The Language of

Science

M. A. K. Halliday

Edited by Jonathan J. Webster

Volume 5 in the Collected Works of M. A. K. Halliday

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CONTENTS

PREFACE

ἐν ἀρχη ἦν λογος

The rate of glass crack growth depends on the magnitude of the applied stress.
'The fracturing of glass', *Scientific American*, December 1987

What about this quote identifies it to the reader as the discourse of science? How did these features evolve into what we recognize as scientific English? In the papers included in this volume, *The Language of Science*, the fifth in the series of his Collected Works, Professor Halliday looks at the language of science from various perspectives, from the historical to the developmental, as a language teacher and as a linguist.

This volume, however, is much more than a volume of papers on scientific language. It is about that most fundamental ability of humankind, the ability to theorize about ourselves and our world. It is about how we move from commonsense theories of everyday experience to technical and scientific theories of knowledge. It is about how our ways of meaning are evolving, from the congruent to the metaphorical, from the clausal to the nominal.

And God said ... With an utterance, the world came into existence. The clausal origin of the universe, as told in Genesis, mirrors our own use of language to construe reality, and transform experience into meaning. Such is the reality-generating power of grammar, that it enables us to define 'the basic experience of being human'.

Over the course of history, as the need arose for more powerful and abstract theories of experience, humankind has relied on the

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power of language 'to reconstrue commonsense reality into one that imposed regularities on experience and brought the environment more within our power to control'. Aptly titled *How Big is a Language? On the Power of Language*, Professor Halliday's introduction to this volume and the next makes clear that the source of that power lies in its potential for grammatical metaphor.

Grammatical metaphor, which is explored in detail in the first section of this volume, involves the junction of category meanings, not simply word meanings. Examples of grammatical metaphor include *length*, which is 'a junction of (the quality) "long" and the category meaning of a noun, which is "entity" or "thing"', and *motion*, which is 'a junction of the (the process) "move" and the category meaning, again of a noun'. With grammatical metaphor, the scientist can make the world stand still, or turn it into one consisting only of things, or even create new, virtual realities.

In the second section of this volume, Professor Halliday discusses how the features of scientific English have developed over time, evolving to meet the needs of the experts, giving them enormous power over the environment, but at the risk of alienating learners and turning science into 'the prerogative of an elite'. What can the language educator do to help those who have been shut out of scientific discourse? The language educator can only help the learner, if (s)he understands how the discourse works. Halliday makes a strong case for adopting the 'paradigmatic-functional' design of systemic grammar to accomplish this task.

Scientific discourse foregrounds things at the expense of qualities, processes and relations. Grammatical metaphor in scientific discourse is described as 'a steady drift towards things; and the prototype of a thing is a concrete object'. Thus he notes 'the interesting paradox: the most abstract theorizing is achieved by modeling everything on the concrete'. The nominalizing grammar of science results in a discourse that is ultimately just about things. The discourse becomes that which it creates.

<p style="text-align:center">και ὁ λογος γαρ ἐγενετο</p>

ACKNOWLEDGEMENTS

variants for just one lexical verb, provided it had a passive as well as an active voice.

I included in the tally systems whose terms are realized prosodically, by tone and location of tonic prominence; these will not appear in written form, at any rate not in a text composed in normal orthography, and they are not systems of the verbal group as such but systems of the information unit (realized as a tone group) and hence most typically mapped into a clause; these added significantly to the total – but they have to figure somewhere in the overall account of the grammar. And on the other hand some further distinctions were left out. In any case, the aim was not to establish an exact quantitative value, which would be impossible, but to give an idea of the order of magnitude of a characteristic grammatical paradigm. It takes only thirty independent binary choices to yield a paradigm of a billion options; and while grammatical systems are not typically independent, every language has a very large number of them. Systemic grammars of English in computational form now have between one and two thousand.

It is not this aspect of the 'how big?' question that is being explored in this volume and Volume 6. But let me add one more point about the system network form of representation. The network is, as I have said, a theoretical model of the paradigm: it theorizes a language as a meaning potential – or better, perhaps, as a meaning potential potential: that is, a system that has the potential to create a meaning potential. Clearly, then, the interdependence of the systems that make up a network is of critical importance to determining its overall power. But this can only be established empirically, on the basis of an extensive body of natural text. Such bodies of data are now available, in the form of a computerized corpus. So far, parsing and pattern-matching software, though it has become highly sophisticated, has still not reached the level where the necessary analysis can be carried out mechanically on a big enough scale; one needs to process the grammar of tens of millions of clauses. But Matthiessen has been building up an archive of texts which he has analysed 'manually' for a number of selected features, and investigating the degree of dependence among different grammatical systems. He has examined the frequency profiles of some primary systems of English grammar, such as those of transitivity and mood; and in what he stresses is an 'interim report' (in press) he offers a provisional finding concerning patterns of systemic interdependence. Leaving aside cases where one system is fully dependent on another

(such that the two are formally – though not functionally – equivalent to a single system), Matthiessen finds that the degree of mutual conditioning between systems depends first and foremost on their metafunctional relationship. Systems within the same meta-functional component of the grammar affect each others' prob-abilities significantly more than do systems from different metafunctions. This important finding (with Matthiessen again stressing its provisional nature) gives substance to the metafunctional hypothesis: not only pointing up the fact that the grammar is organized along metafunctional lines, but also suggesting that it is this that provides the framework for the balanced interplay of information and redundancy in the grammar as a whole. Where different **kinds** of meaning are combined, the level of information is very high.

Matthiessen's investigation of the conditioning of probabilities between systems raises in turn the question of the probability profiles of the systems themselves. This is taken up in some papers appearing in the next volume (Volume 6). The suggestion made there is that major (primary) grammatical systems tend towards one or other of two quantitative profiles: either the terms are roughly equiprobable, or they are skewed by about one order of magnitude. (This is the formulation for binary systems such as singular/plural or positive/negative.) If this kind of regularity turned out to be valid, it would mean that mutual conditioning of systems would be a noticeable and significant feature of the grammar. A great deal of work is needed to explore this aspect of the meaning potential of a language. But clearly the quantitative properties of systems in lexicogrammar are an important ingredient in language's semogenic power. To cite a familiar example used by Halliday and Matthiessen (1999), if a shift in the frequency patterns of one major grammatical system can open up a new domain, in the way that future tense in weather forecasting creates a virtual reality in which the future is the unmarked time, this shows that the meaning potential that inheres in the system of tense is not just a simple choice among three possibilities. It is a much richer resource which carries within it a notable reality–generating power.

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The papers brought together in Volumes 5 and 6 are organized around this same basic issue: that of 'how big is a language?', interpreted as the question of its power. This cannot be assessed in

any straightforwardly quantitative terms, such as the number of possibilities arrived at by combining all the options in a network representation of the lexicogrammar. These papers are concerned rather with ways in which the meaning potential gets extended beyond the set of selection expressions generated by a grammatical network. Volume 6 focuses on the notion of a language as a prob-abilistic system (using "system" here in its wider sense – Hjelmsle-vian rather than Firthian – to refer to a language as a whole); the basic proposition is that a system (back to its technical sense!) is made up not simply of 'either *m* or *n*' but of 'either *m* or *n* with a certain probability attached'. In that case, local variants of these global probabilities constitute an additional semogenic resource. If for example the global system of *polarity* is formed out of 'positive 0.9/ negative 0.1', while some local variants show negative as equal in frequency to positive, or even significantly more frequent than positive, then the overall meaning potential of the *polarity* system is much more than that of a simple opposition. Register variation as constituted by the resetting of grammatical probabilities is just as meaningful as would be variation marked by a categorical shift into a different inventory of words and structures.

This leads in to the question of the language of science, which is the topic of the current volume. There is of course no single register of science; there are numerous scientific discourses, not only cov-ering diverse disciplines and sub-disciplines but also, and more sig-nificantly, different participants in the processes of science: specialist articles (including abstracts), textbooks, science for lay readers and listeners and so on. These have in common the function that they are extending someone's knowledge in some technical domain: the audiences being addressed may be anywhere from high level pro-fessionals to complete novices, but the text is organized so as to tell them something that they don't already know, with "telling" cov-ering a range of interpersonal attitudes from a tentative suggestion to an aggressive attempt to persuade.

If we look into the history of the discourses of technology and science, we find new strategies evolving: new ways of organizing the grammar as a resource for making meaning. I think the best way of characterizing these strategies, in very general terms, is that they are grounded in the processes of *metaphor*. Not that metaphor in itself was anything new; metaphor is a feature of every language, and in fact it is a potential that became built into language in the course of its evolution, from the moment when the content plane became

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'deconstrued' into the two strata of semantics and lexicogrammar (as happens in the life history of the individual child; cf. Part 2 of Volume 4, and also Painter 1984, Oldenburg-Torr 1997). Once that has taken place, any relationship of form and meaning can be 'decoupled' and replaced by a new 'cross-coupling' in which the meaning is now represented by a different form; only, it is no longer the same meaning, because some fusion has taken place, a 'semantic junction' in which the meaning of the original form has left its mark.

This is the critical characteristic of metaphor. When for example *an inflexible will* is relexicalized as *an iron will*, a new meaning is construed which is a junction of the congruent senses of these two lexical items, 'which cannot be deflected' and '(made of) a rigid metal'. The simile form, *a will like iron*, provides the link between the congruent and the metaphorical modes of meaning. Of course, this particular example has been around for a very long time; it is now fully coded in the language, not construed afresh on each occasion. But this is the essential nature of the metaphoric process.

The step that was taken when languages began to evolve technical forms of discourse was simply to move this strategy across from lexis into grammar. This probably started, or at least first reached a significant scale, with nominalization: decoupling 'qualities' and 'processes' from their congruent realizations as adjectives and verbs, and recoupling both these meanings with nouns. The cross-coupling here is not between words (lexical items) but between grammatical classes. It was already happening long ago, in the classical languages (Chinese, Greek, Sanskrit) of the Bronze and Early Iron Ages; but we can illustrate from English, with words such as *length* and *motion*. These show the same phenomenon of semantic junction; but it is a junction of category meanings, not of word meanings:

Thus, the word *length* expresses a complex meaning that is a junction of (the quality) 'long' and the category meaning of a noun, which is 'entity' or 'thing'. Likewise *motion* expresses a complex meaning that is a junction of (the process) 'move' and the category meaning,

again, of a noun. It seemed natural to refer to this as "grammatical metaphor", to show both its relationship to, and its distinctness from, metaphor in its familiar, lexical guise.

The potential for metaphor, which arises once language evolves to become stratified (though to put it like that makes it sound too much like a by-product, whereas metaphor is an inherent part of the stratification process), is a major contributor to the overall power of language. But it is especially grammatical metaphor, because of the breadth and generality of its application, that has the most significant effect. Grammatical metaphor creates virtual phenomena – virtual entities, virtual processes – which exist solely on the semiotic plane; this makes them extremely powerful abstract tools for thinking with.

