabilistic strategies to make conclusions about the distal causes of our visual stimuli. Howe and Purves argue that sets of retinal stimulations that contain inwardly pointing arrow tail-like patterns typically coincide with environmental sources that are actually farther apart than in sets of outwardly-pointing arrow point-like patterns. The visual system routinely employs a particular strategy based upon this statistical regularity, but this strategy results in the wrong conclusion – the conclusion that one line is actually longer than the other – when presented with the Müller –Lyre stimuli. If this statistical regularity and the associated probabilistic strategy are learned by the visual system in early infancy, the Müller -Lyre illusion would be a prime example of adaptive automation. The

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96 Howe and Purves argue that the illusory length of the Müller -Lyre arrows is explained by a probabilistic strategy by the visual system due to statistical regularities in visual stimuli of naturalistic images (2005). They propose that this has an evolutionary source, but also note that the same conclusions apply to statistical regularities in images of non-natural manmade environments (Howe and Purves 2005, 1236). While it could be the case that this misinterpretation is an evolutionary – and so, modular – adaptation to visual regularities or it just could as easily be the case that this is an automation of experience in early childhood. Either way, this would be an illusion that is difficult to dispel, depending on regular use or reinforcement. Since the particular mechanism tracks some stable features of the visual image relative to their causes, this mechanism is always in use and therefore difficult to change. By analogy, dispelling this illusion would be like trying to quit smoking while continuing to smoke a pack a day.
automation 'modularizes' a perceptual function by reducing the problem to a manageable heuristic strategy, which is then reinforced by use over time.\(^{97}\)

As we have noted, processes built up or entrenched by automation may be extremely difficult to alter and might easily be confused with naturally inflexible or encapsulated mechanisms. This resistance to change might be better described as a case of 'cognitive inertia'. To illustrate this concept, imagine that a municipal government has decided to start a repository for sand bags upon a particular plot of land. Each year, at least one bag of sand is added to this repository. In some years, the city may have a surplus of sandbags and add a few more. During the first few years, it is relatively easy for the city to relocate the repository, as there are relatively few sand bags there. However, over time and with greater use, the repository becomes loaded with more and more bags of sand, and the weight of the sand bags perhaps makes the dirt below them settle, making them harder to remove. Now, imagine that this repository is built on giant wheels – again, when the repository is new, it is easy to roll the repository to somewhere else or to deconstruct it, but after greater use over time, the mass of the sand bags is such that the sheer impulse needed to overcome the repository's inertia becomes exponentially higher. If the repository were to be moving, it would be very difficult to stop or redirect this motion; if still, it is very difficult to change its location.

\(^{97}\) Even if the processing behind the Müller-Lyre illusion were innate, the issue is still open whether it is diachronically penetrable. Given the right conditions of neuroplasticity and cognitive inertia (a concept we will explore momentarily), I believe it is. If so, it would not be strictly modular in Fodor's sense.
Essentially, the story of the repository is the story of learning and, I would hold, of much of cognition. The act of adding sandbags is the act of adding new information and making new neural connections. The more the repository is used, the greater number of connections or the greater the reinforcement of what exists, and the more the process is entrenched within the system. This explains why, if a particular psychological function is much used, it will be largely resistant to synchronic change. However, the system may still allow for diachronic alteration (as in moving a few sandbags at a time)\(^\text{98}\). Furthermore, the greater the neuroplasticity that an individual's brain retains over time, the less the friction under our cognitive sandbags and the more the system is flexible to change; this, presumably, is one factor that decreases with age. One way in which our metaphor of the sandbag repository is not apt, however, is that it leaves out one key feature of automation, namely that the more frequently a particular psychological mechanism is used, the better it becomes at performing its function. This meshes well with Fodor's ideas that the domain specificity, inflexibility, and encapsulation of modules result in their speed and efficiency of operation. However, nowhere do we need the total encapsulation of sensory phenomenology to accomplish the same cognitive demands. After all, the more a system is able to adapt to changing long-term environmental conditions, the better it fares evolutionarily in new environments.

\(^{98}\) A sandbag repository may be moved by either a sustained sandbag-moving effort over time or it may be moved by a powerful natural cataclysm such as an earthquake. By the same token, it seems likely speculation that an automated cognitive process may be altered by diachronic cognitive pressure, by neurological damage, or even any cognitively traumatic event associated with any of the loose collection of rapid onset psychological disorders that comprise what are colloquially called nervous breakdowns.
An encapsulated system – on the other hand – will remain the same, inflexible, and will die out. In comparison to Fodor's modules, automation allows a cognitive system that is adaptive (responsive to changing conditions) and has both greater growth potential and customisability. Fodor's modules are endogenously (genetically) specified and rigidly fixed, meaning that the capacities and functions that they are capable of filling are predetermined. However, in a cognitive system that creates automations as specializations of originally attentive functions from experience – that is, in which automated functions and attentive functions are etiologically continuous – such a system would be able to tailor its functions on a continuing basis to changing conditions that it is required to process. It would be able to automate specific functions meeting the same requirements as Fodor's modules, be capable of generating new automations from task regularities as they occur, and be able to attenuate or change them as the need arises. This nicely parallels the intuition that learning is a cumulative process, built piece by piece as our growing capacities to understand the world allow us both to see and to ponder ever finer questions.

As we have already seen, this does not mean that automations are necessarily synchronically penetrable to voluntary control, rather it may be the case that should the sustained pressures necessitate change, that such change is possible. Too much flexibility can be just as detrimental to survival as not enough flexibility: we will return to the concern of perceptual relativism shortly. However, it is just as possible that automations may actually develop with synchronic cognitive information taps built in to their operation, the function that is automated includes flexibility, perhaps as is the case in the 'negative condition' of memory colour, where the effect retains sensitivity to the background knowledge of the observer and may be cancelled out.

Norman gives a similar picture of new experience set amidst the backdrop of memory: The concept of the schema is very important because it says that the memory structures are organized into small units of information – that new structures can be built only by analogy to old structures or by addition to old structures. It says that we don't just experience something and build a whole new memory representation.... The concept is very important because, as I said, it argues for a certain kind of structure of the knowledge within memory that is heavily based on experience; it says that once you start developing a particular set of knowledge structures, you're committed to them for the rest.
that reacts in such a way, perceptual and cognitive functional capacities are gradually built up; as more of the processing is automated, ambiguity in sensory stimuli is reduced and pared away in manageable chunks\textsuperscript{101}, we are able to devote our resources to even finer points of scrutiny, to identify and resolve even finer ambiguities, and to bring the external world into increasingly better focus.

These requirements are common to both perception and cognition, and it makes sense that they would be handled in the same way\textsuperscript{102}. In the same manner as ambiguity reduction in synchronic cases, automated processes also work to fill in

\begin{description}
\item[of your life, essentially.] They will color your interpretation of everything, and these interpretations will be very difficult to change. Possible, but difficult. (Norman in Baars 1986, 386)
\end{description}

\textsuperscript{101} An interesting trade-off is that this also makes the detection of false-positives or hallucinations more likely – as more of the resources necessary to generate a percept of any external object in question are em parcelated together and less external stimuli or higher-level processing is required to initiate the percept. If we view this from the perspective of memory, this might help to explain the effects observed in AJ’s hyperthymestic syndrome. In fact, object identification and scene segmentation may be accomplished in the same manner as the automation of visual search tasks: the cognitive resources for identifying a commonly viewed (or commonly looked for) object may be em parcelated and the process automated with time and use. Thereafter, less external stimuli would be required to generate the experience of said object, as its features from memory would be packed along with the automated process to increase cognitive efficiency.

\textsuperscript{102} Norman observes that even higher-level knowledge does not often transfer between domains, that “people who reason flawlessly, apparently effortlessly, with great depth and sophistication about one domain, when they move to a new domain, they’re like children” (Baars 1986, 388); this might be seen as the hallmark of automation in action in making not only automating perceptual functions but also converting higher-level functions into skilled reasoning. With automations, we are continually able to generate new automations as long as we are able to continue learning. This means that we are able to continually enhance our abilities as opposed to modules, which cannot account for continuing internalisation of functions. However, this does not necessarily mean that scientists see electrons. The sensory information underlying increasingly specialized conceptual knowledge is (a) not used as regularly as those underlying our naive physics and (b) perhaps too ambiguous between sources and not constant as other information. Few scientists, I will wager, can see let alone tell the visual difference between a neutrino and a quark without perhaps either a cloud chamber or some pretty sophisticated instrumentation and perhaps calculation. A scientist does not need to establish a connection between her conceptual knowledge and her sensory input except in the areas of detecting the effects of the concepts she is interested in, because for the most part her use of that theory is restricted to the intellectual domain rather than the sensory one. This does not, however, preclude her training some sensory capacity with constant use, as is the case with synchronic perceptual adaptation. However, any university student will know that the process of connecting concepts involved in learning – just like perceptual adaptation – does not necessarily happen instantly and often requires much repetition and reinforcement. This is especially so when one has ‘learned’ something wrong and must rebuild their conceptual schema. Making a conceptual change connected to perception, which itself contains many functions that are constantly being repeated and reinforced, would be that much harder to overcome.
the gaps of our perception with emparcelated mechanisms that formerly would have required greater resources to accomplish\textsuperscript{103}. These automations would no longer require widespread higher-level input, but would have the most basic schema of that higher-level processing packaged together and made autonomous.

Some paradigmatic examples of how automation alters the nature of our perceptions might be the following: the ease with which we come to recognize now familiar faces, an increased capacity to recognize individuals of an unfamiliar ethnicity after prolonged exposure to a different culture, the ability to tell apart individual animals of the same species and similarity, say, one goat from another, or the gradually increasing ability to hear distinct phonemes of a foreign language. In all of these tasks, one might have to rely initially upon conscious cues (e.g. upon the way an individual dresses or walks, or specific features such as hair, eyes, jaw-line), but over time, as our perceptual abilities become automated, we will be able to perform these tasks without recourse to conscious

\textsuperscript{103} One could see this gradual reduction of stimulus ambiguity over time as being similar to the solving of a jigsaw puzzle, and the puzzle image as the outputs of perceptual processing. At first, you start off with a massive jumble of seemingly random pieces of information. By applying strategies, you begin linking certain pieces together in groups – perhaps by edge similarities, or by finding more complex features such as straight edges on pieces that belong at the edges of the puzzle, or even more complex 'higher-level' features such as observing the content of the image printed on the pieces' surfaces. If one knows that flowers are images that occur infrequently on the puzzle image, one might even pick out all the pieces that have flowers printed on them and place them aside and try to fit those together. In solving the puzzle, any relevant information is useful, whether it be details such as edge shapes or 'big-picture' information such as the surface image (or perhaps even the knowledge that the blues in an undersea puzzle will likely get darker the lower one goes in the puzzle). Now, just as perceptual information changes from one moment to the next, imagine that the someone comes over and knocks over the jigsaw puzzle every few moments, but also that your strategies for solving the puzzle are implemented more and more automatically each time – the puzzle will virtually reform itself to its previous state of assembly each time it is knocked over. The ever-growing clusters of joined, 'solved' puzzle-pieces are the outputs of those automated strategies, allowing one to see ever-greater areas of the total image information contained in the puzzle regardless of change over time and apply that information to solving the remaining areas of the jigsaw. The more of the puzzle one solves, the better one is able to focus on the remaining gaps and pieces with effortful, conscious processing.
cues. The cues picked up may even be higher-level without conscious remembering or awareness: the ‘eureka moment’ often experienced by scientists taking a break from a problem suggests that higher-level problem-solving may continue in an automated manner even after the cessation of volitional and attentional control.

