Language, Thought, and Information Processing

PATRICIA SMITH CHURCHLAND

UNIVERSITY OF MANITOBA

There is no doubt that some of the information-bearing states of the central nervous system are not a species of sentential attitude; that is, they are not describable in terms of the person's being in a certain functional state whose structure and elements are isomorphic to the structure and elements of sentences.[1] Obviously, for example, the results of information processing in the retina cannot be described as the person's believing that p, or thinking that p, or thinking that he sees an x, or anything of that sort. At the other extreme, there is also no doubt that some intelligent creatures talk, and indeed, sometimes talk silently to themselves. Between the obviously non-linguistic information processing and the obviously linguistic behaviour, there appears to be much of a cognitive sort going on in the brain-mind in virtue of which the intelligent behaviour is intelligent. The nature and form of these intermediate processes are the source of profound perplexity and the cause of much speculation. As yet, the perplexity and speculation have not sired anything that could justly be called a theory of information processing in intelligent beings, though the search for information-processing models appears to be providing an impressive bounty of inspired guesses concerning at least some parts of what must be an awesome organization.

In this paper I mean to focus on a very general and fundamental question concerning the character of information-processing models for humans; to what extent—how far down—can the processing be described in terms of operations amongst sentential attitudes such as beliefs, desires, thoughts, and so on? My answer is that we had best abandon the sentential attitude for all but rather superfi-

cial processing, and that we should set about forging a new paradigm to do service in a scientific psychology. The first part of the paper will consist in a discussion of the role of the sentential attitude in certain theories of the brain-mind, and the second part will explore the reasons for doubting the integrity of the sentential attitude as a paradigm in theories of how the brain-mind works.

Since about the mid-fifties, there has been a growing interest amongst psychologists in the possibility that information-processing models, as used by computer scientists trying to simulate intelligent behaviour, might be exploited for theorizing about how persons accomplish such things as remembering how to solve differential equations, figuring out how to fix a motor, learning a language, etc. Frustrated by the theoretical sterility of abstemious forms of behaviourism, intrigued by what seemed to be theoretical fertility in intelligence simulation research, and encouraged by Chomsky's unblushing posit of mental states, psychologists began to nurture the promise in taking the brain-mind to be an information-processing device, and they began to construct models which hypothesized the existence of certain organizations of functional states which operated on information received.

Broadly speaking, there are several empirical constraints limiting the class of adequate hypotheses: (1) the functional organization must be realized in neural stuff,[2] (2) the verbal organism, man, presumably evolved from non-verbal organisms, and (3) non-verbal organisms as well as verbal organisms behave intelligently, and therefore enjoy complex information processing. The effect of these constraints has meant, for example, that there is a presumption against the idea that what is really needed are *two* radically distinct theories of intelligent behaviour, one for intelligent verbal animals, and one for intelligent non-verbal animals. Notwithstanding our unique linguistic abilities, and the need for a theory of intelligence that will account for them, it would be viewed with deserved suspicion if it were claimed that we need to look for one sort of theory for verbal organisms, and a theory of an entirely different cast, with entirely different structure postulated, for non-verbal organisms.[3] Saltation is, I suppose, not inconceivable in the evolutionary process, but saltation of such proportions as would force us to see man as a

creature without epistemic affinities to non-verbal creatures is an hypothesis of unworthy wildness. On the contrary, there is reason to think that, greater though our cognitive faculties may be (and certainly some of that increment is owed to the fact that we *have* learned rather than that we *can* learn a language), the human brain shares much with the subhuman brain. Accordingly, we should expect a theory of information processing in humans to be a special case of the theory of information processing in organisms generally. The problem then, for information-processing research, is to find a model of how we (our nervous systems) intussuscept information, transform and filter it, and come to represent the world in the astonishingly complex, rich, and efficient way that we do.

Granting the aforementioned constraints, there are a number of general questions, quite apart from the details we all lust after, which need to be asked, pertaining to the fundamental form we might expect our own information processing to take. The question which I mean to worry in this essay concerns the extent to which *linguistic* behaviour will provide the template in characterizing information processing in the brain. The query is this: are inner processes best thought of as analagous to action performed with speech, albeit silently and unconsciously; and consequently, should the processing be taken to consist pretty much of complex sequences of sentential attitudes[4] (believes that p, calculates that the probability of e is m/n, wants that p, and so on) mediated by such operations as inference? Or alternatively, is it possible that the best theory will be one which hobbles the model of overt speech, relegates sentential attitudes to a very minor role in the theory of information processing, and seeks in their stead non-sentential states and processes to account for how the brain represents the world and guides behaviour? On this latter alternative, the theory would postulate an organization for processing information, but only a small part of that organization would involve sequences of sentential attitudes, and much would involve cognitive states which are not sentential attitudes.

Since the use of the expression 'sentential' in application to models and theories of information processing in cognitve systems is perhaps not established,[5] it behooves me to set out as concisely as possible just what is meant. Typically, a theory of information processing which is sentential has the following features.

(1) It takes the cognitive states to be attitudes toward sentences and hence to be identified via sentences. The identification is presumed to be possible by dint of an isomorphism holding between the states of the person (his brain, or in the case of a dualist, his soul) and the relevant sentences of a set. (There will be various theories concerning how the sentences are best analyzed.)

(2) It takes the theoretically important relations between the cognitive states to be characterized by means of the resources of logic. The logical characterization of the relations between the states of the person (his brain, his soul) is alleged to be possible by dint of the aforementioned ismorphism. (There will be various theories of logic which will be variously favoured and invoked by cognitive psychologists and philosophers of mind.)

(3) It takes the transitions between states to be a function of the logical relations holding between the sentences identifying those states, which, in the most straightforward case will consist of inference, abductive and deductive.[6] This characterization of the transitions is again construed as possible on the basis of an isomorphism presumed to obtain between states of the person (his brain, his soul) and sentences. (There will be various theories of logical and quasi-logical transitions variously favoured and invoked.)

(4) It takes the evaluation of the cognitive virtue or excellence (rationality) of the system to be a function of the extent to which it succeeds in doing what the favoured theory of state transition (e.g. theory of inference) says it ideally should do.

