Problem Solving

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Abstract

The purpose of this paper is to provide tools for problem solving, especially for those involved in linguistic investigation. Beginning with a summary of Beveridge's book, *The art of scientific investigation* (1957), examples are given of how preparation, mindset, and practices of scientists brought about the kind of discoveries that have made major changes in our lives. The second part of this paper illustrates some principles gained from Beveridge as well as other scientific and mathematical principles and then applies them to linguistic analysis.
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References
Problem solving

W. I. B. Beveridge (1957) wrote what turned out to be a classic on research methods and problem solving. What immediately follows in sections one to seven is a summary of the content of his book, *The art of scientific investigation*. Beveridge deals with problem solving and scientific research under the successive headings of “Preparation,” “Chance,” “Hypothesis,” “Imagination,” “Intuition,” “Observation,” and “Reason.” His remarks are highly relevant to the kind of linguistic investigations that we are doing within SIL. The remainder of the paper will address general principles of problem solving and will give suggestions to facilitate good and effective research work.

1 Preparation: Reading

1.1 Types of readers

According to Samuel Coleridge (1856:13) there are four different types of readers: the hourglass-type reader, who retains none of the information—the information just passes straight through him; the sponge-type reader, who just soaks up all the information, both good and bad, without any discrimination, believing all that is read, with no critical examination at all; the jelly-bag, who allows all that is pure to pass away, keeping only the refuse and dregs; and the diamond miner-type reader, who looks through all the information for what is good, and keeps only that.

1.2 How to read

Beveridge says to read critically, maintain independence of mind, and don’t believe all you read. If you read like a sponge and believe all you read, accumulating a mass of information in your mind can actually bias you against new, original ideas. Look for significant analyses and generalizations. Have a clear understanding of general principles but don’t look upon them as fixed laws. If you think in terms of general principles and are actively engaged in research, reading is likely to help you rather than hinder you. But if you read uncritically, reading can actually hinder your problem solving, because it can bias you against new ideas. Don’t overload your mind with massive detail. (You can look it up.) Make sure you see the wood, not just the trees.

1.3 What should you read?

Ignore what you don’t need to read. Skim what doesn’t merit close study. Study intensively what you need to. Read important parts over and over; talk about it, and think about how it applies. For journals as well as books, concentrate on the important ones.

Bacon in his work “Of Studies” gives us a lot of wisdom. Here is Bacon’s first maxim:

> Some books are to be tasted, others to be swallowed, and some few to be chewed and digested; that is, some books are to be read only in parts, others to read but not curiously, and some few to be read wholly, and with diligence and attention. Some books also may be read by deputy, and extracts made of them by others. (Bacon 2001)

Heed especially Bacon’s second maxim: “Read not to contradict or confute, nor to believe and take for granted, nor to find talk and discourse, but to weigh and consider” (in Beveridge 1957:3). Also, “Reading maketh a full man, conference a ready man, and writing an exact man” (Bacon 2001). So we need to read, to discuss, and to write.
2 Chance: Aha! Serendipity

Many discoveries are made apparently by chance. We often seem to stumble on something important. But in fact, discovery isn’t completely random at all. We need to have prepared minds if we are to take advantage of chance. Pasteur once said, “In the field of observation chance favours only the prepared mind” (Beveridge 1957:34). We need to recognize the clue when we see it, and we need to know how to interpret the clue and make the interpretation work for us. We need to contemplate all unexplained observations and take nothing for granted.

If you want to be good at research, try to develop a curious mind. Notice that a child is inherently curious—just watch one! Notice how much a child learns by observation and by asking. On the other hand adults tend to learn mostly from others by word of mouth or by reading. We tend to become uncritical and incurious. We take too much for granted and are afraid to ask questions lest someone think that we are asking “silly questions.” In fact, sometimes “silly” questions lead to outstanding fundamental discoveries.

Some spectacular instances of discovery by chance in the field of science are the cases of Perkins, who discovered coal tar dyes when he tipped a test tube of chemicals down the sink and saw some pretty colors, and Fleming, who discovered Penicillin when he saw that mold was not growing in certain cultures where one would have normally expected it to grow. They noticed things that other people had seen but not noticed.

3 Hypothesis

A hypothesis is just an educated guess at explaining the state of affairs; it is a guess at how the state of affairs works, and no more! But a hypothesis does enable us to get started in our investigations.

A hypothesis is often useful even though it is wrong. In fact most hypotheses turn out to be wrong in some sense, but that by no means precludes their usefulness. Even with geniuses, the birth rate of hypotheses barely exceeds the death rate.

Note Max Planck’s remark in his acceptance speech for the Nobel Prize, awarded for the discovery of the quantum theory, one of the greatest discoveries of all time in physics: “Looking back....over the long and labyrinthine path which finally led to the discovery [of the quantum theory], I am vividly reminded of Goethe’s saying that men will always be making mistakes as long as they are striving after something” (Beveridge 1957:60). He made lots of mistakes before he got where he wanted to.

So let us never be afraid if our initial hypotheses are confused and incorrect. That’s where we start. We need to take risks. Beware of excessive caution. The best scientists get about eighty-five percent of their initial hypotheses wrong! It’s the ones they get right that count!

A hypothesis of itself is not the solution to the problem but it is a possible solution or the beginning of a possible solution. Hypotheses need to be checked out against data. In checking out hypotheses, take nothing for granted. Also don’t cling to ideas that are useless.

4 Imagination

4.1 Order and generalisation

Develop a feeling for order. Seek generalizations that tie up a bundle of data into an orderly whole. Seek explanations.

4.2 Curiosity: “Why?”

Develop a feeling of curiosity and apply it to anything that is either not explained or not fully understood. Continually ask questions. Why does something work the way it does? Why does something have the form that it does? Why? Why? Why?
In 1925 as a medical student in Prague, Hans Selye and some other students were shown several patients in very early stages of various infectious diseases. Selye himself describes the situation as follows:

I began to wonder why patients suffering from the most diverse diseases have so many signs and symptoms in common. Whether a man suffers from severe loss of blood, an infectious disease, or advanced cancer, he loses his appetite, his muscular strength, and his ambition to accomplish anything, usually the patient also loses weight, and even his facial expression betrays that he is ill. What is the scientific basis of what I thought of at the time as the “syndrome of just being sick”? Could the mechanism of this syndrome be analysed by modern scientific methods? (Beveridge 1957:56)

Selye’s question was dismissed by his teachers at medical school at that time as being a “silly question.” After all, it’s obvious they were sick, wasn’t it? What else was there to worry about? But Selye himself refused to dismiss the question, and eventually came up with the idea of “stress.” He went on to develop the science of stress, and was the world authority on it till he died. His persistence saved thousands and thousands of lives.

So let us all be careful not to dismiss “silly questions” or questions with “obvious answers.” It isn’t always obvious. So called silly questions can sometimes lead to major discoveries. Beware especially cross-culturally; culture is full of surprises.

4.3 Images

Try to make mental images. Allow your mind to wander freely. Daydream. Diagrams, or images can be helpful. At times they are more helpful than a description in words. Hadamard, a former great French mathematical researcher, said, “The more complicated and difficult the question is, the more we distrust words, and the more we feel we must control that dangerous ally and its sometimes treacherous precision” (Hadamard 1945: 96).

4.3.1 Shortcomings of words

I think that descriptions with words can suffer from three shortcomings:
1. Sometimes we don’t know what some of the words we use mean.
2. Sometimes the meanings of the words that we use can assume a life of their own and actually lead us astray. Here are a couple of examples of where words can mislead and assume a life of their own: The expression “global warming” can be misleading because a lot of people think immediately that it means that everywhere will get warmer. In fact, one counter to that idea is that when the polar icecap melts as the result of global temperature rises, the ice-cold water that gets into the surrounding oceans will flow in currents past certain countries and those countries could get colder. So there is a sense in which the original term was misleading.
Another instance has often been cited by Benjamin Lee Whorf, who was an American linguist in the 1940s who also had a job working as an inspector for an insurance company. Whorf was asked to investigate the frequent occurrence of fires (hundreds of them!). He found that many fires ignited in storage yards where there were lots of empty petrol drums. Such areas were often labelled “empty drums.” The word “empty” suggests the idea of ‘containing nothing’ and implies the lack of any hazard. In many other situations, such as empty rubbish containers, such an idea would be true. But in the case of “empty petrol drums” they were probably even more dangerous than full drums because of the free petrol vapour that was likely to be around them! Whorf found that some people were fooled by the word “empty” in this situation, and so often smoked there. The consequences were of course catastrophic!
3. Expressing something in words forces a linear arrangement of thought, whereas many of the complex relationships that we have to deal with are anything but linear. (e.g., Halliday said that many discourse features are like “Indian blankets,” not linear but woven!)
4.3.2 Helpfulness of images

Here are some examples:

1. Kekulé discovered the benzene ring, a concept that revolutionized organic chemistry. He was sitting, while writing a book. Here is Kekulé’s own description of what happened:

   But it did not go well; my spirit was with other things. I turned the chair and sank into a half sleep. The atoms flitted before my eyes. Long rows, variously, more closely united; all in movement wriggling and turning like snakes. And see, what was that? One of the snakes seized its own tail and the image whirled scornfully before my eyes. As though from a flash of lightning I awoke; I occupied the rest of the night in working out the consequences of the hypothesis....Let us learn to dream gentlemen. (Beveridge 1956: 56)

2. A dictionary definition of “dog” would not give you any idea what a dog was like or teach you how to recognize a dog when you saw one, if you didn’t already know. Note the following dictionary definition of a “dog”: “a domesticated, carnivorous animal, having a long snout, an acute sense of smell, non-tractable claws, barking, with a howling, whining voice”; from Oxford dictionary. How much does this help you to recognize a dog if you had never seen one before? On the other hand each one of us has a rich mental image of what a dog is, and this enables us easily to recognize a dog, and to tell a dog from a non-dog. Notice that such an image is a dynamic image, including motion, sound, colour, and smell. It is a multimedia image, not a static image; it is not just the image you get from a two-dimensional drawing on paper.

3. In every day life, there are maps, flowcharts, pie-charts, graphs, and schematic semantic networks. Langacker says they are “all metaphors.”

4. Translation consultants ask what image a given key word in translation invokes in the mother tongue speaker of the target language.

5. George Lakoff, a well known cognitive linguist, gives an analysis in which he shows that the thinking and behaviour of different kinds of Christians depend quite a bit on what image they have of ‘father’. These folk all have some image of ‘God the Father’ but their image of ‘father’ can vary widely.

6. Identifying with an animal, a germ, or even a part of speech may bring about solutions. There is the story of the man who lost his dog. He said to himself “If I were a dog, where would I go?” He went there and found the dog. Zinsser in his researches on typhus got bright ideas by identifying with the disease in his imagination (Beveridge 1957:57), saying to himself, “If I were I typhus bug, what would I do?” Similarly we can say to ourselves, “If I were a certain morpheme in this language, where would I go, and what could I do?” etc.

   Imagery is necessary to capture ideas and relationships that sometimes we cannot express in words.