When a visual process becomes automated on repeated goal-directed viewing, it requires successively less contribution from both the more integrative ‘mainstage’ types of processing that handle novel types of stimulus and also from the stimulus information itself. The resources required for perceptual determination become streamlined and more autonomous. This process also explains why one might make the leap to think of such mechanisms as encapsulated or modular, even though they start out as fully ‘central’ processes and may retain some link to such systems. A module and an adaptive automation would be qualitatively indistinguishable.

Holistic Perception, Information Transfer, and Unified Phenomenology

Through our new picture of holistic perception, we no longer have multiple sources of mane perceptual and mainstage phenomenology but different sources of information flow that we are aware of in a single perceptual phenomenology. Instead of each component of the perceptual system (both processors within and outside of mane perception) generating its own phenomenology, sense data, or

\[104\] It is likely this is what happens in language mechanisms that learn to skip repeated words in a passage or to tolerate degrees of noise in word recognition. One may not even experience the skipped word or the noise, and will then be surprised upon a more careful re-reading to discover the omission. Automation may also be an alternate or additional reason to existing explanations of why we do not notice gradual changes, as in the gradual yellowing of white painted walls over time. We simply find ourselves carried along by the inertia of our minds.
features of phenomenology, different perceptual processors contribute *information* that serves in producing perceptual determinations. We then become aware of these determinations by whatever physiological means by which we achieve conscious experience (I will not hazard a guess as to the nature of these means, as that is an entirely distinct matter). We would consider the outputs of basic *mane* perceptual mechanisms – the closest psychological mechanisms to functionally transduced information from the sensory receptors – including adaptive automations and innate modular mechanisms (if they exist) as information rather than phenomenology\textsuperscript{105}. The same would apply for mainstage processing – particularly those processes and functions with greater influence over our perceptual determinations, which we formerly interpreted as 'generating' their own phenomenology. Our perceptual phenomenology thus contains a mix of information from these sources – e.g., adaptive automation, synchronic perceptual integration, or other functions of cognition. Insofar as these sources of information are constrained by their internal rules for functioning, our experience stays consistent over time, more or less consistent across individuals, and that tracks certain characteristics of the distal perceptual world.

It is not necessary on the holistic account for synchronic informational contributions of mainstage processing or the outputs of automations to be *distinctly* phenomenologically represented; what is necessary is that the informational output from these sources contributes to our total perception of the

\textsuperscript{105} On our new account, however, and rather unlike Fodorian input systems, *mane* perceptual mechanisms are importantly penetrated both in intra-cognitive and *intermodal* respects as clearly suggested by our empirical evidence for intermodal effects. In fact, the neuroplasticity of sensory cortical centres and recent studies into these areas suggest that *mane* perceptual processing areas in the brain may not even be fundamentally unimodal, instead sharing processing functions between multiple sensory modalities (Ghanzafar and Schroeder 2006).
object. I explicitly avoid talk of qualia or sense data as these traditional terms for
distinguishing phenomenological components may not even exist as traditionally
conceived on our understanding of perception: this is a view of holistic
informational transfer rather than a view of phenomenological reduction. Our
view rejects Fodor's view of perception in which phenomenology simply reduces
to the representational outputs of maine perception and to which mainstage
cognition then tags on additional propositionally encoded information. Instead,
processes in a variety of levels of complexity – both what we have referred to as
'mainstage' and mane types of processing feed information into one uniform
perception\textsuperscript{106}. Some of these processes involve informational outputs from
adaptive automations, or contributions from mainstage functions through the
opening of information taps. By whatever process responsible for
consciousness, we are phenomenologically aware of this perception and perhaps
of some of the various informational factors that contribute to the percept, but this
awareness is not a simple reduction\textsuperscript{107}. A reductionistic account – when taken
with the empirical data we have reviewed – would leave us with either two
redundant phenomenological systems (mainstage cognitive and mane
perceptual) each capable of generating phenomenology that are somehow
spliced together or a system in which higher-level information is able to co-opt
phenomenology produced by mane perceptual systems. Instead, our account
has different cognitive systems of different types – we will, for the sake of

\textsuperscript{106} Of course, on the holistic non-hierarchical view, even these terms may be inadequate to
describe the processing involved.

\textsuperscript{107} In fact, if we are to take the automation theory view, these contributing processes should be
consciously accessible at some point if they are to be slowly emparcelated into new voluntary
automations. I will also add that I do not aim to propose a theory of consciousness, as this awaits
further empirical data.
convenience, continue to refer to them as *mane* and mainstage – which together process information that our cognitive-perceptual system uses as a whole.

Our new understanding of holistic information transfer, mainstage processing is always a part of what we end up experiencing – at the very least, at an attentional level – and it is therefore not productive to distinguish the percentage of mainstage and *mane* processing in our phenomenology. Under standard perceptual conditions, much of our processing falls to adaptive automations (perhaps even some to perceptual modules – with the understanding that such modular outputs are now informational rather than phenomenological), which decreases the onus on mainstage resources for the processing of these functions. However, the more novel and ambiguous the stimulus, the greater perception relies on mainstage information. Integrative functions – such as visualization, the cross-modal transfer of information, and the interaction between different levels of cognition – are most helpful when a cognitive system encounters novel or ambiguous stimuli. The use of mainstage informational functions help pare down the indeterminacies contained in the impoverished stimuli by advancing perceptual hypotheses that are either supported or not supported by evidence until the desired perceptual goal at hand is achieved.

Holistic information transfer also has consequences for our views on phenomenology, as our phenomenology will typically reflect the confluence of information that goes into our perceptual determinations. For example, our perceptual processes may treat a perceptual blob as a soccer ball but when it feels cold, hard, and heavy to the touch, the perceptual system has now
disconfirmed the soccer ball hypothesis and determined the object to instead be a bowling ball. An individual with higher visualization capacities may even report seeing the mottled soccer-ball patches on the surface of the ball – perhaps their visual system is misinterpreting patches of specular reflectance – and report a jarring surprise at the realization that the object is not a soccer ball. In this degraded sensory condition, the perceptual system increases information flow to allow greater input from mainstage processes. The ‘false positive’ of the soccer ball hints at the importance of having a tentative perceptual determination – any possible determination – for the available information when perceptual conditions are degraded or uncertain. Under survival conditions – especially where there is the perception of danger and a physiological arousal – it is more conducive to survival for a non-threat to be mistakenly identified as a threat (be it mountain lion, jagged point, or cliff) than for a genuine indication of danger to be missed. The level of informational flow would also be constrained – as in Duncker’s memory colour experiment – by the necessity of some level of evidential support for their hypotheses. Of course, what our model will not do is tell us exactly how phenomenology is constituted from perceptual informational

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108 One may be tempted to suggest that conditions in which perceptual information are impoverished are rare, and that they only occur at night and in other non-standard contexts, but I would suggest that they are relatively common. Degraded or ambiguous information can come in the form of distant objects, obscured images, quick-moving objects, non-standard light conditions, fleeting images, and any number of other perceptual contexts. Each of these may involve an opening of cognitive information taps to reduce the situations in which the perceptual system is unable to compensate for the data.

109 One might be tempted to see this picture as stating that we are all in the grip of delusions and unable to distinguish between hallucination and reality. However, as our hallucination and dreaming studies have shown us, there is also likely to be some mechanism – perhaps some function from the parietal lobe – which in healthy individuals tags visualizations as voluntary and helps us to distinguish between pure imaginings and percepts. As the researchers have proposed, an abnormal or deactivated functioning of this mechanism would likely leave us unable to tell between experiences of low-fidelity percepts and of pure imaginings.
outputs – we simply do not understand the neural correlates of consciousness well enough nor do we know how this disparate information is bound together in conscious experience to give us a positive answer to this question\textsuperscript{110}.

The Question of the Continuity of Cognition with Mane Perception

If diachronic adaptive automations and synchronic information taps exist, this raises the question of the continuity between mainstage cognition and mane perception. At the very least, the contents of our perceptions and attendant phenomenology influenced by mainstage cognition is a significant component of mental life not only in imaginative action planning or abstract reasoning, but as a vital component in the processes that comprise human experience. Information from our sensory receptors is typically underdetermined, especially so in the cases of degraded or ambiguous stimuli that we have examined. As a result of this underdetermination, the brain requires the extra processing afforded by mainstage cognition to elaborate on the information provided by the perceptual world, whether in small inferential leaps allowed by modules or in the far greater capacity suggested by vivid visualization studies. Adaptive automations – whose ontogeny includes mainstage processing – help to reduce some of these perceptual probabilities. Where ambiguities remain, mainstage processes provide hypothesis generation and perhaps supplementation by visualisation.

\textsuperscript{110} This information transfer view sets aside the manner in which phenomenology is actually created or unified. The question of phenomenology remains unexplained whether one speaks in terms of information transfer – that is then brought to awareness – or in terms of a reductionistic account of phenomenology. We do not yet know enough to flesh out a fully featured identity theory for conscious experience. One can ask how distinct modules output phenomenology that is then unified just as easily as one asks how we become aware of our holistic percepts. The same problems of neural correlates and of binding persist in both cases.
On Fodor's account, all processes supplementing sensory input come from within sealed components of the input systems with little to no influence from the mainstage cognitive functions. The studies we have reviewed about visual learning, hallucination, lucid dreaming, and colour memory suggest that this "radical isolation of how things look from the effects of much of what one believes" is not as radical as Fodor would think (Fodor 1984, 35) and that a degree of perceptual plasticity is perhaps an important survival adaptation. The widespread involvement of internally-generated information in perception is also evidenced by the variety of conditions – both disordered and healthy – and therefore the relative ease to which conditions may give rise to hallucination. Furthermore, even if we were to take Fodor's old reductionistic view in which mane perception and mainstage cognition each have distinct phenomenological outputs, the existence of informational pathways that allow internally generated phenomenology to spill over and intrude upon our sensory phenomenology would lead us to conclude that perhaps internally generated phenomenology is in some manner or form the very glue that holds our sensory phenomenology together.