In the light of this very brief explication of what it is for a theory of information processing to be sentential, the guiding question of this paper can be re-stated: to what extent is the presumption of isomorphism between cognitive states and sentences tenable?

The spirit of the sentential paradigm for theories of the brain-mind is perhaps most splendidly and succinctly captured by Ian Hacking. In answer to the question, 'Why does language matter to philosophy?' Hacking avers:

> *It matters for the reason that ideas mattered in seventeenth century philosophy*, because ideas then, and sentences now serve as the interface between the knowing subject and what is known. (his italics) ([22]:187)

This is, I think, a pure distillation of the assumptions involved in the sentential approach to cognition, and notice that Hacking does not hedge his bets and say that sentences constitute one interface amongst others, but rather that they constitute *the* interface.

A prominent contemporary inspiration for sentential theories of the brain-mind is Wilfrid Sellars.[7] In his classic paper, "Empiricism and the Philosophy of Mind," Sellars argued that mental states are, in certain relevant respects, theoretical states. According to Sellars, embodied in our ordinary conceptual scheme is a theory of the inner life of persons—a theory which postulates the existence of mental states which figure in the etiology of overt behaviour but which are themselves inner and private. The model which subserves the theory is overt speech. Invoking his Jones parable to explain this rather complicated idea, Sellars has us imagine the mythical Jones seeking the theoretical means to transcend the explanatory inadequacies of the tribe's Rylean behaviourist psychology:

> . . . Jones develops a *theory* according to which overt utterances are but the culmination of a process which begins with certain inner episodes. *And let us suppose that his model for these episodes* which initiate the events which culminate in overt verbal behaviour *is that of overt verbal behaviour itself. In other words, using the language of the model, the theory is to the effect that overt verbal behaviour is the culmination of a process which begins with 'inner speech.'* (his italics) ([35]:186)

The inner processes then, involve such states as believing that p, desiring that p, hypothesizing that p, and even perceiving that p, all of which are analogically related to overt utterances of p.

> *Seeing that something is the case* is an inner episode in the Jonesean theory which has as its model *reporting on looking that something is the case.* (his italics) ([35]:190)

As a thesis about the status and character of common sense psychology, Sellars' account is profound and powerful, but nothing in the thesis implies either that common sense psychology itself is correct as far as it goes, or even assuming

that it is correct as far as it goes, that it will bear expansion and development. In fact, in later writings Sellars reveals a significant misgiving concerning the dependence of common sense psychology on sentential attitudes:

> The 'linguistic model' begins to look far too narrow and specialized to capture the nature of thinking, even at the strictly human level—let alone in the sense in which animals think. ([36]:304)

Other philosophers who have drunk deeply from the Sellarsian well seem more robustly confident of the soundness of the sentential model than Sellars himself. Harman, for example, is thoroughly convinced that the representational character of brain-mind states is tied to sentences, and he says:

> Representational characteristics of mental states derive from representational characteristics of sentences of the language of thought. ([23]:57)

The same conviction would appear to underlie Rosenberg's comment that ". . .linguistic representation is *the* basic nonderivative mode of representation." ([34]:112)

From another direction, John Woods gives pithy expression to the sentential assumption when he says:

> *Ratiocination is linguistically incarnate.* In fact, so efficient an instrument and medium of reasoning is language that there can be little good reason for not accepting the following hypothesis: *HYPOTHESIS 3.10* Between any ratiocinative language "L" and ratiocination "R" there exist certain relations "S", "S1", "S2" etc. by virtue of which to know certain facts about L is to know certain things about R. ([43]:41)

The sentential model does not, it appears, want for admirers, but it is certainly time to assess whether it deserves the devotion it enjoys.[8]

On the face of it, the sentential approach to information processing in intelligent organisms may seem to be uniquely and strikingly plausible. For one thing, part of the theory sought is already available, embedded in the common sense conception of how humans beings work.[9] The theoretical task, though nevertheless immense, is already begun on the sentential strategy, insofar as the basic kinds of information processing states are already characterized and identified (believing that p, wanting that p, and all the rest.) The main job will consist in extending as well as elaborating this kernel of theory

which is a part of common sense. On the other hand, if one finds it necessary to forswear the sentential approach, the theoretical task is ever so much more immense, for our common sense conception of how intelligent organisms work does not provide more than a scanty stock of psychological concepts of a non-sentential stamp which might be dusted off, smartened up, and put to use. On the sentential strategy, common sense provides the basic tools, and the theory of cognitive dynamics of intelligent beings is to be built by means of them. On the non-sentential approach, we shall have to start pretty much from scratch. Starting with meagre store is rather daunting in the scientific enterprise, and perhaps it would be more efficient to begin with the ready trove of common sense. The crucial question, of course, is whether the tools of common sense are up to the task required of them, or whether it might not be a bit like using more and more intricate arrangements of basla wood and baling wire to reach through the earth's atmosphere to outer space beyond. If they are adequate, the attempt to develop a non-sentential conpetitor may seem like wanton Feyerabendian excess. But if they are not up to the task, the sooner the non-sentential strategy is recognized, befriended, and developed, the better.

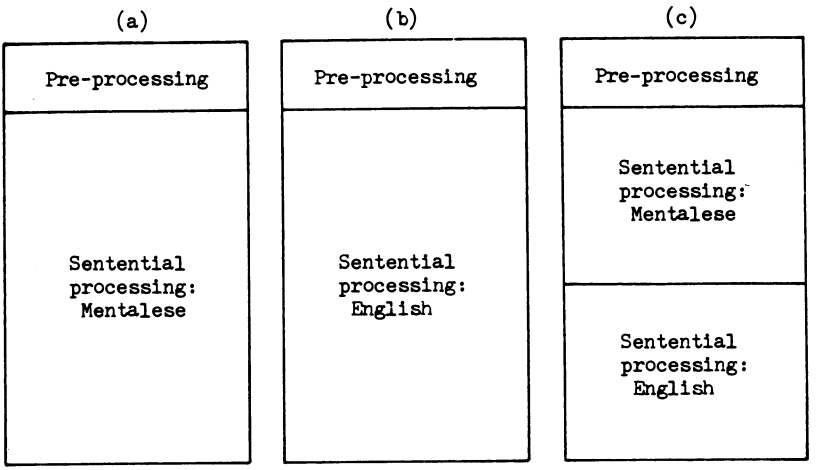
For those who hold that the common sense conception of our internal epistemic dynamics is spared interrogation because it enjoys an *a priori* sanctity, the only approach conceivable will be sentential. This is not the place to argue that common sense is theory laden, that there is no Given, that there are neither epistemological foundations nor unrevisable theories nor even First Philosophies. I unabashedly avow my persuasion to these claims, and perhaps some of the reasons I shall advance for shifting the paradigm of the sentential attitude will move diehard empiricists to consider afresh the arguments for naturalizing epistemology.

