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J.GRAHAM BEAUMONT

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by

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On Reading the Subject

It seems rather curious to be delivering this lecture when I have already been in the College almost two years. Not that I am not grateful for the opportunity to settle in, but it is a measure of the warmth of the welcome which my family and I have received, that Swansea already feels so definitely our home. I should just like to take the opportunity to thank those in the College, and beyond, for that warm and friendly welcome.

Of course, there are family connections going well back into history which ought to make us feel at home. [*slide: Swansea Castle*] Iolo Morganwg tells us that in "AD 1099 Harry Beaumont invaded Gower, and took it from the sons of Caradoc ap Jestyn and he built the castle of Swansea." Beaumonts also built the castles at Penrice, [*slide: engraving of Penrice Castle*] Llanridian, Oystermouth and Loughor, and the priory at Llangennith, and I hope that the Wales Tourist Board is suitably grateful.

A little later, it was Henry, Baron Beaumont, who arrested Edward II at Neath Abbey on November 15th 1326. A good deal more recently, J.T. Barber Beaumont (for rather complicated reasons travelling at that time under his mother's name) visited Swansea on his tour through Wales in 1801 [*slide: title page "A Tour Throughout South Wales and Monmouthshire*"]. It was he who noted an unusual curiosity.

"As we were strolling on the sands, about a mile above the town, we remarked a group of figures, in birth-day attire, gamboling in the water: not suspecting that they were women, we passed carelessly on; but how great was our surprize, on approaching them, to find that the fact did not admit of doubt. We had not paused a minute, before they all came running toward us, with a menacing tone and countenance, that would seem to order us away. Though we did not understand their British sentences, we obeyed, and very hastily too, on finding a volley of stones rattling about our ears. This hostile demonstration, we afterwards found, arose from a suspicion that we were going to remove their clothes, a piece of waggery often practised by the visitants of Swansea, to enjoy their running *nudiores ovo*.... In our subsequent

rambles on the beach these liberal exhibitions of Cambrian beauty afforded us many pleasing studies of unsophisticated nature."

[*slide: Henry Hussey Vivian and his third wife Averil Beaumont at the time of their marriage in 1870*] Finally, Averil Beaumont became the third wife of Henry Hussey Vivian and, in due course, Mistress of Singleton Abbey. My thanks to Professor Ralph Griffiths for this delightful illustration.

But ... to Psychology. It would be surprising if a psychologist were not interested in the behaviour of inaugural lecturers. There is the, I suspect apocryphal, story of the new professor about to give his inaugural lecture, who was asked by the Vice-Chancellor, "Tell me, which do you have: slides or ideas?".

A president of the British Psychological Society, some years ago, giving his presidential address - presidential addresses share much in common with inaugural lectures - identified three categories of title: 'Whither, or where are we going?'; 'Glucose 6 phosphate', or a eulogy on the technical complexity of the subject; and the autobiographic. I hope to encompass a little of all of these in what follows - with both slides and ideas.

It seems to me that it is my duty this evening, as a Professor, not only to profess my subject, but to show you how it relates to a profession, and is of value outside the walls of this institution.

Which brings me to my title. I have always been fascinated and entertained by the ambiguity of language. It is a subject which now interests psychologists and cognitive scientists because of the problems inherent in arranging for machines to understand natural human language. Here is a particularly rich example:

[*slide:* ITS TOUGH ON THE STREETS]

Some years ago an advertising campaign used the slogan "ITS TOUGH ON THE STREETS". Advertisements are good sources of these ambiguities because their strident tone often demands upper case letters and the removal of punctuation. What was the message which the advertisers wished to convey?

I have used this example with classes of students and challenged them to find as many meanings as they can in this string of text. I think that we have now identified 12 possible meanings - although some are, admittedly a little contrived. However, you will see some of them quite readily. For example:

[*slides: the following 9 meanings are illustrated by humorous cartoons*]

- The roads are going to need repairing more often;
- It is unfortunate for our present highway system;
- Urban living is particularly stressful;
- The 'oldest profession' is a particularly demanding one;
- It is capable of withstanding the wear and tear of urban travel;
- Assuming a soap-opera family called 'The Streets', life is treating them unkindly;
- Assuming a popular folk hero called 'Tough' - here he is standing on the pavement;
- Assuming an urban district known as The Streets - something similar to The Lanes in Brighton or The Park in Nottingham - a decision has been taken not in its interests;
- Assuming a book or a popular song entitled "Tough on the Streets" - here it is;

and so on.

What is interesting if I now remind you of the advertisement [*slide: shows original advertisement of slogan with red Renault car in front of a gasometer*], which was for Renault cars, is that while the advertisers wished you to understand that their car would withstand urban driving conditions, the more salient response seems to be that people think that their rate bill is likely to increase!