Thus what grammatical metaphor does is to increase the power that a language has for **theorizing**. All use of language embodies theory; as I have said in various earlier contexts, the grammar of every language contains a theory of human experience: it categorizes the elements of our experience into basic phenomenal types, construing these into configurations of various kinds, and these configurations in turn into logical sequences. For much of human history, no doubt, this was the only model of reality; and it remains the model of reality into which human children are first inducted. But as some human groups became settled, developing writing systems and technical competences, so their theory of experience became more abstract and more powerful – and more and more the product of conscious design. Grammatical metaphor reconstrued the human environment, transforming the commonsense picture of the world into one that imposed regularities on experience and brought the environment more within our power to control. This reconstrued version of reality is the one our children have to master as they work their way through the obstacle course of the educational process. It is presented most clearly in the discourse of the natural sciences, which is where it evolved. This is the theme of the papers in the present volume.

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There is obviously no way of measuring the size of a language – that is, assigning it some kind of overall quantitative value. Some things can be counted: the number of distinct syllables, for example [this is discussed in a subsequent volume of papers on the Chinese language]; and possibly, though with rather less accuracy, the number

grammatical metaphor occurs in other contexts, interpersonal or non-technical ideational, it can still cause problems; but it is found to be more accessible and may help to bridge the distance to the fully metaphoric discourse of the scientific disciplines.)

Grammatical metaphor adds a new dimension to the expanding meaning potential. It is not simply adding new features and new systems to the network; rather, it is 'thickening' the processes of meaning by creating another plane of semiotic reality, where theories can be construed out of 'virtual' phenomena which exist solely on the semiotic plane. In that respect it provides an essential component in the construction of scientific knowledge. By the same token, metaphor in general – but in particular, because of its ability to irradiate the entire discourse, metaphor in the grammar – is a major source of the energy that constitutes the power of language.

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Thus, what began for me as an enterprise in language education, trying to find the source of the difficulties faced by learners of science, turned first of all into an excursion into history, as I tried to follow back the grammatical styles of scientific writing in English through the preceding centuries. I did not concern myself with the genres of scientific discourse; not, obviously, because I thought them unimportant but because they had already been studied and described by others much more thoroughly than I would have been able to attempt. It was intriguing to see how the metaphoric grammar evolved, from Newton to the present day, as more of the clause got co-opted into the metaphoric code and the density of metaphor steadily increased. Sadly for personal reasons I was unable to finish a book that I was writing, bringing together (under the deliberately ambiguous title *Language and Learning*) the educational and the historical aspects of the picture; it remains one of the (all too many!) unfinished projects of a rather disorganized life.[1]

Meanwhile I came to think of grammatical metaphor from another angle, namely that of its central role in (as I have been putting it here) extending the power of language. In this respect, tying it too closely to the language of science may turn out to have been misleading. Metaphor, as I have tried to make clear, is a feature of all post-infancy language: once the "content plane" has been deconstrued into (what we call) a stratum of lexicogrammar and a stratum of semantics, any connections between the two can be

decoupled and new 'cross-couplings' established, resulting by what I have been calling "semantic junction" in new constructions of meaning. Whether there was a time when this kind of cross-coupling happened only with individual lexical items, not grammatical classes, I do not know; in any case languages differ greatly in what they grammaticalize, and how they do it, so it is not easy to formulate the question in sufficiently abstract terms. But it seemed to me that the wholesale transformation of discourse into syndromes of grammatical metaphor (such as those I am using now) was a recent feature and was associated with the theorizing of knowledge which transformed technology into science; it was then, by virtue of its esoteric nature and accompanying prestige, borrowed into other discourses as a vehicle of power. This history may be wrong – it may simply reflect my own way in when coming to explore the phenomenon twenty-five years ago. But the point is that it is **motivated** in the discourses of science, because of its massive potential for creating new knowledge; whereas elsewhere, say in bureaucratic discourse, its function is a **ritual** one – motivated because of its association with power, but having no semogenic potential (creating no new edifices of meaning) in the context in which it is occurring.

As in all the other volumes, most of the papers collected here began as single invited lectures or as chapters of books. This explains why material gets repeated: the background has to be made explicit on each occasion. It also explains why many of the chapter titles are rather too general: they began as titles of abstracts which had to be submitted long before the paper itself came to be written! But at the same time, I tried to use each occasion as an opportunity for going further into the topic; I hope that the parts do add up to a reasonably coherent whole. And I hope that my own writing, while it relies on grammatical metaphor in both its two main functions (technicality and rationality; see Chapter 3), is not so saturated with it that it brings on a bout of semiotic indigestion. I try to avoid this by reading what I write aloud; but for that to be effective it would have to be addressed to an audience other than myself, and that is rather too much to inflict on one's relatives and friends.

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It is perhaps not too fanciful to suggest that the chapters in Volume 6 also fall within the scope of this same motif, the power of language. They cover two related aspects of language as system and process.

One is the representation of a language in computational form, and the use of a computer to operationalize the relation between system and text (text generation and parsing). The other is the quantitative study of text data as compiled in a computerized corpus. Both fall within the domain of computational linguistics; more importantly, following the paradigmatic principle both theorize the grammatical system as a network of connections that generate instances of text.

To put these papers in some kind of chronological sequence, I will switch into the narrative mode, with apologies for the consequent prominence of first person themes. The story starts with machine translation. I had first read about this in, I think, 1950, just as I came to know Jeff Ellis and Trevor Hill and we began to follow up our shared interest in the development of national languages in newly decolonized countries. UNESCO had then produced a significant report which stressed the advantages of education in the mother tongue, and it seemed to me that machine translation would make it possible to produce the necessary teaching materials cheaply and quickly. I applied for a position in one of the early projects but was turned down – the task was seen as one for computer engineers, not for linguists!

In 1956 Margaret Masterman invited me to join the Cambridge Language Research Unit, which she had set up to investigate machine translation from a theoretical standpoint; the other founder members were A. F. Parker-Rhodes and R. H. Richens. Using test sentences from three languages (English, Chinese and Italian), we worked on the representation of grammatical structures; but I failed to persuade my colleagues that we ought also to represent the underlying grammatical systems. (See Jacqueline Léon 2000 for an account of the history of the C.L.R.U.)

At University College London in the 1960s I started a research project in the grammar of scientific English (DSIR/OSTI Programme in the Linguistic Properties of Scientific English), with Rodney Huddleston as chief investigator. He, Richard Hudson and Eugene Winter undertook a large-scale analysis of scientific texts, with the aid of Alick Henrici as programmer. Henrici was the first to implement some components of systemic grammar in a computer, forming paradigms from a network and operating on the structural output. (See Huddleston et al. 1968; Henrici 1981.)

Meanwhile I had been counting (manually) occurrences of a number of grammatical features in four varieties (registers) of English texts, noting the first 2,000 occurrences of each system (tense,

polarity, etc.). I was interested in the information and redundancy of grammatical systems. The view that prevailed among linguists was that information theory had nothing of interest to offer to linguistics; but that was because they were not thinking paradigmatically. Information can only be a property of a system, not of a structure. A paper I wrote on this topic in 1968 got lost; but the reason I selected two thousand as the number of occurrences to be counted was that I wanted 200 instances of the less frequent term – as the bottom line, so to speak – and I had noticed in my first rough tryouts that if a binary system was skew (like positive/negative polarity) the relative frequency of the two terms seemed to tend towards one order of magnitude.

It was not until 1992 that I was able to return to the study of grammatical probabilities. Meanwhile in 1980 – the third of my encounters with computational linguistics, which seemed to take place at roughly twelve-year intervals – I had the good fortune to meet William Mann of the University of Southern California, who was inaugurating a project in text generation and invited me to write the initial grammar for it. By this time computers had evolved to the point where they were now a valuable resource for linguistic research, and this would provide for the first time an opportunity for testing the basic mechanism of a systemic grammar. Christian Matthiessen joined the project and over a number of years extended the scope of the grammar and worked with Bill Mann in exploring strategies for controlling the grammar 'from above'. By the end of the project there were about a thousand systems in the total grammatical network. (See Mann and Matthiessen 1991.)

In 1992 I worked for some months in John Sinclair's ground-breaking COBUILD corpus research project, and collaboration with Zoe James produced what I think was the first large-scale quantitative study of grammatical systems, covering one and a half million clauses of running text. That work with Zoe is one reason why 1992 stands out for me as an exciting year. The other is meeting Michio Sugeno, then professor at the Tokyo Institute of Technology, who was reading up systemic theory because it seemed to him to offer the kind of approach to language that he was seeking in order to test and develop his ideas on 'intelligent computing' – the keynote being that, if computers were to move forward significantly in the future, they would have to learn to mean like human beings. This resonated well with the project that Christian and I had been pursuing at odd moments ever since 1985, and which eventually emerged in 1999 as

the book *Construing Experience through Meaning*. Sugeno called his own project "computing with words"; I suggested that perhaps "computing with meanings" would be more apt.

The chapters in Volume 6 have been chosen and arranged so as to bring out the motif of computational and quantitative methods as a way in to a deeper understanding of language. I think that this sort of work is still only just beginning, and will in time have a significant impact on our theoretical knowledge of semiotic systems.

Notes

1. But one for which I feel more than usually delinquent. I had been invited as a Lee Kwan Yew Distinguished Visitor by the National University of Singapore; with the understanding that, having given a series of lectures, I would write them up as a book for the University Press. I tried to rewrite the lectures, much too ambitiously, but had to put the project aside on two occasions, owing to illness in my family, and after that, never managed to complete it. I feel very aware of this failure to honour what I regarded as an important commitment.

EDITOR'S INTRODUCTION

This first part of this volume, *Grammatical Metaphor*, contains four papers, all published since the mid-nineties, in which Professor M. A. K. Halliday sets out to 'problematize the issue of a special grammar for the languages of science' (Chapter 4, *The grammatical construction of scientific knowledge: the framing of the English clause*). What we come to realize is that, in fact, 'Science has no beginning; it is simply the continuation of the grammar's theorizing of ourselves and our relations with our environment.' Humankind is forever 'theorizing' about ourselves and the world around us. To understand something we must first turn it into meaning, only then can we internalize or know it. To transform our experience into meaning, we need language. Be it commonsense or scientific knowledge, no matter whether it concern our 'taken for granted reality' or some phenomena far removed from the experiences of daily life, there can be no theorizing without language, or more specifically, without the semogenic power of the grammar.

'The categories and relations of our commonsense world are not given to us readymade'; rather, as Professor Halliday explains, 'we construe them grammatically, using grammatical energy to theorize – to select among the indefinitely many ways in which experience could be "parsed" and made to make sense' (Chapter 4). But while we acknowledge it to be the same grammatical power at work in common-sense and scientific theorizing, nevertheless, we must recognize that '[a] scientific theory is a dedicated and partially designed semiotic subsystem which reconstrues certain aspects of components of human experience in a different way, in the course of opening them up to be observed, investigated and explained'

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(Chapter 3, *Things and relations: regrammaticizing experience as technical knowledge*). In the discourse of science, the clausal world of the mother tongue, in which 'experience is construed as an interplay between happenings (which are transitory) and entities (which persist)' (Chapter 1, *Language and the reshaping of human experience*), is reconstrued as 'a semiotic universe made of things' (Chapter 2, *Language and knowledge: the 'unpacking' of text*).