4.4 Beware of conditioned thinking

There are times when you are in a mental rut and don’t seem to be able to get out of it. Every time you get down to work, you seem to persistently think along the same lines. Conditioned thinking seems to arise when associations form between ideas in a chain of thought, and these associations become a fixed pattern. When you find yourself in this predicament, (1) try to explain your work to somebody; (2) discuss your work with somebody and allow all kinds of questions; and then (3) abandon the problem for a while.

   Facts and ideas of themselves are dead—imagination gives them life.

   New associations and fresh ideas are more likely to come out of a varied store of memories and experiences than out of a situation that is all of one kind. So have wider interests. Study a subject different from the one you majored in.

   Note that in the case of Kekulé’s discovery of the structure of the Benzene ring described previously, the difficulty that many of his contemporaries had was that they were conditioned into thinking that the old carbon methane-like structure was the only one there was. They couldn’t think “outside the box”
(i.e., beyond the limits of convention) but Kekulé managed to. See also how Eric Thompson and his colleagues dealt with the problem of Mayan decipherment (section 11.3). They had gotten into a rut they couldn’t get out of. When they discussed things they did not allow all kinds of questions. There were some questions which they ridiculed, and these kept them in their box!

## 5 Intuition

### 5.1 The subconscious and relaxation

Work intensely on the problem and then abandon it and relax. Give yourself freedom from this and other conflicting interests, and also freedom from interruptions; then a solution may often appear. It seems as if your subconscious sorts things out. All kinds of top scientists advocate this! But also remember what Pasteur said: “Chance favours the prepared mind” (see section 2).

### 5.2 Allow time

You need time in your program for intuition to work for you. Don’t despise it, because it is extremely valuable. And you need time to meditate if you want bright ideas. (If you try too hard you may reach a state of mental blockade, because you are too tired or too tense.)

### 5.3 Bright ideas

Write your bright ideas down because they can disappear very quickly. Regard this as a very high priority.

### 5.4 Complement your consultee

In terms of intuition versus organization, a consultant needs to be a complement to the consultee. If they can’t organise, you need to help them to organise. On the other hand, if they can’t intuit, you need to help them do that. Don’t assume that people can do everything without help. The best of us need help in some things.

## 6 Observation

Data is extremely complex and often confused and messy. It is impossible to see everything. What can we see? What do we need to see? How can we optimise? What follows are some important considerations on various aspects of observation.

### 6.1 We are most likely to see just the things we look for.

Often this means the things we are trained to look for, or what our hypothesis says should be there, or what we expect to see, or what has been foreseen. For instance, see the different interpretations of the following skeleton diagram of a cube.
This could be regarded as a picture of:

- three sets of parallel intersecting lines,
- some kind of irregular polygon,
- a transparent box,
- a wire framed cube,
- an open box,
- a glass paper weight, or
- an ice cube.

Wittgenstein would say that we see it as the way we have chosen because we have seen organisation in the picture.

### 6.2 Seeing as

We strongly tend to see through a framework or a grid. This is “seeing as.”

Suppose that you are in the countryside and on the shores of a lake. You see what appears to be some sort of bird flying above the lake. You say, “I see a duck.” By saying this you probably mean, “I see it as a duck.”

The thought “I see it as a duck” carries with it a number of expectations, for example, that (1) when it lands on the lake it will make good contact feet and tail first with a nice splash, (like good ducks do, but which some other birds don’t); (2) it will not rocket vertically upwards (like a rocket would have!); and (3) it will not suddenly loop the loop (like a stunt plane could have!).

And, if on further observation, that thing we thought was a duck were to behave in ways that differed from normal duck behaviour, we would want to revise our opinion that we had seen it as a duck. Specifically, if for instance, we subsequently saw our purported duck loop the loop in flight, we would at least say that it was a very unusual sort of duck! We might even conclude that it was no duck at all!

If we see something as an X, this means that that thing can be expected to behave in all the ways that X’s behave, because we tend to interpret new structures in terms of structures that we already know. See also Langacker (1987:105): “We interpret novel experience with reference to previous experience.”

### 6.3 Don’t prejudge

People whose minds are not disciplined tend to notice only the things that support their views and to ignore the rest. So beware, especially if you are dealing with new data, and more especially if you are dealing with cross-cultural data. Culture is full of surprises!

### 6.4 Change your viewpoint

Many important discoveries are made by people looking at the same data but seeing things in them that no one has ever seen. Einstein said he had the same data as everyone else, but he looked at it differently. Hence, the importance of multiple perspectives.

### 6.5 Beware of zero realisations

In language, we are most likely to see things which have a physical realization, such as morphemes that have some phonemes, or phoneme sequences, to back them up. So we must be careful not to ignore null
elements. A glaring example of these is the zero pronoun forms in language. Note that you can get zero pronouns in morphology, in syntax, and in discourse. And they are important. There are other zero elements too, for example, zero verbs!

7 Reason

Beveridge wrote that “the origin of discoveries is beyond the reach of reason” (1957: 95). Reason will not enable you to hit on discoveries, either factual or theoretical. Nevertheless, it has an important place in research.

7.1 The role of reason

7.1.1 To verify hypotheses against data

“Dreams and vague ideas are idle fantasies until reason turns them to useful purposes” (Beveridge 1957: 58). In language analysis this means to check the ideas against solid data, and to check them again against counterexamples. A politician’s analysis, which cites only data that supports a hypothesis and ignores data that apparently or actually contradicts it, is not an acceptable analysis for us.

However, the other side of the coin is that there is nothing reprehensible about making a mistake provided it is corrected in time (see Max Planck, section 3). So let us not be excessively cautious.

7.1.2 To interpret data (in terms of a hypothesis)

7.1.3 To build up a theoretical framework that is consistent, believable and holds water

7.2 The approach of reason

7.2.1 Approach a problem in terms of a related problem

Sir Isaiah Berlin, a leading Oxford philosopher and a world authority on ideas and problem solving, once gave the following approach for solving difficult problems in philosophy: Supposing you had a problem and you did not have the faintest idea how to solve it. What do you do? You can ask yourself the following questions:

1. If you did have a solution to the problem, what would it look like?
2. And if you didn’t even have any clue about (1), you could still ask, “Everything is like something, what is this like?”

For quite a few problems in language, we can use the above questions as the basis for a problem solving approach.

7.2.2 Readjust the description of a problem

Faced with a problem whose solution you do not know, is there is any possible way that you can adjust the terms or the description of this problem so that it looks like a problem that you already can solve? It is clear that once you can do this, you should be able to solve the original problem. Note that when this is the case, you can solve your new problem because you know how to solve the old problem.

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1Isaiah Berlin originally quoted this statement made by E.M. Forster in a letter Berlin wrote to Mary Fisher (Hardy 2004). Forster’s statement is actually “Everything must be like something, so what is this like?” (Forster 1936:49).
Once you have an answer to the question, “Everything is like something; what is this like?,” you then also need to ask, “And how is it different from what I thought it was like?” Two things can be very similar without being identical.

We have now completed the discussion under Beveridge’s headings. From now on, this paper will deal with some other general principles and suggestions to facilitate good and effective research work.

8 Generalisations: Some illustrations

Sometimes a model which adequately accounts for a limited amount of data may need to have that model extended or generalised in some way to account for more data. And as we go across languages we may also find that that we need to extend or generalise a model in some way. Here are some illustrations from language.

8.1 Transitivity in clauses

The traditional idea of the transitivity of a clause is in terms of how many objects the clause can have. This is the old grammar-school view and might be stated as follows:

- A clause with no objects is intransitive.
- A clause with one object is transitive.
- A clause with two objects is ditransitive.

However, if we look at the morphosyntax of some languages of the world, we see that morphemic markers of transitivity do not always behave consistently with the definitions above, which are in terms of “how many objects.” Thus, here are two specific examples from Samoan:

1. na fasi e-le tama le teine
tense hit erg the boy the girl
The boy hit the girl.

2. na vaai le tama i-le teine
tense see the boy oblique the girl
The boy saw the girl.

The ergative case marker on the subject ‘the boy’ of the first clause is a marker of high transitivity, similarly the oblique marker on the object ‘the girl’ of the second clause is a marker of low transitivity. And yet both clauses have a single nominal subject and a single nominal object, so according to the old definition they should have the same transitivity. But according to the morphemic markers they don’t! Hence, there must be another difference between them, (because there is no difference in the number of constituents, i.e., number of objects.) We need some sort of different viewpoint here, some generalisation.

Let us look at the traditional definitions again. What more can we say about them? We can say that in an intransitive clause (which has no object) there is no transfer of the effect of the action from one entity to another entity; in a (singly) transitive clause there is transfer of the effect of the action from subject to object, while in a ditransitive clause there is transfer of the effect of the action from the subject to two objects. So perhaps the more transitive a clause is, the more transfer of the effect of the action there is from the subject to something else (i.e., to the object/s). Let us try this as a revised definition.

Applying this to the two Samoan examples, notice that in an action like ‘hit’ there is more transfer of action effect from subject to object than there is in an action like ‘see’. In fact, for the situation in ‘see’ it is hard to understand how the object of the clause is affected at all. Hence the difference in the morphemic marking of the two clauses is not surprising in the light of the new way we look at transitivity, that is, in terms of how much the object is affected (i.e., in terms of how much transfer of effect there has been).
Here are more examples from Chichewa (Bantu, East Africa):

(3) This child he-past-eat-indicative
This child has eaten.

(4) Woman she-present-eat-ets-indicative child
The woman is feeding/causing to eat the child. (Add another constituent).

(5) This child he-past-eat-ets-indicative
This child has eaten too much. (More food transfer!)

Note that the same transitivizing marker -ets is present in both (4) and (5). In (4), which is a causative, there is an extra argument on the verb so that the verb has two core NP’s and ‘the child’ is affected. In (5), there is in fact no second overt NP (i.e., no clause level object) but there has been a great intensity of action and a great deal of food has been transferred (affected), hence the transitive marking on the verb. We have looked at transitivity from a different perspective; that is, from number of constituents to transfer of something to something.

8.2 The perfect in various languages

In languages like English, the perfect (e.g., “I have lost my computer”) reports an anterior (past) event with current relevance, and usually the marked event is off the main event line. “Current relevance” means that the anterior event report has consequences (i.e., relevance) at the time of speech. “I have lost my computer” could have as a consequence, “I am not able to receive emails.”

But in many West African languages the perfect is an event with forward looking relevance. And moreover, often the event marked as a perfect is on the main event line (not off the event line as it always is in English). So it is similar to the English perfect but not exactly the same. And the difference is important.

How can we generalise the description so as to fit all languages? What English and these other languages have in common is the relation of forward looking relevance (also called “prospective relevance”). Either they report an anterior event with current relevance or they record an event with forward looking relevance. However, the on-or-off main event-line property is not shared between them.

But some people, (including one or two linguists whose names I dare not mention!) have tried to reason backwards, and have said that in certain African languages there are certain forms that cannot possibly be on the main event line because they are marked for perfect. In fact, that conclusion is erroneous for those languages, because there are other reasons for seeing that those events are indeed on the main event line. Those linguists have, I’m afraid, reasoned backwards. Ignoring the data, they have wrongly shored up an inadequate hypothesis.

Note how the description of the perfect has been modified and generalised as we have tried to fit in more languages.

Note here a possible mistake that translation consultants need to heed. One translation consultant has been known to say, “This form is a perfect in the source language [a European language], so we must have a perfect form in the target language” (which happened to be a West African language). This was an incorrect conclusion.