I invite you to look out for similarly intriguing advertisements. Incidentally, my thanks to our photographic technician Liz Harwood for the cartoons, and for the other slides you will see this evening.

Which brings me back to my title: **On Reading the Subject**. This was invented in the spirit of intentional ambiguity, and I hope that it has not been, as a result, too uninformative. What it will allow me to talk about is:

- On the subject of reading - its psychological study;
- On the subject of reading an undergraduate degree in psychology - including my reaction on reading the subject;
- On having read the subject of psychology - psychological careers and the profession of psychology.

Before I embark on these, perhaps there is at least a fourth meaning that I should dispense with: this kind of reading of subjects. [*slide: 19th century satirical engraving 'L. Bump after J. Bump'*] Phrenology had two periods of vogue: the first in the 1820's, and then subsequently in the 1880's through into the 20th century. [*slide: three phrenological heads*] These phrenological heads represent the main periods, and a modern reproduction.

Phrenologists generated remarkably detailed analyses of their subjects, which would be the envy of modern psychometricians. [*slide: 'Phrenological Chart of Character' with manuscript entries*] Here are the results of a 'delineation' of a Miss Marjorie Adams by Stackpool E. O'Dell and Miss Florence H. O'Dell, Consulting Phrenologists, in December 1914. Their report reveals not only that Miss Adams was injuriously weak in Concentrativeness and Self-esteem; [*slide: 'Diet Table' similar*] that she should take green vegetables and tea on only three days a week; but [*slide: 'Marriage Chart' similar*] that she should marry a man with a large degree of conjugality, philoprogenitiveness and hope, a large brain, of stout and tall build, with medium brown hair and hazel eyes.

[*slide: phrenological chart: the frontispiece to* Spurzheim, 1825] One is tempted to think of phrenology as firmly dead and buried, but I was startled to see it recently figure in an episode of 'Grange Hill', so it may yet stage a come-back. Phrenology is much castigated, but Gall, Spurzheim and the rest did not have it so completely wrong. They in part lead the interest in cortical localisation of function which is still with us. We now accept that there are anatomical asymmetries of the brain - bumps - which may relate to specific functional development. All that the phrenologists got

wrong was the idea that the form of the surface of the brain is reflected in the surface form of the skull.

But to my main point: the psychological study of reading.

Reading is something which most of us do quite effortlessly. Indeed, reading becomes so habitual that if I put up a slide and ask you to look at it, but not read it, you will find that almost impossible. Please don't read it.

[*slide:* Of its remarkable history Reading shows but few traces]

We can demonstrate the difficulty of not reading text that we see rather more formally in a phenomenon known to psychologists as the Stroop effect.

[*slide:* bed *printed in yellow;* power *printed in red;* pillow *printed in green*]

If we present words to subjects and ask them to name the colours in which the words are printed, we can establish the average response latency of identifying the colours. The correct responses are, from the top, "yellow", "red", "green". If we now present words of similar length and frequency which happen to be the names of colours, and again ask the subject to identify the colour of the printing [*slide:* red *printed in yellow;* green *printed in red;* yellow *printed in green*], then where the colour word conflicts with the colour of the ink, naming the colour of the ink takes significantly longer. This colour word interference effect occurs even if subjects are prepared for this type of stimulus, and instructed quite explicitly to ignore the word which is used.

So, reading is for most of us a highly practised, even compulsive, skill. Nevertheless, a significant proportion of children, and even some adults, have difficulty in acquiring this skill. This is in contrast to speech. Developmental difficulties in learning to speak, in the absence of gross pathology of the speech apparatus or of the nervous system, are extremely rare. It would obviously be valuable to have a better understanding of the processes involved in normal reading so that difficulties with learning to read could be better understood.

Currently, the dominant approach in psychology is that of Cognitive psychology. Cognitive psychologists emphasise the importance of mental processes in thinking, reasoning, memory, perception and language, which they conceive in terms of information processing models. One of the conventional ways in which research questions are tackled is by task analysis, by which a given function is broken down into component processes linked by both serial and parallel channels of communication. The task analysis is frequently performed by manipulating the task material and task demands, and studying the resulting task performance in terms of either accuracy or speed of response. Further evidence comes from the study of the functions as they develop in children, and by the study of adults who suffer injuries to the nervous system. The result is a cognitive model in an algorithmic form which can simulate the parameters of human performance.

I hope to show, in a rather sketchy way given the time available to me, how this has been achieved for reading functions. You should understand that, although I shall not show you the underlying empirical data, all the effects which I describe can be demonstrated by careful controlled measurements in the laboratory. Cognitive psychologists are careful to remain scrupulously within the bounds of scientific evidence.