A picture involving dual (mainstage and mane) phenomenologies would require one to conceive of internally mainstage processes such as imagination or memory in the manner of a cognitive 'heads-up display'\textsuperscript{111}, controlled by a central

\textsuperscript{111} By heads-up display, I refer to the clear display screens often found in the cockpits of military jets and other aircraft to present vital information, such as pitch, attitude, distance, or targeting information. A heads-up display (HUD) in an aircraft is located in the pilot's line of sight between the pilot and the cockpit glass (either on top of the main instrument display or on pilot's helmet visor) so that – as the name suggests – the pilot does not have to look down or otherwise take his eyes off his surroundings in order to access important data; the pilot simply looks through the HUD and sees the data superimposed on top of his view of the outside. As other applications – both military and non-military – have adopted head/helmet-mounted HUD displays to allow their wearers to instantly and conveniently access information, the term heads-up display has
generative processor and distinct from the image upon which it is superimposed. This is, I think, how we usually think of mainstage cognitive processes such as visualisation and imagination, but it seems to me to be the wrong conceptual approach in relation to perception. Even on Fodor's account, data derived from sensory stimulations underdetermine our information about the world and this necessitates further analysis and reconstruction before it is output as sensory phenomenology. This, after all, is the job of his perceptual modules. Input systems perform higher-level inferences that supplement our sensory information prior to phenomenological awareness. Input systems may not be mainstage processors on Fodor's account, but they replicate mainstage functions in order to accomplish their task. In much the same way, our automated processes and cognitive information taps contribute information to multiple levels of perception. Mainstage processing is not merely presented atop a fully complete sensory phenomenology: 'higher-level' information is integrated into the very lens through which we view the world.

On the present picture of holistic information transfer, it is wrong to say that sensory phenomenology is impenetrable to mainstage cognitive processing because it no longer makes sense even to speak of sensory phenomenology. Our experience takes its form from the influence of both external and internal sources at multiple levels; to make a distinction here would be artificial\textsuperscript{112}. Mane commonly come to denote any such system. Familiarity with HUD systems has been popularised through depictions in all manners of films, television programmes, and video gaming.\textsuperscript{112} This explains the difficulty Fodor has in naming his input systems and keeping them distinct from his central systems. His basis for this segregation was to make observation – the product of mane perception by way of perceptual modules – distinct from the information provided by mainstage cognition. In fact, mane perception is itself importantly penetrated by mainstage cognitive information before its outputs reach accessible awareness. It is then little wonder when
perception is not only penetrated by mainstage information under conditions which allow information taps to open, but through the effortful formation of adaptive automations – those processes which are so easily mistaken for encapsulated modules.\footnote{113}

In a cognitive system with synchronic perceptual plasticity and with diachronic adaptive automation, mane perception could be described as continuous with mainstage cognition in two ways. First, synchronic processes fill in the gaps in information from sensory stimuli that persist after adaptive automation processing and so we may term this a 'continuity of function' between some faculties of mane perception and mainstage cognition. Insofar as their outputs may both influence our perceptual experience in the same way – especially if their processing circuitry is shared – and if they truly work hand in hand when processing ambiguous or deficient perceptual stimuli, then mainstage cognition and mane perceptual mechanisms are both necessary for perceptual experience. It appears very likely that this is the case as in the hallucination we find no qualitative difference between phenomenology that takes its form from mainstage information and that from the outputs of mane perception. Additionally, indistinguishability is all we need for there to be crossover between theory and observation (one possible example of the crossover I have in mind is psychosis involving hallucinations); if the observer cannot tell the difference between what she is imagining and what she is obtaining from the external world, then it is sometimes possible for what she is observing to be based upon information from her own theoretical content.

\footnote{113} We might instead see the balance of information to which our perceptual phenomenology is sensitive as something like a sliding bar with external input on one side and internal supplementation on the other. The less resolution or information we receive about the external stimulus, the more our internal resources are called upon to compensate. However, this analogy is by no means exact. You simply don’t close your eyes and suddenly see internally-derived imagery and even dream imagery presumably has a function, time, and place, that normally is not invoked during wakeful activities as in merely closing one’s eyes. Even the colour memory examples show that there typically has to be some reason for our minds to ‘colour in’ the stimulus. However, identifying any mere specified function with a module is more deflationary of modularity than even Fodor will admit (1983, 48), of either encapsulation or of modularity as a whole. Furthermore, as far as wakeful dreaming outside of disordered hallucination, we can all describe cases – particularly on dark and stormy childhood nights – where our imagination has ‘run away with us’, so to speak.
studies, where fiction and reality are separated by a mere ‘tagging’ of ownership.

Second, many automated processes which become more and more modular over time begin as mainstage cognitive processes. If a significant proportion of our *mane* perceptual mechanisms begin in this way – as they very well may have developed during early childhood – then such mechanisms behind early perception are also etiologically continuous with mainstage cognition. Together, these two types of continuity represent a strategy by which our perceptual system attempts to make best use of the resources available to it without allowing our perceptual experience to fluctuate too wildly in response to the possible higher-level concerns.

**Escaping Perceptual Relativism, and on Adaptation**

If modularity is not the final word on perception and if theory may indeed spill over onto observation, we are once again faced with the spectre that our healthy, non-schizophrenic observer will be set adrift on the sea of perceptual relativity. There is a lighthouse on the horizon: even if observation is not theory-free, there are a number of external influences that keep it aimed firmly at the coastline. Just as the external world constrains the ways in which all life forms, in a given niche, extract and process nutrition from it (even very diverse species from vastly different lineages), the same is likely to be true of the mind. The environment constrains the ways in which we may extract and process information from it, given our biologically specified survival functions. In both cases of nutrition and perception, these environmental factors – along with genetics – lead to similarities across species and certainly across individuals.
within species, even when evolution concurrently produces cognitive systems capable of wide variation. For example, we have already addressed the possibility – raised by the Müller-Lyre illusions – that these conditions appear as statistical regularities that are extracted from the perceptual environment by a learning, automating system (or incorporated into automating systems by evolution).

Animal studies show us that at least some non-human animals may share some similar mainstage cognitive capacities with humans. For example, a recent article by Raby et al (2007) shows that scrub-jays are capable of planning for future conditions. Scrub jays will anticipate where food will be unavailable the following day and will alter their behaviour to ensure that they have caught and stored food in advance at that location. New Caledonian crows will make tools out of twigs and leaves in order to catch food (Kenward et al 2006), and that these behaviours are passed on partially through social learning. The considerable amount of research into the cognitive abilities of chimpanzees, apes, dolphins, and avians allow us a glimpse into neural systems separated from us by thousands, hundreds of thousands, and millions of years. What is particularly telling is that such animals come from branches of evolutionary history that have diverged widely from human evolution and yet they converge upon comparable cognitive abilities. One factor that these creatures share with humans is a similar physical (and perhaps social) environment from which to learn. While I do not mean to detract from the influence of evolutionary and genetic pressures, certainly if such environmental influences are enough to constrain species adaptation, they are enough to constrain the ontogeny of
individual cognitive systems capable of variability and adaptation. After all, the
greater the freedom of a cognitive system to change in response to differential
environmental conditions, the more adaptively advantageous that system will be.
This is, of course, only possible without the widespread radical encapsulation of
sensory perception that Fodor and his successors propose.

Beyond the environmental effects, to postulate that there are continuities
between mane perception and cognition does not mean that ‘anything and
everything’ can affect perceptual experience in an unencapsulated system.
Clearly, the colour studies have shown us that there must be at least some
sensory-evidential reason whenever mainstage processing effects a significant
alteration to our perceptual determinations. In the case of colour constancy, this
increased sensitivity to mainstage processing occurs only to maintain the desired
connection between percept and environmental source when information from
the stimulus is impoverished\(^{114}\). Furthermore, these synchronic effects – e.g., the
widening of information taps – seem most likely to occur in situations of
uncertainty when higher-level supplementation of existing information would be
most useful. Voluntary automations also require a certain amount of
reinforcement and practice to be maintained: they do not happen immediately,
nor are they easily changed. Cognitive inertia plays just enough of a similar role
as Fodor’s encapsulation to prevent perception from being easily dissociated
from reality without also preventing our system from adapting to new conditions.

\(^{114}\) By this, I do not intend to advocate the position that the purpose of our perceptual system is
necessarily to represent the external world in a veridical manner. This simply is not the case – for
example, the luminosity of objects in the image that we see does not vary in a direct relationship
with the actual luminosity of objects in the environment. I simply mean that mainstage processing
is increased in order to preserve whatever usual relationship our perceptions share with their
environmental sources.
In these ways, our cognitive system maintains a balance between perceptual constancy and adaptability, allowing a sufficient level of constancy across individuals to permit communication and a sufficient level of variability that we can grow and continually refine our perceptual experiences.

Some Advantages of Adaptive Automations to Fodorian Modularity

Given that the view of adaptive automations replicates or approximates certain aspects of modularity, one may ask what advantages the present view truly has over modularity\textsuperscript{115}. We have already seen how our present model of perception allows us to move beyond doubts of the reliability of our basic perception. While I believe that this model has a large number of additional advantages to modularity, I shall pick out two in particular.

As the name implies (and as we have already seen), adaptive automations allow a system to be more responsive to environmental changes than a fixed, modular system. Modular systems can only adapt over evolutionary timescales. Adaptively automated systems can change not only over the course of a single generation – neural systems are at their highest adaptivity in childhood, when the system has fewer existing automations (thus less cognitive inertia) and maximal neuroplasticity – but will continue to do so over the course of an individual’s lifetime. We constantly adjust or readjust to the environment as with the sailor’s ‘sea legs’, we adjust to motion and balance when we learn to dance, and we can adapt unused neural resources to new tasks as when blind subjects learn to ‘feel’ vision with their tongues; these are all cases where the cognitive-perceptual

\textsuperscript{115} I thank Martin Hahn for presenting this ‘deflationary argument’.
system creates new adaptive automations at different stages of life. With adaptive automations, even though the vast majority of our perception remains relatively constant due to cognitive inertia, we can still create new perceptual connections and in fact have the capacity (given adequate cognitive pressure) to alter previously automated perceptual connections\textsuperscript{116}. Our view of automations explains why the perceptual system maintains the level of flexibility found in the cross-modal, neuroplastic, and diachronic effects as we have discussed in our empirical examples\textsuperscript{117}. As I have suggested previously, I also believe this continuing flexibility of adaptive automations to be the story behind much of what we call learning.