8.3 The complement in various languages

We start with complements in English, introduced by the complementizer that as in:

(6) John knew that he was sick.

in which that he was sick is a complement clause, needed to complement or fill out the rather incomplete meaning of John knew. When someone says “John knew,” I, as hearer, would like to know what it was that John knew. This is the traditional view of complement, and with this view we tend to think of
complements as something that occurs in clauses, to complement or fill out the meanings of verbs like ‘know’ or ‘think’ or ‘say’, etc.

Langacker, however, has a very insightful generalisation of the idea of complement which enables us in other languages to include a lot of data which is morphologically marked in the same way. Thus for instance in Mpyemo, a Bantu language of the Central African Republic, we have a complementizer marker $nɛ$ which we might give a preliminary gloss of ‘that’ for. This is because $nɛ$ does function to introduce complement clauses for main verbs like ‘say’ and ‘think’ etc, as in

(7) She said $nɛ$ (that) she couldn’t marry him.
(8) He thought $nɛ$ (that) his brother-in-law was asleep.

where the complement clause has been underlined.

Langacker calls clause fragments like ‘she said’ or ‘he thought’ “dependent elements” because they are not complete thoughts in themselves. Rather, they depend on another element, the complement, to complete the thought for them.

Now, looking further at more data in the same language (Mpyemo), we find that there are many other elements which are dependent in the same sort of way. That is to say, these elements too, are in some sense incomplete thoughts in themselves, and depend on some sort of complement to complete or flesh out the thought for them. Here are some examples:

(9) Presentational sentences
   There was $nɛ$ a certain king in the village. (The sentence introduces ‘a king’.)
(10) Evaluative constructions
   It is good $nɛ$ that people know that stabbing someone is bad.
       (What is it that is good?)
(11) Locative adjectives (like ‘near’)
   A village near $nɛ$ Bango. (Where is the village near? We need to locate the village.)

These are just a few of the many usages of $nɛ$ in Mpyemo. There are many more. We would have missed all these extra usages if we had stuck to the traditional model and failed to generalise.

8.4 The preposition ‘of’ and the characterisation relationship

A few years ago Langacker wrote a very insightful paper on the meaning of the preposition of in English (Langacker 2000). If we look at simple examples like, The house of John, we might come up with the idea of ‘possession’, but we soon find that this is inadequate when we see examples like

(12) the Queen of England,
       a box of matches,
       the assassination of Lincoln,
       the Battle of Waterloo, and
       the love of God.

Is there a unitary description that covers them all? Langacker comes up with the idea of “characterisation,” that is to say, the noun that comes with the preposition serves to “characterise” the head of the phrase. For instance, in the first example above, the head of the phrase is “Queen” and the prepositional phrase “of England” characterises the kind of queen that she is. That is to say, the Queen “of England” is characterised differently from the Queen “of the Netherlands” in that the two have different countries they are responsible to, they have different sets of responsibilities, live in different places, etc. This very general idea works very nicely for any example that can be cited, although the detailed explanations cannot be given here.

Now it is very easy for someone doing field analysis of a target language to look at his/her data and say “Well, this obviously does not apply to me, since I don’t have any ‘of’ prepositions in my data at all.”
In fact, this is a very dangerous way of thinking. It is much better to ask, “Is there any relationship of characterisation in my target language data? And if so, how is this relationship expressed morphosyntactically?”

For instance, in New Testament Greek, the genitive is a relationship of characterisation. In fact, the word “genitive” is derived from genus which means ‘kind of,’ ‘type of’. Think carefully about the meaning of an expression like “the love of God.” How does it relate to “God is love”? Both thoughts are in the New Testament.

Another question to ask concerning your language data is, “Is there a possessive in the target language, and if so how does its meaning generalise?”

Again, what about the associative construction that is found in many African languages? Is the relationship of characterisation relevant here?

Finally, I will mention the ezafe construction in Persian and related languages. Many linguistic books tell us that it has no meaning. (I think they are wrong). The idea of characterisation is probably pertinent here.

9 Some practical methods

9.1 Regrouping to bring out a regularity: The Gauss illustration

Gauss was one of the great mathematicians of all time. When he was about ten years old, Gauss was given an arithmetic problem to solve, along with the other boys in his class. The math master said to the whole class, “Add up the following numbers, and hand in your answers on my table in the front of the class.” The numbers were: 1, 2, 3,...97, 98, 99, and 100.

Young Gauss looked at the numbers rather hard for a minute or so, wrote down his answer, which was just a single number on a sheet of paper, and handed his result in. The rest of the class slaved away for about twenty minutes, trying to do the sum by long addition. In the end, Gauss was the only one who got the right answer and his answer sheet consisted of just one number, the correct answer! There was no working. How did he do it?

Clearly none of us was around at the time to ask Gauss exactly what he did, but it was probably something like this:

He paired the first number 1 with the last number 100, and added them up, thus:

\[1 + 100 = 101.\]

In the same way he paired up the second number 2 with the second to last 99, the third 3 with the third to last and so on. Notice they all add up to 101, thus specifically

\[1 + 100 = 101,\]
\[2 + 99 = 101,\]
\[3 + 98 = 101,\]
\[\ldots,\]
\[50 + 51 = 101.\]

Since each of the pairs adds up to 101, the only question left is how many such pairs are there? And the answer to that question is clear: 50. So all the pairs together add up to 5050 (50 x 101), and this conclusion, of course, Gauss arrived at comfortably in his head.

Notice the following two things that Gauss did which changed what looked like a very difficult problem (which none of the other boys managed to do) into a very easy one, one which anyone could do in his head.

1. He looked at the problem in a new way, in fact he regrouped the data. (Specifically he paired off the first with the last, the second with the second to last, ...); and
2. He removed an unnecessary restriction. (After all, in adding up the sum of a series of numbers, no one says that you have to add the numbers up in the order they were given, i.e., as
1 + 2 + 3 + 4 + 5.... (Yet all the other boys tried to add the numbers up in that order and they all failed.)

By regrouping, he saw a regularity which made the problem both more easily solvable, and more insightfully solvable.

You can regroup things together with advantage, if by regrouping you bring out a regularity. (Sometimes this means regrouping together things that have a common property.) Here are some examples from language:

1. Regroup together the variants of a phoneme. They may look different phonetically, but they are complementary in a way rather similar to the way in which 1 and 100 were complementary in Gauss’s problem.

2. Regroup together the tense markers in a paradigm (or say, the person markers). They share the property that they all fill the same slot, and in a way they say the same sort of thing.

3. Make equivalence classes, or group opposites, which would come under this rubric also.

9.2 Looking for isomorphisms, that is, similarity of internal relationships

This is really another instance of Sir Isaiah Berlin’s principles; “Everything is like something; what is this like?”

Often, in many areas of research, investigators have found that two (or even more) apparently different phenomena have similar internal structures. An isomorphism has to do with similarity of internal relationships in apparently different phenomena.

In sections 9.2.1 through 9.2.3, we look at various different areas of knowledge: first physics, then elementary maths, then language.

9.2.1 Physics

There are illustrations of isomorphism from various fields of physics. For example, electrostatics, classical hydrodynamics, gravitation theory, and heat conduction all obey the same equations (within limits). So the results you get in one field can be carried over to another.

9.2.2 Elementary maths

As another illustration, here is an example from elementary algebra and geometry:

Consider the elementary algebraic identity

\[(a + b)^2 = a^2 + 2ab + b^2\]

This equation describes the same state of affairs as the following geometrical figure.

In this figure the area of the bigger square is made up of the sum of the areas of the two smaller squares (\(a^2\) and \(b^2\)) plus areas of the two little rectangles along the sides of the squares (area of each such rectangle is \(a \times b\)).
So what we are saying is that whether we use the diagram or use the formula, we are still saying the same sort of thing. But some people are more comfortable with a formula, and some people are more comfortable with the diagram. It doesn’t matter a lot which way you look at it.
However, there is a need for caution. Make sure there really is an isomorphism, that is, a similarity of structuring! Don’t force an isomorphism when there really isn’t one. If you press things too far, you could be misled.

### 9.2.3 Language

Pike’s grammatical matrices were really an analogy from the phonetic work chart. Thus in your phonetic chart you have place of articulation across the top of the chart and various manners of articulation down the side of the chart.

Table 9.1. Phonetic workchart

<table>
<thead>
<tr>
<th>Manner</th>
<th>Place of articulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>stop</td>
<td>bilabial</td>
</tr>
<tr>
<td>fricative</td>
<td>labiodental</td>
</tr>
<tr>
<td>affricate</td>
<td>alveolar</td>
</tr>
<tr>
<td>nasal</td>
<td>postalveolar</td>
</tr>
<tr>
<td>liquids</td>
<td>velar</td>
</tr>
</tbody>
</table>

By analogy Pike derived his grammatical matrices. Here, is a matrix for Aguaruna clauses.

Table 9.2. Grammatical matrix for Aguaruna (Peru) clauses.

<table>
<thead>
<tr>
<th>Aguaruna clauses</th>
<th>transitive</th>
<th>intransitive</th>
<th>nominative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imperative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>active</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>declarative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>interrogative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of predication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>interrogative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of item</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>subjunctive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>equative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>declarative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>interrogative</td>
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<td>of predication</td>
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<td>interrogative</td>
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</tr>
<tr>
<td>of item</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Look at the two charts (matrices). Note how similar they are in structure, even though they are displaying quite different things.

The matrix display of the clauses enabled people to look at the totality of the clauses in Aguaruna in a new way. It was a simpler, better organisation. The same can be applied to any language. It is a two dimensional display, rather than just a linear list.
You can also play around with a model. Thus with a table or matrix, you can permute rows and columns. Fruitful things can happen when you play around with a model.

Caution: Don’t take your analogy too far. In other words don’t force it! Check everything against the real world as it is, and never as your artificial model might force it to be. If a model does not fit the data, revise it or throw it out. Don’t ever force your model onto the data.

9.3 Exploiting the limits of logical patterning

Look at the logical possibilities of patterning cross-linguistically. If you explore all the possibilities, many new hypotheses may occur naturally to you and will not be surprises.

The next section will illustrate patterning with tone and stress.

9.3.1 Tone and stress

Traditionally it was known a few decades ago that many languages followed the tendencies below:
1. In stress languages, multisyllabic words had one primary stress (often in Europe).
2. In tone languages, multisyllabic words had contrastive tone on every syllable (often in Africa).

By and large, up to about forty years ago most people thought of languages in these terms. A number of exceptions gradually crept in, like toneless syllables in various African languages, but as an overall tendency this is the way people thought.

But if we examine the logical possibilities, why should the following combinations not be possible?:
1a. multisyllabic words with more than one primary stress (multiple primary-stress languages);
2a. multisyllabic words with contrastive tone on some but not on all syllables (i.e., pitch-accent languages); and,
2b. multisyllabic words with tone patterns on the word rather than tones on the syllable.

In fact, in due time all the logical combinations in (1a), (2a) and (2b) were found in the world's languages. Thus combination (1a) was found in the multiple primary-stress languages like the Arawak languages in Peru and Brazil in South America. Combination (2a) was found in the pitch-accent languages as found in Africa and the South Pacific. Combination (2b) was found in the word-tone languages of West Africa.