I propose, in the next few minutes, to build up a very much simplified model of reading performance. It is derived from a number of contemporary models, and I must acknowledge the influence of the work of Andrew Ellis, John Morton and Philip Seymour, amongst others, in the specification of this model. Let me first show you the model, and then explain why each component is included [*slide: Figure 1. A model of reading processes.*].

We begin with the simple observation that it is possible to read and write text without any understanding of it at all as text, [*slide: as Figure 1, with direct route from* Visual Analysis *to* Writing *highlighted*]. As an extreme example, if I ask you to copy this text [*slide: a string of Japanese text*], you are certainly able to write it down, but without understanding what it means, or even recognising the characters which comprise the text. You are 'reading' it in only the most restricted sense. You have to take it on trust that it is the name of a friend of mine and says "Takeshi Hatta".

Most true reading involves some rather deeper analyses. They all begin with the recognition of characters, or strings of characters, in a visual processor.

[*slide*] bbb
ffl
ccceccccc
ktkkk
???!?

If you can tell whether the items in these arrays are all the same or not, then your visual processor is functioning correctly. I hope that you will see that they all contain differences, except for the first.

The next stage [*slide: as Figure 1, highlights* Visual Analysis *through* Grapheme Identification *and* Grapheme-to-Phoneme Conversion *to the* Alphabetic Lexicon] involves translating graphemes into phonemes. Graphemes are the elements of written language, in English mostly single letters, but also small groups of letters such as 'ch' 'th' 'qu' 'eau' and so on. Phonemes are the corresponding basic elements of spoken language. They are sometimes defined as the minimal units of speech that "make a difference" to the fluent speakers of a particular language. In all languages there are rules which govern grapheme-to-phoneme conversion, although languages differ in the degree to which these rules account for grapheme-to-phoneme correspondences. In English there are many exceptions; in Welsh there are relatively few, and in Italian there are almost none at all. Just consider for a moment these English words: [*slide*] 'bough', 'bought', 'though', 'through', 'cough', 'tough', 'slough' (swamp), 'slough' (skin). It is hard to see what the rule is for the conversion of the grapheme sequence 'o u g h' in each of these words.

Words which are pronounced according to the grapheme-phoneme conversion rules are termed 'regular' words, and the exceptions 'irregular'. To make the point entirely clear, here are some examples [*slide*] *regular*: 'gave', 'omen', 'penny'; *irregular*: 'have', 'women', 'yacht'.

If you are surprised that any of your reading proceeds in this way, by performing this kind of direct conversion, consider two situations. The first is when you meet novel words. You may not think that this occurs very often, but you only have to pick up the telephone directory to find a wonderful source of novel words. Here are a few taken at random from the Swansea directory which were new to me: [*slide*] 'Emmott', 'Esling', 'Hullin', 'Magness', 'Phyall', 'Raggatt'. You are in no doubt, or at least little doubt, about how to pronounce these names, and do it quite without difficulty. If you have never seen these names before, you **must** use grapheme-to-phoneme correspondence rules in order to pronounce them.

I can of course, make sure that you have never before seen the string of graphemes which I present to you, if I choose to show you non-words: letter strings which are not actually English words. You may find these perfectly easy to pronounce, and these non-words are examples: [*slide*] 'dokon', 'sate', 'bip', 'rute', 'teep'. Once again, you must be using grapheme-to- phoneme conversion rules, and you can pronounce them easily because they conform to the general structure of English words, and so the rules can be applied. If I had shown you these: [*slide*] 'pqzn', 'bqyt', 'wvaj', 'pdfehwok' you would have had rather more difficulty. That is because, as English readers, you have not learned rules which enable you to convert these sequences.

So, there must be a route which permits reading words, which include novel words and pronounceable non-words, by a grapheme-to-phoneme translation route.

But, why do we think that phonemes have to be involved? Why not go straight from graphemes to word recognition? In some cases such a route may be used, but there are a number of reasons for thinking that it is not the normal route. One is the kind of problems which certain brain damaged patients suffer, which suggest that the phonology is important. Such patients would be unable to tell that 'berry' rhymed with 'bury' but that 'ferry' did not rhyme with 'fury'. The inability of some patients to perform normally in a letter cancellation task is also relevant. The patient is asked to cross out occurrences of the of the letter 'e' while reading aloud the text. Certain patients, by comparison with normals, tend to miss the silent - unpronounced - 'e's which occur in the text.