The process of learning brings us to the second major advantage of adaptive automations over modularity. Adaptive automations are a general process that applies not only to 	extit{mane} perception, but also to mainstage cognition as well. It provides a way that we can harmonize these two aspects of cognition that have for so long been held to be distinct. Functions that begin as fully mainstage processes and gradually move towards more fixed, expert, autonomous, and streamlined operation offer a promise of explaining certain aspects of mainstage cognition. The same promise has lead contemporary modularity theorists to propose modularity theories for mainstage cognition, but the same reasons that adaptive automations – in combination with cognitive taps

\textsuperscript{116} Contrary to inflexible modularity, \textit{it is not the case that all people – especially people knowledgeable about the illusion – must in fact see the Müller-Lyre illusion at all times!} It is interesting to note that during the defense presentation of this particular thesis, roughly half of the attendees admitted that they did not initially see the illusion.

\textsuperscript{117} A point of clarification: neuroplasticity is function of physiology, but in our model, it also functions in service of automations. More precisely, one of its primary purposes is to make possible the connections that allow for the processing of new adaptive automations.
and a holistic informational picture of perception and cognition – are advantageous over Fodorian perceptual modularity make adaptive automation advantageous over modularity theories of cognition. As much as flexibility is present in perception, it is even more prevalent in mainstage cognition.

Another Alternative to Modularity: Karmiloff-Smith

In the years following the publication of *Modularity of Mind*, much of the response to it has fallen into two major camps. The battleground has moved – perhaps prematurely – from perception into mainstage cognition. Members of the first camp take Fodor’s arguments for modularity to be decisive and they propose variant modularity theories (called ‘massive modularity’ theories) that attempt to extend the scope of modularity to encompass all of mainstage cognition. As the same arguments against modularity of perception will – for the most part – apply equally to theories for the modularity of cognition, I will refrain from addressing these theories in the main body of this thesis. Members of the second camp stand against the wholesale application of modularity theory to the mind by arguing for cognitive systems whose ontogeny are *developmental* in nature. This camp is currently represented by a scant few proponents. The most influential of this developmentalist camp is Annette Karmiloff-Smith, who concedes the point that perception is encapsulated (1992, 166), but argues that at the very least,

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118 For examples of these types of ‘massive modularity’ theories, please see Appendix III. It is interesting to note that Fodor himself expressly disapproves of this move to apply modularity to mainstage cognition in *The Mind Doesn’t Work That Way* (2000).
many of our cognitive mechanisms are derived from post-natal learning\textsuperscript{119}. Because Karmiloff-Smith proposes a view that is somewhat similar to my view of adaptive automations, I want to take a brief look at this theory in order to better understand the issues that face other developmental alternatives to modularity theory. While Karmiloff-Smith’s approach is largely compatible with the automation theory that I have proposed above, there are clear differences between the two views that will become apparent upon closer examination\textsuperscript{120}.

i. Representational Redescription Theory

Karmiloff-Smith takes inspiration from the developmentalist psychologist Piaget, who pioneered early studies from the late 1920’s through to the 1960’s where he examined the developmental stages of children and neonates. Piaget held the non-nativist constructivist stance that the majority of our psychological mechanisms are built ground-up during childhood out of an undifferentiated domain-general \textit{tabula rasa} interacting with its environment (Karmiloff-Smith 1992, 10). In contrast to Piaget, Karmiloff-Smith’s Representational Redescription (R-R Theory) incorporates both nativist elements and features of domain specificity and yet retains the developmentalism at the core of Piaget’s views. R-R Theory holds that the \textit{appearance} of modularity – at least in mainstage cognition – is a product of both the experiences as of the infant/child

\textsuperscript{119} While some may object to labelling Karmiloff-Smith a developmentalist, in contrast to the massive modularity theorists her views are decidedly inspired by the true developmentalists such as Piaget combined with certain concessions to the side of modularity. While I shall treat her theory as a representative of developmentalism, others may feel more comfortable calling her a quasi-developmentalist.

\textsuperscript{120} For another influential non-modularist work, see Steven Quartz’s “The constructivist brain” (1999), where Quartz presents a picture of the mind and brain that overlaps with the arguments and ideas I have given in this thesis.
and of the general genetic predispositions. These predispositions structure how the brain and its psychological framework grow in response to experience. Later plasticity in such systems is subsequently created by an innately determined drive to continually reformat already represented information in novel ways. I should again note that her intent is primarily to address claims of modularity in mainstage cognition. In contrast to my position, she seems more or less content to allow that "Fodor is probably right that there are perceptual modules, in his strict sense of the term" and instead addresses what she believes to be the more pressing question of whether mainstage cognition is modular\textsuperscript{121} (1992, 166).

For Karmiloff-Smith, proponents of massive modularity have greatly overstated the case for widespread innate specification of brain structures. She and Michael Thomas (1998) point out empirical evidence that suggests that the brains of newborn humans do not have specialized processing areas for processing of faces (a presumably modular task), that these regions form at around 3 months of experiential input, and that preferential attention to faces in neonates only appears following a considerable amount of visual and audio sensory input (Johnson & Morton, 1991; Johnson, 1998). The same studies suggest that the processors for many significant cognitive functions important for

\textsuperscript{121} Although she accepts the likely existence of Fodorian perceptual modules, it is not absolutely necessary to interpret Karmiloff-Smith as saying that all of \textit{mane} perception is strictly modular. She goes on to state that "to the extent that the mind is modular, this is the result of a gradual process of modularization, and that much of cognitive development is domain specific without being strictly modular" (1992, 166) – this may indicate a willingness to accept some apparently modular components of \textit{mane} perception are modularized. Since she agrees with elements of modularity but combines it with constructivist-inspired elements, I take Karmiloff-Smith's as a conciliatory view between the unrestricted 'New Look' cognitivist (perhaps such as Paul Churchland) and the strict modularity theorist. Karmiloff-Smith's views are actually somewhat similar to my arguments for adaptive automations, and indeed our approaches to the issue of modularity are largely compatible. However, there are key differences between the two views beyond merely the disparity in our willingness to grant greater modularity in perception, a matter to which I will return shortly.
survival\textsuperscript{122} – and presumably important to our genes in an evolutionary sense – gradually become localized in the brain as an individual grows and develops from infant to adult, and that this "neocortical localization and specificity are acquired developmentally through interaction with environmental input" (Thomas and Karmiloff-Smith 1998, 246). Such results suggest to Thomas and Karmiloff-Smith that the "detailed innate specification of domain specific modules is not only unnecessary but biologically implausible... Genes do not code for higher-level modules" but rather for general architectural features isomorphic throughout the human neocortex, and there has been no evidence that there are genes that code for detailed post-natal development in specific neocortical areas (Thomas and Karmiloff-Smith 1998, 246)\textsuperscript{123}. This runs contrary to the modularity theorist's commitment to endogenously specified systems and suggests that much of what appears modular – at least in mainstage cognition – is in fact built up over time by the accumulation of experiential connections. Gradual neural specialization largely replicates the cognitively insulated, neurally localized, fast-operating, and domain specific properties of modularity in adults without the strict adherence to the restrictions of non-assembly, innateness, and complete encapsulation (of both the diachronic and synchronic kind) (Karmiloff-Smith 1992, 5; Thomas and Karmiloff-Smith 1998, 248)\textsuperscript{124}.

\textsuperscript{122} These survival functions include Fodor's favourite modular paradigm of language (Neville 1991).

\textsuperscript{123} Karmiloff-Smith is more conciliatory to modular views in her earlier work as she clearly proposes that there is "both a certain amount of detailed specification and some very skeletal domain-specific predispositions, depending upon the domain" (1992, 15), whereas we have seen above in her later work that she denies any genetic evidence for detailed innate neural specification in the neocortex.

\textsuperscript{124} Karmiloff-Smith first proposes this 'modularization thesis' in her earlier book, Beyond Modularity (1992), but does not expand further upon it due to lack of evidence. In fact, this is
Given the above view, it is surprising that Karmiloff-Smith also believes that there is some evidence for a Fodorian innate specification of lower-level perceptual systems. Nor does she think that the development of higher-level systems is determined entirely exogenously. She points to studies in which certain basic types of visual discrimination, such as shape discrimination, have been demonstrated to be present in infants at birth. In other studies, young infants react to contraventions of the basic laws of physics – e.g. balls that appear to levitate (Karmiloff-Smith 1992, 13). Infants shortly after birth are capable of a variety of impressive feats of understanding and recall (Karmiloff-Smith 1992, 33), and some areas of the brain seem hard-wired to process certain types of input: e.g. studies have shown that even congenitally deaf children whose parents did not know sign-language are capable of spontaneously developing their own methods of signing communication (38). Evidently, children are born with a certain level of neural sophistication – either by genetics or by pre-natal development – a fact at odds with any theory (such as Piaget's) that postulates an entirely undifferentiated tabula rasa system (Karmiloff-Smith 1992, 32-35). While the mind cannot be wholly modular, Karmiloff-Smith believes that it also does not face the initial cacophony of input data utterly unaided.

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125 One must also note that for infants in close contact with parents, family, or caretakers, there are already numerous environmental pressures – those that come with basic social interaction, for example – for children to develop even the most basic means of communication, let alone the child's own drive towards desire-fulfillment. The case could still be made, however, that the infant requires certain initial social inclinations towards interaction to help the process along which are then environmentally reinforced, attenuated, or inhibited (in neglected children, for example).
There are domain-specific systems, but they need not be of the totally innate and rigid forms envisioned by modularity theorists.

Karmiloff-Smith’s solution is to allow for some genuine cases of Fodorian innate specification – particularly in the ‘peripheral’ systems of *mane* perception. However, she also argues that there are non-Fodorian systems which are developmentally sensitive to experience and yet which nonetheless involve innate specification. This occurs in two ways. First, there are innate domain-specific attentional predispositions or biases that, while they do not predetermine the ultimate ontogeny of a cognitive system, provide the developmental kick-start to encourage certain areas of growth out from the initial chaotic blur of inputs in the neonate. To be clear, these domain-specific constraints are expressly not the detailed, fully specified pre-programmed nativist types of modules. Rather, they are specific aspects of the initial neural architecture that make certain pathways better at processing specific input domains such as language, naive physics, mathematics, and visual input but which also do not preclude the same pathways from being able to process other types of input (Karmiloff-Smith et al 1998, 591). These aptitudes are thus ‘domain relevant’. They predispose the system to focus on certain types of input analyses, such that with repeated processing of a given kind of information, the associated brain areas develop into domain-specific processing systems that resemble modules.\(^\text{126}\). For Karmiloff-Smith, architectural biases and predispositions of these sorts are necessary to explain why infants and neonates have an affinity for the basic informational domains that are

\(^{126}\) Karmiloff-Smith nicely summarizes this position by stating that “Nature specifies initial biases or predispositions that channel attention to relevant environmental inputs, which in turn affect subsequent brain development” (1992, 5).
common to all infants—such as language. They provide a general guidance and thus increase the likelihood that experientially dependent development will proceed in certain directions.