If the minds of investigators had been open to the various logical possibilities, a great deal of frustration in field work could have been saved. Thus for instance, in the first investigations on multiple primary-stress languages (Peru), it was thought that since there was some sort of “accent” on several syllables in words, that accent had to be some kind of tone accent (i.e., pitch). So the early investigators tried listening for tone (i.e., pitch). But in fact the accent was a stress accent, that is, some kind of intensity accent, and because pitch as such was not contrastive, the native speaker pronounced his words with large fluctuations in pitch on the various syllables. In other words, the investigators could never hear pitch consistently because it wasn’t contrastive in that language in the first place. It was not until they tried listening for intensity that they began to hear it consistently. If they had considered the various logical possibilities earlier on in their investigations, they could have started listening for intensity earlier and so saved themselves much frustration.

By a similar token, if you are dealing with a pitch-accent language you will hear an accent on some syllables of a word which may sound like an intensity accent (i.e., stress, extra force) because of your previous linguistic background (European). However, if you mimic the accent by pronouncing an intensity accent where the native speaker expects a pitch accent (i.e., high pitch), it will sound strange to the native speaker.

Once we had an experience at Horsleys Green with a native speaker of a language from Papua New Guinea (Motu) which was a pitch-accent language. She often used to say to our English-oriented language learners “Please don’t stress my language! It sounds awful!”
And when you listen to the native speaker of such a language talk, it may sound to you as if there is free-fluctuation-of-intensity accent on the various syllables, as indeed there should be because intensity is not contrastive.

9.4 Using multiple perspectives

It is important to remember that the same data can be viewed from different perspectives. Each perspective has its own advantages, and its own limitations. Some perspectives are better for seeing and understanding certain phenomena. And other perspectives are better for seeing and understanding other phenomena. It is often the case when we see things from one perspective, that we are excluded thereby from seeing things from another perspective. This is because reality is more complex than either perspective. So be aware of the limitations of each perspective, and be prepared to use more than one perspective.

9.4.1 In physics

In the theory of light, there is the corpuscular theory (due to Newton) in which light is viewed as a series of particles. (Newton called them “corpuscles,” and scientists today call them “quanta.”) There is also the wave theory (due to Thomas Young) in which light is viewed as a series of waves. Some phenomena can only be understood using one viewpoint, but other phenomena can only be understood using the other viewpoint. For instance, secondary emission can only be understood by the corpuscular or quantum theory, while interference can only be understood using the wave theory. (Secondary emission occurs when you shine one kind of light at some substances, and another kind of light comes out. Waves cannot do that but particles can. On the other hand, interference occurs when two waves can cancel each other out. Two particles cannot cancel each other out, but two waves can.)

The interesting thing is that when we go deeper into physics we learn that there are more fundamental formulations, such as the Schrodinger equation which can give some solutions in the form of corpuscles or quanta, and some solutions in the form of waves. The lesson here seems to be that if you understand the system deeply enough, two apparently irreconcilable viewpoints can be seen to derive from a common superordinate theory.

(But notice that in the history of science, the Schrodinger equation came more than a century after the two original theories. The two original viewpoints were in themselves partial, but they had to do until the better, superordinate theory came along. For the time being, the two partial but different perspectives were useful, better than nothing.)

9.4.2 In language

The above remarks on multiple perspectives do not apply only to some realms of abstract science like physics. It is important to remember that multiple perspectives are helpful in looking at language as well.

9.4.2.1 Phonology

Thus in phonology we have both phonemic phonology and different varieties of generative phonology. Phonemic phonology is essentially an item-arrangement (beads on the string) model. It is a useful model for getting the basic contrasts out, and often it will get you to a quite useable orthography. However, it has quite severe limitations in that it is not useful for dealing with morphophonemics. The generative model is much better for that, but often not so good for getting out a basic orthography. We need both.

A variant of the principle of multiple perspectives is to look at the same data from different standpoints, emphasising different bits of the set of relationships that are involved. This probably isn’t quite as radical as the difference between waves and quanta in physics where one would seem to be
starting or between phonemics and generative phonology in linguistics, but we are more or less in the same vein.

Here are some examples from language where alternative ways of looking at the same data are useful.

9.4.2.2 Textual rhetorical relations

There are two ways of looking at the data. Rhetorical structure theory looks at the rhetorical relation; thus the sentence,

(13)  John was hungry so he went to the restaurant

would be described as having a “causal relationship” between the first and the second clause. And this relationship is expressed by the connective “so.”

On the other hand, semantic structure analysis looks at the constituents, that is, at the clauses that make up the sentence, and names the function of each constituent. Thus the sentence,

(13)  John was hungry so he went to the restaurant

would be described as being a reason-result sentence, with the first clause being the reason, and the second clause the result.

These are complementary viewpoints, not conflicting ones. Each one tells us something that the other does not. There isn’t necessarily a one-to-one correspondence between the two viewpoints. We may decide to choose one and ignore the other, but if we do we could miss out on seeing something in the data.

9.4.2.3 Clause structure

In the usual generative account, clause structure is described using the categories of noun phrase, verb phrase, etc. The function description is in terms of subject, object, etc. The pragmatic description is in terms of topic and comment, and the cognitive linguistic description is in terms of trajector and landmark.

These again are complementary descriptions, and they tell us different things about the clause. For certain purposes we might decide to opt for one description, and leave the others to one side. But we should at least be aware that there are alternative descriptions which can alert us to properties that we might otherwise miss out on.

9.5 Choosing perspectives

The next example is rather different from all the previous examples in section 9.4, “Using multiple perspectives.” In the previous examples, what we are saying is that all the data can be (and should be) looked on in different ways, according to different perspectives. However, when given a corpus of data in the next example, some of the data fits one description, and the rest of the data fits a different description. In other words, it is sometimes not true that “one size fits all”! Or if you like, beware of exceptions; they can be significant, and they do need to be accounted for.

9.5.1 Thetic clauses in topic-comment studies

The following example is taken from discourse studies. In a discourse, most of the main clauses do have the topic-comment structure; that is to say, the clause divides up into a topic, which is what the clause is “about,” and a comment, which is what the speaker tells you “about the topic.” Nevertheless, in any discourse there are also thetic clauses, and these latter do not have the topic-comment structure. What the thetic clauses do is introduce an entity or a situation which will then be a topic in succeeding clauses in the discourse. Thus, for instance, the clause “There was a penguin on the front lawn” is a thetic clause which introduces “a penguin” which the speaker can then talk about. It doesn’t really make sense to say that the above clause is about a penguin.
So if you insist that topic-comment sentences are the only ones around, you will run up against inconsistencies, and against data you can’t account for. That is not helpful. In fact, you can easily see that the two different types of clauses do different things, they have different functions within the total discourse.

In general, turn the problem inside out, back to front. Look at it another way.

9.5.2 Different kinds of grammar models

There are more formal grammars like government and binding theory and relational grammar, both of which are generative in origin. There are also semantically based grammars like cognitive grammar (Langacker, Lakoff), and the semantically based work of Anna Wierzbicka, as well as the semantic-syntactic approach of van Valin’s role and reference grammar. Each has its own advantages, and it is unwise to say that only one approach is correct or valid.

(Incidentally, semantics is not the “hairy mess” that you’re left with after you have finished your lower level grammar. It is a perfectly respectable study in its own right that is advantageous to begin early on in your program. Nor is discourse the “hairy mess” that you can start on only after you have finished all your lower level grammar. It is a legitimate study in its own right that you can start on quite early in your language program, and experience has shown that there are quite a few morphemes whose meaning is not properly understood until you have a good look at their discourse function, and sometimes even at their cognitive and cultural function.)

9.6 Extensions

9.6.1 Extensions in mathematics

9.6.1.1 From a single premise

Let’s start with an illustration from mathematics:

In one-dimensional geometry, a line is bounded by points.

In two-dimensional geometry, a surface is bounded by lines.

In three-dimensional geometry, a solid is bounded by surfaces.

In four-dimensional geometry, a 4D-body is bounded by solids.

Note how we build up from something simple, something well within our own experience, and then perform a thought experiment which extends what we already know, to something which may be outside of our immediate experience. Most of us can’t visualize a four-dimensional space with four-dimensional bodies, but we can say something about such a space based on the regularities we have observed within the one-, two-, and three-dimensional spaces that we do know about.
9.6.1.2 By duality

Here are more illustrations from mathematics:

**lines and points**
1.a A line is made of points,

but also 1.b a point is the intersection of lines.

**planes and points**
2.a A plane is made up of points,

but also 2.b a point is the intersection of planes.

**triangles, points and lines**
3.a A triangle consists of 3 points (vertices)
and the lines joining them (the sides),

but also 3.b a triangle consists of 3 lines (the sides)
and the points they intersect in.

**parts and wholes**
4.a The whole is made up of parts,

but also 4.b the parts constitute the whole.

The last illustration (4a and 4b) can be applied in many disciplines outside mathematics.

9.6.2 Extensions in linguistics

Here is a linguistic example which may be analogous to this sort of thing from Nambiquara (Brazil):

(14) wa³ko³-na¹-tu¹-wa²
    work-I-future-imperfective aspect
    ‘I will work’

but also
(15) wa³ko³-na¹-tu¹-wi¹
    work-I-future-imperfective.speech quote
    ‘I will work’ (I/you he/she/we/they said).

The difference between the forms (14) and (15) was that (14) was a simple declarative with the
meaning ‘I will work’, while (15) was the form that was used when the speaker was quoting someone
else as having said the words of (14).

In addition there was another form:

(16) wa³ko³-na¹-tu¹-瑄³
    work-I-future-??
    ‘I will work’ (supposed gloss? But what did it really mean?)

It took us a long time to figure out what this last form (16) really meant! In actual fact, when we
finally found out, it turned out to mean a quoted thought, that is, quoting someone who was thinking, ‘I
will work.” This was a form that occurred frequently, but in the monolingual situation we were in, no one could tell us what it meant. If we had sat down and indulged in some of the thinking games set out earlier, we probably would have arrived at that conclusion much sooner. Once we saw this, large chunks of discourse that were formerly quite obscure to us, immediately made sense. It was certainly very important for a natural translation.

Another example of an extension in linguistics comes from the Canela language in Brazil. In Canela there were long verb forms (with the final syllable of the verb stem being CVC), and short verb forms (with the final syllable of the verb being CV). The first solution offered by the language helper as to the difference in meaning of these forms was that:

- Long forms referred to events that happened a short time ago.
- Short forms referred to events that happened a long time ago.

Unfortunately, on looking at extensive amounts of text, and listening to people tell stories, it was found that every story had both long and short forms, irrespective of whether the events of the story occurred a long time ago or a short time ago.

The final solution after looking at a large volume of text was that:

- Long forms marked primary information in discourse, i.e., they essentially foregrounded main line information; and
- Short forms marked secondary information in discourse, i.e., they marked essentially non-foregrounded main line information, background information, and setting information.

There is a real sense in which an event that happened a long time ago might have been thought of as something more remote, more distant, and therefore less foregrounded.

Question for translation consultants: How would this sort of difference affect the form of the back translation that gets done?

9.7 Turning a problem inside out

This has to do with deliberately trying to look at a problem in a completely new way, adopting a new perspective on the problem (multiple perspectives all over again).