This reshaping of experience is accomplished over 'three successive waves of theoretical energy' (Chapter 2), which Halliday describes as follows: ***generalization***, i.e. from proper noun to common noun, making possible our commonsense theories of knowledge; ***abstractness***, i.e. from concrete categories to abstract ones, making it possible to retheorize in 'uncommonsense' terms; and ***metaphor***, i.e. from congruent construals to metaphorical ones, allowing us to retheorize over again, in the form of our technical and scientific theories of knowledge. Each wave takes us 'one step further away from ordinary experience', but at the same time each step may be thought of as having 'enlarged the meaning potential by adding a new dimension to the total model'.

The power of metaphor is inherent in the nature of language; it is 'a concomitant of a higher-order stratified semiotic – once the brain splits content into semantics and grammar, it can match them up in more than one way' (Chapter 4). Metaphor in the grammatical sense – grammatical metaphor – allows 'the wholesale recasting of the relationship between the grammar and the semantics' (Chapter 1). Halliday gives the example of calling 'move' *motion*. It is more than just turning a verb into a noun. Rather, the category meanings of noun and verb have been combined together to form a new type of element. While nothing in the real world has changed, repeating the metaphorical process over and over again with hundreds if not thousands of words gradually reshapes our experience of the world, 'making it noun-like (stable in time) while it is observed, experimented with, measured and reasoned about' (Chapter 1).

Grammatical metaphor is '[a] critical feature of the grammar through which the discourse of science evolved' (Chapter 1). Elaborating this point in Chapter 4, Halliday writes,

Scientific discourse rests on combining theoretical technicality with reasoned argument; and each of these relies on the same metaphorical resource within the grammar. Semantically, each relies on the grammar's power of condensing extended meanings in a highly structured, nominalized form. In the latter, it is a ***textual*** condensation, in which

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stretches of preceding matter are condensed instantially, to serve as elements – typically thematic elements – in the ongoing construal of information [...] In the case of technicality, however, the condensation is ***ideational***: it is a paradigmatic process, in which the metaphoric entity is distilled from numerous sources of related semantic input.

There are parallels to be found between the evolution of the language of science and the development of the individual human. Generalization occurs in the transition from child tongue to mother tongue (ages 1–2 years). Between ages 4 to 6 years, children begin to 'construe entities that have no perceptual correlate'; they can handle abstraction. It is also around this age that children in literate cultures begin to 'recast their language into a new form, as written language'. Writing, as Halliday notes, is more than just a new medium, it changes the way we mean (Chapter 1). The ability to grasp the move from congruent to metaphorical comes later, around the age of puberty, between ages 9 to 13.

'Thus we have two histories,' writes Halliday in Chapter 4, 'both change, over time, in the same direction: from the congruent to the metaphorical, building up new meanings through repeated instances of semantic junction' (Chapter 4). The writings of Galileo and Newton reveal evidence of significant innovations which have since 'infiltrated more or less every register of our standard written language' (Chapter 1). The evolution of a new form of discourse begins 'the process whereby our experience will be reconstrued. It is a long process, stretching phylogenetically from the iron age to the present age of information science, and ontogenetically from initial literacy to adulthood; and in the course of this process, knowledge becomes designed, systemic and technical' (Chapter 4).

Also, in Chapter 4, Professor Halliday notes certain problematic features of scientific/educational discourse: 'namely its exclusiveness and ritualistic power'. More generally, 'It is just possible that a semiotic which foregrounds things at the expense of processes and relations – precisely because we are not aware that it is doing so – may be dysfunctional for the relations between ourselves as a species and our environment, and even for our interactions one with another.'

If, as noted at the outset, science has no beginning, then it has no end. In the transition to an 'information society on a global scale', Professor Halliday asks, 'Will our grammars go on evolving towards yet another reshaping of experience?' (Chapter 1). As information

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technology causes the disjunction between the written and spoken language to break down, will the grammar move towards a new synthesis of the clausal and nominal modes? 'Whatever the "information society" will actually look like in the next two or three generations' (Chapter 1), Professor Halliday concludes,

> I am confident of one thing: that the new forms of human experience, no matter how much they differ from those we recognize today (which are already very different from those that I grew up with), will still be being construed, exchanged, contested and transmitted by means of language.

Chapter One

LANGUAGE AND THE RESHAPING OF HUMAN EXPERIENCE (1995)

Those of us who work in universities are fortunate in that in our research we can usually choose our own point of departure: we can fix the boundaries of what we are investigating, and we can decide on the perspective in which we want to locate it. This is not to say that universities are 'ivory towers'; in my experience, academics are more anxious than most people to be relevant and useful to their community (which is not to say they always manage to succeed!). But if they are to make their contribution to knowledge and, via knowledge, to people's lives, they have to be allowed to theorize: if you want to apply principles to practice of any kind you have to have principles to apply, and that means developing a theory. And in order to develop a theory, you have to be able to determine the content, and the approach. As my teacher, J. R. Firth, used to say, if you are a linguist, then language is what you say it is; you are not called upon to define it in simple terms – indeed it is far too complex a phenomenon to be defined at all; and you are certainly not bound by any commonsense notions of what language is (still less by moralistic conceptions of what it ought to be!).

But while scholars must be free to delimit their own objects of study, and to adopt their own ways of approaching and theorizing

complex structure embodying both transitivity and mood. This is a very powerful semogenic resource, which we all learnt to control very early – some time during the second year of life.

It is customary in western thinking to relegate language to a subordinate status, that of (at best) reflecting, or (at worst) obscuring and distorting, the reality of the world we live in. We are brought up to believe that the categories of our environment, the regularities we observe within it, are objective features existing independently of ourselves and of the way we talk about them. We assume there are 'natural classes': that the meanings construed in the grammar – the word meanings, and the meanings of grammatical categories – are given to us by the very nature of things. If we reject this view – as I think we must – it is tempting then to go to the opposite extreme: to assert that there are no natural classes at all, and that what we encounter in our environment is a random flux of happening in which there are no regular proportionalities and the grammar has to impose order by inventing categories of its own. Neither of these extremes is satisfactory. Rather, our environment as we experience it is bristling with analogies: everything that happens is in some way like something else. The problem is, most things are like many other things in many different ways. What the grammar does is to sort these out: to give priority to some subset of the possible dimensions along which phenomena can be perceived as being alike.

We see this selective recognition most obviously in vocabulary. Think of any lexical set in everyday English, like *tree / shrub / bush / hedge*, or *hot / warm / mild / tepid / cool / chilly / cold*, or *car / van / truck / lorry / coach / bus*, or *jumping / hopping / skipping / prancing / leaping*: these are not clearly distinct perceptual categories; they are constructs of the language, and as everyone who learns a foreign language knows they do not correspond from one language to another. At the same time, they are not arbitrary: they all construe some aspect of perceptual or at least experiential likeness. These lexical examples illustrate rather specific domains of experience: growing plants, temperatures and so on. But there are some variables so general in scope that we meet them in almost every figure we construct; and these tend to get organized systemically rather than lexically. For example: every happening has some address in time, either relative to now or relative to some other happening or state of affairs. Here again the grammar has to **construe** the experience; this time it does so in the form of grammatical systems. But the same principle holds good: the grammar selects certain analogies, certain

kinds of likeness, to be construed as regular proportions, like tense in English, where there is a regular proportionality such that *went : goes : will go ::: said : says : will say ::: ran : runs : will run* and so on. Again each language does this in its own distinctive way.

What the grammar does is to construct a semiotic flow – a flow of meaning – that is analogous to the flow of events that constitutes human experience; in such a way that, when this semiotic flow is superimposed on experience it operates selectively as a grid. This gives depth, dimensionality to our perspective, so that certain regularities are made to stand out. I used the wording "grammar transforms experience into meaning"; and it is this that constitutes what we call "understanding". To understand something is to transform it into meaning; and the outcome of this transformation is what we refer to as 'knowing', or – in reified terms – as 'knowledge'. Understanding, and knowing, are semiotic processes – processes of the development of meaning in the brain of every individual; and the powerhouse for such processes is the grammar.

This semogenic power in the grammar depends on selection. The grammar selects patterns that have experiential value, and construes them into a multidimensional semantic space. And since these various patterns, the different dimensions that constitute a semantic space, often contradict each other and conflict with each other, the grammar of every language is based on compromise. The only way of construing the incredibly complex interactions between human beings and their environment – let alone those between one human being and another – is to evolve a system that is highly elastic: that has a great deal of 'play' in it, that celebrates indeterminacy, and that is optimally functional as a whole even if none of its parts ever seems to be entirely optimal when taken by itself.

This system, language, has evolved – along with the human species: it's the *sapiens* in *homo sapiens*. We cannot observe language evolving. But we can, and we do, all the time, observe the epigenetic processes whereby language develops in the individual. We are all familiar with the – often very explicit – efforts made by children in matching up their meanings to those of their elders round about; and these older, wiser folk (parents, big brothers and sisters and so on) join in the game: 'no, that's not a bus; it's a van', 'that's not blue, it's green' and so on. Since all semantic categories are inherently fuzzy sets – not just those construed lexically, but even the apparently clearcut grammatical ones like positive/negative or singular/plural (consider an English clause like *not everybody believes*

that, do they?: is that positive or negative? is it singular or plural?) – there is always going to be some semantic drift across the generations. But when children learn a mother tongue, they are shaping their own experience as individuals according to the accumulated experience of the human species, as already construed for them by the grammar. The grammar defines for them the basic experience of being human; with lots of local variations, but shaping, as a whole, the form of their commonsense knowledge: their knowledge of the ecosocial system that is their environment, and of their own place, and their own identity, within it.

And then, when all this has just become taken for granted, it has to change. Once our children reach the age of around five, in the literate cultures of Europe and elsewhere, we (the adults) decide that they (the children) need to recast their language into a new form, namely as written language; we put them into school, and teach them to read, and to write. We think of writing, in this case, as just a new kind of channel, a new medium: children already know the fundamentals of language; they're now going to learn to process language visually, in order to gain access to books and magazines and forms and public notices and all the other trappings of our written culture. If we think of literacy as in any way changing their language, we usually mean by this a change of dialect: it is a means of inducting them into the standard form of the language. We don't think of it as changing the way they mean.

But why do we teach them writing at just this age (one of the few things about which all literate cultures seem to agree)? We put them into school to get them out of the house and off the street: that's the popular answer. But the real reason is a more subtle one. Children of around four to six years old are just reaching the stage, in their language development, when they can handle meanings that are abstract: they can construe entities that have no perceptual correlate, like *worth* and *clue* and *habit* and *intend* and *price*; and this has two important consequences. First, it means that they can cope with abstract symbols, like letters or characters, and the abstract concepts that go with them (including the critical distinction between writing and drawing); so they can now master this new medium. Secondly, it means that they can cope with abstract categories, and so are ready to explore new forms of knowledge. In other words they are ready for a reshaping of their previous experience.