Having adverted to a bifurcation in approaches to information-processing theories, I should straightaway explain that what is envisaged is not that there are precisely two possibilities, and well defined ones to boot. Between the two extremes of processing that is wholly sentential and processing that is wholly non-sentential, the possibilities crowd along a spectrum, varying in the extent of sentential processing assigned. Neither are these many possibilities well-defined, though the sentential extreme is perhaps better understood

(ill though that may be) than any other possibility. In any event, it is my observation that the sentential extreme of the spectrum dominates cognitive psychology and also contemporary philosophy of mind, that the sentential attitude serves as the prevailing theoretical paradigm, and that to the extent that alternatives on the non-sentential end are perceived, they are thought to be *mere* possibilities, and not worthy of serious attention. It is acknowledged, for example by Fodor ([19]:28), that it is indeed an empirical question whether the sentential presupposition (for him, the 'computational presupposition') is actually true, but he is nonetheless quite innocent of any real suspicion that it might be false, or that the stresses and strains already visible in the sentential approach could be signs that we have to re-assess the prospects of that dear and comfortable old shoe, the common sense psychological theory.

The following chart (Figure 1) is an attempt to give a rough picture of certain nodes of possibility. Group I takes all significant processing to be sentential, whereas Group II allocates a substantial block of processing to non-sentential structures. In each group I have allowed for the possibility that two theories, otherwise in agreement on the *extent* of sentential representation, may differ as to the *medium* of representation, some preferring a genetically endowed language (Mentalese) as the medium, others preferring the acquired language (English) as the medium. I have also in each case set aside a block for *pre-processing*, though for obvious reasons I do not take there to be a sharp distinction between processing and pre-processing, especially in the absence of a theory of information processing which draws such a distinction. I shall follow the custom of neuroscientists in taking pre-processing to be processing that takes place in the nervous system exclusive of the brain proper. I insist that I not be understood as offering more than a heuristic definition, the utility of which is owed to the probability that interesting disagreement on the form of information processing (sentential or non-sentential) is likely to arise at levels beyond the level of processing by the nervous system exclusive of the brain. Nor do I mean to foreclose by fiat the possibility that someone may wish to hold that even pre-processing is sentential. In fact, as we shall see, Harman seems to embrace just this extreme position. Finally, the size of the blocks is meant to represent only roughly how much processing of the relevant type is going on in the model in question.

GROUP I HYPOTHESES:



GROUP II HYPOTHESES:

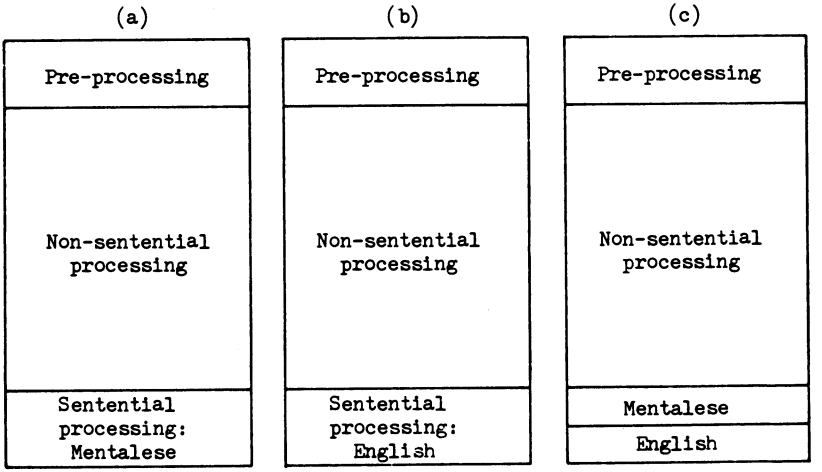


Fig. 1

The approach I(a) is unstintingly embraced and extensively discussed by Fodor in [19]. He takes absolutely seriously and almost for granted the idea that the psychological theory embedded in common sense should be expanded upon to generate the grander theory of processing which is to account for learning a language, intelligent choice, perception, and so on.

The expansion consists of hypothesizing highly complex sequences of sentential attitudes as underlying, for example, the belief that I now see a raccoon under the apple tree, that I intend to tie my shoe laces, etc. He provides a sketch of the sort of model we can expect to get for choice:

1. The agent finds himself in a certain situation (S).
2. The agent believes that a certain set of behavioural options (B_1B_2,. . . .,B_n) are available to him in S; i.e., given S, B_1 through B_n are the things the agent believes that he can do.
3. The probable consequences of performing each of B_1 through B_n are predicted; i.e., the agent computes a set of hypotheticals of roughly the form 'if B_i is performed in S, then, with a certain probability, C_i'. Which such hypotheticals are computed and which probabilities are assigned will, of course, depend on what the organism knows or believes about situations like S. (It will also depend upon other variables which are, from the point of view of the present model, merely noisy: time pressure, the amount of computation space available to the organism, etc.)
4. A preference ordering is assigned to the consequences.
5. The organism's choice of behaviour is determined as a function of the preferences and probabilities assigned. ([19]:28-9)

Despite the fact that this is, as Fodor warns, only a theory schema, and a highly idealized one at that, it does boast features paradigmatic of the sort of theory Fodor imagines will gradually emerge from research. That it draws heavily on common sense psychological theory is self-evident, and that the information-bearing states are sentential attitudes is equally evident.