The second reason is that regularity of pronunciation has an effect upon reading speed. Independently of the orthography - the graphemic form - pronounceability is related to the speed of reading a word, so the phonemic form must be involved in some way. Lastly, you have no difficulty in reading and **understanding** this sentence:

[*slide:* rownd the ruggid rocs the raggid razkul wran]

You can, presumably, only achieve this by converting the non-words into their pronounceable form, and then recognising the non-words as homophones of English words which you can recognise. So, we believe that much reading proceeds by this kind of conversion.

Well, you may say, there are sometimes words with which I am familiar, but which I cannot pronounce. Readers of the novels of Dostoyevsky may well find themselves recognising the names of characters as if they were hieroglyphics, but without actually pronouncing the name. Oh! its *that* character again, you think, without making the effort at pronunciation. Indeed, you are right, it is possible to extract meaning without pronunciation - but probably not by this route. If I take the novel away, and ask you to write down the name of the character you will have great difficulty. You recognise the meaning of the word, but are not reading the word with the precision necessary to reproduce it, which we would expect if an orthographic route is being employed.

[*slide: as Figure 1 highlighting route from* Alphabetic Lexicon *through the* Orthographic Processor *to* Writing] Once the elements have been decoded, and the word recognised, it can be passed directly to the orthographic output processor and written. This is presumably the route taken in writing irregularly spelled words [*slide*] like 'yacht', salmon', 'spinach', 'ocean' and so on.

Alternatively, words can be passed to a phonological output processor [*slide: as Figure 1 with routes from the* Alphabetic Lexicon *through the* Phonological Processor *to* Speech *and via* Phoneme-to-grapheme Conversion *to the* Orthographic Processor *and* Writing *highlighted*] from which they can be spoken. Also, they can be written by this route, by the reverse conversion of phonemes-to- graphemes. This is the only way in which you could attempt to write down a novel word which you had heard but not seen. If I give you a word with which you are probably unfamiliar -ligulate - and

ask you to write it down, you would probably write it like this [*slide:* ligulate] and be perfectly correct. You have constructed the orthography from the phonology. It will not have escaped you, from observing the errors of children, that it is common to see spelling errors where the irregularity has not been recognised, and a purely phonetic spelling, just following the phoneme- grapheme conversion rules, has been applied.

So far, so good. However, we have reason to believe that there is a quite separate route to reading, and that it is important at two stages in life. Firstly, it is important when young children first begin to learn to read. It is also the most frequently employed route for adult practised readers.

This route works quite simply by the recognition of whole-words. There is no analysis of the graphemic components. The word is just recognised and read. In formal terms this route [*slide: as Figure 1 showing link from* Visual Analysis *to the* Logographic Lexicon] proceeds from visual analysis directly to a logographic lexicon. What evidence do we have for this route? The principal evidence is that there is no effect of word-length or of word regularity for common words being read by practised readers. [*slide:* business *and* legal] It takes no longer to read 'business' than 'legal', even though one has more letters and syllables than the other, and is an irregular form. By the route we have just discussed it ought to take much longer to process 'business' than 'legal'. This is just not so for experienced readers. They simply recognise the word in a single go, and understand what it means.

This can also be demonstrated by lexical decision tasks - deciding whether a particular string is a valid English word or not. Again, there are no effects of length or regularity for common English words.

[*slide: as Figure 1 highlighting the route from the* Logographic Lexicon *to the* Semantic Processor *and the* Phonological Processor *and on to* Understanding *and* Speech] The logographic lexicon feeds to a semantic processor - which you need to decide what a word actually means (reading does not necessarily imply understanding!) but this must have rich interconnecting links with the phonological output processor, if only so that: firstly you can speak (read aloud) words read by the logographic route (the left to right arrow in the model) and so that you can understand words read by the orthographic route (the right to left arrow in the model).

The evidence is that most of adult reading proceeds by this logographic route, but that also the early reading vocabulary of children is acquired by this route. Children commonly then progress to learning the grapheme-phoneme correspondence rules, making all the predictable errors until they have learned the exceptions to the rules. Eventually they progress to the more sophisticated adult orthographic and logographic routes.

There is an interesting observation that there is a group of older children and adults who, while intelligent, expert and rapid readers, are poor spellers. There is research to support the idea that these are individuals who learned to read at an early age and in a short space of time. Current ideas are that they progressed so rapidly through the stage of grapheme- phoneme conversion, and acquired the adult logographic strategy so readily, that they failed to correctly acquire either the grapheme-phoneme conversions, or when appropriately to apply these rules. As a result they read rapidly, with good comprehension, but are poor at spelling, and may also be relatively poor at reading aloud.

[*slide*]	happly	vegatable
	sumer	vegitation
	wich	trackters
	realy	protien
	cerials	Israilites

One of my own sons exhibited exactly this pattern of spelling, although now, at almost 14, he has made successful efforts to overcome the problem, but at age 11 he was still making these kinds of errors. I must apologise for embarrassing him by this illustration. Rapid progression in learning to read is not necessarily an advantage.

