On the Mechanics of Emma

John C. Marshall and John Morton

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John C. Marshall
Interfaculty Group on Speech and Language Behavior, University of Nijmegen, Nijmegen, The Netherlands and

John Morton
M.R.C. Applied Psychology Unit, Cambridge, Great Britain, and
Max-Planck-Gesellschaft, Projektgruppe für Psycholinguistik
Berg en Dalseweg 79, Nijmegen, The Netherlands

Normal adults can and do reflect upon their own (and other people's) linguistic behavior. Although we do not wish to belabor this point, it is as well to distinguish from the outset between two types of "awareness" that must be explicated in any account of such metalinguistic abilities. At risk of seeming contradiction, we shall call the first type *tacit awareness*, and the second *explicit formulation*. In order to illustrate the distinction consider the following "sentence":

The birds is coming.

On the assumption that the advertising agency which publicizes the works of Alfred Hitchcock knows its job, we may presume that a substantial number of people found this sentence amusing and memorable. It is difficult to see why this should be so unless they were tacitly aware of the fact that either the verb should be *are* or the noun phrase should be enclosed in inverted commas. When we turn, however, to explicit formulation, we would guess that fewer people have the ability to remark that the subject of English sentences must agree in number with its verb; and, indeed, until 1955 only one person formulated a fully generative rule capturing this generalization for the infinitude of well-formed English sentences.

If people were unable to evince evidence of tacit awareness there would

be no informants; if no one was able to express the generalizations underlying regularities of usage there would be no grammarians.

A Putative Paradox

Such "awareness," either tacit or explicit, seems to involve having (at least partial) access to the internal structure of the mechanisms which underlie knowledge and behavior. It is in this sense that awareness of structure (or function) is a *meta*-ability; and by virtue of being a meta-ability the notion can easily lead to paradox if it is invoked as part of the explanation of primary linguistic abilities. Thus Chomsky (1965) draws upon the analogy between the child's (tacit) discovery of the grammar of the language to which he is exposed and the linguist's (explicit) formulation of that grammar, but he is careful to stress that the child acquires this skill unconsciously: "It seems plain that language acquisition is based on the child's discovery of what from a formal point of view is a deep and abstract theory--a generative grammar of his language--many of the concepts and principles of which are only remotely related to experience by long and intricate chains of unconscious quasi-inferential steps" (Chomsky, 1965, p. 58).

The obvious moral to draw from Chomsky's analogy is that although making linguistic intuitions explicit may be useful for the adult who wants to write down a grammar on paper, this is clearly not essential to the child who is writing a grammar on brain cells. It is Chomsky's biologism--"we may regard the language capacity virtually as we would a physical organ of the body" (1976, p. 1)--which forces him into an epiphenomenalist position. In a particularly clear expression of this view, he continues (p. 23): "I see nothing surprising in the conclusion, if it proves correct, that the principles of rule organization that underlie the *WH-island* constraint are special properties of the language faculty, just as distribution of orientation specificities is a special property of the visual cortex." This position may indeed be correct, but once such a biologism is embraced it is difficult to see how linguistic intuitions could aid in the development of the language faculty any more than cardiac intuitions could aid the embryological differentiation of the heart.

Much the same point can be made from the psychological literature. Consider the famous exchange reported in Brown and Bellugi (1964, p.135):

Interviewer: Now Adam, listen to what I say.
Tell me which is better . . . some water or a water.

Adam: Pop go weasel.

When quoted, this exchange is usually prefaced by some such remark as "Unfortunately, we cannot obtain grammaticality judgments from a two-year old." It is important to realize, however, that the "unfortunately" refers to the state of the adult investigator, not of the child. Little Adam is not having language-learning problems; rather big Brown is having grammar-writing problems.

The point is one of logic rather than fact. If a two-year old could tell us that *some water* is grammatical but *a water* is not, that would simply demonstrate that he had already (i.e., previously) acquired the distinction between count nouns and mass nouns (or, minimally, that he had heard adults say *some water* more frequently than *a water*). First you learn something, then you *may* be able to verbalize explicitly what you have learned. But it is difficult to see how this order could be reversed. How could one have intuitions about mass versus count nouns and then learn that there is such a distinction?