Karmiloff-Smith's reasons for her position on innateness are one part theoretical and one part empirical. Her theoretical rationale for accepting innateness is that "Domain-specific constraints potentiate learning by limiting the hypothesis space entertained" (1992, 11), that "the infant would have to start out with innately specified linguistic predispositions and attentional biases so as to constrain the class of inputs that it computes in ways relevant to not violating specific linguistic principles" (1992, 35). Domain-specific constraints make it easier to reduce the associational possibilities in the neonate's sensory input to what is most important, thereby giving it a starting point to learning. The implication here is that without this starting point, there would be nowhere for a totally non-nativist Piagetian mind to begin sorting the chaotic input it receives into some semblance of order. To demonstrate this principle, let us relate it to a familiar analogy: starting points are important in reducing chaos just as it is easier for one to solve a jigsaw puzzle if one knows to begin with the outside pieces first. While it is possible to solve a jigsaw puzzle from any point, this one morsel of advice vastly reduces the hypotheses necessary once any particular piece is identified as an element of the borders. Of course, this principle is closely related with my own views of online perception in adults, except that Karmiloff-Smith intends it as a justification for innate predispositions.

On the level of complexity required for linguistic processes, there is the further empirical contention that all domain-general analogies from other domains
of input – such as the manipulation of physical objects as models of syntactic and semantic rules in language use – are inadequate will suffice to simulate (and thus help the infant learn) the subtle intricacies of language without a pre-existing predisposition towards language processing. Karmiloff-Smith explicitly cites several articles that claim that analogies from physical manipulations vastly underdetermine the possible permutations of even simple linguistic distinctions (1992, 46). The same articles conclude that there must be some innate force driving language processing and its associated development on its own domain-specific terms.

Domain-specific predispositions are also necessary to account for cases where "complex syntax and lexicomorphology... may coexist with very severe general cognitive impairments" as in internal hydrocephaly, spina bifida, and Williams Syndrome (Karmiloff-Smith 1992, 35). This last point may seem directed solely against traditional Piagetian developmentalists as a contention that domain-specific development exists in infants and neonates rather than domain-general cognitive development alone, but it also demonstrates the above idea that domain specificity – of a lesser form than Fodorian domain specificity – may precede cognitive sophistication: the innate element forces the child to focus on linguistic input and continue to develop their language centres independently even when domain-general cognitive resources are deficient

127 Karmiloff-Smith describes this process in more detail: “Attention biases and some innate predispositions could lead the child to focus on linguistically relevant input and, with time, to build up linguistic representations that are domain-specific. Since we process language very rapidly, the system might with time close itself off from other influences – i.e., become relatively modularized” (1992, 36). It is very important to distinguish between her use of domain-specific (knowledge) representations, which Fodorians claim are innate and which Karmiloff-Smith argues
Taken together, these “innate, knowledge-impregnated predispositions [function as] a head start in each domain” (Karmiloff-Smith 1992, 10). These “domain-specific [attentional] biases [which are added] to the initial endowment”, when combined with experiential input, lead the processing circuits of these domains through a “progressive process of modularization” (Karmiloff-Smith 1992, 10). For Karmiloff-Smith, innateness need not be extensive; only a “fairly limited amount of innately specified, domain-specific predispositions (which are not strictly modular) would be sufficient to constrain the classes of inputs that the infant mind computes” and with progressive selection, even create systems that appear somewhat modular and encapsulated (1992, 4-5).

In Karmiloff-Smith’s examples, linguistic development may occur despite cognitive impairment. This demonstrates the domain-specific development can proceed independently of domain-general development – without encapsulation from it – and leads us to Karmiloff-Smith’s second major claim of innateness in cognition. She holds that there is a particular, content-independent, autonomous, and innately specified set of developmental stages which unfold independently and spontaneously within all individual cognitive domains as they develop in response to external input. These processes are both domain specific – proceeding different rates within distinct domains – and domain general – they occur uniformly with the same sequence of stages across domains (Karmiloff-

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128 Karmiloff-Smith does not state in what specific way these predispositions would count as ‘knowledge-impregnated’ and how it may contrast with to ‘knowledge-containing’, as this connotes a more Fodorian position than what she has been describing.

129 We will discuss these stages very shortly. Again, whereas perceptual domains we discussed previously were such as ‘vision’, ‘audition’, ‘smell’, examples of Karmiloff-Smith’s cognitive
Smith 1992, 18). The initial stages proceed much in the manner of modularization. However, unlike modularity, the latter stages that Karmiloff-Smith describes actually allow mainstage cognition to better control and manipulate the behavioural expressions of the represented information contained within; these processes are what ultimately allow flexibility and plasticity in cognition. They are broken down into four representational stages, termed Implicit (I), Explicit-1 (E1), Explicit-2 (E2), and Explicit-3 (E3).

At the implicit level of information representation, a novel behavioural or processing function is internalized from experience, but this information is not yet available to conscious access: it cannot yet be reported by the subject or and is "relatively inflexible" to alteration of its content (Karmiloff-Smith 1992, 21). Representation level I is relatively autonomous and procedural in nature, where external data drives the development of neural connections resulting in the smooth execution of new behaviours. It is only once these representations are re-represented into new formats at levels E1, E2, and E3, that the these new behaviours may be reshaped or altered, but the original representations of previous levels remain for future use. At level E1, the analogue I-level representations are digitised (reduced and distilled) and converted into a manner more suitable for domain-general cognitive access, becoming more flexible to alteration, but not yet available for conscious access. The further re-representation of this information from the non-conscious but cognitively accessible E1 to levels E2 and E3 introduce conscious access, and finally the

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domains would be 'language', 'physics', 'mathematics', their subsets divisible into microdomains such as 'gravity' (Karmiloff-Smith 1992, 6).
capacity for verbal report of that consciously accessible information, respectively. At these later stages, the subject is able to influence and alter the behavioural expression of these representations in the same way that a piano player – having internalized the behaviours necessary for playing a musical passage and then re-represented that behaviour in consciously accessible, and then verbally accessible manners as specific chords and dynamics – may ultimately influence the tempo, dynamics, and vigour at which that passage is played. The progressive occurrence of these innately determined developmental stages within a particular domain results in processes that are both modular and ultimately flexible, but also externally influenced and directed.\footnote{Karmiloff-Smith points to similar studies as I have previously mentioned showing that deprived sensory areas in the brains of individuals blind or deaf from an early age reconfigure themselves to process new inputs, demonstrating that the "brain is not prestructured with ready-made representations; it is channelled to progressively develop representations via interaction with both the external environment and its own internal environment" (Karmiloff-Smith 1992, 10). The external environment provides input that causes the developing brain to reconfigure in response to new information, whereas the internal environment both modularizes information into ever more automatic processes while also re-representing that information into formats more accessible to use by higher-level cognition.}

ii. Representational Redescription or Adaptive Automations?

One might ask how, then, the above described adaptive automation view differs from Karmiloff-Smith’s representational redescription view and what advantages it holds over R-R theory. I will acknowledge, first, that the adaptive automation view has a number of superficial similarities with R-R theory and that the two perspectives are largely compatible. The adaptive automation view is not mutually exclusive with there being some Fodorian modules (where their outputs are informational rather than phenomenological) and it asserts – like R-R – that
this cannot be the end story for every aspect of cognition. While not embracing innateness, the adaptive automation view is also not incompatible with there being some types of innately specified systems of the Fodorian or Karmiloff-Smith variety. However, there are significant differences between the two pictures and these differences have interesting consequences.

The most visible difference between the two approaches is that adaptive automations are intended to account for flexibility in perceptual processes, whereas Karmiloff-Smith dismisses ‘peripheral’ functions such as *mane* perception as likely Fodorian in nature. The examples I have given above should be enough at the very least to convince the reader of the possibility that non-Fodorian systems exist in *mane* perception, and I will let those examples stand as presented. Karmiloff-Smith’s examples of innate cognitive features in neonates may suggest that some aspects of *mane* perception are modular, but this need not hold for all of *mane* perception.

The next major difference is the stage at which plasticity and higher-level penetrability begins to appear. For Karmiloff-Smith, mainstage cognitive influence plays no part in the initial I-level formation of informational representations, it only begins to have influence at later, explicit, levels of cognitive development in a particular domain from E1-E3. In contrast, adaptive automations – which would fit in at the I-level on Karmiloff-Smith’s ontogeny of cognitive systems – permit of higher-level influence right from the start, playing an active role in determining the ultimate form of the automation that is created. During the process of adjustment and adaptation that produces I-level behavioural mastery, the ultimate form of the implicit representation that is
produced is a product of both the external data and internally-guided directives. These directives are innate in the case of Karmiloff-Smith's attentional biases, whereas in adaptive automations, they are in the form of voluntary mainstage pressures that focus attention as an impetus for the initiation of an automating process. A violin does not teach you to play it simply by being perceived, one must actively confront the cognitive system with the intended behaviours in the early fully-flexible pre-representational stage intended for the analysis of novel stimuli, then repeat this behaviour with conscious scrutiny for goal-fulfillment, and thereafter the autonomous processes will train themselves and internalize the implicit procedural data\textsuperscript{131}. This is not necessarily always so – neonates do not yet have higher-level intentions in mind when they begin learning and Karmiloff-Smith's language development example may also serve as an exception – there may indeed be domains that are innately driven by domain-relevant biases.

On the adaptive automations account, mainstage receptiveness may extend even further into the automation process, allowing the system to incorporate indeterminacy and flexibility into the adaptive automation, a process that may result in what I have previously described as 'information taps' that are incorporated into an automated process. We will recall that these 'taps', of course, were important for explaining situations of synchronic perceptual penetrability. The incorporation of cognitive taps could either be a totally autonomous process in which neural system adapts to recurring indeterminacies

\textsuperscript{131} The same kind of executively-guided pressure may also guide – on the adaptive automations account – an automation to become somewhat trained in several domains of information (contrary to the R-R domain-specific account). This would probably take a form such as the generalized learning example in Seidler (2004).
or it could be influenced in the goal-directed manner as in learning to play a musical instrument. This demonstrates a committed assertion of plasticity in the adaptive automations model – though not necessarily of conscious penetrability – in the earliest steps of automation that is not present in the R-R model of cognitive development. Once the automation process begins there is no reason on the adaptive automation account that there cannot be further redescriptive processes as given in R-R theory. However, just as hinges or pivots may be built in or added to a mechanical device while the rigidity of other parts is reinforced, the adaptive automation account leaves cognition open for flexibility and control to be ‘built-in’ to the initial automation process. These points of flexibility themselves would be part of the original adaptive building blocks during the continuing evolution of an automation as it is gradually refined, modified, and stabilized rather than this flexibility merely a product of later reformatting of established representations.