But what is the practical value of all this fascinating work - and I can assure you that it gets even more absorbing as you get further down into the detail, beyond the level which I can present to you this evening? There are two areas in which this knowledge can be applied. The first, and most obvious, is in assisting children who have difficulty in acquiring reading skills. The second is in the rehabilitation of the brain injured.

I do not want to become embroiled in the debate which is normally triggered by the use of the term 'dyslexia'. Please note that when I use it here it means no more than an inability to read at the normal level which would be expected for an individual's age and intelligence. I am assuming nothing more - except, I suppose, that the inability can be described as a cognitive processing deficit and modelled in the way which I have illustrated.

Adopting this approach, the evidence - and there is now a great deal of evidence - is that there are three broad types of dyslexic deficit. [*slides list the three types, and show Figure 2*] These are **Developmental Phonological Dyslexia**, in which the problem is in grasping the grapheme-to-phoneme conversion rules. Secondly, **Developmental Morphemic Dyslexia**, in which the problem is establishing a sufficiently large sight vocabulary and reading fluently by the logographic route. Thirdly, **Visual Analytic Dyslexia**, in which the problem is in selectively focussing on the appropriate elements within letter arrays. You will easily see how this relates to dysfunctions in particular regions of the model.

I mention this particular scheme, which relies heavily on the work of Philip Seymour, because part of my own research is involved with this particular model of dyslexia. We are collaborating with Professor Seymour's lab at Dundee in translating the specific tests which are applied to assess the functioning of the various components in the system, already partly in computer-administerable form, into an integrated assessment scheme which will apply 'expert systems' techniques to yield a computer-aided description of the child's difficulties. We believe that this work, when complete, will lead to a richer and more accurate description of the subject's difficulty than was previously possible, make it more widely available, and permit more effective remedial programmes to be designed on the basis of the psychological description of the cognitive deficit.

I also mentioned the adult brain damaged. Patients who have suffered head injuries, disease, or cerebro-vascular accidents in the brain also sometimes lose the ability to read. We can similarly distinguish a number of different types among these acquired dyslexias, and identify them with relatively specific defects in the processing system as I have modelled it. Once again, this is of practical benefit because not only does it provide a psychological description of the patient's problem, but it permits a programme of rehabilitation to be planned. If your television is faulty, if you have a

circuit diagram, and if you can detect where the fault lies, then you have a reasonable chance of repairing the device. The same holds true for damaged brains. Once we can identify the precise difficulty, there is some real hope of designing effective retraining procedures.

A few moments ago, I mentioned the use of 'expert systems' technology to assist in the diagnosis of failures of the cognitive system. This is, perhaps, best illustrated by another area in which we are undertaking research: that of the difficulties which some children encounter in developing arithmetic skills. This research is being carried out in collaboration with the Test Development Unit of the National Foundation for Educational Research, and I must acknowledge the contribution of Dr. Neil Hagues in developing certain of the algorithms which I shall mention, and for the empirical data to which I refer.

As a small child I was fascinated by a skill practised by my father: not only could he rapidly estimate and cast up the totals of pages of ledger entries (a now long-lost art), but he also had a magical ability to detect the presence of errors in ledger entries which led to an incorrect balance. Given the discovery that the total was in error by 3/8d (anyone too young to understand the mysteries of pounds, shillings and pence will have to bear with me for a moment), my father would immediately seek for the figure '4' transposed between the shillings and pence columns. On discovering that the balance was out by £11/17/-, he would just as rapidly calculate that £13/0/7 had been entered for £1/3/7. It fascinated me as a child, and the discovery of how it was done was undoubtedly part of the basis of a continuing interest in mathematics. Isn't decimal money dull by comparison!

Of course, the lesson to be learnt from this is that within formal systems, errors of a given type produce predictable results. It is possible, given the errorful outcomes, to work back to the error in the system which produced the fault.

We can apply the same principle to understand the errors in cognitive systems. We can do it for reading, as I have just shown, but we can do it even more successfully for arithmetic processes. This is partly because children are taught quite formally how to perform arithmetic operations, and we therefore have a clearer model of how the child may be performing the calculation.

Let us consider the problem of subtracting one three digit integer from another three digit integer. We will only consider problems where the result will be a positive integer. Now, I was taught as I suspect many of you were by an archaic method. Given the problem of subtracting 8 from 6, we were taught to subtract 8 from 10, add the result (2) to the 6; enter the resulting value (8); and 'carry one' to the lower figure of the next column to the left. Children are no longer taught to do it in this fashion. They are now - quite sensibly - taught to perform 'decomposition'. That is, they decompose the upper figure in the next left column. By this method, 8 from 6 becomes 8 from 16, with the upper figure in the 'tens' column being debited by one.