9.7.1 Example from discourse

In the early days of discourse analysis (1960’s or so) people talked a lot about logical connectives, for example, words like ‘but’, ‘because’, etc., and how these expressed relationships between clauses in a paragraph. So it was thought that logical connectives (or logical relations) held a paragraph together.

But another way of describing the same state of affairs is to say that a paragraph is held together by its logical connectives. (Just use the passive of the above.)

This is already a slightly different viewpoint.

From this we can go one step further, and ask, “Are there any other relationships that hold a paragraph together, besides the logical connectives?” The following two examples are coherent texts without logical connectives. Note that some paragraphs are obviously coherent, but their coherence is not provided by logical connectives. The first example is from A tale of two cities, by Charles Dickens (an account of the state of affairs just before the French revolution of 1789):

(17) It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way—in short, the period was so far like the present period, that some of
its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only.

There was a king with a large jaw and a queen with a plain face on the throne of England; there was a king with a large jaw and a queen with fair face on the throne of France. In both countries it was clearer than crystal to the Lords of the State preserves of loaves and fishes, that things in general were settled for ever.

In the first paragraph of this example, there is not a single logical connective, and yet it is clear that this paragraph has something that holds it together. In fact, one relationship that does a lot to hold it together is the contrast between opposite lexical items like best-worst, wisdom-foolishness, belief-incredulity, light-darkness, etc. This mechanism is a far cry from logical connectives but it is a legitimate coherence mechanism in English.

The second example is from Winston Churchill’s *The age of revolution: A history of the English speaking peoples* 3 (1957: 368):

(18) In the New Year of 1815 peace reigned in Europe and in America. In Paris a stout elderly, easy going Bourbon sat on the throne of France, oblivious of the mistakes made by his relations, advisers, and followers. His royalist supporters, more royal than their King, were trying the patience of his new-found subjects. The French people, still dreaming of Imperial glories, were ripe for another adventure. At Vienna, the Powers of Europe had solved one of their most vexatious problems. They had decided how to apportion the peoples of Saxony and Poland among the hungry victors, Prussia and Russia. But they were still by no means in accord on many details of the map of Europe which they had met to redraw. After the exertions of twenty years they felt they had earned enough leisure to indulge in haggling, bargains, and festivity. A sharp and sudden shock was needed to recall them to their unity of purpose. It came from a familiar quarter.

Napoleon had for nine months been sovereign of Elba. The former master of the Continent now looked upon a shrunken island domain. He kept about him the apparatus of Imperial dignity. He applied to the iron mines and tunny fisheries of his little kingdom the same probing energy that had once set great armies in motion. He still possessed an army. It included four hundred members of his Old Guard, a few displaced Polish soldiers, and a local militia. He also had a navy for which he devised a special Elban ensign. His fleet consisted of a single brig and some cutters. To these puny armaments and to the exiguous Elban Budget he devoted his attention. He would henceforth give himself up, he had told the people of Elba, to the task of ensuring their happiness. For their civic ceremonies he devised an impressive uniform. At Porto Ferrajo, his capital, he furnished a palace in the grand manner. He played cards with his mother and cheated according to his recognized custom. He entertained his favorite sister and his faithful Polish mistress. Only his wife, the Empress Marie Louise, and their son were missing. The Austrian Government took care to keep them both in Vienna. The Empress showed no sign of wishing to break her parole. Family Habsburg loyalty meant more to her than her husband.

A stream of curious visitors came to see the fallen Emperor, many from Britain. One of them reported, perhaps not without prejudice, that he looked more like a crafty priest than a great commander. The resident Allied Commissioner on Elba, Sir Neil Campbell, knew better. As the months went by close observers became sure that Napoleon was biding his time. He was keeping a watch on events in France and Italy. Through spies he was in touch with many currents of opinion. He perceived that the restored Bourbons could not command the loyalty of the French. Besides they had failed to pay him the annual pension stipulated in the treaty of peace. This act of pettiness persuaded Napoleon that he was absolved from honouring the treaty’s terms. In February 1815 he saw, or thought he saw, that the Congress of Vienna was breaking up. The Allies were at odds, and France, discontented beckoned to him. Campbell, the shrewd Scottish watchdog was absent in Italy. Of all this conjunction of circumstances, Napoleon took lightning advantage. On Sunday night, the 26th of February, he slipped out of harbour in his brig, attended by a small train of lesser vessels. On March 1 he landed near Antibes. The local band, welcoming him, played the French equivalent of “Home, Sweet Home.”

Look at the second paragraph of the Winston Churchill text. This paragraph is highly coherent but again there are virtually no logical connectives. What holds this paragraph together as a unit is the way
Churchill describes Napoleon’s current state as sovereign of Elba and repeatedly contrasts that state against his former state as master of the Continent (Europe.) This description and contrast is maintained throughout the paragraph. However, it is easily seen that this coherence strategy is confined entirely to the second paragraph. There is nothing of it in the first paragraph, and nothing of it in the third paragraph.

As far as problem solving is concerned, if we only ask what logical connectives there are in these paragraphs that give coherence, we finish up with no answer. But if we look at things from a different viewpoint and ask what there is that gives coherence to the text, then we come up with all sorts of interesting hypotheses.

9.8 On breaking up a problem into bite sized chunks

Some problems that look very big can be broken up into smaller sub-problems, each one of which is solvable in itself. Thus as a simple example, if you wanted to write a grammar sketch, you might try breaking down the total task into component parts:

Clauses
Phrases
Stems
Roots

Then you could break down each of the above items in turn into smaller subdivisions, for instance:

Clauses
Independent clauses
Intransitives, transitives, ditransitives, equatives
Dependent clauses
Adverbial clauses, conditional clauses, relative clauses
Embedding
Etc.

A big problem, which may look quite unsolvable can often be broken up in this way. Moreover, we can define intermediate goals in terms of the sub-problems, and as we complete each such intermediate goal we can cross it off the list of things to be done, and so we keep track of how far along we are in the total task of doing the whole problem.

The really difficult problems often cannot be broken up conveniently in this way. However, even with such difficult problems, it may be possible to single out a sub-problem, which is a valuable step along the way, if we were able to solve it.

10 Some problem solving principles and illustrations

10.1 Two basic questions to ask in problem solving

The first two basic questions to ask in problem solving have been provided by Sir Isaiah Berlin (see section 7.2.1). He posed the following questions:

1. If you did have a solution to the problem, what would it look like?
2. And if you didn’t even have any clue about (1) above, you could still ask, “Everything is like something, what is this like?”

Once you given an answer to question (2), you can proceed to do something, but then at some stage in your progress, you also need to ask, “And how is it different?” We can’t expect carbon copies of everything.
10.2 Various things that scientists do

The really big problems in science take many good people to solve. Depending on what stage the solution of a problem is at, different scientists will do different things. These are some of the important things that scientists do:

1. Describe what's there. (This is sometimes facetiously and unfairly called “stamp collecting.”)
2. Tidy up the data and the field; get the right hypotheses and start checking them.
3. Put it together; relate and explain.
4. Put it together; generalise and extend.

Ronald Langacker, world class cognitive linguist, has written about this also from his point of view, which is that of a cognitive linguist. His remarks will be found in appendix A, “Langacker on the Role of Methodology.” The steps (2), (3), and (4) above overlap largely with Langacker's conceptualisation and validation phases.

In the following section, illustrations from the history of science demonstrate how these successive steps were implemented.

10.3 Some illustrations from the history of science

10.3.1 Planetary motion

Copernicus (about 1530) got the right hypothesis, that the earth revolved around the sun. Up until then people generally thought that the sun revolved around the earth.

Kepler (about 1660) described the phenomena very carefully, wrote some descriptive rules which were very complicated, but they did describe what happened. But people didn't understand why. For instance, one of Kepler's laws was “The radius swept out equal areas in equal times.” (But why?) Also, “The orbits were elliptical, and equal areas were swept out by the radius in equal times, and the square of the time period was proportional to the cube of the distance of the planet from the sun.” (But why?)

Newton (1687), in “Principia” formulated the laws of motion to apply to objects on earth, and then extended these laws to apply to planetary motion as well. By using the inverse square law of gravitational attraction, he was able to interpret all of Kepler's descriptions and find out the underlying causes, that is, that gravitational attraction accounted for all the phenomena. This was a generalisation of historic proportions. Newton explained why!!

10.3.2 Electromagnetic induction

Faraday (about 1830) knew currents flowing in a coil produce magnetism, so he asked whether magnets could possibly produce current flowing in coils. The vital ingredient was motion. A stationary magnet could not do it, but Faraday found by experiment that a moving magnet could and did. This discovery is the basis of all electrical engineering. Faraday had discovered a very important generalisation. He had linked together two things that people hadn't linked together before.

The next contributor to the same enterprise was Clerk Maxwell, Cavendish, Professor of Physics at Cambridge (1875). Maxwell discovered the electromagnetic field.

10.3.3 The electromagnetic field and electromagnetic waves

To begin with, Clerk Maxwell knew the characteristics of electrostatics and magnetism and that one could affect the other, as can be viewed in the table below.
Electrostatics: Like charges repel, unlike charges attract (known before).
Magnetism: Like poles repel, unlike poles attract (known before).
Combined: Moving magnets produce electric currents (see Faraday above).

Currents flowing produce magnetism (known before).

These were considered separate phenomena but Maxwell asked why should they be regarded as separate? There is so much similarity. These similarities surely should mean something! Surely these things must be linked together somehow! Could one description suffice for both? Everything is like something, so what is this like? (back to Isaiah Berlin again.)

This led to Maxwell’s electromagnetic equations which introduced the electromagnetic field and electromagnetic waves. Maxwell was also able to predict that light had to be an electromagnetic wave as well.

Later on (years after Maxwell’s death), things like gamma rays, X rays, and radio waves were discovered, and it was found that these also came under the same description, that is, they were all somewhat like light waves (even though these new phenomena were waves that no one could ever see, unlike light, which all normal people can see).

So Maxwell’s work both described what was happening, explained it, and led to generalisations and extensions that predicted further as yet unrealised phenomena. Maxwell’s generalisations were among the greatest ever made in the history of physics.

In Langacker’s terms, Maxwell’s work would correspond to the conceptualisation phase, namely, to look for a coherent theoretical model. Notice that quite detailed descriptions of “what was there” were already available when Maxwell started. But he was the one who put it all together, and what’s more he made predictions that were only verified experimentally many years after his death. That was amazing.

Linguistics, fifty to sixty years ago, was largely concerned with describing what’s there. But these days we need both to describe what’s there and ask why it is that way.

10.4 Stages in the problem solving enterprise: A recap

The various stages in solving a problem are given next.

10.4.1 Problem identification and description

Try and define your problem carefully. Describe the problem in words. Describe it as accurately as you are able to in writing at this stage. Describing it accurately can help you to know what you are looking for. Refer to your written problem description from time to time. It may need to be revised at later stages of your analysis and this is by no means a waste of time, since it will help define your problem.

And if you have a clear idea of what your problem is, you will know what the right questions are to ask. And asking the right questions is an important step in getting the right answers.

10.4.2 Data gathering

You do need an adequate amount of data before you can define a worthwhile problem and can form a decent hypothesis. And having some idea what the problem is will help you select the kind of data you need.