Seen in this light, linguistic intuitions have the status of an optional extra, completely disconnected from the mechanisms responsible for the acquisition of linguistic skill. The "extra" has the added disadvantage of being associated with talk of awareness, consciousness, and the ego. Given no useful role to perform, linguistic awareness becomes not so much the ghost within the machine as the ghost outside the machine. We seem to be stuck with the position that William James (1890) captured so neatly with the following analogy: "So the melody floats from the harp-string, but neither checks nor quickens its vibrations; so the shadow runs alongside the pedestrian, but in no way influences his steps."

A Change of Metaphor

In an attempt to bring linguistic awareness back *within* the system, we suggest the following analogy: Represented within many perfectly familiar machines is a distinction between *use* and *mention*. The machines we are thinking of are those in which one component can monitor the state of another component. Imagine a motor car in which a red light (on the dashboard, say) flashes when (if and only if) the petrol tank is almost empty. Such a signal *mentions* the state of the petrol tank, but is not part of the mechanism whereby the use of petrol is involved in propelling the car. To the question "Can you have (i.e., is it logically possible to have) a well-functioning

car which does not include such a monitoring device?", the answer is clearly "Yes." To the question "Is it *sensible* to have a car without such a device?", the answer may well be "No."

We shall rely on variants of this analogy to elucidate the role of linguistic awareness in the processes of language comprehension and production. In our (restricted) usage of the term, then, the primary functions (and perhaps the ontogenetically earliest functions) of linguistic intuitions are negative. Awareness arises out of devices for finding faults. In complicated machines (e.g., devices of the complexity required for producing and understanding utterances in a natural language) many qualitatively different types of process can go wrong. When something does go wrong, it is often helpful if the machine can signal not merely *that* a malfunction has occurred, and *where* it has occurred, but also *what kind* of malfunction it is. We are visualizing, then, a hierarchy of monitoring, control, and repair processes which we believe correspond with one way of using the terms *linguistic intuition* and *linguistic awareness*.

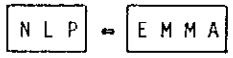
Building a Set of Levels

Let us start from the premise that normal language processing proceeds without awareness. If this were not so, then speaking would itself be evidence for (and co-extensive with) awareness, and the term would become totally vacuous. Although there is a hint of circularity in possible defenses of this premise it seems uncontentious to agree that simple, fluent assertions--for example, "That's a cow"--can be uttered without awareness of any of the structural parameters which enter into the description of the remark. We choose to represent normal language processing as normal language processes (NLP) in a (no more opaque than usual) black box. This is a notational idiosyncracy which we see as value-free and non-committal. For the moment, the contents of NLP are mysterious apparati.

Normal language processes serve two functions. They receive inputs and *compile* or interpret them by following a program (a program determined in part by embryological growth, in part by environmental action). The program will be subject to modification by learning and in light of information coming from other processes which deal with non-linguistic aspects of the internal and external world. The NLP also cause speech to be produced, either

as a result of their own operations or by virtue of stimulation from other external or internal events. Naturally we do not assume that input and output processes are identical (indeed we believe that in some cases they are almost independent). Nonetheless, for present purposes we can begin without differentiating them.

We now note that there are some clear and uncontroversial cases of linguistic awareness, for example, explicit comments on the form of linguistic rules. Such behavior seems to presuppose the monitoring or observing of primary linguistic processes (or, better perhaps, the monitoring of the *results* of such processes). We will represent this monitoring by another box containing an even more mysterious apparatus--or EMMA. And we shall claim that EMMA can both monitor NLP and, if necessary, change the mode of operation of NLP.



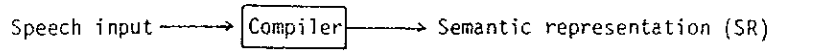
For purposes of the argument we thus define "awareness" as EMMA-functioning. Certain consequences follow. For example, in a particular situation, either EMMA operates or she does not. There are therefore no *degrees* of awareness, although the extent and type of information about NLP to which EMMA has access will, of course, vary. A further consequence of our formulation is the avoidance of an infinite regress of awareness of awareness of awareness.... Two-way communication between EMMA and NLP implies that the operation of EMMA will sometimes result in a change in NLP to which EMMA again has access. That is, what looks like awareness of awareness is simply awareness of the consequences of awareness. We hope, in this way, that the concept of EMMA may eventually remove some of the philosophical problems which arise when the term *aware* is given quasi-spiritual connotations.

Who is EMMA?