Let me give you an example of what I mean. When my son was small, he used to play with the neighbour's cat, which was friendly

but rather wary, as cats are with small children. On one occasion he turned to me and said "Cats have no other way to stop children from hitting them; so they bite". He was just under three and a half years old. Some years later, in primary school, he was reading his science textbook. One page was headed: "Animal Protection"; and underneath this heading it said "Most animals have natural enemies that prey upon them. ... Animals protect themselves in many ways. Some animals ... protect themselves with bites and stings." Now Nigel had worked out this explanation – why animals bite – for himself (no doubt in dialogic contexts; commonsense knowledge is dialogic knowledge) at the age of 3½; it was now being presented back to him, five or six years later, monologically – and in a different grammar. I don't mean that the grammar was more formal; in that respect, in fact, there was no significant difference. What differed was the grammar's shaping of the experience. It was now a general fact, not just about cats but one relating to a wider, systemic class to which cats belong, namely animals; and biting, in turn, was part of a wider, systemic class of behavioural and other properties which included stinging, running fast, having certain colouring and so on. But even more drastic than these generalizations is the way the grammar has reconstrued the essential nature of the experience. It has taken the wording *protect themselves* (as a verb) and reworded it as a noun *protection*; and this is then classified as *animal protection*, implying a possible typology of protections of different kinds. (Notice by the way how ambiguous this expression *animal protection* is if you take it by itself: does it mean 'how people protect animals', 'how people protect themselves from animals', 'how animals protect people', 'how animals protect themselves', or even 'how people use animals to protect themselves'? – there are at least five plausible interpretations!) Similarly the meaning 'bite' has been worded as the noun *bites*. In other words, the grammar has replaced the names of happenings with the names of things.

From the child's point of view, this is a new way of seeing the world. He would have said *by biting and stinging*, not *with bites and stings*; after all, biting and stinging is something you do, or at least something you have done to you if you don't watch out, it is not some object that is being used as a tool. In the child's grammar, happening is construed by verbs; whereas nouns construe things – things that take part in happening, certainly, but not happenings as such. Why is this? – it is not because of any prior cause or grand principle of design, but simply because that is the way that grammar

evolved. It is important I think to make this point explicit, to avoid any false assumptions about cause and effect. People often ask: does human experience determine the form of grammar, or does the form of grammar determine human experience? The answer has to be: neither – or, what comes to the same thing: both. The form taken by grammars, with their nouns, verbs and the rest, is shaped by human experience; just as, at the same time, the form taken by human experience, with its happenings, things, qualities and circumstances, is also shaped by the grammar. There is just one process taking place here, not two. In the evolutionary history of homo sapiens, this is how our experience was transformed into meaning. And this is the kind of pattern – the 'world view', if you like – that is first construed by children, the way their semantic space is organized and deployed. A verb means happening; a noun means an entity – a thing; and both typically have some correlates in the world of perceptions. We call this mode of meaning the *congruent* mode of the grammar; and it is this congruent pattern that lies behind the wealth of commonsense knowledge that children lay down in the first few years of life.

But if grammar can construe experience in this way, it can also reconstrue it in other terms. Having once established that biting and stinging, and protecting, are forms of happening and doing – that is, having construed them congruently as verbs – we can then say "but there may be some experiential value, some payoff, in treating them 'as if' they were some kind of abstract entity or thing". Note that we don't need to say this, in so many words; we can simply mean it, so to speak, by reconstruing them, in incongruent fashion, as nouns. If we do this, we have enlarged our total meaning potential: we have enriched the model of experience by creating a new semiotic category that is both happening and entity at the same time. So the child is beginning to explore a new way of understanding and of knowing; we can call it "written knowledge" – or better (since although it was associated with writing it doesn't actually depend on being written down) "educational knowledge".

At this point, we might want to ask why. If our species was well enough served by the congruent shaping of experience in which grammar evolved, why reshape it in a different form – one which seems to blur the very distinctions on which the commonsense knowledge depends? In the west, of course, it was the ancient Greeks who started it, as they started so many other things, when they used the grammar in precisely this way to create abstract entities

for some time that the brain of mammals evolved as the ecological relationship of the organism to its environment became more and more complex; as linguists, we can agree with this, but add to it 'and as the social relationship of one organism to another also became more and more complex'. Gerald Edelman, perhaps the leading neuroscientist working in this field, in his theory of neural Darwinism traces the evolution of consciousness from its origins (probably in the warming of the blood, the endothermic principle) through two stages: "primary consciousness", with selective recognition of experience based on biological value, and "higher-order consciousness", extending to self-consciousness, memory, and the ability to apprehend the future. Higher-order consciousness seems to have evolved only in homo sapiens. Now I think we can show that higher-order consciousness is semiotic consciousness – that is, the ability to mean, or to transform into meaning; and that the critical element in higher-order consciousness is grammar. But it is a form of consciousness that develops, in the individual human organism, only after infancy. Human infants, in the first year of life, first develop primary consciousness; they do construct a system of meaning (what I described, in *Learning How to Mean*, as "protolanguage"), but this is not yet a 'language' in the adult sense. Why? – because it has no grammar. The elements of infant speech are pure signs, content-expression pairs analogous to a cat's miaow or the danger warnings signalled by an ape. (I am not belittling these creatures, or their abilities; I am simply locating them in an evolutionary perspective.) For the human child, this primary semiotic serves as their protolanguage in the sense that it is there they first learn how to mean; but they then replace it, in the second year of life, by the higher-order semiotic system which we call "language". And language, unlike the protolanguage, has a grammar in it.

Children take this step very quickly, leaping over what must have occupied hundreds of generations of evolutionary time. I shall have to try to describe this leap in metaphorical terms. What the child does is to deconstruct (or rather, deconstrue) the two faces of the sign, the content and the expression, and insert a new, purely abstract stratum of organization in between. This new, interpolated stratum is the grammar. You can watch – or rather, listen to – this happening if you observe carefully a child's transition from proto-language to mother tongue. The culmination of this transition is language as we know it: a stratified semiotic system consisting of a semantics, a grammar, and a phonology. The phonology is the

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system of expression, where language interfaces with the human body, through the organs of articulation and of hearing. The semantics is the system of meanings, where language interfaces with the whole of human experience. But the grammar interfaces only with these two interfaces (this is what I meant by calling it "purely abstract" just now); it does not interface directly with either surface of the material world. Because of this freedom it can adapt readily to changes in the ecosocial environment (Jay Lemke 1993 has shown how this adaptation can take place): both local changes in the ongoing context of situation and global changes in the background context of the culture.

Thus major historical shifts in the human condition – the shift into settlement, that into iron age technology – take place at once both materially and semiotically: the different construal of experience in the grammar is inseparable from the different nature of experience itself. And this means that further semiotic shifts may always take place. We now meet with another instance of the reshaping of experience by the grammar: that which accompanied (and, likewise, formed an essential part of) the transition into the modern, "scientific" age which we associate with the European Renaissance. If we look at the writings of the founders of modern science – Galileo's Italian, or the English of Isaac Newton – we find there that the grammar is evolving some further significant innovations; and now, some ten generations later, these have infiltrated more or less every register of our standard written languages. We are all familiar with the sort of wordings that are characteristic of today's scientific discourse, like

> *Osmotic tolerance is accomplished in bacteria by an adjustment of the internal osmolarity.*

But these same features are regularly present in much of the written discourse that impinges on us all the time: not just in science but in non-technical contexts as well – particularly those concerned with establishing and maintaining prestige or power. My airline told me that

> *Failure to reconfirm will result in the cancellation of your reservations.*

The managing director of a business corporation apologizes because

> *We did not translate respectable revenue growth into earnings improvement.*

And a financial consultant advises that

A successful blending of asset replacement with remanufacture is possible . . . [to] ensure that viability exists.

Military strategy requires that

Manoeuvre and logistic planning and execution must anticipate . . . the vulnerabilities that deep attack helps create.

And in the driving cab of the locomotive

Strength was needed to meet driver safety requirements in the event of missile impact.

– that is, the glass must be strong so that the driver remained safe even if it was struck by a stone.

We know where schoolchildren encounter this metaphorical kind of grammar. This is the language of the specialized disciplines – of knowledge that is technical and grounded in some theory (the theory may or may not be explicitly affirmed). Just as the first reshaping of experience took place when they moved into primary school, so this second reshaping coincides with another educational transition: the move from primary to secondary school. The critical feature of grammar through which the discourse of science evolved is one which children cannot fully apprehend until they reach their middle school years, around the age of puberty. This is the phenomenon of grammatical metaphor. While the first phase of educational knowledge, that associated with writing, depends on abstractness, this later phase, that of technical knowledge, the discourse of the specialized disciplines, depends on metaphor: metaphor in the grammatical sense, the wholesale recasting of the relationship between the grammar and the semantics. Instead of

If a fire burns more intensely it gives off more smoke

we now say

Fire intensity has a profound effect on smoke injection.

We have already seen the beginnings of this transformation: some abstract terms like *motion, speed, proportion* are already metaphorical in origin, since they involve reconstruing processes or qualities as nouns: treating them as if they were kinds of things. So this second reshaping of experience is exploiting a resource that had already begun to be available with the first. But now it is no longer a matter of creating technical terms; the metaphor takes over the entire discourse – because it provides the means for developing a sustained

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argument, the sort of logical progression that goes with experimental science. The grammatical metaphor allows any observation, or series of observations, to be restated in summary form – compressed, as it were, and packaged by the grammar – so that it serves as the starting point for a further step in the reasoning: some theoretical conclusion can be drawn from it. Here is an example from a microbiology text:

> When a *solution* of any substance (*solute*) is separated from a *solute-free solvent* by a membrane that is freely permeable to solvent molecules, but not to molecules of the solute, the solvent tends to be drawn through the membrane into the solution, thus diluting it. Movement of the solvent across the membrane can be prevented by applying a certain hydrostatic pressure to the solution.

Note the expression *movement of the solvent across the membrane*, where the grammatical metaphor 'packages' the preceding assertion to function as point of origin for the next.

In sentences like these, the metaphoric recording involves more or less the whole of the grammar. Qualities become nouns; happenings become nouns or adjectives; and logical relations become verbs. It seems that only entities stay as they are; but their status too may be affected, as will be seen when we analyse the grammar in functional terms: in *movement of the solvent across the membrane* the active entity *solvent* is still a noun; but instead of functioning as an active element in the figure it is functioning as possessor of another noun *movement* – and this is not an entity at all but a happening that has itself become metaphorized. In other words, the original things often disappear, becoming mere modifiers of these metaphoric nouns – as happened with *fire* and *smoke* in *fire intensity has a profound effect on smoke injection*. It is not unusual to find sentences in which every element has been functionally transposed into something other than its congruent form.

Given that the grammatical processes taking place here at this third stage are so complex and varied, can we see anything like a general pattern emerging, in the way experience is being reshaped? I think perhaps we can. While the language of the primary school contained among its abstract terms a number of nouns derived from verbs or adjectives whereby happenings and qualities were reified as general principles (like *motion, force, multiplication* and so on), with the technical language of the sciences and other disciplines – the classroom "subjects" of the secondary school curriculum – this process of grammatical metaphor has been elaborated to such an extent that the

reality it projects is of quite a different order. In place of the mixed, clausal world of the mother tongue, in which experience is construed as an interplay between happenings (which are transitory) and entities (which persist), our technological world is one that consists almost entirely of things – the only 'happenings' in it are the relations we set up between one 'thing' and another. Thus in each of the following examples we find two processes, both construed as nominal groups; they are then being said to be related, one to the other, by a logical relationship that is construed as (or includes within its construal) a verbal group [this logical relator is shown in italic]:

fire intensity *has a profound effect on* smoke injection
the conducting capacity *depends on* the width of the channel
lung cancer death rates *are associated with* increased smoking
rapid changes in the rate of evolution *are caused by* external events
increased responsiveness *may be reflected in* feeding behaviour

This sort of discourse has served well for the natural sciences, where it was important to construe a world of 'things', including virtual entities that could be brought into existence as and when the discourse required them; some of these virtual entities then remain in existence as theoretical constructs, while others function locally in the argument and then disappear. Symbolically, this kind of discourse is holding the world still, making it noun-like (stable in time) while it is observed, experimented with, measured and reasoned about.