I am not entirely convinced that there is anyone who would, if he thought about it, accept I(b), though a number of philosophers who eschew Mentalese appear nonetheless to be whole-hearted in their commitment to the sentential paradigm. Consider, for example, Gilbert Harman, ardent foe of Mentalese and ardent advocate of a Sellarsian theory of meaning [23], [24]. In the course of ruminating on a theory of mind, he has occasion to consider how the data from sensory chan-

nels figure in our representation of the world. He claims that we use the data from the eye in the way we use premises in an argument, save that the inference is *automatic*:

> The claim that perceptual inference is from sensory stimulations should rather be interpreted to mean that sensory stimulations serve for the perceiver as representations that constitute data for his inference. ([23]:185-6)

> Different sorts of stimulation of his retinal nerve represent different things to the perceiver. The data of his inference include not only the claim that his eye is being stimulated in one way or another but rather whatever is represented by that stimulation. Does he believe the data? *He uses them in the way one uses beliefs in inference.* (my italics) ([24]:186)

Now I take Harman to be quite content to suppose that visual processing and even visual pre-processing is sentential—it proceeds from state to state via inference, and the states themselves, though not 'linguistic', are nevertheless somehow (inexplicably somehow) sufficiently like sentential attitudes to be treated as such in processing. Harman apparently has his doubts about the extent to which our representations are sentential ('linguistic'), as the first part of the following quotation shows, but notice how having given with one hand, he swiftly retrieves with the other:

> How things look is constituted by a partly pictorial non-linguistic representation of oneself in certain surroundings—a representation which you are (at least partly) *disposed to treat as one of your beliefs*. (my italics) ([23]:183)

Now whatever 'linguistic' means for Harman, it is clear that insofar as he takes the agent to be 'treating' his non-linguistic representations as beliefs, and insofar as the relations between the states are inferential, he is presupposing the sentential paradigm. The only sort of mechanism for processing Harman seems willing to countenance is inference, and as a result, he finds himself in the unenviable position of having to say that the data from sensory channels may be non-linguistic, but for all that, they function just as though they were. From the point of view of explanatory usefulness this is rather like saying that though of course there is no *deus ex machina*, the brain functions as though there were. *Prima facie*, one would have thought, if the data are non-linguistic, then the process-

ing which uses these data, and leads (if and when it does) to a perceptual judgement, precisely must be distinct from the processes characteristic of argument.[10,11]

Quite apart from the question of whether the processing should be thought to be through and through *sentential*, there is the question of whether, if it *is* sentential, the medium of representation can be English, and English only. The answer is no, for there is an obvious and devastating defect with I(b). Learning, and in particular learning a language, is to be explained on the thorough-going sentential approach as a function of the organism's framing hypotheses, testing them against the evidence, rejecting falsified hypotheses, and in general comporting itself like a proper Popperian. Now if the organism's only medium of representation is English, there is no medium of representation in which to acquire the medium of representation, English. Moreover, on I(b) we cannot encompass within our theory the information processing of non-verbal animals, thus violating the second and third constraints mentioned on p.3. Fodor goes straight to the heart of the matter:

> The obvious (and I should have thought sufficient) refutation of the claim that natural languages are the medium of thought is that there are non-verbal organisms that think. ([19]:56)

Accordingly, I(c) might be thought to be more accomodating, for one might argue that Mentalese is the language of thought until and unless one acquires a natural language, in which event, the acquired language gradually takes over as the language of cognitive representation. Someone who objects to Mentalese as far as a theory of meaning is concerned, as Harman [24] and Rosenberg [34] do, may not have objections to the posit of Mentalese in the context of devising a theory of information processing. Harman, correctly in my view, sees Mentalese as explanatorily otiose as far as a theory of *meaning* is concerned, but whether he finds it otiose in a theory of language *learning*, or in a theory of perception, is not altogether clear. One objection he raises, though not the most important one, is that on the Mentalese hypothesis in a theory of meaning, one needs to postulate a coding-decoding device for taking Mentalese strings into English and vice versa. The beauty, or one of the beauties, of supposing that English, and English only, is the medium of thought is that we can dispense

with this bit of seemingly excess baggage, the coder. Notice, however, that if we have to postulate Mentalese in our psychological theory, following the strategy for I(c) suggested above, we still need a coder. Even if one imagines that English gradually assumes responsibility for the child's thought, we still need to posit a coder for the period when the child is learning the language, when his English is not yet sufficiently developed to serve as the medium of thought, but when he does engage in some articulation, and can understand a good deal of what is said to him.

It might be that Fodor can as well accept a version of I(c) so long as the English information processing component is strictly limited—limited perhaps to nothing more than the inner dialogue we engage in when, for example, we rehearse what we expect to say to the traffic cop. But certainly Fodor, unlike Harman, will demur at the suggestion that unrehearsed English utterances must be preceded by English thought, that voluntary actions must be preceded by English calculations, thoughts and intentions, that English thoughts are inferred as the result of sensory stimulations. In Fodor's view, the processing antecedent to unrehearsed English utterances is conducted in Mentalese, the processing antecedent to voluntary actions is in Mentalese, and the perceptual conclusions are also in Mentalese. The accord between Fodor and Harman has to do with the sentential character of the information processing; the discord has to do with the medium of representation.

Now the presumption underlying Group II hypotheses is that a substantial amount of processing will be characterized by a theory which postulates cognitive structures and states which are *not* sentential attitudes, and that some such processing figures in learning, perception, intelligent choice, etc. Thus where Fodor would expect sequences of sentential attitudes, Group II hypotheses would provide for radically different structures. As indicated earlier, some reason is needed for preferring the non-sentential approach to information processing in humans, and I shall now proceed by considering several of these reasons. The consequences of pursuing the sentential strategy to the hilt are to some extent explored by Fodor in [19], and the more dramatically untoward of these consequences arise in connection with language learning. It is to this that I now turn.