10.4.3 Hypothesis generation

You need a hypothesis, a hunch, or some sort of lead as to what is happening in your data. Discussion and brainstorming are useful here. Discussions at this stage should definitely be the green-lighting kind of discussion. Almost anything should go. Judgemental and critical remarks are likely to be damaging rather than helpful at this stage. Lakoff said that bright ideas are like young plants; they need to be watered and nurtured to make them grow. This is so important—let’s never forget it.
And as far as linguistics consultants are concerned, one should never negatively jump on a consultee’s early ideas or early hypotheses. If you need to, try to gently persuade. But if at all possible, try to develop the consultee’s ideas if they have any at all. Try to expand and enhance them, and perhaps sometimes modify them. Their own ideas are the ones that they will own!

**10.4.4 Data organisation and checking of data against hypotheses**

You need to check your data against the hypotheses you have. You’ll probably need to revise or reword some of your hypotheses so that the data fits. If the data doesn’t fit the hypothesis, it’s the hypothesis that must give, never the data. (See the write up on the perfect, in section 8.2.) You may need to look for new kinds of data as indicated by the hypotheses. You will need well-motivated means of data organisation (perhaps some form of charting) so that you can handle large volumes of data. Remember, your hypotheses need to be checked against large volumes of data. One example by itself proves nothing!

**10.4.5 Synthesis and critical evaluation**

This involves having your data organised carefully and your conclusions described in words so that someone else can check and evaluate them. Make your statements precise and explicit so that they can be either verified or falsified if at all possible. (In fact, a very instructive way of learning more about your data and your language is to deliberately look at data and try to falsify your own hypothesis. When you have got to the place where you can’t do it (i.e., can’t falsify it), your hypothesis is probably in pretty good shape.

Don’t be afraid of counterexamples at this point. They will teach you a lot.

Welcome criticism at this point. It is far better to find out now that you need to revise your solution, rather than later after you have applied the conclusions to some practical end (i.e., in literacy or translation) and found out the hard way that your solution was inadequate.

Write up your solution coherently. You learn an enormous amount about your problem and your language by doing so; far, far more than by discussion alone. The fact of the matter is that most of us need to go through the struggle of expressing the concepts clearly in writing before we really understand the material. Ideas get clarified and organised, and relationships that weren’t apparent before will come to the fore. No one who has ever gone through the benefit of writing up a solution will ever deny its usefulness. But equally no one who has not tried writing something up, ever wants to do it. It is hard work.

Be prepared to go through several drafts. Some of the very best people go through many drafts. Maybe it’s because they have been willing to go through those drafts that they are the best people. Professor Harry Jones, a world authority on the theory of metals at the time, said once to me. “I had to write that one out twelve times before I understood it.” If Jones, a world authority, needed to do it, surely we need to do so at times too. It could be that one reason why Jones was a world authority was because he had the patience and the humility to write the stuff out those twelve times!

**10.5 Some considerations in producing a good analysis**

The following are considerations which will probably help in almost any analysis that we do.

**10.5.1 Check your assumptions carefully**

Be sure that all your assumptions are correct. Be particularly wary of assumptions that everyone makes. (Does the sun really go around the earth? Lots of people used to believe that it did!)

In particular, be wary when others use the term “obvious.” Remember that under suitable assumptions, anything can be obvious. For instance, for a good communist it is obvious that capitalism is bad. Or for certain people today, it is obviously right for them to kill anyone not of the same religious persuasion as they themselves are! But it is not obvious to us, I am sure. If something is obvious to
someone else but not to you, it may be no more than that you two have different sets of background assumptions. And it is not necessarily true that their set of background assumptions is superior to yours. As mentioned earlier, Hans Selye observed a group of patients and he did not assume all these patients were “just sick.” He questioned symptoms these patients shared in common and arrived at the idea of “stress.” (See section 4.2.) Let us all be careful not to dismiss “silly questions” or questions with “obvious” answers.

10.5.2 Beware of stereotypes

Often we see what we expect to see or what we want to see and are prone to miss everything else.

10.5.3 Don’t confuse a mere correlation with a cause and effect explanation.

For instance, long ago, it was well-known that there was a tendency for there to be more malaria near swamps, and also less malaria at high altitudes. In fact, the word “malaria” means ‘bad air’, and it was thought that the cause of malaria was the bad air and the low altitude swamps. But these relationships are correlations, not an explanation. We now know that the real cause of malaria is the anopheles mosquito that bites you and transmits microbes to you. But near swamps at low altitudes there are often more mosquitoes, and at high altitudes there tends to be less mosquitoes. So there is a correlation between altitude and malaria incidence, but that correlation is not a causal explanation.

10.5.4 Be wary of reversing a conditional.

If you have a conditional like

If A then B,

there is a strong temptation to assume that the reverse conditional

*If B then A

is also true, although many times it is false.

For example “If focus then accent” is usually true,

but “If accent then focus” is often false. Some accents are activation accents, they are not focus. (See Lambrecht 1994 on activation accents and focus).

10.5.5 On parameters

It is very important to be clear what parameters, if any, are involved. Sometimes a new parameter needs to be invoked that has not been thought of. Or sometimes you need more parameters than you’ve got. Occasionally you may need less.

There are times when a new parameter needs to be introduced, but it hasn’t been. Consider how often people use the term “prominence” without any specification of what is being made prominent. There are at least three kinds of prominence: prosodic prominence, topical prominence, and focal prominence, and they are not the same. The term “important” is also a term which is often used without specifying the relevant parameter—what is it that is important about it?

Sometimes more parameters are needed. Consider the case of pragmatic accent placement (mentioned previously). There are two parameters involved: the propositional relation (topic or focus) and the activation property (activated, accessible, inactive). If the description is carried out with just one parameter instead of two, there will be unnecessary confusion and complication.

Use of parameters must be justified by the data. Do not arbitrarily proliferate parameters without any data backing.
10.6 Split up your problem into subproblems.

Sometimes if the problem is too big, it pays to divide it into doable sub-problems, but trying always to still keep the main goal in mind.

11 Decipherment of Maya writing

Amongst the ruins of the ancient Maya culture of Mexico were found some very complex and incomprehensible inscriptions. The history of how these inscriptions were finally deciphered, and all the bungling and false starts along the way is an interesting and instructive lesson in methods of research.

11.1 Preliminaries: Types of writing systems

There are basically three different kinds of writing systems (or scripts): logographic, syllabic, and alphabetic. Every visual system of communication (including writing) has two dimensions:

- the semantic relating to meaning
- the phonological relating to sound

In some writing systems, the semantic and the phonological intertwine quite subtly, and care needs to be taken if we are to recognise and distinguish them.

11.1.2 Logographic systems

The semantic dimension of a logographic system is expressed by logograms. A logogram is a written sign that stands for single morpheme (or sometimes a complete word). Ancient Sumerian is a good example of a logographic system. Chinese and Japanese are written logographically, but their writing systems also include phonological components. The phonological dimension in this case is expressed by rebus words, which are sounds in picture form.

11.1.3 Syllabic systems

In syllabic systems, there is a sign for each manifestation of a syllable type, that is, for each different manifestation of a syllable type there is a different sign.

For instance, if a language has
- five vowels: a, e, i, o, u, and
- consonants: f, h, w, m, ...

then there would be a different sign for each combination in that language:
- fa, fe, fi, fo, fu
- ha, he, hi, ho, hu
- wa, we, wi, wo, wu
- ma, me, mi, mo, mu
- ...

Cherokee is a good example. It was devised by Sequoyah, a Cherokee Indian and has eighty-five signs.

Chinese script has a phonological component that consists of 895 syllabic signs which give the general sound of the character. The rest of the character is semantic and grammatical in its import.

In Japanese writing, the logographic system coexists side by side with a syllabic system to give a viable writing system. The root morphemes (logograms) in Japanese are in Chinese characters. The
phonological component of this system has forty-six signs that stand for forty-one CV syllables and five vowels. The words have roots and suffixes, and the suffixes are expressed by the syllabary.

11.1.4 Alphabetic systems

Alphabetic systems are based on the segmental phonemes of the language.

Phoenician was the earliest alphabetic system. This being a Semitic language, vowels were relatively unimportant so the Phoenicians didn’t bother to write them.

The Greeks borrowed the idea of an alphabetic system from the Phoenicians, but because the Greek language had contrastive vowels, they took some of the old Phoenician signs that represented consonants and reassigned them to represent vowels.

11.1.5 Decipherment of Egyptian writing: A very brief account

The Ancient Egyptian system of writing has three forms:

- **hieroglyphs**—most often found in monuments and public inscriptions
- **hieratic**—a cursive script mainly used in priestly texts, found in papyrus manuscripts
- **demotic**—a cursive script employed in business transactions, also found in papyrus manuscripts

There are about 2500 individual signs in the Egyptian corpus, which consist of phonograms and semagrams. Phonograms have a phonological function, and are divided up as follows:

- twenty-six are single consonants,
- eighty-four are clusters of two consonants
- several are made up of clusters of three and four consonants.

Semagrams have a semantic function (or at least a partially semantic function). Most signs are picture-like. The same sign can be used as either a phonogram or as a semagram, for example, the goose sign can be the biconsonantal z (phonogram), or it can mean ‘bird’ (semagram).

The earliest theories thought the hieroglyphics were sacred carvings, in fact, this is what the word “hieroglyphic” means. So each separate sign is a piece of knowledge, a piece of reality. There is no thought of a writing system being present, nor was there any idea that the hieroglyphics were connected in any way to human language.

Here is an example of how they thought the system worked. The hieroglyphic of a baboon can mean ‘moon’, ‘the inhabited world’, ‘writing’, ‘a priest’, ‘anger’, and ‘swimming’. Even as late as Kircher (1602–1680), people held to this kind of a solution. People in those days thought that the Chinese writing system was also organised that way, and that, of course, was to them a bit of extra proof that they were right! (What a hypothesis!)

Eventually, various obelisks (monuments) found their way into the West, and in 1798 Napoleon’s army found the Rosetta Stone, which had three parallel texts on its face—in Greek script, demotic script and hieroglyphic script respectively. Copies were made and circulated to interested scholars.

In 1822 Champollion recognised the names of some of the early rulers of Egypt on both the Rosetta Stone and on monuments set up in the square of Rome. Then in the same year, Abbe Remusat published a study of Chinese writing, which showed that even Chinese script was strongly phonological in its structure, and not just a string of ideographs. Armed with this idea, Champollion simply took off and in about eighteen months he completely cracked the ancient Egyptian system, showing that the script was largely but not entirely phonological. It was based on Coptic grammar, and the hieroglyphic forms of the masculine, feminine, and plural could be read. (Coptic was and is a spoken language.) Demonstratives, possessive and ordinary pronouns, noun class markers, etc., could be read as well. So he identified grammatical forms, all connected with language!
11.2 A brief history of unsuccessful attempts at deciphering Maya script

Bishop Diego de Landa was a Spanish priest of the Franciscan order who worked in the Yucatan peninsula from 1547 to 1563. He wrote *Relacion de las cosas de Yucatan*. In *Relacion* he had worked out details of the Maya calendar, giving the names of the days in the 260-day calendar and the names of the months in the solar year, all with their appropriate hieroglyphics. Landa also gave his explanation of how the Maya writing system actually worked; his explanation was that the writing was essentially phonological (but notice, he did not say it was entirely phonological).