But this sort of synoptic vision is less relevant to other realms of our experience; and it may be positively obstructive in certain contexts, when it becomes a means of obscuring the critical issues and a vehicle for maintaining the *status quo ante* of power. We see extreme cases of this obfuscation in the language of military strategy, where instead of *weapons that kill more people* the planners now demand *weapons of greater lethality* (and, as we saw, *manoeuvre and logistic planning and execution must anticipate by many hours the vulnerabilities that deep attack helps create*). Such discourse seems not so much to construct reality as to construct unreality.

What I have been suggesting is that, if we compare the two histories, the evolutionary history of the linguistic system and the developmental history of the learning of language by children, we find that the two are related epigenetically: that is, the development of the child's power of meaning follows the evolutionary trajectory

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LANGUAGE AND KNOWLEDGE:
THE 'UNPACKING' OF TEXT (1998)

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As I was planning this paper, I noticed that, in the title of our conference, *text* appeared in inverted commas ("scare quotes", as they are called these days), whereas *unpacking* did not. My topic was very close to the conference theme; but I wanted to problematize, not the text, but the unpacking. So l hope you will excuse me, first for appropriating the wording the organizers had thoughtfully provided – and secondly for changing it, transferring the scare quotes from the *text* to the *unpacking*. What this means is that I shall take the concept of "text" for granted: but I shall treat 'unpacking' as something that needs to be unpacked.

My own "text" – in the other sense: that which is to be the topic for exegesis – could be the first paragraph of the original conference description:

> Developing cognitive processes, building knowledge of the world and of self takes place through overt exploration of meaning. One of the chief ways of doing this is through formal education where the learner moves from the world of common-sense knowledge, which is typically spoken 'text', to the world of educational knowledge, which is typically 'text' written down. The purpose of this conference is to explore how language, in the way it is put together, allows the development of common-sense and educational knowledge and also how this exploration of 'text', both oral and written, can play a

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* Editors' note: Professor Halliday delivered this paper in his keynote speech at the 1996 conference entitled 'Language and Knowledge: The Unpacking of "Text" '.

significant part in shaping the social system and defining the individual's access to, and participation in social processes.

What happens, linguistically, as a child moves from common-sense knowledge to educational knowledge? From one point of view, the picture seems fairly clear; for some years now linguists have been accumulating detailed information about children's language development, from infancy through to primary and secondary schooling – although there is still much remaining to be found out, even in relation to English, perhaps the most thoroughly investigated language of all. But while I do want to be reminding you of some features that will be familiar enough, such as increasing nominalisation, I shall try to look at such features from the point of view of what they mean: asking what changes take place in the child's potential for meaning, and so looking at language development as the development of the semogenic, or meaning-creating, resource.

I shall make the assumption that all forms of human knowledge are capable of being construed as text. Knowledge is prototypically made of language. Once you have language – whether 'you' as species, or 'you' as individual – then you have the power of *transforming experience into meaning*. But, by the same token as you are enabled to do this, you are also constrained to do it; you have not internalised an experience until you have transformed it into meaning. And once you have done that, it has the potential for being worded – it can now be transformed into text. Since it is the lexicogrammar that has transformed experience into meaning in the first place, this experience already exists as 'virtual' text. But experience comes to be construed in very different ways, as children mature – as they move from home and family, via neighbourhood and peer group, into primary school and then beyond.

The perspective I am adopting here is that of a continuous developmental progression, from birth through infancy and childhood, then via primary and secondary schooling, through adolescence and into maturity (for research in early language development, based on case studies, see Halliday 1975, 1978, 1979, 1983, 1984b (all in 2004), Oldenburg-Torr 1990, Painter 1984, 1989; for case studies of language development and learning in childhood, Derewianka 1995, Painter 1993; for large-scale research in conversation between mothers and three-year-old children, Hasan 1991, 1992, Hasan and Cloran 1990; for language education and children's language experience in school, Martin 1989, 1993, Halliday and

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Martin 1993, Part 2, Martin, Wignell, Eggins and Rothery 1988). Let me at this point just highlight certain aspects of this developmental progression. We see how, in early infancy, linguistic and biological maturation proceed together. When babies first sit upright, and so view the world as landscape, they begin to develop a small inventory of differentiated signs with which to explore and to control it; and when they learn to crawl around, so that their relationship to the environment is constantly changing, they expand this into a semiotic system, the **protolanguage** – small sets of contrasting signs in distinct functional contexts. In the process, they become able to separate the 'self', semiotically, from the environment by which the self is defined: this is the level of primary consciousness, which humans share with all "higher" animals (perhaps all those which control their body temperatures; cf. Edelman 1992). Then, when children learn to stand up and move around on two legs, combining perspective with mobility, their infant protolanguage develops further, becoming 'language' in the sense that we know it. This is Edelman's "higher order consciousness", and it is in its developed form unique to homo sapiens – as far as we know, although current work now going on in primatology, such as that in Atlanta (Benson & Greaves 2004), should make it clear how far other apes have moved in the same direction. Critical to this post-infancy language is that it is **stratified**: it has an additional level of semiotic, a lexicogrammar, that is absent from the infant protolanguage. Higher order consciousness is consciousness that is built on grammar.

Moving from infancy to childhood enlarges the horizons, both materially and semiotically at the same time. And this enlargement takes place on two fronts. One is interpersonal: the enlargement of the sphere of social control, from the small 'meaning group' of the infant towards the 'speech fellowships' of adult life. The other is ideational: the enlargement of the experiential domain, from the small world of the infant towards the unbounded world that lies beyond. When we talk of 'building knowledge of the world and of the self', we usually think in terms only of the second form – of language as knowledge, rather than of language as interaction and control; but both are involved at every point, and new ways of meaning, new textual resources, tend to develop in interpersonal contexts first, even if their eventual functional load is mainly experiential. To give a brief example: the evidence shows that children first develop logical conditions ('if ... then' relations) in the context of threats, warnings and promises, where the interpersonal

element predominates, rather than in ideational contexts of reasoning about the world.

As children move through these ever enlarging spheres, the nature of their text changes. They learn new ways of meaning. We tend to think of this first and foremost as adding new words; that of course they are doing all the time – but then so are we, as adults: this is a steady process, one that goes on throughout our lives. But there are also critical moments, periods of more rapid change; and these tend to be brought about in the grammar. Thus, as well as moving into new semantic domains, and refining the grid – the *delicacy* – of those already entered, both of which are relatively steady and gradual developments, children pass through three, more catastrophic changes, in which the grammar comes to be radically transformed. The first is the move from protolanguage to language, already referred to, when the grammar is first laid down in the second year of life. The second is the move from everyday spoken grammar to the grammar of literacy, when we take them and put them into school around age five; and the third is the move from the grammar of written language to that of the language of the subject disciplines, when we move them out of primary into secondary school. If we want to characterize these in terms of knowledge, then the three critical moments are the moves into commonsense knowledge (age 1–2), into educational knowledge (age 4–6) and into technical knowledge (age 9–13, childhood to adolescence). Each of these moves is enacted through a critical progression:

1) generalization: from 'proper' to 'common' terms (individual to general);
2) abstractness: from concrete to abstract elements;
3) metaphor: from congruent to metaphorical construals.

The first enables the child to *construe* experience (to transform it into meaning, as I put it earlier); while the second and third successively *reconstrue* experience in an increasingly theoretical mode. Again modelling this in systemic terms while *elaborating* the meaning potential (refining the grid) and *extending* the meaning potential into new domains are relatively steady processes; *enhancing* the meaning potential involves shifting the gears, moving on to a higher plane where what is known has to be reconstituted in a deeper, long-term perspective. In terms of a concept that has been used in evolutionary theory, language development takes the form of "punctuated equilibrium": periods of relatively steady growth, with moments of

rapid change from time to time; and each such punctuation requires some 'packing' of the text.

Let me make explicit what I am talking about. Consider the following pairs of example sentences:

(1a) Strength was needed to meet driver safety requirements in the event of missile impact.
(1b) The material needed to be strong enough for the driver to be safe if it got impacted by a missile.

(2a) Fire intensity has a profound effect on smoke injection.
(2b) The more intense the fire, the more smoke it injects (into the atmosphere).

(3a) The goal of evolution is to optimize the mutual adaption of species.
(3b) Species evolve in order to adapt to each other as well as possible.

(4a) Failure to reconfirm will result in the cancellation of your reservations.
(4b) If you fail to reconfirm your reservations will be cancelled.

(5a) We did not translate respectable revenue growth into earnings improvement.
(5b) Although our revenues grew respectably we were not able to improve our earnings.

Those lettered (a) are typical specimens of adult written English, such as we come across every day of our lives; highly metaphorical, even if not particularly technical. In those lettered (b), I have unpacked them into a more congruent, less metaphorical form. I will have to explain, of course, in what sense they had first been "packed" – in other words, I need to unpack the metaphor of packing. In part, perhaps, I could explain it as meaning 'packaged': the wording seems to have been more elegantly wrapped – which is why it is not noticeably shorter; the implication that 'packing' means reducing in size is actually rather wide of the mark. And yet, in spite of this, there is a sense in which such instances have been condensed, or compacted: more meaning has somehow been 'packed' into the text. If we want a physical metaphor, the (a) versions seem to be considerably more dense. It is as if, when we move from common-sense knowledge into literate and then into technical knowledge, the

There is of course some lexical unwrapping: *accurately – exactly, confirm – prove – be sure*; but the main work is being done in the realm of the grammar. Figure 2.1 gives a brief summary of some of the grammatical variation.

[18] clause: Value + *be* + Token (both nominal)	lexical density: 6/1 = 6
n.gp.1: Deictic + Epithet + Thing + Qualifier	[of + [De + Th +Qu [of + [De + Th]]]]
[12] 1 clause: Value + *be* + Token (both clausal)	lexical density: 12/3 = 4
el.1 (nexus): [[Sayer + Process ‖ Senser + Process + Phenomenon + Manner]]	
[6] 2 clause complexes, each of 3 clauses	lexical density: 6/6 = 1
c.c.l: $\alpha'\beta$ $(\alpha'\beta)$	c.c.2: 1 $'2(\alpha'\beta)$

Figure 2.1 Some grammatical variation among text variants displaying different degrees of 'packing'

If we now take this text down to the grammatical potential of a six-year-old we have to do more work so as to make it concrete:

you can be sure you know what's happening (because) you do something and then you see that it works;

after which you give an example:

– like growing plants: you water them, and they grow.

The **example** cannot of course be derived systemically from the grammar of the preceding text! But making it concrete in this way suggests how it might be made accessible to our three-year-old:

Look – wasn't it good that we watered that philodendron? See how well it's growing!

The three-year-old cannot yet construe the abstract meanings of *you do something and then you see that it works*.