The somewhat stupefying conundrum of how children learn a language is argued by Fodor to be amenable to solution once it is seen that the resources of Mentalese can be engaged by the child. Conforming to the method used earlier in delineating a theory schema for intelligent choice, Fodor argues that in learning a language the child frames hypotheses, tests them against the evidence, accepts those which have not yet been falsified, rejects those for which there is falsifying evidence, etc. The hypotheses are framed in Mentalese, the same language the child uses for representing his environs, calculating his preferences, etc. The hypotheses are, on Fodor's thesis, biconditionals, which match a Mentalese predicate with a predicate of the target language, and look like this:

$$\ulcorner \text{Bear}(x) \urcorner \text{ is true in L iff } G(x)$$

For every predicate in the language *vocalis* that the child can learn, there must be a predicate available in Mentalese, since learning proceeds *only* via the framing of hypotheses, etc. The consequence, which Fodor intrepidly stands by, is that there is no such thing as concept learning. Given the assumption that language learning consists of the child going through certain sequences of sentential attitudes, the argument is simple. Consider any concept, C. Either there is a Mentalese equivalent to C, or there is not. If there is not, the child cannot learn C, at least not by framing hypotheses etc., and there is no other way, in Fodor's view and in the view of a dedicated sententialist, for him to learn it. If there is an equivalent to C, then it is already part of the system, and the child has not *learned* a new concept, but only acquired the English translation for it. So far as using Mentalese is concerned, Fodor alleges that we are just built to use it correctly. Mentalese is *ab initio* intelligible, and insofar as it is a system of representations (conceptual scheme, if you like), it embodies a theory of how the world is. But no concepts can augment this inner theory, short of evolutionary changes in our innate cognitive machinery.[12]

What started out to be merely an extension of the comfortable and familiar common sense explanations of intelligent behaviour turns out to be savage in its demands on credulity. It implies an essentially static view of human knowledge, it denies concept learning, and it fails utterly to account for, and is apparently inconsistent with, the fact that development in science has given birth to concepts undreamt

of in the philosophy of our forbears.[13] It is because he cannot permit that learning might proceed by non-sentential means that Fodor finds he must thus embrace such awkward results.

The succubine temptation, in the face of such horrendous consequennces, is to deny that the child literally frames hypotheses and tests them, and to retreat to the shadowy haven of metaphor. Thus, it might be urged that the apprentice speaker does something *like* framing hypotheses and testing them, but unlike the master speaker, he does not literally do so because, of course, he does not yet have a language in which to frame such items. This will be seen for the mere handwaving it is, and it is to Fodor's credit that he refuses to indulge in it. If learning is sentential in character, then the child requires a system of representations which is language-like in the relevant respects. It is to no avail to say that he has a system of representations that is *sort of* sentential: either the toddler has states the structure and elements of which are relevantly related to sentences, or it does not. I see no room for something which is neither fish nor fowl, but sort of both.

In saying that the organism uses a medium of representation which is language-like, Fodor means that it is language-like in the sense that it has something which corresponds to logical elements, it is generative, and it has features of intentionality, of reference, and of truth. In what sense does the organism *have* this language? Can one, for example, upon intense introspection unearth a Mentalese word hitherto confined to the subconscious depths? Nothing so simple-minded is envisaged. The idea is that insofar as we take the organism to be going through a series of psychological states, sententially characterized, we mean that the structure and elements of his physical states stand in the relevant relations to the structure and elements of sentences (analyzed by some logico-grammatical theory). Fodor explains the point thus:

> The idea is that, in the case of organisms as in the case of real computers, if we get the right way of assigning formulae to the physical states, it will be feasible to interpret the sequence of events that cause the output as a computational *derivation* of that output. In short, the organic events which we accept as implicated in the etiology of behaviour will turn out to have two theoretically relevant descriptions if things turn out right: a physical description in virtue of which they fall under causal laws and a psychological description by virtue of which they constitute steps in the computation from stimulus to response. ([19]:74)

By now it seems clear that a theory of language learning constructed within the sentential paradigm is catastrophic, though, as Duhem taught us, if one is fervent enough one can always abide with the consequences and refuse to *tollens*. Stubborness aside, the sentential catastrophe in the theory of language learning does supply a motive for re-assessing the prospects of Group I candidates.

An additional argument against the adequacy of a thorough-going sentential approach to cognitive systems can be extracted from Dennett [14], [17] and [18]. In these papers, the critical focus is not so much on the *sentential* assumptions *per se* of cognitive psychology, but rather on the idea that *molar* psychology is as fundamental as psychology needs to get, and as fundamental as it can get. Dennett argues that if a scientific psychology *is* possible, it must ultimately also be possible to explain intelligent behaviour (either on the part of the person, or his intelligent faculties, or his 'homunculi') by means of structures which are not themselves intelligent. Otherwise one begs the question or regresses viciously. In its callow states, says Dennett, psychology may, provisionally and without deception, beg the question by postulating intelligent faculties and/or homunculi in the expectation of making good later on. However, in psychology's maturer states the intelligent homunculi and intelligent faculties of its youthful progenitors must in turn be explained and replaced by non-intelligent structures. Dennett picturesquely envisions that the intelligent homunculi provisionally tolerated in early theories of information processing (the 'executives', 'librarians', interpreters', etc.) are eventually replaced by gangs of less intelligent, dimwitted homunculi, each of which in subsequent deeper theories is replaced by gangs of utterly witless homunculi, which are at last so wanting in wit as not to be considered homunculi at all.

This argument of Dennett's can be taken to be an attack on the sentential model because the dimwitted homunculi of the deeper psychology do not, for example, frame hypotheses and test them, despite the fact that a certain orchestration of activities on the part of a gang of dimwitted homunculi consists in what we would now, at this stage in psychological theory, describe as the *person's* having framed the hypothesis that p.[14] As for the witless homunculi featured at the deepest level of the future psychological theory, they do not do any-

thing more intelligent than what a simple electrical component of a computer does, and they are no more the subject of sentential attitudes than is, say, a diode. Such intelligent activities as hypothesizing that p and inferring that p, which figure in the explanation of a person's behaviour in the immature theories, must themselves be replaced in the more mature theory by non-intelligent processes. In this fashion then, do sentential attitudes cease to be of anything more than passing and superficial importance to a theory of information processing in cognitive systems. It may perchance be the case that nature is unkind and that intelligence in nature is wholly inexplicable, but it would be defeatist to believe that. Neuroscience is still in *statu nascendi*, as is cognitive psychology, and it is certainly too early in the game to settle for a question-begging psychology.