Finally, for those who would argue that Karmiloff-Smith’s example of complex linguistic development coexisting with mainstage cognitive impairments constitutes evidence that higher-level-sensitive adaptive automations cannot exist, I would argue that the example only shows that in some cases, the process of adaptive automation may proceed autonomously with minimal direction by mainstage cognition. What it does not show is that the adaptive automation development is insensitive to higher-level inputs in a Fodorian manner. Although it is true that in such cases, impairments in cognition would presumably translate to deficits in the developments of such systems if executive cognition is solely responsible for its ontology, it is not my assertion in adaptive automations that
every connection is micro-managed and serialized through mainstage cognition at some point or other. I believe – like Karmiloff-Smith – that we do not often adequately acknowledge how many hypotheses may actually be entertained by mainstage cognition in the vast amounts of processing time that our neural systems are active even by the time we reach early childhood. However, this does not mean that every neural and associational connection is brought to global awareness: the case of cognitive impairments is one of those cases where adaptive automations would proceed exactly as described in the R-R picture, with an attentional bias driving an implicit proceduralization of a particular behaviour in a manner to which it is structurally suited to processing and additional processing occurring in a domain-internal manner. The picture of adaptive automations given herein has always been one of a range of processes between Fodorian modules and fully plastic higher-level processes – systems in the manner of R-R theory fall squarely in the middle.

There are two lessons to take away from R-R. First, it demonstrates that the initial cognitive state of the neonate is likely to require some manner of catalyzing directives as a starting point to begin reducing the initial perceptual chaos into ordered analytic systems. Whatever form this may take, the proficiency to which neonates take to processing data and the rapidity to which these mechanisms develop suggests that there may be some level of innate direction. However, as Karmiloff-Smith has already stated, even a minimal amount of direction is enough to set the infant on the path to its future cognitive development. I would hazard a guess that mainstage cognitive goals that initiate progressive cognitive development may be emergent from the interaction of a
scant few initial dispositions, the cognitive systems in which they promote development, and copious amounts of novel perceptual data. Secondly, even with initial predispositions for the processing of certain informational domains, the manner of processing for these domains need not be entirely pre-described and yet will produce exogenously-sensitive, module-like systems with a capacity for flexibility. With continuous cognitive pressure – applied by attentional biases or by executive direction – the development of implicit representations or adaptive automations may both produce systems that appear more or less modular.

Areas for Future Work

There are two primary areas in the view I have presented above that need further work. First of all, automations on the account described exist on a spectrum between the short timescale adaptations – as of the adaptation of the system to wave motion – to the long-term adaptations that would serve the same functions as Fodor's modules. The difference between the two would be the amount of cognitive inertia built up that impedes the adoption and incorporation of the particular automated function. Since there is presumably no automation necessary for non-wave movement, one can easily be built up as necessary for ocean movement. However, if the automation underlying the Müller-Lyre illusion is one that is often used in regular perception, then altering it may be correspondingly difficult. It may also be the case that certain functions remain more plastic even on continued use or are easier to automate. It would be interesting for our purposes to observe a subject raised at sea coming first ashore, whether it is as easy for this subject to adapt to life without wave motion
as for us to adapt to seagoing life. Further research is necessary to find out any other conditions aside from cognitive inertia that affect the ease of automation and the neurophysiological distinctions which may affect the way different stimuli are adaptively automated.

Second, like all other current models of cognition and perception, our picture of holistic perception, cognitive information taps, and adaptive automations is necessarily incomplete. The physiological picture has yet to adequately explain how information becomes bound together in the mind and available to consciousness and the physiological mechanisms behind information taps and adaptive automations remain unknown pending further empirical studies. In absence of great empirical advances into these areas, a complete picture must remain forthcoming.
CONCLUSION

In exploring current trends in research, we have seen evidence that an encapsulated system such as proposed by Fodor’s modularity theory is unlikely to be the final word on the processes behind perception. A growing body of research indicates that the mechanisms that process our perceptual information are penetrated by information flow from the various modalities and from higher-level systems. Furthermore, the prima facie qualitative indistinguishability between psychological states that result from internal processes and those which result from processing of external stimuli suggests that there is a greater influence from internal, paradigmatically cognitive processes than previously realised, and that the two are not as separable as we once believed. We have evidence that information from the paradigmatically cognitive processes penetrates our perceptual experience in many ways; this leads to the conclusion that previous reductive explanations of perceptual phenomena are inadequate to account for the facts. Confluences of information occur on both ‘synchronic’ short time scales and on diachronic long time scales, and suggest a dynamic alternative model of perception to Fodor’s in which the perceptual system makes holistic determinations about sensory information from a variety of interconnected informational sources.

With the process of adaptive automation, we can see how systems that are very similar to Fodor’s modules may accomplish the same tasks yet do not require the rigid encapsulation and endogenous specification that seem to prevent modular processes from being adaptively advantageous. We have also seen that encapsulation is unnecessary for a system to continue to track the
world and to allow enough shared experience between individuals to allow for communication, both colloquial and scientific. There are enough features of our physiology and of the environmental conditions (the latter of which also includes social conditions) that already constrain our perception enough to allow communication not only between humans, but also between humans and non-human species. It is also not the case that our perception without encapsulation is set adrift on the sea of relativity; the basic realities of neural processes, such as cognitive inertia, also help constrain our perception to an acceptable degree of consistency.

We have also seen that mainstage 'higher-level' cognitive processes are important components of perception in that they reduce ambiguities, provide hypotheses, and help our perceptual system to deal with unfamiliar situations where sensory information is inadequate. In certain situations, these cognitive information taps can be widened and greater amounts of mainstage processing brought to bear to solve perceptual problems.

I do not think there is anything utterly new in much of what I have proposed, but I do see it as a formulation of views upon which many different researchers and thinkers in on the subject are converging. Researchers and theorists such as Paul Churchland and Michael A. Wapner continue to push relativistic views of perception that are perhaps more relativistic than I believe are warranted, but in some important respects parallel many of aspects of automation that I have given above. Brewer and Lambert have also argued for a more conservative penetration of mainstage cognition (by way of theoretical knowledge) to maine perception. Arguing as we have that weak 'bottom-up'
information may be overridden by top-down influence, they also state that "it seems likely that strong bottom-up information will override top-down information" and thereby alleviating the epistemologist's concerns about relativism (Brewer and Lambert 2001, S179). Even so, they conclude that science is filled with examples where theory has influenced observations with weak bottom-up information (Brewer and Lambert 2001, S179). The preference for particular theories can and often do also lead scientists to interpret and evaluate data in distorted ways, whether willingly or by committing "systematic errors" (Brewer and Lambert 2001, S182). Whether or not the processing behind sensory phenomenology is encapsulated, scientific observation and scientific methodology is already theory-laden (2001). Another researcher, Donald A. Norman, has stated that in the debate between relativism and extreme

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132 One wonders whether some form of atypical automation or protracted diachronic conditioning, perhaps as brainwashing or some form of psychosis, or even synchronic hypnosis, might just circumvent this normal perceptual biasing towards bottom-up information. We already know that some forms of hallucinations have this capacity.

133 Brewer and Lambert relate stories of how early astronomers' belief in moons led them to perceive early fuzzy images of Saturn's rings as large moons on either side. The notorious 'face' on Mars is another such example – in 1976, early photographs sent back to Earth from NASA's Viking 1 orbiter probe included images of what appeared to be a giant stone face carved into the surface of Mars, leading to rampant speculation about extraterrestrial life. Images by more recent probes have shown this face to have been nothing but an optical illusion created by shadows and topographical features. The example shows precisely that higher-level resources structure the search for evidential and contextual cues, whether the interpretation involved is mana perceptual or higher-level in nature. This leaves open the additional philosophy of science question as to whether higher-level observational evidence is truly at risk from minor variability in lower-level perceptual plasticity (I owe this point to Martin Hahn). Many scientific observations now rely on highly technical experimental results, measured quantitatively and independent of qualitative individual observation. In theory, this takes the subjectivity out of scientific observation, but in practice – as the 'face on Mars' and 'moons on Saturn' examples demonstrate – the conclusions that researchers draw, the reasons that guide their research, and the assumptions behind the use of their tools and apparatus are still highly influenced by variable theory. As a result, we have a second layer of the theory-observation debate and concerns about the referents of our language that I have specifically chosen not to address in this thesis. The present model of perception given herein is not committed to a particular theoretical response to this aspect of the theory-observation debate. However, at the very least it provides reassurance that – contrary to concerns of the reliability of perception for discourse – our perceptual systems maintain adequate commensurability across individuals (at least at this lower level of perception) for scientific debates and our higher-level discussion of theory and observation to get off the ground.
encapsulated specialisation, “as is the nature of such debates, the answer will be in the middle. I think there is much more specialization than we previously believed; but I suspect that the specialization is not as strong as Fodor, at the moment, seems to be advocating” (Norman in Baars 1986, 388).

If the picture I have given is correct, I suspect there will turn out to be greater variation in degree – etiological compromises aside – than in highly specialised natural kinds if and when we finally understand the different systems of the brain. That is, if it is possible for a properly functioning human to suffice with a *mane* perceptual system that taps higher-level functions sharing circuitry with *mane* perception, and that uses a general process in order to create automations where necessary rather than having multitudes of separate and predefined input systems, then it seems empirically likely to be the case. This seems a fairly sensible hypothesis if for the only reason that a system with fewer more versatile types of fundamentally different systems rather than one fully composed of a wider range of inflexible and fundamentally different modular processors would be simpler, more efficient, more adaptively advantageous, and therefore more powerful manner of producing the same results.