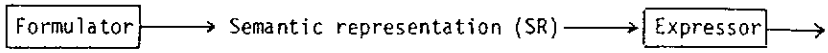
Here, as everywhere, we prefer to hedge rather than last ditch. We feel it will be wiser not to attempt a rigid definition of EMMA-functions; we shall rather approach her by stealth. We shall look at speech production and perception separately, attempting to specify the kinds of mechanisms that are necessary to account for phenomena which have been interpreted as evidence of awareness.

The comprehension of speech requires (at least) the conversion of an acoustic signal to a semantic code. We shall call the mechanism that accomplishes this feat the compiler, and thus represent speech recognition in the

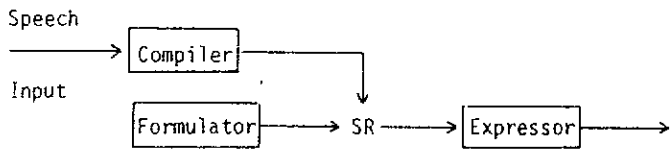
following way:



In a similar oversimplified fashion, we shall regard language production as a system with two primary components. In the first place an expressible intention must exist which can be formulated in a semantic representation. The semantic representation must then be converted into a form which can be (physically) expressed, viz:



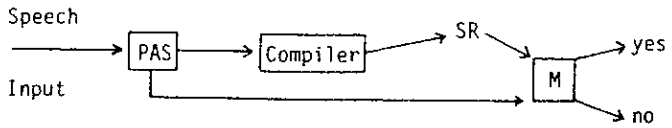
Since the semantic representations (SRs) of production and recognition must match, we can link the two systems as follows:



If we think of these devices as the primary components of the performance system, then any device which has access to the results of their computations without itself being part of the primary performance machinery is a part of EMMA. Let us now attempt to be a little more specific.

Input Monitoring

We have referred to the central component of the language understanding system as a compiler which takes speech as input and produces a semantic representation as output. Clearly, however, the infant will frequently find himself in a situation where either no semantic representation or a drastically limited representation becomes available even after a fairly long stretch of speech has been heard. The utterance "Desist from procrastination!" is unlikely to mean very much to a one-year old. If the compiler produces literally no output, then nothing further need to be said or done. If the compiler produces a very restricted output then little will be done. (One might argue that, for the infant, happiness is a warm intonation contour, and can trigger a smile.) But eventually the child does come to notice that something has gone wrong. There has been an input to the compiler and no (or too little) output. At this point we do seem to need a monitor (M), viz:



We can use an output triggered by a precategorial acoustic system (PAS), an independently motivated component of the perceptual system (Crowder & Morton, 1969), as one of the inputs to the monitor.

In their simplest form, the rules for this system are: If the inputs to the comparator are either 0,0 or 1,1 then respond (internally) *yes* (that is, no problem); if the inputs are 1,0 (acoustic stimulation but no SR) then respond *no* (there is a problem). The child's simplest overt response to the *no* condition is to look puzzled or to say "Eh?" or "What?" This limited system will, of course, only deal with the case where zero semantic information emerges from the compiler.

To accomplish this simple function the inputs to the comparator need not really be ordered (or labelled). But eventually the comparator must be sensitive to order (or labelling) if the child is to gain access to the location and not merely the existence of input failures. We can illustrate the distinction in the following pair of exchanges. In the first conversation the child is 4;7, and the exchange is taking place in a noisy kitchen; the radio is on, and dishes are being washed. The topic--which has already been running for a couple of minutes--concerns what the child had been doing at school that day:

Adult: Did you enjoy yourself?
Child: What?
Adult: Did you have a good time at . . .
Child: No, no, *say* it again!

The adult has misunderstood the force of the "What?", thinking that the child had failed to understand when in fact she had failed to *hear*.

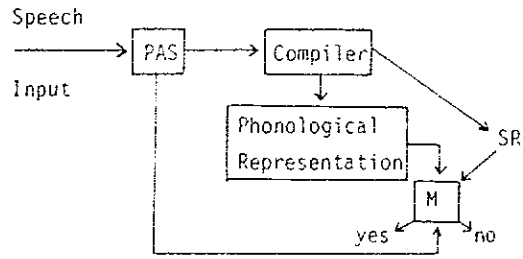
A month later, the reverse misunderstanding occurred. A typical dinner-time conversation is in progress:

Adult: And then the grape juice ferments and alcohol results from this process . . .
Child: What?
Adult: And the grape juice . . . (repeating the utterance with an identical intonation contour)

Child: No, no . . . in a *different* way so I can understand.