Before leaving the ontogenetic trail, let us just take another sentence, one that might very naturally be said to the three-year-old:

Look – it must be raining! People have got their umbrellas open.

We can now repack this step by step going up the age range instead of down.

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How can you tell that it's raining? You can see that people have got their umbrellas open. (6)

We can prove that there's rain falling by seeing that people's umbrellas are open. (9)

What best proves that it's rainy weather is the fact that the umbrellas have been extended. (12)

The best proof that the weather is pluvious is the fact that the umbrellas are extended. (15)

The truest confirmation of the pluviosity of the weather is the extendedness of the umbrellas. (18 up)

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Thus there is a systematic link between the extent of packing in a text and the semiotic maturation of the text-user (or, unpacking this, between how far a text is packed and how old the user is). As I noted earlier, the construct of generalization, abstractness, metaphor corresponds to the three critical moments in child language development:

+ generalisation: from child tongue to mother tongue, age 1–2
+ abstractness: from common-sense (grammar) to literate, age 4–7
+ metaphor: from congruent (grammar) to metaphorical, age 9–13

(cf. Painter 1984, 1993, Derewianka 1995, Halliday 1975, 1999, 2004). In moving from infant protolanguage to post-infancy language, children construe *classes*, with "common" nouns, verbs and so on as distinct from "proper" names (the proper name is transitional from the non-referential protolanguage to the category-referring mother tongue). At first, these common terms construe concrete, perceptual phenomena; but from around the age of four these start to extend to phenomena that are not directly accessible to the senses. Since reading and writing depend on being able to process abstract entities, this means that children of this age can now become literate; and they can move from commonsense to educational forms of knowledge, coping with terms such as *movement* (name of a process), *length* (name of a quality), *circle* (name of a form), *metre* (unit of measurement). Then, the further critical step by which they cross the frontier from literate to technical knowledge, taken essentially at puberty, is the move into metaphor: metaphor in the grammatical sense, the replacement of one grammatical class by another, of which the prototypical example is nominalization (but

see below!). Thus the packing of text represents – and enables – the progressive construction of knowledge, from commonsense through literate to technical; it is the opening up of the individual's meaning potential through new forms of semogenic power.

Note that packing is not the same thing as increasing complexity. Let me return briefly to Figure 2.1: which of these forms are we going to say is the most complex? In terms of lexical density, and the internal structure of the nominal groups, clearly the complexity increases as the text 'matures' (with the age of the user). But in terms of the structure of the sentence (the **clause complex**, in systemic terms), the complexity actually **decreases**. The wording addressed to the six-year-old consists of two complexes of three clauses each (which might easily be combined into a single clause complex with six clauses in it: *you can be sure you know what's going on because you do something and then you see that it works*), involving both hypotaxis and parataxis and both expansion and projection. We recognise this pattern as a phenomenon of the difference between speech and writing: as the text is packed it becomes more 'written'. Written technical discourse, in particular, is characterised by rather simple clause and sentence structures: each sentence typically one clause, that clause consisting of just one or two nominal groups (one of them perhaps 'governed' by a preposition), propped up by a verbal group, usually a relational process and most typically the verb *be*. The nominal groups, on the other hand, may be enormously long and complex – since all the lexical material is compressed into these one or two groups. I have referred to these two complementary types of complexity as "lexical density" and "grammatical intricacy" (Halliday 1987a): density measured as the number of lexical words per clause, intricacy as the length and depth of the tactic structures whereby clauses come together to make up a clause complex. We can see how, as the text is progressively 'packed' from the six-year-old version to that of the adult, the **density** is tending to increase (a mean value of around 1–2 in casual speech and around 6–10 in technical writing is typical of many samples that I have counted), while the **intricacy** correspondingly decreases. It is this combination of two associated features that characterises the variation that is familiar to us under the label of nominal and clausal styles (note that the opposition is not between nominal and **verbal**, it is between nominal and **clausal**).

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To get a sense of the grammatical gradation that links these two different "styles", we might consider another paradigm of agnate wordings:

1   Glass cracks more quickly the harder you press on it.
2   Cracks in glass grow faster the more pressure is put on.
3   Glass crack growth is faster if greater stress is applied.
4   The rate of glass crack growth depends on the magnitude of the applied stress.
5   Glass crack growth rate is associated with applied stress magnitude.

(The original version, which is the fourth one in the set, is taken from Michalske and Bunker, 'The fracturing of glass', *Scientific American*, December 1987.) I have taken the original and produced four rewordings; these are ranged in order from most congruent to most metaphorical. We could give an informal semantic gloss on each of these variants, by treating it as if it was congruent: that is, on the presumption that (a) a clause nexus realises a **sequence**, a clause realises a **figure** and an element of clause structure realises an **element**, and (b) of the types of element, nominal groups realise **participants**, verbal groups realise **processes**, and adverbial groups or prepositional phrases realise **circumstances**. Thus, version (1) would be a sequence of two figures; the first figure consists of three elements, a process *crack*, a participant *glass* and a circumstance *more quickly*; the second figure has four elements, a process *press*, a participant *you*, a participant *it* ('glass') introduced as a circumstance *on it*, and a circumstance *harder*; and the two figures are bound together by the conjunction of the two circumstantial adverbs in comparative form (*more quickly, harder*), each accompanied by (what in modern English appears as) the definite article *the*. (This could have been construed congruently by a conjunction such as *if* or *when*.)

By contrast, version (5) would be a single figure consisting of three elements, a process *is associated*, a participant *glass crack growth rate*, and a participant *applied stress magnitude* introduced circumstantially by *with*. The participants have now become both complex and abstract. They are complex because each is construed as a 'thing' having a string of hyponymic classifiers, e.g. *rate, growth rate* ('kind of rate'), *crack growth rate* ('kind of growth rate') and so on. They are abstract because *rate, magnitude, growth* ... are the names of qualities

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('how fast') or processes ('growing'). Furthermore the process, instead of 'cracking' or 'pressing on', is now one of 'causing or being caused by', which we could also characterize as being abstract. We could then perhaps summarize the semantic progression of these five variants as follows:

(1) thing *a* undergoes process *b* in manner *c* to the extent that in manner *x* person *w* does action *y* to thing *a*
(2) (complex) thing *b-in-a* acquires property *d* in manner *c* to the extent that (abstract) thing *xy* has process *z* done to it
(3) (complex abstract) thing *abc* has attribute *c* under condition that (abstract) thing *xy* has process *z* done to it
(4) (complex abstract) thing *c-of-abd* is caused by (complex abstract) thing *zyx*
(5) (complex abstract) thing *abcd* causes / is caused by (complex abstract) thing *zyx*

Here is another set of agnate expressions (clause complexes/ clauses), illustrating the same kind of gradation but glossed in grammatical terms so as to bring out the small steps by which this movement between the most clausal and the most nominal con- stitutes a 'packing' of the text. The original is taken from Stanier et al. 1987, p. 205.

1   Osmolarity increases, so putrescine is rapidly excreted.
                                   (clause nexus: paratactic)
2   Because osmolarity increases, putrescine is rapidly excreted.
                                   (clause nexus: hypotactic)
3   That osmolarity increases means that putrescine is rapidly excreted.
                         (clause: two rankshifted clauses, finite)
4   Osmolarity increasing leads to putrescine being rapidly excreted.
                      (clause: two rankshifted clauses, nonfinite)
5   Increasing of osmolarity causes rapid excreting of putrescine.
                         (clause: two nominal groups, verb as Head)
6   Increase of osmolarity causes rapid excretion of putrescine.
                    (clause: two nominal groups, mass noun as Head)
7   Increases of osmolarity cause rapid excretions of putrescine.
                    (clause: two nominal groups, count noun as Head)

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qualities, (re)construed as nouns; e.g. *recognition, resistance, develop-ment, sterilisation, heat*. But these are not all of the same kind, nor are they all present for the same reasons.

(a) Some are early technical terms from classical times, e.g. *heat*: Greek θερμον, θερμοτης, derived from θερω 'heat up', meaning 'quality of being hot' or 'measurement of how hot'. This is originally created as a **semantic junction**: a quality construed as a thing – that is, by a class of word (noun) that congruently construes things: so it is in origin a complex element having the features of both. It is taken over, already as a technical term, into Latin *calor* and thence into modern European languages such as English. Since it has become a thing, it can be measured (cf. the expression *quantity of heat*, as used for example by John Dalton in the early nineteenth century); it can be a participant, in different participant roles within the clause; and it can be expanded to form taxonomies using the resources of the nominal group: *latent heat, radiant heat* and so on.

In other words, *heat* has become a technical element in a scientific theory; and in the process, the original metaphor has died. It is now a "dead metaphor". And once it is dead, it can no longer be unpacked. The semogenic process that begins with transcategorising an adjective *hot* into a noun *heat*, whereby a new type of complex phenomenon is brought into being (one that is both 'quality' and 'thing'), is now complete; the semantic feature of 'quality' has been transformed, and there has emerged a virtual thing, a thing that exists on a higher, more abstract level, functioning as part of an ordered chain of explanation. (Hence, just as the **relation** of grammatical metaphor is analogous to that of metaphor in its canonical, lexical sense, so also the **process** whereby a metaphor comes into being, lives, and dies, is also analogous. The only difference is that whereas in classical metaphor one **word** takes over from another, in gram-matical metaphor one **grammatical class** takes over from another.)

(b) A similar process has taken place with the term *resistance*, except that here the congruent form is a verb, semantically a process; so the semantic junction that takes place is that of **process** construed as thing. This term also has become technicalized – the metaphor is dead: and it appears in a variety of theoretical contexts from elec-tricity to immunology each with its own specialized taxonomic environment.

(c) Such taxonomies are typically construed in English as Classifier +

Thing structures in the nominal group; and here we find these two metaphorical terms combining to form just this structure: *heat resistance*. And once again a semantic junction has taken place. The congruent meaning of this Classifier + Thing structure is 'a kind of', 'a class of'; so *heat resistance* becomes a kind of resistance, analogous (say) to resistance to various kinds of disease or disease-bearing agents (e.g. *phylloxera resistance*, resistance to attack by a particular species of louse); *heat resistance* has thus become a complex technical term on its own. We may note that *heat resistance* is not equivalent to *resists being made hot* – heat-resistant bacteria are not bacteria which resist being heated; they are bacteria which survive even when they **are** heated. This grammatical metaphor is also dead; 'heat resistance' is a complex virtual thing, and the metaphor can no longer be unpacked.

(2) Common to all these instances of grammatical metaphor is the fact that they have become **systemic**. We may contrast, in this respect, the word *recognition*. *Recognition was essential* is agnate to *people had to recognize*; here the metaphor is not systemic – it is, and remains, **instantial**. The context for it is purely discursive: the need to organise the information as 'recognise ... only then could develop', with 'recognise' construed as the Theme, and hence nominalized. This grammatical metaphor is not dead, and can readily be unpacked.

Except in special cases of designed systematic taxonomies, like those of chemistry, and some in medicine, all grammatical metaphors begin as instantial, created in response to the needs of the unfolding discourse. Some of them – the majority, in fact – remain this way, being recreated on each occasion. There is no thing as 'recognition' in the sense in which the word is being used here (there is, of course, in diplomacy, where *recognition* **has** become technicalized). Others become systemic: that is, they become systemic options within the meaning potential of a given register. This is a normal semogenic process within languages as a whole; what creates technical terminology is the combination of two processes: *from instantial to systemic* and *from congruent to metaphorical*.