Again, I would like to reiterate that I do not mean to say that there are no modules in the brain, but rather to say that there is enough evidence to the contrary that one cannot justify a contrary view of an integrated perception. While we do see evidence of localized, functionally specified groups of neurons in roughly the same locations in the brain across most humans, what we do not have is a radical and comprehensive cordon ing of the sensory perceptual systems generating the phenomenology of observation from the mainstage
cognitive systems primarily responsible for theory. Instead of introverted engineers squirreled away in cells, we find these functionally-specified systems to actually be quite chatty, coordinating their efforts with systems in other departments by intercom, by instant messaging and in a variety of other manners. The avenues of communication exist, and they do so in a widespread manner. This explains our evidence of adaptation over time – as in diachronic plasticity – and in quick temporary sessions – as in memory colour – and is certainly not modularity as Fodor originally envisioned it if it is indeed modularity at all. At the very least, some significant number of intermediary automated systems fill in the rift connecting modularity and higher-level systems and it seems increasingly likely that we have a dynamic array of connections which fill in the gaps in our stimulus information to produce a unified and continuous whole.

Ultimately, our debate comes down to the age-old question of whether you can teach an old dog (or human) new tricks. If one were to ask Fodor, where the trick is perception, his answer would be a resounding no. There is very little you can teach it at all. On our new picture of perception, the answer becomes a tentative maybe. You can certainly teach a youthful pup a variety of new tricks, but where perception in the adult is concerned, the ability to change depends on the built-up cognitive inertia involved and the continuing neuroplastic conditions present in the subject's brain. Where you have connectivity, neuroplasticity, and relaxed cognitive inertia, the avenues of learning and perceptual adaptation are wide open roads for new cognitive growth.
APPENDIX I – Further Clarifications

A few more points of clarification that are helpful for understanding the philosophical and psychological issues at hand.

Firstly, all of these discussions involving perception or observation intuitively involve our conscious phenomenology. However, consciousness is not actually vital to most of these descriptions: many lower-level and mainstage cognitive processes from the mechanisms that produce colour constancy to mechanisms that reconcile new beliefs with our existing theoretical framework can proceed entirely without conscious awareness. While I have chosen to speak of the outputs of Fodor’s modules as sensory phenomenology, I also acknowledge that they could just as easily produce sub-phenomenological information accessible to mainstage cognition but not actually consciously available, as in cases of blind-sight. Modularity theorists who follow in Fodor’s footsteps often deny that the outputs of Fodorian input systems are necessarily conscious (Shallice, in Block, Flanagan, and Güzeldere 1999, 270). Since we do not yet have a clear understanding of the function(s) of conscious awareness, it is important we take note that none of the descriptions of cognition or perception necessarily hangs on awareness, although anything available to conscious awareness can be considered a paradigm case of cognitive access\(^\text{134}\). Sensory

\(^{134}\) Regardless of the views of later modularity theorists, it is fairly evident that when Fodor speaks of the outputs of the perceptual modules, he is primarily describing our sensory phenomenology. He often speaks of outputs of perceptual modules as representations of the world that “perception makes available to thought” (1983, 40). When wondering about the outputs of language modules, he restates the question as asking “which \textit{phenomenologically accessible} properties of an utterance are such that, on one hand, their recovery is mandatory, fast, and relevant to the perceptual encoding of the utterance and, on the other, such that their recovery might be achieved by an informationally encapsulated computational mechanism?” (1983, 88; italics mine).
phenomenology, as a prime example of a pre-doxastic perceptual output accessible to mainstage cognition as an input to belief formation, would therefore be typical of the outputs of modular systems. Whether non-phenomenological modular outputs would count as observation is a matter for later debate which I will not address herein.

Secondly, I occasionally speak of 'bottom-up' versus 'top-down' processes. The meanings of these terms are twofold. 'Top-down' usually refers to cognitive processes that are directed by or have input from the highest-levels of cognition, but it often also serves to refer to neural processes in the causally earlier stages of visual processing in the brain (the LGN, for example) that are directed or influenced by mechanisms in the later stages of visual processing (V1-V5 in the visual cortex). It is important to note here that the implied identity may not be genuine; higher visual centres may not even necessarily be the neural correlates of higher-level cognitive functions. 'Bottom-up' processes, in contrast, generally refer to both the neural and cognitive processes that begin from the sense receptors – the lowest level of visual processing – and are then analysed by increasingly complex neural structures. It is partially this terminological baggage that has resulted in the usage of the term 'mainstage cognition' rather than 'higher-level' cognition throughout much of this thesis.

Thirdly, Fodor is a computational functionalist, which means that he believes psychological mechanisms to be akin to computer programming, complete with representational code, and that neural mechanisms are the

The phenomenologically accessible properties clearly refer to the modular output, and the subsequent conditions are – as we shall see – the specific conditions for Fodorian modularity.
physical hardware implementing those programs. When addressing Fodor's theory, one must always keep in mind that programming and hardware are not identical and that at certain times the mechanisms Fodor speaks of are neural and at other times they are computational in nature.
APPENDIX II –
Some Studies that Violate Hardwiring, Autonomy, and Completeness in Detail

Vivid visualisation and imagination. Beyond neurophysiological imaging, there are also much anecdotal evidence for a deep hardwired link between the mechanisms that subserve *mane* perception and those that subserve higher-level imagination. In one notable case Oliver Sacks describes the case of the neurologically impaired Dr. P, the "man who mistook his wife for a hat", who had lost the same faculties in "not just visual perception, but visual imagination and memory" as well as in his dreams (1998, 22). Sacks describes how Dr. P had shown a level of visual difficulty in seeing certain objects on his left side (1998, 10)[135], and how this also translated to his ability to imagine and internally visualise buildings on the left side of a street imagined from memory. Sacks had asked Dr. P to imagine walking down a local street and list the buildings he encountered and Dr. P could only describe buildings on his right side; this occurred yet again with the opposite buildings when he was asked to imagine walking down the street from the reversed direction. Sacks observes that these “difficulties with leftness, his visual field deficits, were as much internal as external, bisecting his visual memory and imagination” (1998, 15). As further evidence of a genuine link between Dr. P’s perceptual and mainstage cognitive deficits, Dr. P’s aphasic problems with visual perception crossed over to his

[135] In Fodor’s defence, what Sacks describes are examples of Dr. P having difficulty finding objects on his left side – a deficit that could be completely recognitional in nature, in which the difficulty is not in seeing but in identifying. Identification may in this case be a product of so-called ‘higher-level’ process as in belief fixation, but Fodor is never entirely clear what types of identification are modular (as in his linguistic parsers) and what are purely higher-level. I believe that such a distinction proves to be increasingly forced and artificial to maintain in much the same way that the memory colour studies show the likely assistance and confluence of object identification and memory upon the very phenomenology of perceived objects.
dream phenomenology, as “when he was questioned closely, that he no longer had visual images in his dreams” (Sacks 1998, 22). We shall see shortly that there is much neurophysiological evidence on this apparent link between perception and dreams to weigh in on the case of encapsulation.

I noted earlier that when considering neurophysiological evidence, one must keep distinct the notions of top-down influence with respect to the causal order of processing – as in later stages of the visual cortex processing ever-more refined aspects of sensory data, in turn influencing earlier processing – and top-down influence with respect to mainstage cognition influencing early perception. Here, however, we see studies and evidence that satisfy both notions of top-down influence, since the studies we have considered observe the effects of later-stage processing that are functionally part of mainstage cognition on early perceptual processing that is very likely to be part of perception. In this case, top-down influence cannot be said to be merely part of module-internal operations as is allowed by Fodor (1983, 76-86), since it involves influence by accepted higher-level ‘central’ cognitive processes.

*Memory and visualisation*. If vivid visualisation and imagination share resources involved in perception, it seems likely that vivid remembering – the source material from which our imaginings are drawn – ought to also share resources with perception. As an interesting and complimentary parallel to imagination, we find in the empirical literature an increasing number of studies suggesting that vivid remembering also activates neural resources involved in perception. Unfortunately, work in this area somewhat preliminary as
conclusions are hampered by the fact that most of these studies focus for perception upon the studied memorisation of an image to be vividly recalled at a later point (Wheeler et al 2000; Nyberg et al 2000; Slotnick 2004). This leaves the question open as to whether these studies are detecting post-sensory-phenomenological mainstage cognitive resources such as Fodor’s ‘belief fixation’ process or whether they are observing a shared systems between higher-level and mane perceptual systems that are indeed influenced by higher-level aims. Studies that do manage to show a sharing of physiological resources must still pass the test of demonstrating a concurrent state of interference caused by the competing demands for access to these resources from mane perception and mainstage cognition – a criteria that many of these studies neglect to specifically examine. Furthermore, much of the difficulty in tracking down specific physiological features of the brain is further complicated by individual variations (Kayser et al 2007), but also by the fact that different features of an image – whether perceived or recalled – may be processed in different areas of the brain (Slotnick 2004). This means that different images recalled or perceived may activate different localities in the brain in different manners, constraining the accuracy of functional imaging techniques.

An example of such difficulties will be helpful. Wheeler et al report in a recent study finding that subjects performing a vivid memory recall task under functional MRI showed activation in visual and auditory cortices in “distinct subsets of those activated during Perception” (2000; 11129). However, in their study, they found that it was later sensory regions “most likely beyond areas V1, V2, V3a, and V4” that were being activated in both of their perception and recall
tasks (11127). Initially, this conclusion may support Fodor's contention that higher-level processes are functionally and neurologically distinct from the early and encapsulated systems that constitute the perceptual modules. A modularity theorist might argue that it is perhaps post-sensory-phenomenological mainstage belief fixation that Wheeler et al are observing rather than processing that goes into the production of sensory phenomenology. However, the observation of the activation of neurologically later-stage processing areas does not necessarily mean the sole activation of functionally higher-level processing, especially if mainstage cognition is non-localised as Fodor suspects. A modularity theorist could also take the stance that Wheeler et al are observing some common component of both perceptual and higher-level systems but that either the rest of the module remains inaccessible to mainstage cognition, the common component is not itself internally penetrable to mainstage cognition, or that encapsulation somehow keeps the demands for the same processing resources distinct and separate. The fact that we can also entertain vivid