Not all children find this easy, and some make repeated and more or less consistent errors in battling with this problem. The task for us is to accurately diagnose the error which the child makes. Here are four examples of relatively common errors.

[*slide*]
```
  624
 -137
  513
```

This is one of the most common errors. It is simply to apply the incorrect procedure of subtracting the smaller from the larger in each column. No decomposition is attempted. In this case, 4 is taken from 7 to give 3, two from three to give 1 and then 1 from 5 to give 6. Of 2600 children selected because of their evident difficulties with arithmetic, 28% exhibited this error. It is not a difficult error to spot.

[*slide*]
```
  672
 -235
  457
```

This is a much less common error, and one which is less obvious. In this case, when it is necessary to decompose the tens, a 'one' is added to the tens instead of being subtracted. So: 5 from 2 won't go, so decompose the 7 tens into 6 tens and one ten to make 12. Five from 12 is 7, then 3 from - it should be 6 - would be 2. However, the child has added one to 7 to give 8 tens, so 3 from 8 has yielded 5. Of 1913 children, 2% made this error.

[*slide*]
```
  603
 -147
  566
```


Children often have a problem in decomposing zeros. In this example, the zero tens cannot be decomposed so the decomposition is carried to the hundreds. One from the six hundreds carries to the tens, and these ten tens can be decomposed into 9 tens, and one to make 13. In this case the zero which has to be decomposed has been changed to one ten, and the digit to the left of the zero has not been decomposed. This error occurred in 7% of 802 problems analyzed.

[*slide*]
```
  304
 -168
  204
```

Finally, and this is what makes the real-life task so difficult, children make composite errors - they make more than one error at once. In this example the child has done two things incorrectly. The answer offered is a combination of having taken the smaller from the larger, and having applied the incorrect rule 0-N = 0. In a group of 806 cases, 7% made this composite error.

The NFER analysis has identified 32 error types in a large corpus of children's errors. Algorithms have been developed which can identify the error made in about two-thirds of the cases. This may not sound terribly impressive, but given the very chaotic multiple errors made by some children, and the possibility for inconsistency in the operation of number bonds, this is quite a good result. More importantly, the algorithms can perform better than experienced teachers in identifying the persistent errors which characterise a child's performance. To be able to identify such a characteristic error, and assist the teacher in accurately targetting remedial help, is a significant contribution to the teaching of arithmetic.

But where do the 'expert systems' come in? It is possible to provide this kind of diagnostic help by using computing systems which employ traditional procedural programming. The applications are inelegant, but they are feasible, and indeed NFER will shortly be marketing a system written in BBC BASIC to provide this kind of diagnostic assistance.

We believe that the use of expert systems, in what is known as a rule-based programming environment can significantly improve on current systems. Such a system has within it an explicit model of the human cognitive system being studied. It relates the performance which is observed to its own internal model of the system and draws inferences about how the performance was generated and therefore the errors which were involved.

The advantages come in that the system itself, because it embodies a psychological description of performance, generates a psychological account of the errors which are being made. The system itself carries out the interpretation of the defects in the system. Beyond this, because the system has powers of inference, it has the ability to seek out and interpret errors, and combinations of errors, which may not have been identified by human experts. This ability to perform induction carries the system beyond human competence and offers the possibility that the 'expert system' will outperform the simple algorithmic approaches based upon algorithms devised by human insights.

This technology opens up a whole range of new possibilities for the way in which machines can support and extend the human ability to understand the operation of cognitive systems. The aim is not to replace human expertise, but to support it and extend it by the provision of tools which can aid human decision making.

It is now time that I returned to my remaining two meanings of 'On Reading the Subject', albeit rather briefly.

On the subject of reading an undergraduate degree in psychology. Given that we accept that an appropriate format for British higher education is the study of a single discipline in some depth, then there is an argument for suggesting that Psychology must be at least as valuable a discipline to study as any.

Not so many years ago Classics was regarded as providing the basis for a sound general education. For whatever reason, it has fallen from that position of grace, and yet little consideration seems to be given to the value of different disciplines in replacing it as a preparation for general administrative, executive and managerial careers.

As an example, about two-thirds of our psychology graduates go, not into the specialised psychological professions, but into what I will call 'general' careers in which they will make use, I hope of their psychology, but in which they will probably not regard themselves as 'psychologists'. Of course, degree schemes differ in the extent to which they are providing specific vocational preparation for later employment, but a significant proportion of the College's graduates are being prepared by their courses for these general careers.

What qualities - one is tempted to refer to 'transferrable skills' at this point - are desirable in a graduate destined for this type of career? Here is a list that I would consider valuable.