Again, the adult has misunderstood the point of the "What?", thinking this time that the child had simply not heard. The misunderstanding is soon corrected when the child shows how badly formulated (rather than quietly expressed) the adult's purported explanation was.

In order to express the distinction that the child is making we seem to require a system of the following nature:



But now the decision rule for the comparator must become more complex. The input 1, 0, 0 (i.e., acoustic input, but no phonological or semantic representation) triggers the request to speak up (exchange 1), but the input 1, 1, 0 (i.e., acoustic input, phonological representation, but no semantic representation) triggers the request to express the *content* more clearly (exchange 2).

We have spoken so far as if failure to compile a semantic representation was an all-or-none process. But clearly this is not so. Consider the following exchange with a child of 4;9:

Adult: You look very elegant in your new dress.
Child: What does *elegant* mean?

Here the monitoring device which caught the (partial) failure to compile has been able to "dig out" and specify the linguistic unit which has caused the failure. It would seem that this requires an explanation at least as complicated as the following: The compiler produces a complete phonological code (no null symbols) but only a partial semantic code, that is a code with a hole in it (X1 X2 ..... Ø ..... Xn). This null symbol triggers the routing of the available semantic code to the expressor which in turn produces a phonological code. We then need a new form of comparator, one which can substract one phonological code from another. The residue of this operation is that segment for which the compiler failed to find a semantic representation. This residue can then be used to initiate requests of the type "What

does *residue* mean?" It is in this way that the child is "driving" her own acquisition process. Clearly, one can eventually learn what *elegant* means without asking. But it must be more efficient to ask rather than wait for the next twenty occurrences and hope to form the relevant inductive generalization on the basis of "context of situation." EMMA is thus a crucial part of the (internal) educational system.

Yet another form of monitoring operation would seem to be involved when the semantic representation is checked, not for holes, but rather for congruence with the context of situation in which the input utterance was produced. For example, a long telephone conversation with a child of 5;3 is well underway when the following exchange occurs:

Adult : What have you been doing at school today?
Telephone: Click.
Adult : Hello?
Child : Why did you say *Hello*?

Clearly, the child's question has located the source (in this case, pragmatic) of the difficulty: Why say *Hello* when I've already been talking with you for five minutes? We presume then that (compiled) semantic representations are constantly monitored for their consistency with a much more general (and constantly updated) cognitive representation of the state of the world.

Output Monitoring

We now turn to the converse problem of specifying the ways in which the child can monitor and hence regulate and correct his own speech output. If we look at Clark's paper in this volume we see that in the earliest stages of language acquisition the child's mother serves as an external monitor. The following exchange from Scollon (1976) shows how lack of comprehension, real or feigned, on the part of the mother leads to a sequence of attempts to express the same content by the child, attempts which differ from each other by a small number of features:

Brenda: [ʃ] (holding up mother's shoe)
[ši]
[š]
[šiš]
[šu]
[šu?]

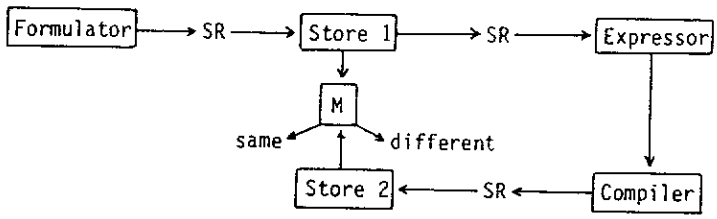
Brenda: [ʂuʂ]
Mother: Shoes! (p. 150).

These attempts seem to approximate more and more closely the correct form and it is tempting (Scollon found) to conclude that the child is actually listening to her own output and comparing it with an adult "standard." The difference is then used as a means of correcting the next attempt. While this is a possible substructure for the sequence we feel it is excessively adult-omorphic. A simpler account might claim that the child's output representations are both incomplete (with respect to the adult "model") and, perhaps, rather loosely "associated" with whatever semantic structures the very young child is in command of. We have no intention of discussing here the possible growth and learning mechanisms that are required. (In any revealing account it would be necessary to formulate these mechanisms at a quasi-physiological level anyway.) A plausible set of theories would have in common the feature that successive attempts to "activate" output structures become more and more successful.. There seems to be no reason, on a psychological level, to invoke a more complex mechanism than that which is responsible for the phenomenon of operant conditioning (Marshall, 1970).