136 Wheeler et al note that among the areas that they observed were activated by both perception and vivid recall tasks, studies have implicated activity in the left ventral fusiform region in the processing of shape, colour, and texture properties of objects and activity in the other activated areas have been observed in the processing of object spatial properties (2000, 1129).
137 It is interesting to note that in the Cui et al study (2007), the researchers reported activity in Brodmann areas (BA) 17 and 18 of the early visual cortex, whereas in the Wheeler et al study (2000), visual cortex activations were estimated to be later in the visual cortex, including Brodmann area 7 (located in the parietal somatosensory cortex), and Brodmann area 19. Another study, Slotnick et al (2004) suggests that early visual cortex BA 17 and 18 activation occurs during non-conscious memory activation, perhaps when stimuli are primed by repetition and reinforcement to be activated in a subsidiary manner when a subject is presented with novel sensory stimuli such as an unfamiliar face (2004, 217). This supports the contention here that the same higher-level processes are components of both maine perception and in higher-level visualisation. Slotnick also suggests that activations of later visual areas BA 19 and BA 37 occur during conscious memory activation, such as in the directed vivid recall task in Wheeler et al. Even if distinct higher-level processes are involved in both the unconscious and conscious memory retrieval conditions, this shows at the very least – particularly in the unconscious condition – that higher-level resources are indeed active during maine perception.
memories and maintain a degree of awareness of our sensory surroundings and the attentional realities involved suggests that if the same neural resources are involved in both sensory phenomenology and visualisation, they ought also to be capable of being shared by concurrent processes. This multitasking may further complicate the results of functional neuroimaging. Without a demonstration of interference caused by *mane* perception and mainstage cognition sharing resources, results are still forthcoming from this avenue of research.
APPENDIX III –
Alternative Theories: Contemporary Massive Modularity Theories

While debate in philosophy on the status of modularity in perception and cognition continue through exchanges such as those between Fodor and Churchland and the present thesis, many researchers in psychology are attracted to the allure that modularity theory presents of easily breaking down the constituent parts of the mind. These contemporary modularity theorists extend the claims of modularity in an attempt to decompose mainstage cognition under the loose banner of ‘massive modularity’ theory. These ‘massive modularity theories’ take the claim about perception as definitively settled by Fodor in favour of modularity and instead focus upon applying modularity to cognition at large. I should note that Fodor himself expressly disapproves of the application of modularity to higher-level ‘central’ cognition, as he argues in *The Mind Doesn’t Work That Way* (2000). Furthermore, in the attempt to make their modularity theories more resistant to criticisms such as those I have levelled above, each adjust Fodor’s basic requirements for modularity in their own ways. As we shall see, these attempts often leave modularity even weaker than it was originally. My treatment herein of these alternative modularity theories will be necessarily superficial as my focus in this thesis is specifically directed towards Fodor’s original modularity theory and not the numerous variations of it that now exist. However, where my previous criticisms apply for Fodor’s more limited version of the theory, they also apply – more or less – to the various extensions and contortions of modularity theory. Two examples of modern modularity theorists that I will briefly mention are Dan Sperber and Max Coltheart.
Sperber describes his conception of massive modularity as the position that there are “genuine modules, that modules came in all format and sizes, including micro-modules the size of a concept, and that the mind was modular through and through” (2002, 47). Sperber’s modules, like Fodor’s, operate on highly specific types of problems in an inflexible and involuntary manner and would have all the clearly defined functional roles, fast operation, endogenous specification\textsuperscript{139}, hardwiring, informational encapsulation, of Fodor’s modules. Unlike Fodor, Sperber’s modules need not be ‘vertical’ systems. Making a distinction between the information a module accepts as inputs and the encapsulated database of informational resources to which a module has access during processing, Sperber argues that Fodor’s requirement of restricted inputs is unnecessary for maintaining the informational encapsulation of modular databases. So long as a module’s computational databases are encapsulated, these modules can also be the types of horizontal – and therefore typically cognitive – systems that accept general inputs from a wide variety of domains and so make up the constituents of mainstage cognition\textsuperscript{140}. In essence, Sperber eliminates domain specificity from the requirements of modularity in order to tailor modularity to domain-general cognitive functions.

\textsuperscript{139} Sperber criticizes Fodor for rejecting evolutionary justifications for the development of cognitive modules, arguing that such explanations for modular functions would allow a modularity theorist to better defend a case for any particular functionally specific cognitive process as a modular system (2002). The same reasoning also makes it clear that Sperber also subscribes to Fodor’s other requirements of modularity such as speed, hard-wiring, non-assembly, and innateness. Modules exist in us because as simple, quick, reflex-like mental mechanisms, they are adaptively advantageous and so have been passed down through genetic and thus innate hardwiring.

\textsuperscript{140} One example that Fodor rejects as modular due to violations of domain specificity and which Sperber’s massive modularity accepts would be an automatic but general cognitive mechanism specifically geared to perform the operation of Modus Ponens on any of a subject’s beliefs being held under consideration, but which operates irregardless of contrary information in the subject’s possession (Sperber 2002).
In fact, domain specificity is the least of all problems with modularity since pretty much any processor dedicated to a discrete problem could be termed domain specific depending on one's interpretation of domain; I really have no theoretical problem with there being a few modular-type systems of this type\textsuperscript{141}. Our studies above should have already shown that the domain specificity of processors need not – as Fodor would have us believe – be limited processing to single sensory modalities. The primary issue with applying modularity at large to mainstage cognition is that unless we presume an individual to be born with all of her future capacities pre-programmed and that none of her experiences shape her mental life in any way (themselves implausible presumptions), modularity 'through and through' still does not make any sense for a comprehensive theory of mind. Many of the capacities we associate with mainstage cognition do not merely defy Fodorian domain specificity, but also the other modular requirements: informational encapsulation (both diachronic and synchronic), inflexible hard-wiring, endogenous specification, and non-assembly\textsuperscript{142}. We have already seen numerous examples earlier even from *mane* perception: unless an individual is born with foreknowledge of bananas and their associated colours, colour memory violates the specific idea of encapsulated and innate modular

\textsuperscript{141} Given the existence of fight-or-flight instincts, it even seems likely that some elements of higher cognition may have modular connections of some sort. However, this by no means lends credence to a fully modular cognitive picture since instincts are hardly paradigmatic of the flexible nature of higher cognition. The existence of endogenous but domain-specific structural elements is also an important component of Karmiloff-Smith's developmentalist views.

\textsuperscript{142} Although Sperber is committed to these features due to his view that neural hardwiring is underwritten by evolutionary adaptation, he cannot retroactively trade on any one or more of these other modular capacities in order to soften the restrictions of modularity as this no longer leaves us with a uniform and non-heterogeneous classification of natural kinds. Thomas and Karmiloff-Smith make an argument to this effect when they state that once “one chooses to make certain of Fodor's criteria optional or graded, then the notion of modularity is no longer doing any work for the theory” (1998, 247). I will elaborate more on this momentarily.
databases. Any system – whether higher or lower-level – which changes its reaction according to an individual's past experience will violate multiple requirements of modularity. If modules cannot be assembled from smaller components or even other modules, it also makes no sense to state – with Sperber – that they can come in all sizes. Much of contemporary academic psychology depends on the assumption that faculties can be decomposed into simpler systems, and a large internally undifferentiated module would be slow and unwieldy, contrary to the purported advantages of modularity. Finally, Fodor's primary reason for distinguishing between malleable central systems and modular perceptual input systems was to explain the consistency of experience across humans – making mainstage cognition modular runs completely counter to this intent since people do not all think alike. Unless Sperber can provide some manner in which flexibility, change over time, and variability are emergent from disparate inflexible modular components, massive modularity of the sort Sperber intends remains implausible at best.

143 One may wonder whether higher-level learning capacities might somehow be accomplished by inflexible but horizontal modules taking inputs from flexible memory stores such that it is never the processing database that violates encapsulation but simply a receptiveness to a variety of inputs. Indeed, this is likely the picture that Sperber intends in doing away with domain specificity: it is simply that different modular processors get activated by inputs that fit requisite input patterns rather than specific modules changing in response to experience. Once again, habituated behaviours typical of adaptive automations tell a different story. First of all, habituations – and by these I include trained-in reflexes typical of athletes – are formed where there was no such previous behaviour pattern. Second of all, they are fast and autonomous to varying degrees. It seems implausible that these novel behaviours are simply artefacts formed by discrete and unchanging modules scanning our memory stores for patterned inputs. As Fodor would point out, such a system would be incomparably slow next to one whose internal operations themselves – the 'modular' database, if you will – absorb the requisite information to perform the task. The apparent inflexibility of habituated behaviours makes more sense where necessary information for the task is contained in the system rather than detected from a separate and more flexible memory storage system.
Although Max Coltheart’s position is not explicitly presented as a massive modularity theory, he – like Sperber – essentially intends modularity to be applied to much if not all of mental life. Coltheart takes Fodor’s claim that he is not “in the business of defining [his] terms” (Fodor 1983, 37) to mean that Fodor’s requirements were never intended as definitive or mandatory. If Fodor is not providing an authoritative definition of modularity, then none of his proposed properties are truly necessary for modularity and exceptions to these properties do not affect claims of modularity. In contrast to Sperber, Coltheart argues that the only property actually necessary to the individuation of a module is domain specificity (Coltheart 1999, 118), a feature original to his interpretation. Any system or mechanism (of any size) that has a very narrow and clearly defined input can be considered to be a module; all of Fodor’s other requirements are merely general properties that modules may have and are subject to empirical confirmation. The removal of the ‘non-assembled’ requirement also allows modules to be broken down into other smaller modules and in such a way decompose the problematic elements of cognition (Coltheart 1999, 117).

By denying the necessity of all modular properties besides domain specificity, Coltheart tries to explain away internal theoretical inconsistencies such as I have pointed out above and external inconsistencies between empirical facts and Fodor’s modular properties as not constituting violations in Fodor’s theoretical commitments. However, this just leaves Coltheart with an empty theory and reduces modularity to an ad hoc label for any “functionally

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144 I will herein identify massive modularity theories with a commitment to modularity as widespread and comprehensive of mental operation.
individuated cognitive mechanism" (Fodor 2000, 58). This is a description which both Fodor and Sperber agree is too vague and inclusive a definition of modularity to be of any predictive or explanatory value (Sperber 2002; Fodor 2000). Without Fodor's stern commitments on the requirements of modularity, modularity "becomes a descriptive term, theoretically committed to not much more than a general notion of neural specialization" (Thomas and Karmiloff-Smith 1998, 247), as opposed to "retaining the strong theoretical base that leads to precise predictions about what can or cannot interact with what in the human brain" (Thomas and Karmiloff-Smith 1998, 245). Thomas and Karmiloff-Smith are quick to point out - contrary to Coltheart - that Fodor (1983) clearly wanted to exclude 'practiced' abilities such as chess-playing as modular and as such was adamant about the necessity of his modular requirements (1998). This 'weak' approach to modularity risks being vacuous and insubstantial; by denying the necessity of hardwiring and endogenous specification to modularity, we no longer have even neural specialization to claim as a ground for modularity; we might still have Fodorian computationalism but much to the traditional modularity theorist's chagrin, it would be in a neurally undifferentiated brain.

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145 Indeed, a mechanism that is defined by domain specificity need not even have a specific functional role – it is nothing more than a sensitivity and even a transducer or something less could then count as a module!
LIST OF REFERENCES