(3) It would be wrong, however, to equate grammatical metaphor with nominalization. Nominalization is predominant, in the sense that most metaphoric shift is shift into a nominal group. But not all of it is. This is not the sole driving force, even in technical discourse: one that is perhaps equally critical in this context is the experientializing of logical-semantic relationships: that is, reconstruing 'so'

as *cause*, 'then' as *follow* and so on. In this sentence there is a sequence of two processes, 'recognizing' and 'making sterile', with a relator 'only then' (or, in English, 'not until') between them. The congruent construal of this relationship is as a nexus of two clauses joined by a conjunction. We can set up the principle of congruence between semantic and grammatical categories in the following way:

Congruence in rank		Congruence in status (elements)	
semantic	*grammatical*	*semantic*	*grammatical*
sequence	clause nexus	thing (entity)	noun (/nominal group)
figure	clause	quality	adjective (in nominal group)
element	group/phrase	process	verb (/verbal group)
		circumstance (1)	adverb (/adverbial group)
		circumstance (2)	prepositional phrase
		minor process	preposition
		relator	conjunction

The grammatical metaphor thus shifts both the rank and the class status: the sequence, from being a clause nexus, becomes a single clause; and the relator, from being a conjunction, becomes typically a verb – in this instance, there is a further shift whereby the relator is nominalized to become an adjective *essential*. And here again there is a semantic junction: a verb such as *cause, follow, result in* is **both** process **and** relator. It may then become further metaphorised into a noun, such as *cause* or *consequence*; this in turn may become technicalised, the metaphor dies, and the instances can no longer be unpacked.

These are some of the grammatical metaphors contained in that particular sentence. I have discussed them, rather sketchily, case by case, with just passing reference to the general principles involved. A summary of the types of grammatical metaphor I have come across in analysing typical passages of technical discourse in English is given in Figure 2.3 (for a fuller account see Halliday and Matthiessen 1999).

The interesting question that arises is: is there a single principle that we can observe to lie behind these various shifts – a 'general drift' in the direction taken by all the varied types of grammatical metaphor? I think there is; it seems that we can discern a pattern as set out in Figure 2.4, where the arrows numbered 1–10 show the various metaphoric movements that are found to be taking place. The general drift is, in fact, a drift towards the concrete, whereby

Key to figure:	semantic element	grammatical class
	grammatical function	example

1. quality ⇒ entity	adjective ⇒ noun
Epithet = Thing	unstable = instability

2. process ⇒ entity	verb ⇒ noun
(i) Event = Thing	transform = transformation
(ii) Auxiliary = Thing:	
(tense)	will/going to = prospect
(phase)	try to = attempt
(modality)	can/could = possibility, potential

3. circumstances ⇒ entity	preposition ⇒ noun
Minor Process = Thing	with = accompaniment; to = destination

4. relator ⇒ entity	conjunction ⇒ noun
Conjunctive = Thing	so = cause/proof; if = condition

5. process ⇒ quality	verb ⇒ adjective
(i) Event = Epithet	[poverty] is increasing = increasing [poverty]
(ii) Auxiliary =	
(tense)	was/used to = previous
(phase)	begin to = initial
(modality)	must/will [always] = constant

6. circumstance ⇒ quality	adverb/prepositional phrase ⇒ adjective★
(i) Manner = Epithet	[decided] hastily = hasty [decision]
(ii) other = Epithet	[argued] for a long time = lengthy [argument]
(iii) other = Classifier	[cracked] on the surface ⇒ surface [cracks]

7. relator ⇒ quality	conjunction ⇒ adjective
Conjunctive = Epithet	then = subsequent; so = resulting

8. circumstance ⇒ process	*be / go* + preposition ⇒ verb
Minor Process = Process	be about = concern; be instead of = replace

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9. relator $\Rightarrow$ process	conjunction $\Rightarrow$ verb
Conjunctive = Event	then = follow; so = cause; and = complement
10. relator $\Rightarrow$ circumstance	conjunction $\Rightarrow$ preposition/-al group
Conjunctive = Minor Process	when = in times of/in ... times
	if = under conditions of/under ... conditions
11. [zero] $\Rightarrow$ entity	= the phenomenon of ...
12. [zero] $\Rightarrow$ process	= ... occurs/ensues
13. entity $\Rightarrow$ [expansion]	noun $\Rightarrow$ [various] (in env. 1, 2 above)
Head = Modifier	the government [decided] = the government's [decision], [a/the decision] of/by the government, [a] government(al) [decision] the government [couldn't decide/was indecisive]= the government's [indecision], [the indecision] of the government, government(al) [indecision]

★ or noun; cf. mammal [cells]/mammalian [cells]

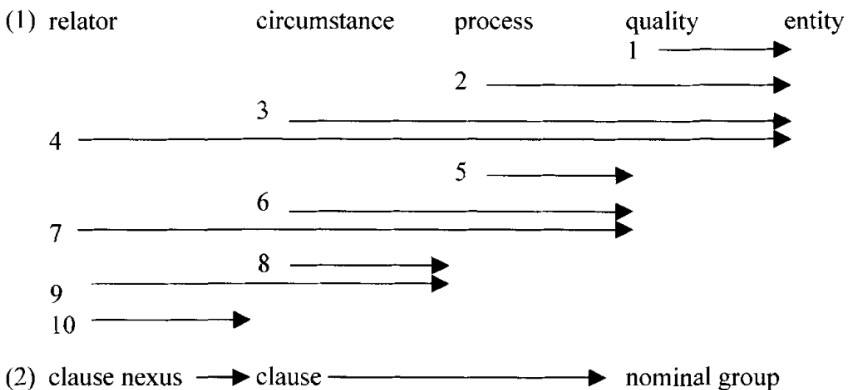**Figure 2.3**   Typology of grammatical metaphors

Figure 2.4   The 'general drift' of grammatical metaphor: (1) status, (2) rank

is an unbroken continuity between the theories of everyday common-sense knowledge and those of rarefied scientific knowledge; the frontier between the two is permeable, so that however 'uncommon-sense' much of science is, it is still construed in language, by people who also always retain their commonsense model of the world.

There is in fact an analogue to a designed scientific theory in the discourse of commonsense knowledge. Probably few of my younger colleagues, at least in the English-speaking world, will remember this; but the commonsense theory of experience is a proverb. My grandmother had a proverb for practically any type of situation; she would say things like:

> You'll never make a silk purse out of a sow's ear.
> A fool and his brass are soon parted.
> Take care of the pence, and the pounds'll take care of themselves.
> What's sauce for the goose is sauce for the gander.
> Beggars can't be choosers.
> It never rains but it pours.
> That's the pot calling the kettle black.

and one of her favourites:

> Least said, soonest mended.

– bringing such sayings quite unselfconsciously into her conversation. These were theoretical generalizations about experience; they are **general** truths but, in most cases, construed as **specific** illustrations. But they are discursively contextualized, of course, so that the sort of theory they are propounding (that, for example, a person or object of low value cannot be transformed into one of high value) becomes accessible because it is triggered by some instance already under discussion. Some do depend on grammatical metaphor (e.g. *more haste, less speed*), but on the whole they tend to be congruent; the listener does not have to unpack them but has to move laterally from one instance to another. We can choose to pack them if we wish; we could say *the transformation of inferior raw materials into superior finished products is an impossibility* – and as soon as we do this, contrasting it with *you'll never make a silk purse out of a sow's ear*, we get a sense of what is added, and what is taken away. It would be hard to maintain, I think, that these two were synonymous!

Clearly the semantic distance here is greater than that between packed and unpacked variants such as those I have been discussing, which are systematically related (or "**agnate**") in the grammar, by

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grammatical metaphor. We might still want to regard the latter type as experientially synonymous, saying that in some sense they construe the same thesis, or 'state of affairs' (though I think we need to question that also, as a rather too facile assumption); and if that was the whole story, then the packing and unpacking of text would play no part in the construal of knowledge. But even if we accept it, it clearly is not the whole story.

Let me come back for a moment to my account of construing and reconstruing experience as involving the three steps of generalization, abstractness and metaphor. We can look at these as three successive waves of theoretical energy. The move from proper name to common name (generalization) is what makes possible our commonsense theories of knowledge; and the move from concrete categories to abstract ones makes it possible to retheorize this knowledge in 'uncommonsense' terms. In the same way, the move from congruent construals to metaphorical ones allows us to retheorize over again, this time in the form of our technical and scientific theories of knowledge. So 'packing', in the specific sense of this third wave of theoretical energy, is merely an extension of a process that has been going on since language began, in which each step has enlarged the meaning potential by adding a new dimension to the total model. None of them leaves the construal of experience exactly as it was before. Of course, we do not discard the earlier models when we add each new dimension; we may expect to find them all enshrined in the grammatical construction of the text. Consider the following passage taken from James Clerk Maxwell's work on electro-magnetism (1881):

> In this treatise we have avoided making any assumption that electricity is a body or that it is not a body, and we must also avoid any statement which might suggest that, like a body, electricity may receive or emit heat.
>
> We may, however, without any such assumption, make use of the idea of entropy, introduced by Clausius and Rankine into the theory of heat, and extend it to certain thermo-electric phenomena, always remembering that entropy is not a thing but a mere instrument of scientific thought, by which we are enabled to express in a compact and convenient manner the conditions under which heat is emitted or absorbed.

Here, we find a virtual (level 3) entity *entropy*, an abstract (level 2) entity *electricity*, a general (level 1) entity *body*, and a 'proper' (level 0)

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entity *Clausius*, representing these four different levels of human understanding, all functioning together in a complex edifice of scientific knowledge. Each one inhabits a differently dimensioned space in the overall interpretative act.

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Each new wave of theoretical energy – each new round of packing, to remain within our own metaphorical domain – takes us one step further away from our ordinary everyday experience. To go from *pussy!* (first calling, then naming, our individual pet) to *cat* (naming the species), we have to have memory; and even more so to get to *cat* as the name of a genus including lions, tigers and so on, since we are unlikely to experience all these together in a collective. To go on from there to the abstract terms **species** or **genus** we have to have a systematic theory; and to go on from there to *gene pool* or '*the selfish gene*' we need a theory of theories, a metatheoretic potential which enables us to project our theories on to new planes of abstraction. We cannot unpack these **systemic** constructs without destroying them; yet if we don't unpack them we produce discourse which is so remote that it has little resonance with daily life. So scientific discourse becomes a discourse of prestige and power, something to be exploited by a technocratic elite that prefers to exclude everyone else from taking part in political processes.