In the late 19th and the early 20th centuries there were two rival camps in the field of Maya decipherment. One camp believed that the script was largely phonological. The other believed that phonology had nothing to do with it, and that the glyphs were just picture writing. The phonological people picked up from where Bishop Landa had left off, but they thought that the system was entirely phonological, and this was their big mistake. What can we learn from this? By overplaying the phonological factor, they arrived at ridiculous and unbelievable results. So for many years, the latter, that is, the picture-writing camp, out-debated the former (phonological ones), and held sway, probably because they were more erudite and better debaters. But still nobody could decipher the manuscripts. They never looked at the history of decipherment, nor at how the Egyptian hieroglyphic problems had been solved.

Eric Thompson was an Englishman who worked at the Chicago Museum of Natural History from 1926 to 1936 and as a staff researcher with the Carnegie Institute from 1936 to 1958 on various projects, one of which was the study of the Mayas, and Maya decipherment. Thompson was a high church Anglican to whom the many events in the church calendar year were important. Starting from this initial viewpoint, he began to concentrate on calendar problems of the Maya decipherment. This had to do with naming and organising the days, months, and years, the many time cycles, and how they related to the Maya gods. It got further and further away from language! (Note that with his high church background, Thompson already carried an initial mental bias.)

Benjamin Lee Whorf, a linguist, dared to suggest that the Maya inscriptions record spoken human language and therefore must include a phonological component. He carried on from where Bishop Landa left off, and he showed that a few of the signs in the Maya writing had grammatical significance. However, in his detailed work, Whorf was rather sloppy, and made errors.

Thompson’s colleagues were not slow in attacking Whorf. One, Richard Long in 1935, said that the Maya script was “embryo” writing, and that therefore there could not be any grammatical sentences. (What an assumption!) Long also added as an argument that the Mayas were barbaric. (Could he prove that?) And therefore, they could not have attained a level of civilisation that could have given them a complete writing system (that included a phonological component). One idea circulating then was that picture writing, syllabic writing and phonological writing represented successive stages in an evolution. (Again an assumption without proof!)

Moreover, Thompson himself attacked Whorf, concentrating on the errors of detail that Whorf made, while all the time quite ignoring Whorf’s main point that the Maya inscriptions have a basis in human language. (Another practice that is bad science!)

Archibald Hill, University of Virginia linguist (Hill 1952) suggested that Thompson’s shortcoming in his method of research was that he was not aware that the problem of Maya decipherment was a linguistic one. According to Hill, the glyphs should represent Maya words or constructions.

Thompson’s answer was, “The linguistic approach is useless. One cannot translate all glyphs into modern Yucatec because many of them are ideographic and in many cases the corresponding archaic term is now lost.”

I have underlined the last part of the sentence above. This is what Thompson asserted, but notice that he asserted it entirely without proof! It was nothing more than a presupposition of his which he could not prove, and which in fact, time would show to be incorrect. Nevertheless, he asserted it as though it were an incontrovertible truth, and by doing so he and his colleagues held up the progress in Maya decipherment by about half a century!

The work of Knorosov will be discussed in the upcoming sections. You will see that it was indeed the linguistic approach that finally succeeded in cracking the code.
11.3 Knorosov’s contribution to a successful solution

Yuri Valentinovich Knorosov was an artillery spotter in Marshal Zhukov’s Red Army that took Berlin at the beginning of May 1945. They were about to put the National Library in Berlin to flames, and Knorosov dashed in quickly to salvage anything he might like. He managed to snatch a one-volume edition of the Dresden, Madrid and Paris Codices published in 1933. (Those three codices represented the most valuable of the Maya manuscripts, and included Bishop Landa’s Relacions.) Knorosov returned to Moscow and studied Egyptology, Japanese literature, and the writing systems of China and ancient India. His PhD supervisor suggested that he try to decipher the Maya system found in the codices he had salvaged from the Berlin National Library. So he learned Spanish and studied Bishop Landa’s Relacion, found in the codices he had rescued. He studied other ancient writing systems including Egyptian, Mesopotamian, and Chinese, and soon came to the conclusion that all the three main components—logographic, syllabic, and phonemic—coexisted in all of them. Moreover, he put the Maya writing squarely in with them, so that, according to Knorosov, Maya writing has all three components coexisting. He called them all hieroglyphic writing. The same glyph could in different contexts have one or other of the functions, logographic or phonological.

Based on this he soon completely cracked the Maya code, and was able to decipher many texts. He was also able to show that a great many of the words that he deciphered were ordinary, well-known words, registered in all the Yucatec vocabularies, and not hypothetical words. (Yucatec, very, very similar to the ancestral form of Mayan on the Yucatec peninsula, is still spoken by hundreds of thousands of people today.)

11.4 Conclusion: What do we learn about scientific method from this?

1. Take nothing for granted; check everything.
2. Question your presuppositions; are they reasonable, or do they block you from seeing the solution?

12 The Bismarck and the Enigma code

At the beginning of World War II, the German Navy had several enormous battleships that were making very damaging raids on the British convoy shipping in the North Atlantic, and the losses to the British were seriously jeopardising the war effort. The biggest German battleship afloat at the time was the Bismarck, which had been built by Hitler just before the beginning of the war, in contravention of treaty restrictions.

At that time, the German forces had a secret encryptic code called “Enigma.” Until the beginning of 1941, the British were unable to break the code, but in the spring of 1941, due to some captures of equipment from German shipping, they were able to decipher the code. Especially important was the capture of a U-boat “U-110” on May 9, 1941, from which they retrieved the Enigma equipment, including even the Enigma settings for the day, completely intact.

Soon by decoding messages, it was clear that the Germans were building up an armada of ships for a major raid on the British Atlantic convoy. By the second week of May it was observed that German reconnaissance aircraft were concentrated in an area near Greenland. Then on May 21, a coded Enigma message was broken that indicated that Bismarck had embarked five prize crews with necessary charts and was carrying out exercises in the Baltic. This alerted the British, who decided to attack the Germans with ships and aircraft carriers. They eventually sighted the Germans in the early morning of May 24th, 1941. One of the British ships, the Hood, was sunk almost immediately by very accurate German gunfire. But the Bismarck itself was also damaged. After this first encounter, the Germans withdrew, and the pursuers pretty much lost her. Then at 18:12 on May 25, a coded Enigma message showed that the Bismarck was heading for the coast of France. They sighted her at 10:30 on May 26, and finally the Bismarck was sunk at 10:37 on May 27. But it is clear that if the British had not broken the Enigma code, she would have escaped.
During the following few weeks the British sank fifteen ships and some ninety thousand tons of German naval shipping because of the information received from breaking the code. But the Germans never did catch on to the fact that their code had been deciphered. They assumed that the Enigma code was so secure that it was impossible to break, and so they looked for all kinds of solutions elsewhere. Some of the pseudo “solutions” that they came up with were that

- the marked increase of the Luftwaffe reconnaissance flights must have given some clues to the enemy;
- there were shore-watchers who saw the German ships and reported secretly to the enemy. After all, there was the British Secret Service, Norwegian agents, and telephone tapping; and
- there were “unlucky circumstances”!

The German Intelligence concluded that their experts had unanimously discounted the possibility of the enemy’s being able to read signals by deciphering them. They did not arrive at the right solution, because they were unwilling to accept the possibility! Had they come to the right conclusion, they could have readily made radical changes to the code, which would have saved them many losses.
Appendix A: Ronald A. Langacker on the role of methodology

A scientific discipline evolves through many phases and comprises numerous kinds of interacting activities. One phase is characterized by curiosity, informal observation, and an emerging awareness that a body of phenomena may be susceptible to analytical investigation. Another phase consists in the systematic collection of basic data about these phenomena; even if this enterprise is only taxonomic, it furnishes the empirical basis for theoretical development. Conceptualization follows: the investigator experiments with various metaphors and preliminary theoretical models, searching for revealing formulations and promising lines of attack. He must then elaborate and articulate a theoretical model capable of accounting for the initially available data and enabling further empirical predictions. In the validation phase, a theory’s predictions are matched against additional data, and refinements are made to enhance its observational adequacy. A further endeavor is the comparison of alternate models, to determine their points of divergence and the nature of the evidence that will distinguish them empirically. One final endeavor is formalization, in which appropriate mathematical expression is sought for the model.

These phases are not rigidly sequenced, nor are they sharply discrete; in practice the investigator finds himself engaged in several simultaneously. Moreover, an evolving discipline may cycle through certain phases a number of times before an adequate theoretical formulation is achieved. The concerns of the investigator naturally differ from one phase to another, as does the mode of discourse most appropriate for discussing those concerns. For example, it is unreasonable to demand rigorous formalization for an emergent theory still in the process of conceptualization, and it is pointless—as shown by the sorry history of the controversy between generative and interpretive semantics—to seek definitive evidence for the choice between two competing theories when both remain largely programmatic.

Present-day linguistics would appear to be quite advanced. There are well-articulated theories, whose validation, comparison, and formalization have received considerable attention. However, it must also be admitted that current theories achieve precise formalization only by excluding from their domain many important aspects of linguistic organization; one does not ask, for instance, how Montague grammar handles phonology, or how relational grammar deals with lexicon (or even the syntactic structure of noun phrases). We can also note the striking lack of consensus about the proper characterization of even the simplest or most fundamental linguistic phenomena. Little in the way of established descriptions, basic concepts, analytical techniques, or general theory commands anything even approaching the unanimous assent of serious investigators (compare this with the situation in, say, chemistry). A central reason for these shortcomings, I contend, is that linguistic theory has been built on inadequate conceptual foundations. Surprisingly little effort goes into the critical examination of deeply rooted assumptions, into uncovering the source of apparent dilemmas (which are usually indicative of underlying conceptual confusion), or into cultivating fundamentally new modes of thought. While our factual knowledge of language proliferates, and the scope of linguistic investigation continues to expand, current theoretical attitudes encourage narrowness and fragmentation, offering little hope for a comprehensive synthesis. [Langacker 1987:31–32]

If the foundations of linguistic theory were really secure, we might expect that by now there would be general agreement about the proper description of something as intensively studied as the English passive or auxiliary system, yet conflicting analyses continue to proliferate. Comparison of the twelve theories of syntax outlined in Moravcsik and Wirth (1980) will leave the reader hard-pressed to find any substantial point of general agreement among the authors, even on the most basic matters (e.g., whether the notion “subject” is an important construct for linguistic theory and, if so, what kind of notion it is). [Langacker 1987:32 fn15]
Appendix B: Richard Margetts on problem solving and scripture engagement

Richard Margetts works in West Africa with SIL on Scripture Engagement. In a personal email (16 June 2008), Richard speaks from his experience and perspective:

I have been trying to work out how problem-solving in Scripture use and linguistics are related—but I am not sure how helpful it is to think about the two in the same way or to try and combine the two without becoming rather vague.

I am involved in SU [scripture use] consulting ..., and the problem solving seems to fall in the following domains: strategy development, missiology, personal and public relations, management, marketing, and communication. In these sorts of areas, the way you go about solving problems is quite different from scientific linguistic research.