All that is necessary then is that the mother provide a simple error signal. This might be the withholding of approval or simply silence. In this situation the formulator is driven by a fundamental communicative rule: "Keep talking until you get feedback (approval)." Thus the formulator keeps sending the same semantic representation to the expressor. This SR is, in effect, the address of the phonological code. The details of such sequences may thus tell us about the way in which phonological codes are stored and develop but nothing at all about complex monitoring. Examples in which an *internal* monitor appears to be required, however, can also be found. For example, the spontaneous correction, "I've been swin—swimming." Without going into detail we only wish to observe that it is not necessary to think in terms of the child listening to her own output and correcting it on the basis of comparison with standard *adult* inputs. In a future paper we will show how such errors are related to redundancy rules in phonological output and to incompetence rules (Smith, 1973).

The previous example of error-correction involves comparison of articulatory or phonological signals. Clark's paper (this volume) also contains cases where it would seem that the detection of mismatch must be in a semantic code. We shall illustrate with an example from another child. At age

2;1 the subject learned the word *caterpillar*; at 2;2 she learned *helicopter*. Approximately two days after acquiring this latter word the following utterance was observed as a helicopter flew overhead: "Look, look! A caterpillar . . . helicopter (laugh)." Since *caterpillar* is a good English word (and was known to the subject at the time of the slip) we presume that the error must have been detected by a mechanism of the following type:



In light of the previous examples of phonological error, the nature of this error is quite interesting. Although the error must be *corrected* by semantic monitoring it is structurally closer to a phonological error. One explanation might run as follows: Given that *helicopter* was not well-entrenched in the child's productive vocabulary, the phonological code available at a particular moment may have been grossly underspecified, e.g., four segments, the terminal one being /ə/. Clearly, such a representation is insufficient to activate an articulatory event. On the assumption that *one* access code for the dictionary is phonological, however, we could imagine that this specification is sent to the dictionary as an instruction to find an item which matches the code. *Caterpillar* is then the first word found which does so.

Let us now turn to morphological errors. Consider the following exchange with a child of 4;11:

Child: I brang it home from school.
Adult: What?
Child: I bringed it home.
Adult: Eh?
Child: I brung it home.
Adult: Oy vay!
Child: Brought!
Adult: What d'you know—we finally made it!

We seem to see here a complex interplay between two monitors, one external (a father) and one internal. The external feedback is minimally informative; it indicates that something has gone wrong but contains no cue to

the location or type of fault. Despite this vagueness of external feedback the child instantly homes in on the inflectional morphology of the verb. We might hypothesize then that an internal monitor is capable of assessing the state of the rules governing past tense inflection; specifically, that the monitor can provide a "confidence rating" for the pairing of stems with regular and irregular endings. A weaker interpretation, however, would claim that no monitor is required and that the sequence should be regarded as the recirculation of the original content through a system of unstable rules. The trigger for such recirculation could obviously be provided by the adult's (uninformative) error-signal. This latter interpretation may run into difficulties in explaining the child's deletion of content (initially *from school,* and eventually everything but the verb) from the hypothesized recirculation. Yet in other cases the weak interpretation may suffice. For example, a correction such as "It eat—it eats bread" does not even need the comparator. If we assume that the compiler can take as input the child's own output, then it would note the error in the output string which has violated the rule: Verbs in the present tense take /s/ when governed by a third person singular noun phrase. The compiler could then just feed back its compiled version to the expressor for re-encoding. This assumes that the error was due to noise in the system and not due to a systematic mischaracterization of the language in the expressor. In the latter case, of course, the result of the re-encoding would be identical with the original output.

Note that in this case no component need "know" which rule had been violated; the information need not be recoverable or available to another subsystem. All that happens is that one part of the normal language system sends a code to another.

A slightly more complex account of the error correction process leads to some interesting predictions. Imagine that the compiler can send back to the expressor not only the compiled version of an incorrect string but also a copy of the rule which has been violated. This is now a more complicated model because the form of the two pieces of information is different. Such "rule transmission" is clearly required if the perceptual system is to teach the production system. Assume that the compiler learns rules by examining the input strings. Then, once the agreement rule described above, or the regular past tense rule is induced, it could be transmitted from compiler to expressor in the way indicated. At an early stage in language acquisition the child will already be using some strong forms correctly (*went, ran, was,*

and so on) and perhaps some correctly, but non-productively, inflected weak forms. As soon as the compiler acquires the regular rule the strong forms will be changed to correspond to the rule-governed form. This fits with the facts of acquisition and also predicts that children will "correct" their own strong forms to the incorrect weak form. One such correction has been reported by Bever (1975):

Child : Mommy goed to the store.
Father: Mommy goed to the store?
Child : No, Daddy; I say it that way, not *you*!
Father: Mommy wented to the store?
Child : No!
Father: Mommy went to the store.
Child : That's right, Mommy wen . . . Mommy goed to the store.