Whilst I applaud Dennett's refusal to be enraptured with sentences, I am less ready to warm to his general conception of cognitive psychology. Dennett is a functionalist of the reductive (or perhaps the eliminative) variety, in contrast to Harman and Fodor who might best be described as conservative functionalists. As a functionalist, Dennett finds compelling the idea that the ultimate theory of intelligence will apply to a motley collection of items whose material bases differ markedly; e.g. humans, computers, angels, silicon-based organisms etc. The predicates of the envisaged theory will be functional rather than biological or physical, and correspondingly, intelligence will be explained in terms of a certain organization of functional states and processes. Functional states are the states they are in virtue of the role they play in the larger functional unit, and the cognitive theory of functionalist stripe will see the physics of the substrata of the functionally described units to be a quite independent affair. My hesitation with respect to functionalism derives not from doubts about its materialist assumptions, but rather from consideration of the live empirical possibility that the full story of what makes intelligent beings intelligent may be reachable only via the physics of the substrata. The common physics of those information-processing systems that display intelligence may in fact be of the first importance, whereas the functionalist expects the ultimate theory of cognitive systems to apply to a collection of items so motley as to fail to constitute a natural kind. The possibility does exist that there *is* a natural kind—call it Epis-

temic Engine[15]—of which humans are but one instance, and that the explanation of the cognitive dynamics of Epistemic Engines awaits future development in, say, thermodynamics. If there *is* such a natural kind, then it is far from obvious that the 'top-down' strategy (as e.g. through standard work in Artificial Intelligence) will be a more fruitful route to its penetration then will the 'bottom-up' strategy (as through work in neuroscience and physics).[16] Then again, it is possible that there is no such natural kind, and that the functionalist preference for top-down as opposed to bottom-up strategies will be vindicated. But having been alerted to the possibility, it is less easy to be unstinting in one's enthusiasm for functionalism.[17]

Are there other sources of disquietude with the sentential paradigm? Indeed there are, and in what follows I shall briefly touch on three. Constrained by limitations of space, I shall confine myself to little more than noting scent on the trail, reserving the deeper treatment for later work.[18]

First, evolutionary considerations should prompt us to be impressed with the continuity between hominids and non-verbal creatures, and with the fact that the human brain contains phylogenetically very old structures, such as the hypothalamus and the reticular formation, as well as more recent modifications such as the enlarged cerebral and cerebellar cortexes. It is perhaps worth dwelling on this fact when one is tempted to think of speech as the model for characterizing all cognitive activity. Suppose language is evolution's strategem for providing for a quantum jump in the information available to certain organisms by allowing for complex information exchange between organisms. How evolution solves the problem of getting information into suitably exchangeable form may well not be the spitting image of how, with each addition in cognitive complexity, she solved the problems of processing the information. To paraphrase Hume in a different context, it may justly be inquired, "What peculair privilege has this little agitation of the breeze which we call speech, that we must make it the model of all understanding?" The hypothesis defended by Liberman [31], which does seem plausible, is that the brain contains a coder which functions as an interface between two quite different kinds of system of representation—the evolutionarily older systems (including, e.g. long term memory) and the evolutionary *par-*

venu, speech. Liberman sees the coder as essentially a device for radically restructuring information in order to get it from the linguistic mode to the non-linguistic mode (and vice versa); not, in contrast to Fodor, for getting information from one linguistic mode to another.[19]

Secondly, as is well known, the results of research on hemisphere specialization have revealed that the left cerebral hemisphere is normally the centre of linguistic competence, while the right hemisphere is especially competent at certain apparently non-linguistic tasks, such as visuo-constructive tasks, tactile recognition and identification of objects, and recognition of human faces.[20] Gamely groping for a theoretical vocabulary where there is none, Sperry ([42]:12) says of the right hemisphere that it reasons by direct perceptual, synthetic, or Gestalt processing. Whatever the shortcomings of this positive characterization, the negative characterization implicit in it, the contrast to 'linguistic' processing postulated for the left hemisphere, is what I am intent on underscoring here. The evidence which leads Sperry and others to conclude that processing in the right hemisphere is normally non-linguistic is certainly impressive,[21] though a determined sententialist might try to save his theory by arguing that the processing in the right hemisphere is only *apparently* non-linguistic. He might say that the right brain processes information in Mentalese, but that it is bereft of the coder with which the left brain is blessed. Thus in the event of hemisphere disconnection, as through commissurotomy, the right brain fails to yield an English response and cannot transmit its Mentalese encoded information to the coding-decoding location in the left brain. The best that can be said for this ploy is that it is decidedly *ad hoc*. One could as well say that the cutaneous nerve endings or the taste buds process in Mentalese but lack an English-to-Mentalese coder, for in neither case is there the slightest evidence to support the hypothesis. The onus of proof rests on the sententialist to provide evidence for taking various neural structures to process information in accordance with his favoured model of information processing.

Another direction of research which bodes ill for the sentential paradigm is concerned with mental images. A growing number of psychologists are exploring the idea that mental images play a significant role in processing and that the

processing which does involve mental images is non-verbal. In a set of experiments conducted by Shepard and Cooper [12][22] subjects were presented with a letter (e.g. "R") or its mirror image in a variety of tilted orientations. The subjects are to determine whether the object presented was a standard instance of the letter or its mirror image. It was found that the response time was always longer if the mirror image had been presented, but, and this is crucial, in either case, the response time was a monotonically increasing function of the angular difference from the upright orientation. Thus, figures which were upside down took the longest to identify, figures which deviated by 90° took longer to identify than those which deviated by 60°, but took less long than those which deviated by 120°. The reason this is taken by Shepard *et al* to cause trouble for the sentential theories is this: if, as the sentential theory would suppose, the subject upon visual presentation produces a sentential description which he then compares to the sentential description of the upright figure, the response-time curve should be pretty much flat. It isn't. Shepard's suggestion, accordingly, is that the processing involved is not sentential, and that it may share something with the processing undergone when a subject perceives an object rotating in three-dimensional space.