[*slides*]

- understand connected text;
- comprehend arguments;
- write clearly and concisely;
- make oral presentations;
- be numerate;
- be able to evaluate and use statistics;
- understand scientific reports;
- understand the 'scientific method';
- understand the social psychology of the working environment;
- possess social skills;
- appreciate the new technologies;
- understand 'artificial intelligence'.

There are undoubtedly others.

Psychology occupies an almost unique position in spanning the arts, sciences and social sciences. Psychology students need to be able to read and understand scholarly works - it is no accident, of course, that psychology grew out of philosophy - and they must appreciate reasoned arguments. They are required to write essays, and it would be a deficient graduate who could not relate her or his behaviour to the historical, cultural and artistic context in which it is set.

At the same time, psychology graduates are required to understand the philosophy and procedures of science. They must perform experiments and write laboratory reports. They must master statistical methods and understand something of mathematical modelling.

In addition, they naturally learn much about themselves, and how others can be expected to behave within the working environment. They understand a great deal about mental health and normal adjustment, which will be valuable in any occupation which they may pursue. Their own personal social skills should also develop as a result of this process of understanding.

Psychology also plays an important role in the application of the new technologies: IT, expert systems, artificial intelligence, the 'electronic office', and the rest. Our students are quite explicitly exposed to these developments as part of their psychological education.

Of course I am biassed, but it seems to me that an education through Psychology confers much of the benefits of both the study of the Arts and the study of the Sciences. Psychology provides the graduate with a peculiarly valuable range of highly marketable skills, making it perhaps the single most appropriate discipline to study within contemporary higher education.

I have to add a personal note. One of the fascinations and joys of psychology for me is the range of subjects with which one can become legitimately involved. Within just my own, not untypical, research interests I find myself moving among computer programming, work with brain damaged patients, electrophysiology, Egyptian tomb paintings, modern photography and mediaeval anatomists. With apologies to Dr. Johnson: when a man is tired of Psychology, he is tired of life.

Which leaves: on having read the subject of Psychology. I would like to have had time to describe to you many of the careers open to professional psychologists - and to argue for the very real social and economic benefits which the application of psychology can confer. That will have to wait for another occasion. I do, however, want to draw your attention to one recent important development in the profession of psychology.

[*slide: logo of The British Psychological Society*] In December 1987, revisions were granted to the Royal Charter of The British Psychological Society permitting it to establish a Register of Chartered Psychologists. The Register opened in June of last year and already we (I say 'we' because as Honorary General Secretary of the Society I have had a particular responsibility for these matters) we have about 3500 Chartered Psychologists entered upon the Register. I should know - I have had to sign all the Registration Certificates [*slide: specimen Certificate associated with the Register of Chartered Psychologists*].

The point is that for the first time in the United Kingdom there is a way in which potential employers of psychologists - organisations or individual members of the public - can be assured of the qualifications of the psychologist they approach. The Register is voluntary, but those included upon it have to provide evidence of appropriate postgraduade training and experience. More importantly, they must abide by a quite strict Code of Conduct which forbids them from carrying out any intervention which may be outside their competance. The Code is backed by the normal kind of disciplinary procedures which are subject to the decisions of a Disciplinary Board upon which psychologists themselves are in the minority.

This is an exciting advance for the profession of psychology, and one with which I am proud to have been involved. Very soon, printed copies of the Register will be available to the public, and should be found in Libraries, Citizens Advice Bureaux, and so on. Even if you only look in the Yellow Pages, the abbreviation **C. Psychol.** is your guarantee that the psychologist is properly qualified and that you are well-protected if you use her or his services.

You recall the slide I asked you not to read? Was its subject the history of the county town of Berkshire? If you know that it was - then of course you must have read it, *and* processed the information and stored it in memory. And, of course, we have another meaning for r-e-a-d-i-n-g (Reading) the subject!

And finally, it will not have escaped your attention that I have, of course, been *reading* the subject matter of my lecture this evening.

Thank you for listening.

Figure 1.

A model of reading processes.