Faced with examples like the above, one is tempted to move immediately to a "high level," "abstract" description which makes specific reference to awareness, consciousness etc. And indeed the child *does* appear to be aware that his own usage and that of his father differ. Similarly, in the following examples (from a child aged 5;3), the child gives every indication of being fully conscious of what has gone wrong; the child's introspections are of an adult character.

Adult: (to second adult) Are you going to put the garage in the car?
Child: Ha, ha, ha. Daddy got it wrong again.
Adult: What should I have said?
Child: Are you going to put the car in the garage.

While we have no objections to using a terminology that includes conscious and self-conscious processes, the danger is that such descriptions can easily lead us to lose sight of the need to formulate a mechanism whereby the child (or adult) has *access* to the subparts of structural descriptions involved in primary language processes.

Conclusions

We believe, then, that "awareness" arises from the operation of error-detecting mechanisms which have access to subparts of the output of primary production and comprehension systems. It is, of course, the sheer complexity of linguistic programs (and the conditions of their appropriate use) that requires the development of fault-finders and fault-describers. Failure to

understand can take place at any level between (and including) failure to hear the physical token and failure to grasp why on earth a token of that type should have been uttered under such-and-such circumstances. Failures to express an intelligible signal can arise on a similarly wide range of levels from conceptual confusion to sloppy articulation. We have accordingly tried to outline some of the mechanisms which are required to change errors into correct responses.

However, given that the relationship between form and content (i.e., phonological and semantic representation) is *conventional* we could just as well use the same devices to change correct utterances into erroneous ones. It would seem that the child, by reflecting upon his own linguistic skills and knowledge, does indeed eventually become aware of the fact that linguistic behavior is rule-governed and not law-governed. The best known discussion of the development of such awareness is, of course, to be found in Vygotsky's claim that the young child initially believes the name of an object to be an intrinsic *part* of that object and only later realizes that you can call it anything you like (although it helps to get other people to do likewise). Although it appears that Vygotsky (1962) underestimated the sophistication of even very young children, the issue that he drew attention to is an important one. The ability of the child to abstract himself from the normal use of language enables him to play games with the relationship between sound and meaning. Thus at age 4;11 one child invented a nerve-shattering song that consisted simply of repeating ad nauseam (albeit at ever increasing intensity) the line: "Yes is no and no is yes." The same child at 5;1 announced that "If I say I'm not tired that means I am tired, and if I say I'm tired that means I'm not." For the next fifteen minutes (before getting bored with the game) she proceeded to replace the content words in her sentences with their antonyms (or other words drawn from the same semantic field) at every available opportunity. For example, she lay on the floor and said "I'm standing on my bed," and sat at the kitchen table at six p.m. saying "Where is my breakfast?" Young children demonstrate quite explicit awareness of the conventional nature of language. For example, one child at age 3;1 remarked, "Mummy says *mato* and Daddy says *marto*." Slobin's paper (this volume) contains other illustrations.

These last examples are clearly ones for which everyone will be happy to implicate EMMA (in the above sense of explicit awareness). But what of the dividing line? We may now confess to having led the reader along the

false trail we ourselves followed. As soon as one postulates any kind of monitoring device, even the very simplest comparator, we see an embryonic EMMA. Thus, rather than being pushed out to the mists to which awareness has been consigned, EMMA functions can be seen at a very early age, and rather than being more complex than Normal Language Processes EMMA appears actually to be simpler. One might accordingly decide to restrict language awareness to EMMA plus consciousness. But that, of course, is another story.

Finally, we would hope to find ontogenetic continuity in EMMA function; just as individual children evolve production strategies in different ways we would expect to find differences in the way their monitoring devices evolve. Our attempted demystification of the developing processes of correction is then also an explication of EMMA and our eponymous heroine has a name which is already an anachronym: For she seems to be rather an Ever More Maturing Adjunct.

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