Of course it is most unlikely that the processing underlying the behaviour discussed by Shepard *et al* can be revealed by introspective monitoring. The idea that introspection will be revealing here is about as implausible as the idea that the mechanisms of information storage and recall, or the mysteries of colour vision[23] will be revealed by introspection. Thus, in pointing up the work on mental images, I do not want to seem to be giving the least support to a phenomenological psychology,[24] and it should perhaps be emphasized that the telling data in the Shepard experiments are *not* introspective. The work by Shepard and others on mental images is important, to the extent that it is, insofar as it concerns intelligent behaviour for which, *prima facie* anyhow, sentential models of explanation are less than adequate. Whether the processing leading to the behaviour in question actually involves a mental image replete with the features customarily attributed to them is what a scientific psychology will determine.[25] It may well turn out that 'mental image' is a crashing misnomer for the information-bearing state in question, and chances are that

our current descriptions in terms of mental images will come to seem quite as quaint as alchemical descriptions in terms of principles. This is not because the processing will be found to be sentential after all, but rather because the mental image is almost certainly as superficial an explanatory posit as is the sentential attitude.[26]

If the foregoing sally against sentential theories of cognitive kinematics is successful and a non-sentential approach is esteemed preferable, a number of questions press in for answers. What are non-sentential cognitive states like? What is their structure and organization? What will be the dimensions of epistemic evaluation of such processes? How much cognitive activity is non-sentential? What will be the consequences for a theory of meaning? What will be the consequences for our conception of ourselves?[27] There is no denying that we are sorely parviscient on these matters—we do not have a theory of intelligent behaviour. Yet, the recognition that there is an alternative to the sentential approach to understanding ourselves will perhaps free the imagination to rove in new and more promising directions.[28]

REFERENCES

[1] Anderson, John R. and Bower, Gordon, *Human Associative Memory*, (Hemisphere: 1974).

[2] Bennett, Jonathan, *Linguistic Behaviour*, (Cambridge: 1976).

[3] Berlucchi, G., "Cerebral Dominance and Interhemispheric Communication in Normal Man"; *The Neurosciences Third Study Program*, ed. Schmitt and Worden, (MIT: 1974): 65-9.

[4] Castañeda, Hector-Neri, "Perception, Belief, and the Structure of Physical Objects and Consciousness," *Synthese* Vol 35 No. 3(1977): 285-352.

[5] _____ "Perceptual Space and the Basic Logical Form of Perception Sentences, *SISTM Quarterly*, Vol. 1, No. 2(1977): 25-30.

[6] Churchland, Paul M., "The Logical Character of Action Explanations," *Philosophical Review* (1970): 214-236.

[7] _____, *Scientific Realism and the Plasticity of Mind*, (Cambridge: 1979).

[8] , "Is 'Thinker' a Natural Kind?" (in progress).

[9] Churchland, Patricia Smith, "Fodor on Language Learning," *Synthese* (1978).

[10] Churchland, Patricia Smith, "A Perspective on Mind-Brain Research," *The Journal of Philosophy*, Vol. LXXVII No. 4 (1980):185-207.

[11] Clark, Eve V. and Clark, Herbert H., *Psychology and Language*, (Harcourt, Brace and Jovanovich: 1977).

[12] Cooper, L.A. and Shepard, R.N., "Chronometric Studies of the Rotation of Mental Images," *Visual Information Processing*,ed. William G. Chase, (Academic Press: 1973): 75-176.

[13] Davidson, Donald, "Thought and Talk," *Mind and Language*, ed. S. Guttenplan, (Oxford: 1975): 7-24.

[14] Dennett, D.C., "Why the Law of Effect not Go Away," *Journal for the Theory of Social Behaviour*, Vol. 5 No. 2(1975): 169-87; reprinted in **Brainstorms**, (Bradford: 1978): 71-89.

[15] ———, "Brain Writing and Mind Reading," *Minnesota Studies in the Philosophy of Science*, Vol. VII, ed. K. Gunderson (1975): 403-15; reprinted in *Brainstorms*, (Bradford: 1978): 39-50.
[16] ———, "Two Approaches to Mental Images," *Brainstorms*, (Bradford: 1978): 174-89.
[17] ———, "Artificial Intelligence as Philosophy and as Psychology," *Philosophical Perspectives on Artificial Intelligence*, ed. Martin Ringle (Humanities Press: 1978).
[18] ———, "Current Issues in the Philosophy of Mind," *American Philosophical Quarterly*, Vol. 15, No. 4(1978): 249-61.
[19] Fodor, J., *The Language of Thought*, (Crowell: 1975).
[20] Gazzaniga, M. M., *The Bisected Brain*, (Appleton-Centruty-Crofts: 1970).
[21] Geschwind, N., *Selected Papers on Language and the Brain*, Boston Studies in the Philosophy of Science, Vol. XVI(Reidel: 1974).
[22] Hacking, Ian, *Why Does Language Matter to Philosophy?*, (Cambridge: 1975).
[23] Harman, Gilbert, *Thought* (Princeton: 1973).
[24] ———. "Language, Thought, and Communication," *Minnesota Studies in the Philosophy of Science*, Vol. VII ed. K. Gunderson (Minnesota: 1975): 270-89.
[25] Hayes, John R., "On the Function of Visual Imagery in Elementary Mathematics," *Visual Information Processing*, ed. William G. Chase, (Academic Press: 1973): 177-214.
[26] Hooker, C. A., "The Information-Processing Approach to the Brain-Mind and its Philosophical Ramification," *Philosophy and Phenomenological Research*, Vol. XXXVI, No. 1(1975): 1-15.
[27] Kimura, D., "Cerebral Dominance and Perception of Verbal Stimuli," *Canadian Journal of Psychology* Vol. 15(1961): 166-71.
[28] ——, "Functional Asymmetry of the Brain in Dichotic Listening," *Cortex* Vol. III(1967): 163-78.
[29] ——— and Durnford, M., "Normal Studies on the Function of the Right Hemisphere in Vision," *Hemisphere Function in the Human Brain* ed. Dimond and Beaumont, (Elek Science: 1974): 25-47.
[30] Land, Edwin H., "The Retinex Theory of Color Vision," *Scientific American*, Vol. 236 No. 6(1977): 108-29.
[31] Liberman, A. M., "The Specialization of the Language Hemisphere," *The Neurosciences Third Study Program*, ed. Schmitt and Worden, (MIT: 1974): 45-56.
[32] Paivio, Allan, *Imagery and Verbal Processes*, (Holt, Rienhart and Winston: 1971).
[33] Pylyshyn, Zenon W., "What the Mind's Eye Tells the Mind's Brain: A Critique of Mental Imagery," *Psychological Bulletin*, Vol. 80 No. 1(1973): 1-17.
[34] Rosenberg, Jay, *Linguistic Representation*, (Reidel: 1974).
[35] Sellars, Wilfrid, "Empiricism and the Philosophy of Mind," *Science, Perception, and Reality* (Routledge and Kegan Paul: 1963).
[36] ———, "The Structure of Knowledge," *Action, Knowledge and Reality Studies in Honor of Wilfrid Sellars*, ed. H-N Castañeda, (Bobbs-Merrill: 1975).
[37] Shepard, R. N. and Metzler, J., "Mental Rotation of Three-Dimensional Objects," *Science*, Vol. 171(1971): 701-03.
[38] ——— and Feng, C., "A Chronometric Study of Mental Paper Folding," *Cognitive Psychology*, Vol. 3(1972): 118-42.
[39] Smith, M. O., Chu, Jennifer, and Edmonston, William E., "Cerebral Localization of Haptic Perception: Interaction of Responses to Braille and Music Reveals a Functional Basis," *Science*, Vol. 197 No. 4304(1977): 689-91.
[40] Sober, Elliott, "Mental Representations," *Synthese*, Vol. 33(1976): 101-48.
[41] Sperry, R.W. "Lateral Specialization in the Surgically Separated Hemispheres," *The Neurosciences Third Study Program*, ed. Schmitt and Worden, (MIT: 1974): 5-20.
[42] Stich, Stephen P., "Beliefs and Subdoxastic States," *Philosophy of Science* Vol. 45, No. 4(1978): 499-518.
[43] Woods, John, *Proof and Truth* (Peter Martin: 1974).