We know that such discourse has given us enormous powers over our physical and biological environment: not by itself, of course, but as the primary semiotic in the dialectic of material and semiotic activity that constitutes the human experience. Without packing the text, it seems, we would never have moved into the machine age, let alone the age of information. All the more important, I think, to be aware of the not-yet-packed, commonsense grammar that lies at the base. In its experiential function, this grammar construes a general typology of experiential categories: processes, qualities, circumstances, relators and things. Some of these category types are less stable than others: processes and qualities are less stable than things, and relators are the least stable of all. We have seen that, in grammatical metaphor, everything shifts in the direction of the concrete: 'packing' the text adds stability and permanence, superimposing on the commonsense construal of experience syndromes of features which collectively serve to establish general principles. In order to stabilize, the grammar creates a semiotic universe made of 'things';

hence the interesting paradox: that the most abstract theorizing is achieved by modelling everything on the concrete. To make 'planets move' into a theoretical term, you turn *move* into a thing, called *motion*, and get the *planets* to function as a class of this thing, namely *planetary motion*. This would not work if *motion* immediately divested itself of the semantic feature of 'process'; but it does not – it begins as a semantic junction of 'thing' and 'process', and then evolves into a more abstract 'thing' in which is distilled a large amount of knowledge that has been accumulated from studying how things move.

But since a text that is highly metaphoric in this sense involves a great number of such 'distilled' terms, by the same token it is likely that, relative to the discourse of commonsense knowledge, it will appear as somewhat ambiguous. Theorizing means generalizing, idealizing out the specifics of this or that particular class of instances; hence in unpacking the metaphors, one is frequently faced with a range of possible congruent forms without any clear principle for preferring one over another. Once you unpack theoretical discourse, it ceases to be theoretical. Inevitably, therefore, a highly technical text has a different meaning for the expert, who processes it without unpacking, from that which it has for the lay person, for whom it may be inaccessible as it stands and ambiguously specific if unpacked. The discourses of science gain their theoretical power precisely because they are not translatable into commonsense terms. It has often been pointed out that scientific principles often contradict what commonsense knowledge leads one to expect; there is bound to be a certain disjunction between the grammar of scientific writings and the commonsense grammar of daily life.

If we 'pack' the text, we turn it into written, standard language; the language of books, written to be read by strangers, people that the writer has never seen or even heard of. Unpacking it brings it back into the family, into the local world of face-to-face encounters. If by 'knowledge' we mean technical knowledge, then it is almost bound to be construed in the form of discourse which is already 'packed'; this is not just a feature of English – it is just as true, for example, of Chinese. But the foundation of human experience, however far that experience may be extended into the mysteries of space and time, ultimately resides in the non-technical construal of local, everyday knowledge, in the typically congruent mode of the local, everyday grammar. Such knowledge does not gain from being packed into a metaphoric format. As my grandmother would have put it, in its own theoretical terms, "Fine words butter no parsnips".

Chapter Three

THINGS AND RELATIONS: REGRAMMATICIZING EXPERIENCE AS TECHNICAL KNOWLEDGE (1998)

1 Questions and assumptions

The question I am asking in this paper is: how does the language of science reconstrue human experience? By **how** I mean both 'in what respects' and 'by what means'. By **the language of science** I mean the various forms of discourse in which the activities of 'doing science' are carried out – but seen as a systemic resource for creating meaning, not as a collection of instances of text. By **reconstrue** I mean 'reconstruct semiotically': that is, replace one semiotic construction by another. I leave open the possibility that, in the end, the question might be dismissed – we might conclude that no such reconstrual takes place; although I have expressly formulated the question so as to suggest that I think it does.

I am concerned specifically with the scientific discourses of English, although it seems that the critical features are present in other languages as well. (Halliday and Martin 1993, Chapter 7 examines scientific writings in Chinese; Biagi 1995 discusses their history in Italian.) My approach is through the grammar, and specifically through systemic functional "grammatics", theorizing the grammar in such a way that it is possible to interpret texts as instantiations of a meaning–creating system and its subsystems. The most general sources for the grammatics are Halliday (1985/94), Martin (1992), Eggins (1994), Matthiessen (1995), Davidse (1991).

some are *bushes* and some are *shrubs*; and of the humans that are passing by some are *walking* and some are *running* (and some are *driving* in cars). We can observe small children working hard to construct the category meanings of words in their mother tongue; and we become aware of the problem for ourselves when we learn a language that is culturally distant from our own. But the more pervasive categories of our experience are those that are construed grammatically, since they provide us with a general foundation for understanding our environment and ourselves.

In the most general terms, the grammar construes experience as *process*, in the form of a grammatical *unit*, a *clause*. Each process, in turn, is construed as a *configuration*, in the form of a grammatical *structure*; the components of this configuration are (1) the process itself, (2) certain entities that participate in the process, and (3) various circumstantial elements that are associated with it; these are construed in the form of grammatical *classes*, the verbal, the nominal, and some more or less distinct third type. Then, one process may be construed as being related to another, by some form of grammatical *conjunction*.

The way things are is the way our grammar tells us that they are. In the normal course of events we do not problematize this construal; it is our 'taken for granted reality', and we do not reflect on why the grammar theorizes experience the way it does or whether it could have been done in some other way. If we do reflect, we are likely still to appeal to a sense of what is natural. We might reason that, as long as to our perceptions things stay just as they are, we do not 'experience' them; experience begins when the organism becomes aware of some change taking place in its environment (or in itself). Hence the grammar construes experience around the category of 'process': a process typically represents some sort of change, of which staying the same – not changing – becomes just the limiting case.

But sorting out a *process* of change from the *entities* that remain in existence throughout and despite the change (let alone from other phenomena that are seen as circumstantial to it) is already a major enterprise of semiotic construction. If we consider a simple clause such as *the sun was shining on the sea* (immortalized as the first line of *The Walrus and the Carpenter*), a considerable amount of semiotic energy has gone into the grammar's construal of this as a configuration of process 'shine', participating entity 'sun' and circumstance 'on the sea'. Taken purely in its own terms, as a perceptual phe-

nomenon, it would have been simpler to construe it as a single unanalysed whole. It is only when the whole of experience is being construed as an ideational *system* that the analytical model – breaking down a complex perception to recognize likenesses of many different kinds – shows up as infinitely more resourceful and more powerful. (To pursue the same text further, the sun's shining may be attended by other circumstances, *with all his might*; and the sun may participate in other processes than shining, trying *to make the billows smooth and bright*.)

What is significant for the present discussion, however, is not so much the particulars of the experiential model, as it evolved in human grammars; rather, it is the fact that the same evolutionary processes which make it possible to construe experience, by transforming it into meaning in this way, also provide the means with which to challenge the form of the construal. When experience has once been construed, it can be reconstrued in a different light.

3 Stratification and metaphor

It is, I think, acknowledged that human consciousness is the product of natural selection (Edelman 1992) – that there is no need to postulate some mysterious entity called "mind" (itself, as Matthiessen (1993) has shown, the rather one-sided product of the grammar's construing of inner experience) that lies outside the processes of biological history. Neuroscientists have shown that the brain (including the human brain) evolved in the context of the increasingly complex relationship between the organism and its environment; I would just want to add here, since this formulation overprivileges the ideational (cf. Section 1 above), that it also evolved in the context of the increasingly complex social interactions among the organisms forming a group. These evolutionary processes have engendered what Edelman calls 'higher order consciousness', something that appears to be unique to homo sapiens.

Higher order consciousness is semiotic consciousness; it is this which transforms experience into meaning. From my point of view in this paper, with its focus on language, higher order consciousness depends on two critical steps by which language evolved. One I have already introduced: that of functional diversity, or *metafunction*: the principle that 'meaning' is a parallel mode of activity (the semiotic, alongside and in dialectic relation with the material) which

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simultaneously both construes experience and enacts the social process. The other critical step is stratal organization, or ***stratification***.

Primary semiotic systems – those of other species, and the "proto-language" of human infants before they embark on the mother tongue – are not stratified; they are inventories of signs, without a grammar. Such systems cannot create meaning; their contexts are 'given' constructs like 'here I am', 'let's be together', 'I want that' (which we distort, of course, by glossing them in adult language wordings). Language, the semiotic of higher order consciousness, is ***stratified***: it has a stratum of lexicogrammar 'in between' the meaning and the expression (Halliday and Martin 1993, Chapter 2). The "signified" part of the original sign has now evolved into a meaning space, within which the meaning potential can be indefinitely expanded (Figure 3.2). Such a system can **create** meaning; its text-forming resources engender a discursive flow which is then modified (rather like the airstream is modified, on the expression plane, by articulation and intonation) so that it becomes at the same time both interactive (dialogic) and representational.
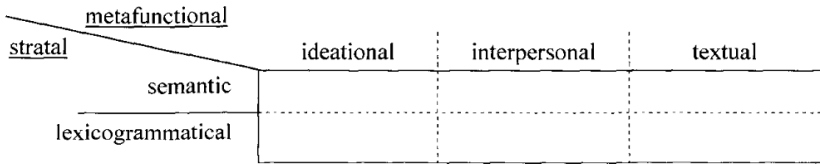
		ideational	interpersonal	textual
metafunctional strata				
semantic				
lexicogrammatical				

Figure 3.2 The 'meaning space' defined by stratification and metafunction

In the primary semiotic, "content" is formed directly at the interface with the experiential world – hence it is 'given', as described above. In the higher order stratified semiotic, meaning is created across a semiotic space which is defined by the ***semantic*** stratum (itself interfacing, as before, with the world of experiential phenomena) and the ***lexicogrammatical*** stratum, a new, purely abstract level of semiotic organization which interfaces only with the two material interfaces. The semiotic energy of the system comes from the lexicogrammar.

This 'thick', dimensional semiotic thus creates meaning on two strata, with a relation of ***realization*** between them: the semantic, and the lexicogrammatical – analogous to Hjelmslev's "content substance" and "content form" within his "content plane". If we focus

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now on the ideational function, we can represent the outline of the way experience is construed into meaning in the grammar of English along the following lines:

	semantic		lexicogrammatical
rank:	sequence (of figures)	realized by	clause complex
	figure	"	clause
	element (of figure)	"	group/phrase
types of element:	process	realized by	verbal group
	participating entity	"	nominal group
	circumstance	"	adverbial group or prepositional phrase
	relation	"	conjunction

For example: *the driver drove the bus too rapidly down the hill, so the brakes failed* (Figure 3.3).
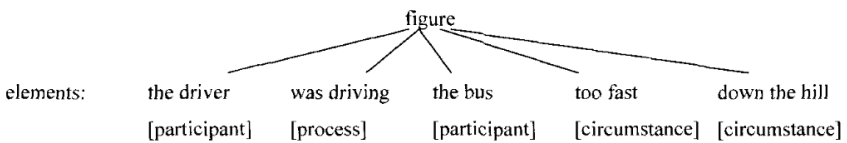
Figure 3.3 Construal of experience

Thus the grammar, in a stratified system, sets up categories and relationships which have the effect of transforming experience into meaning. In creating a formal distinction such as that between verb and noun, the grammar is theorizing about processes: that a distinction can be made, of a very general kind, between two facets: the process itself, and entities that are involved in it.

But, as remarked above, since the grammar has the power of construing, by the same token (that is, by virtue of being stratified) it can also deconstrue, and reconstrue along different lines. Since stratification involves mapping meanings into forms, 'process' into verbal and 'participant' into nominal, it also allows remapping – say, of 'process' into a nominal form: the previous clause could be reworded as a nominal group *the driver's overrapid downhill driving of the bus*. The experience has now been retransformed – in other words, it has undergone a process of metaphor. A stratified system has inherent metaphoric power.

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