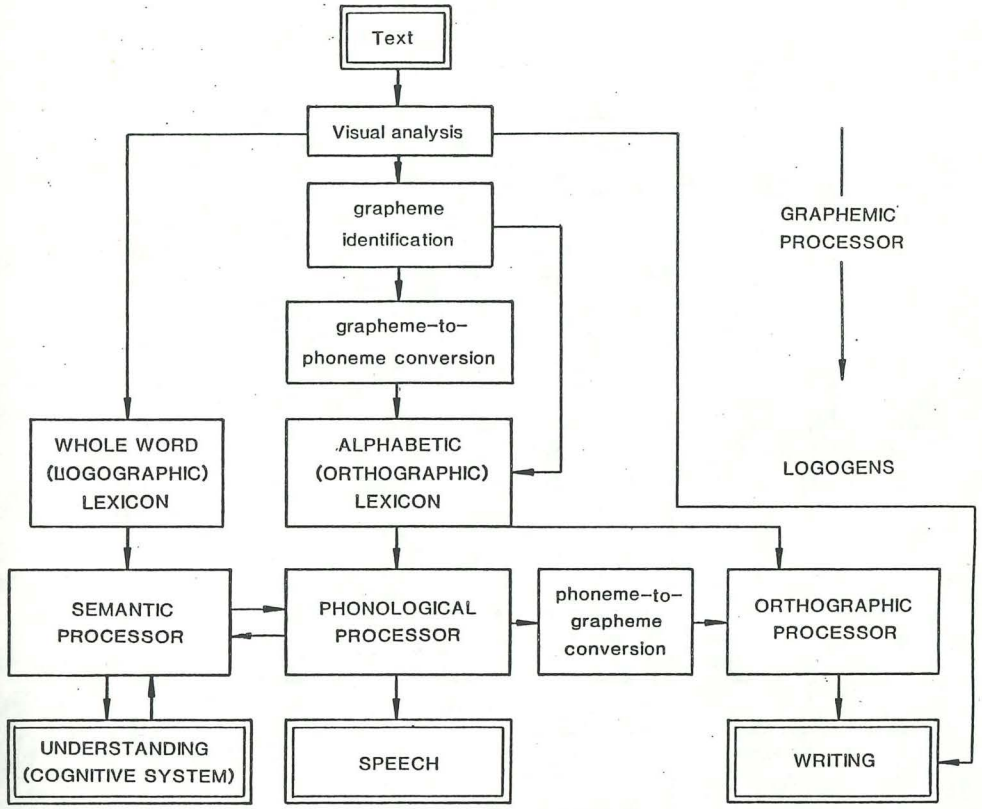

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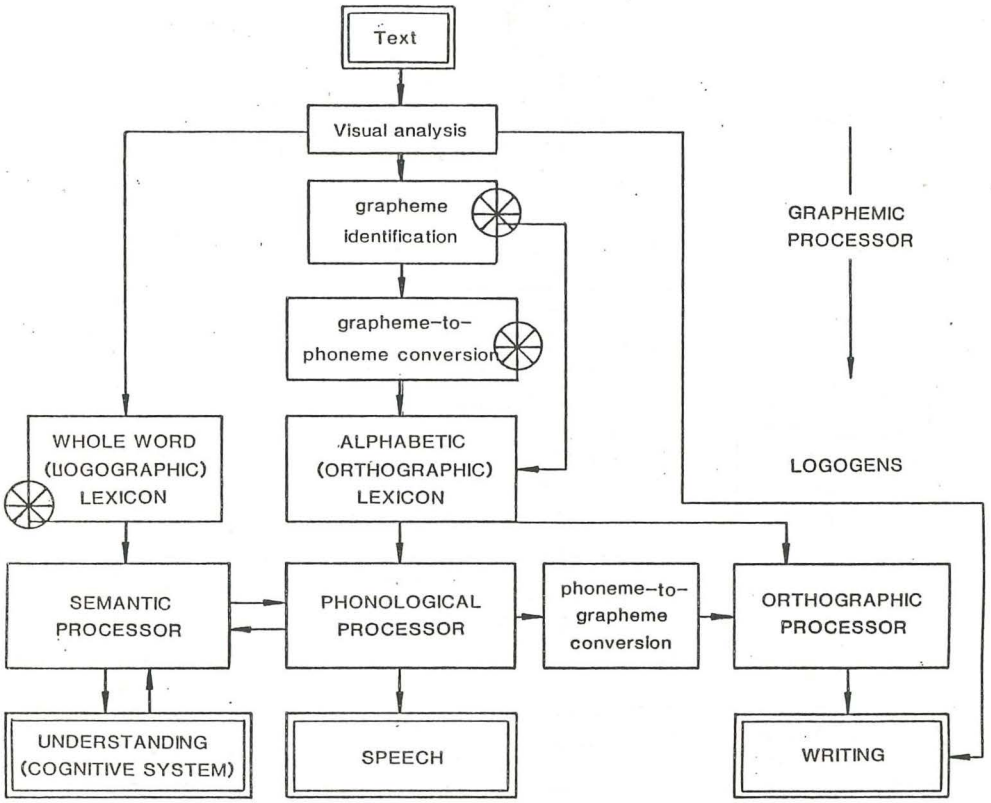
Figure 2.

The reading model with sites of potential dyslexic dysfunction.



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