NOTES

[1]To be rather more precise about this, we should say, as Harman [24] points out, that the sentences are to be conceived under logico-gramatical analysis, which analysis determines their structure and elements.

[2]It may of course be realizable in other stuff as well.

[3]Apparently not all philosophers are convinced of this, however. It would seem to follow from Donald Davidson's thesis to the effect that creatures without language have neither thoughts nor beliefs nor any sentential attitudes whilst creatures with a language most certainly do, that quite distinct psychologies *are* required. The argument which persuades Davidson cannot be summarily stated, but I shall quote from concluding sections of [13] to give the flavour.

> It follows that a creature must be a member of a speech community if it is to have the concept of belief... Can a creature have a belief if it does not have the concept of belief? It seems to me that it cannot, and for this reason. Someone cannot have a belief unless he understands the possibility of being mistaken, and this requires grasping the contrast between truth and error—true belief and false belief. But this contrast, I have argued, can emerge only in the context of interpretation, which alone forces us to the idea of an objective, public truth. ([13]:22)

For a highly interesting discussion of Davidson's thesis, see Jonathan Bennett [2].

[4]For my purposes, the distinction between sentences and propositions will not be observed. What I say goes as well if wherever I use "sentence" or "sentential" the words "proposition" or "propositional" are substituted.

[5]In the case of epistemolgy, roughly this approach is called "the Ideal Sentential Automaton Approach" by P.M. Churchland in [7]. See also D.C. Dennett [15].

[6]For a most illuminating discussion of abduction, see Jay Rosenberg [34].

[7]Others would include Everett Hall, W.V. Quine, Hector-Neri Castañeda, and P.T. Geach.

[8]For examples of psychologists who are sententialists in their apprach to cognitive kinematics and dynamics, see Clark and Clark [11] and also Anderson and Bower [1].

[9]For a discussion of the psychological theory in common sense, see Paul Churchland [6] and [7].

[10]In [42] Stich provides a detailed and convincing discussion of the faults of Harman's theory. The remedy Stich proposes is less convincing, however, and it leaves entirely unscathed the sentential assumption from which the troubles arise.

[11]For an additonal but rather different example of a sententialist at work on a theory of perception, see Hector-Neri Castañeda [4] and [5].

[12]This is, to be sure, a highly inspissated account of Fodor's penetrating discussion of how (and whether) a child learns a language, and I enthusiastically recommend [19] to the reader.

[13]Elsewhere I go into considerable detail on just how unholy these consequences are. See [9].

[14]I suspect that we shall be uncommonly lucky if we get the reduction. If we are less than uncommonly lucky, some version of eliminative materialism will be our lot.

[15]See Paul Churchland [7].

[16]For a brief discussion of this distinction, see Dennett [17].

[17]A much fuller discussion of this worry concerning functionalism, and of the virtues of bottom-up as opposes to top-down strategies, is contained in Paul Churchland [8].

[18]See Patricia Smith Churchland, [10].

[19]Liberman says: "Why must the linguistic information be so thoroughly restructured if it is to be transmittable in the one case and storable in the other? The simple and possibly obvious answer is that the components for transmission and storage are grossly mismatched; consequently, they cannot deal with information in anything like the same form. I should suppose that the reason for the mismatch is that the several components developed separately in evolution and in connection with different biological activities. At one end of the system is long-term memory, as well as the non-linguistic aspect of meaning and thought." ([31]:44)

[20]See [3], [41].

[21]Hooker makes a similar point in [26]. For a small sample of the vast and growing literature on the subject of hemisphere specialization, see [3], [21], [27], [28], [29], [31], [39], [41].

[22]See also Shepard and Metzler [37], Shepard and Feng [38]. For a rather different approach to mental images, see Alan Paivio [32], and John Hayes [25].

[23]For an extraordinary discussion of what needs to be explained in this regard, see Edwin Land [30].

[24]For an interesting discussion of this point, see Pylyshyn [33].

[25]For an excellent discussion of the apporach to mental images taken by a scientific psychology as opposed to a phenomenological psychology, see Dennett [16].

[26]A sententialist approach to mental images may be found in Elliot Sober [39] and in Anderson and Bower [1].

[27]Some of these questions are discussed by Paul Churchland in [7].

[28]I am indebted to Paul Churchland, Leon Ellsworth, and Michael Finlayson for invaluable discussion, and to the NOÛS referees for helping me to improve upon an earlier draft. I should also like to thank Roy Vicent who as a farsighted department head arranged to alter my teaching duties so I might study neurophysiology.