Perhaps what they do have in common is:

1. Be sure you really understand the problem. That demands observation, listening, analysis, asking the right questions, asking the right people—rather than jumping in hastily with an answer to something that is not the real problem. There are too many consultants who would like to give you the solution before they have heard the problem!

2. Apply good interpersonal communication skills. Helping a team to come up with a good solution themselves, which they will own, is better than you looking good and claiming the credit for the idea—and it not being put into practice.

3. Keep abreast of ideas, trends, patterns, successes and failures in other language groups.

4. Make the most of other people’s skills. If you are not an expert in the domain, can you find someone who is—and work together?

5. Be creative and don’t just copy what another group is doing. Contextualise good ideas to fit the situation.

6. Write up what you have done, so others in similar situations can benefit from it in solving their problems.

7. In the commercial world, consultants can make themselves indispensable, by keeping to themselves their secret knowledge. But be different! Make it your goal to train up others to do what you do and share with them what you know.

8. Never give up! Don’t be pessimistic! Be an encourager to those who are tempted to look on the negative side.

9. And, of course, never stop looking to the Lord for his guidance!
Appendix C. How to read and understand a horrible book

1. Take a general approach

Some books, even though very badly written and incomprehensible, are so good and worthwhile in their content that they should not just be laid to one side. But getting through them and understanding them looks a daunting task. Here are some ways to make that task easier and doable.

One needs to realise that in understanding a book or paper, understanding comes at two different levels. First, at a broad level we need to know what the general thrust of the author’s argument is and what he is trying to achieve. Second, at a narrower and more local level we need to understand what each chapter, each section within a chapter, each paragraph, and each sentence and each example are about. Clearly the two are linked. It is also possible to understand the author’s general thrust without understanding all the detail. Sometimes you can fail to understand a part of a chapter, or some examples and still get the general thrust of the argument, and sometimes that might be all that you need. And conversely, it is occasionally impossible to understand what some examples are contributing to the author’s argument without understanding what the author’s general thrust is.

Some of the considerations that are helpful toward understanding a book or paper are given under the headings below.

2. Understand abbreviations and terminology

Often we don’t understand what the author is getting at because we don’t understand his abbreviations and/or his terminology.

2.1 Abbreviations

So be very careful of any abbreviations or acronyms that the author uses. Don’t guess at them because sometimes your guess can be wrong and then you will stay permanently confused. (For instance, if you think that COMP meant ‘completive’ when the author really meant ‘complement’, you can stay in a muddle for a long time. This one actually happened to me not long ago!) So…

Look up in the book to see where the list of abbreviations is. It is usually either near the beginning or near the end of the book. Keep a bookmark at the page where the abbreviations are so that you can refer to it quickly without fuss anytime you want to. Be especially careful of morpheme glosses and also of acronyms.

2.2 Unusual or novel terminology

Sometimes an author will use unusual terminology for an old and familiar concept. Often the author has a good reason for this. For instance, in a book I was reading recently, the author used the term “Privileged Syntactic Argument” instead of the simple term “subject” and, of course, as reader was in a fog for quite a long time until I realised what was happening! When this happens, one’s first reaction should not be to pour down curses on the author for being so awkward, because often he has a good reason for the change. But at the same time, one should keep the old term in mind if it reminds you of familiar relationships and helps you to understand.

If the author defines new terminology that he uses, read his definitions carefully and keep them in mind. Don’t hang on to your old concept of what a term means if it is in conflict with what the author is doing, because if you do, that is an infallible recipe for confusion.
3. Keep track in detail

There are a number of things to pay attention to if we are to keep track in detail, that is to say, if we are to accompany the author at all points in his argument. The following problem points are what I come across in the course of my reading. In a well-written book, none of these points will arise because the author has taken care of all of them beforehand. But there are many books these days where the author has not taken care of all of the points. So here goes...

3.1 Pronouns

Pronouns like ‘it’, ‘this’, ‘that’, ‘these’, ‘those’ and also expressions like ‘the former’, ‘the latter’ and even ‘the first’, ‘the second’ will refer to statements made previously in some part of the text. They could also refer to some piece of data, previously quoted. Be sure you know what each such “pronoun” refers to; sometimes it isn’t at all clear. And if you are not clear in your own mind as the reader, then you are not following what the author is doing. Sometimes it will be helpful to mark these pronouns and expressions in pencil.

3.2 Logical connectives

Logical connectives like ‘but’, ‘however’, ‘because’, ‘since’, ‘therefore’, ‘and so’, etc., tell us the logical connection between one sentence and another, or between one paragraph and another. A good author will put them in where necessary and so the reader will find the argument easy to follow. Some authors just leave them out, and in such a case, if the reader is not familiar with the argument, he can easily get lost. My solution is to go through a piece of text I am not following, and insert what I think is the correct logical connective at the appropriate places. I do this in pencil. The resultant clarification can be amazing. Try it.

3.2 Displacement of figures and tables with regard to the text

In a book which has been put together in a hurry (and in these days, many are!), you often get a figure or a table on one page and the text which explains them on another page, sometimes several pages away. However difficult it is, find some way of looking at both the table and the text at the same time. It is often very difficult to understand the table without the text or the text without the table. Don’t neglect this.

By the same token, sometimes formulas or blocks of data are back-referenced by their formula number only and not by the page they are on. Often you can help yourself by lightly pencilling in the page number. For example, where it says “Fig 5.4.3”, if you find the page it is on, then pencil it in, so that you finish up with “Fig 5.4.3 (p. 432).” This will make it much easier to refer to next time you come to read the text (and for a difficult book you may have to read certain parts of the text several times before you understand it properly).

3.3 Paragraph breaks in the wrong place

In some sloppily written books, sometimes there should be a paragraph break in the middle of a paragraph, because the author has changed his topic, probably without knowing it. But unless you have a paragraph break there you will get lost. So use a paragraph break marker—pencil it in.

A well written paragraph should have its first sentence as a topic sentence, i.e., the rest of the paragraph should expand on or elaborate the first sentence. But occasionally you find badly written paragraphs in which the topic sentence, if it exists at all, is buried in the middle of the paragraph. In that case find it out and underline it. That keeps you on track.
3.4 Data and examples

Data and examples are meant to be there as evidence for the author's argument, and to support his conclusions. The purpose of each data example should be stated somewhere in the presentation. Sometimes it isn't. Look for it. Sometimes it isn't there. Sometimes it is buried in a relative clause or a subordinate clause where you don't expect it, because one tends (rightly so) to look for new information in main clauses. If the purpose isn't stated you may want to pencil in a provisional purpose, that is, what you think the purpose might be, subject to correction later when you understand better.

3.5 Good and sloppy subtitles

A good subtitle will tell you what the next bit of text is about. A poor subtitle won't tell you enough, or sometimes virtually nothing at all. Some subtitles are too brief, some are just downright misleading. You may at times have to write in your own subtitles, it is well worth it.

Sometimes it is even worthwhile to insert a new subtitle at some point in the text. I have found this at times to be very helpful.

4. Keep on track broadly

Try to get some idea, no matter how rough, of the author's game plan. Where is he going? What is he hoping to achieve?

If it is an author you read frequently, try to psychoanalyse him a bit. What are his values? What are the things he regards as all important? Because these are the things he'll come back to again and again. Predictability is a key to comprehension.
Appendix D: On creativity

Here are some characteristics of creative people. To enhance your own creativity seek to develop these characteristics in yourself.

- **Fluency**
  Able to generate a large number of ideas

- **Flexibility**
  Able to choose a wide variety of approaches, to drop one line of investigation for another if necessary
  Able to shift gears, change perspective, shift frames of reference
  Able to see associative links
  Able to ask good questions

- **Sensitivity to problems**
  Able to point out problems, situations and challenges that have escaped the attention of others
  Sensitive to the promising aspects of situations and to hidden opportunities

- **Originality**
  Able to question established thinking
  Able to fragment and differentiate, to see unity in diversity, to see unexpected relationships, to see order in chaos
  Able to dissolve existing syntheses
  Able to use elements and concepts beyond their original established limits

- **Curiosity**
  Seeks understanding, attempts to solve mysteries
  Gets excited about problems
  Does not take things for granted
  Wonders how things might be

- **Openness to feelings and to the subconscious**
  Able to welcome unconscious thought processes
  Responsive to emotions and feelings, intuition
  Has more energy, is impulsive

  - **Primary creativity emerges from the unconscious**
    Spontaneous, open to unconscious thoughts, feelings and impulses
    Taps creativity present (in those who can play, dream, laugh, accept their weakness and softness)
    Measures the relevance of ideas by their fit and harmony, by their appropriateness or belongingness

  - **Secondary creativity comes from the conscious**
    Doesn’t play
    Demands a high degree of order
    Dislikes poetry and emotional expression
    Drowns personal childishness

- **Ability to toy with ideas**
  Plays with ideas, forms, materials, relations, concepts. This puts one’s critical faculty to sleep and passes over the established order.
• **Ability to think in metaphors**  
  Discovers solution through metaphor frequently  
  Perceives and discerns linkages and qualitative similarities between phenomena and objects normally considered too disparate  

• **Aesthetic orientation**  
  Able to greatly enhance creativity and problem solving capacity through expression of art  

• **Ability to analyse and synthesise**  
  Analyses, i.e., breaks down a problem into its parts; is able to define the problem, scan the alternatives, feel out the problem, understand it  
  Synthesises, i.e., rearranges and recombines elements to form a new whole, to orchestrate a new configuration  

• **Ability to discern and select**  
  Able to see what is fundamental in a problem, what is the heart of the matter, what is significant, relevant, what fits and what doesn’t  
  Knows how to eliminate superfluous clutter, how to not get lost in a mass of irrelevancies  
  Recognizes that quality is important; quantity is as nothing if the central point is missing  

• **Ability to tolerate ambiguity**  
  Unafraid of disorder or ambiguity, even though it is confusing and paradoxical. (It is not always possible to have a precise and accurate description of everything.)  

• **Incubation**  
  After hard work, leaves the problem; lets the unconscious operate unrestrained by conscious concentration—otherwise thinking gets ponderous and clogged, errors pile up (Russell and others).  

• **Productive periods**  
  Is aware when there are creative solutions  
  Traces the routes followed to get them, the moods, and the feelings  
  Is aware of personal rhythms  

• **Motivation**  
  Cannot and will not let go of problems  
  Able to be fully absorbed and concentrate  
  Has strong sense of purpose, strong sense of ego involvement  

• **Persistence and concentration**  
  Has the capacity for taking pains, will not let go  
  Has confidence, maintains morale, has pervasive excitement  
  Is not crushed by failure  
  Hard thinking, prolonged reflection, and hard work (at times suppressing a thousand and one diverting thoughts)  

• **Ability to tolerate isolation**  
  Recognizes that at times isolation from distraction and interruption is necessary  
  Recognizes psychological isolation may be necessary as well; creativity can be lonely  

• **Background of fundamental knowledge**  
  Knows his/her field, but is not enslaved to established knowledge by conformity and dogma  

• **Creative memory**  
  Is not a dictionary or a file of information—such a “dictionary” often hinders as much as it helps!  
  Cross indexes and associates; constantly rearranges, prunes, relates, recombines and refines
References


