A Mechanistic Model of English Grammar

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It was by chance that I came to Linguistics. Since adolescence my passion had been the sciences. At school I specialised in Chemistry, Physics and Mathematics, and in 1964, I won the Exhibition Scholarship in Chemistry to Lincoln College, Oxford. I graduated in 1967.

At Oxford, I had been active in the celebrated Oxford Union Dramatic Society (O.U.D.S). I had directed Stravinsky's opera "The Rake's Progress" with professional soloists at the Oxford Playhouse. I had acted in University productions and my performance of Gogol's play for one actor, "The Diary of a Madman," which I performed in a small theatre in Stratford on Avon, was seen by directors of National Education Television in the USA and I was invited to record my performance at their new studios at the University of North Carolina in Chapel Hill.

As a result, after completing postgraduate research on "Free Radicals in Solution" and being awarded my master's degree in Chemistry, I was signed on by The William Morris Agency and became for a while a professional actor. I had moderate success, I spent a year in a leading role in a West End play, I played Richard III at the Lyric Theatre in Belfast, Hamlet at the Marlowe Theatre in Canterbury and my play about Lord Byron, "Natural & Unnatural Acts," was performed at the Folger Library Theatre in Washington DC.

However, in the mid 1970s in search of adventure, I decided to backpack round the world. I caught a ride on an Italian cargo ship to Mexico. I travelled down through through Central America, then Columbia, Venezuela, Brazilian Amazonia, finally arriving in Rio de Janeiro where I had friends with whom I had planned to stay for a few months.

In those days Brazil was virtually "terra incognita." There were no Internet websites and the only source of information was a publication called *The South American Handbook* which, by the time of its yearly publication, was already out of date. Back then, there were few native English speakers in Rio with time on their hands, so friends of my friends asked me to help them with their English.

At first it was easy. My students were at an intermediate or advanced level, so correcting mistakes and making conversation was

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all I had to do. But the moment came when I was asked "When do you use___?" and "Why do you say___?" And I had no idea! So, I bought and memorised Macmillan's *Practical English Grammar*, and from then on, I could at least parrot back examples and exceptions.

By this time I had decided to stay in Brazil. Teaching English was a new challenge. There were so many different approaches and each one with its passionate advocates. There were those who opposed any kind of translation, those who entirely rejected the use of a student's native language, and those who swore by the "Army Method" in which a student had to adjust a given statement to fit new prompts given by the teacher (Student: Mary likes music. Prompt: The children. Student: The children like music). But what was the science behind these ideologies?

Linguistics was then an entirely new world for me. Back when I was at Oxford, Linguistics was not categorised as a "Science"; being largely concerned with meaning it was considered a branch of Literary Criticism and thus fell into the category of The Humanities.

Luckily, however, there was a superb bookstore in Rio. So I began to study linguistics. I was fascinated by the work of Benjamin Lee Whorf—a Chemist like me—and particularly his analysis of Hopi verbs. I decided that eventually I would do a similar analysis of English verbs. I read books about Transformational Grammar but couldn't see how there could be any theories of "language universals" when the data encoded in the grammatical items of each and every language was unknown. I was impressed by the common sense of Dwight Bolinger's *Form and Meaning*. I read Shannon's *The Mathematical Theory of Communication* and wished that, when studying thermodynamics at Oxford I'd known that all those equations could be applied to information.

However, soon after I had begun teaching, I had my own questions about English grammar, for instance:

- Why can we say: It is fallen, It is falling, It has fallen, but not *It has falling? In other words, why can't HAVE operate on the ING participle?
- Why is the past tense, as in "He won the lottery last week' also used for hypothetical events in any time, e.g., "If he won the lottery next week, he would leave"?
- Why does CAN have a past tense in COULD but MUST has no past tense? Why do we need to say "He had to do it yesterday" and not "He*musted do it yesterday"?

There were no answers in either "Traditional Grammar" or in "Transformational Grammar." Traditional grammar talked, not about mechanism and data, but about meanings (which are, of course, subjective—and therefore cannot provide objective data about structure). Indeed, the monumental *A Comprehensive Grammar of the English Language* (Quirk et al. 1985) is more like a catalogue than an explanation.

Transformational Grammar also gave no answers and, moreover, it appears to have made no contribution to language teaching at all. Furthermore, it seemed to rely heavily on rules—as if rules were an explanation. A rule, of course, is no more than a statement of what normally happens, not why it happens. Indeed, a rule could only be an explanation if there were a team of invisible pink fairies grasping the rule book in one hand and marshalling the right words into the right order with the other.

I therefore began my own analysis of English grammar, attempting to reveal the exact data carried by the grammatical items of English and to understand the underlying mechanisms which control their use. My first paper on the subject, "A Mechanistic Model for the English Verb" was published by *Linguistic Analysis* in 1988.

1. Notational Systems

I began by recognising that English is a notating system just like the notating system of Mathematical Physics, and that, for instance, Einstein's description of energy, $E = mc^2$, and William Blake's description of energy "Energy is eternal delight" are constructed in the same way by using symbols or signs to stand for entities in the real world and for the relationships between them.

In Blake's description, the symbols or signs stand for the entities, *energy*, *eternity* and *delight*; while the relationships between them are given by the copula IS and by the adjectival relation (i.e., is a property of). In Einstein's description, the symbols or signs stand for the entities *energy*, (E), *mass*, (m), and *the speed of light*, (c), and the relationships between them are given by equals, multiplied by, and squared.

However, while the data carried by the mathematical symbols is known, the data encoded in the English symbols—the prepositions, participles, modals and tenses—is not. The code therefore needed to be broken.

2. Breaking the Code

Breaking the coded required recognising that in a coherent notating system the symbols on paper must behave in exactly the same way as the entities and relationships they stand for behave in reality. For instance, a symmetric relationship on paper represents a symmetric relationship in reality.

And while this might seem obvious to anyone who, every day, was writing and interpreting formulae for Physical phenomena, it is the failure to note this simple fact that has led to some of the worst errors in traditional grammar. Indeed, later in this introduction I will show how preposition AT has been, and still is, wrongly defined in Traditional Grammar and in teaching materials.

To break the code therefore, the symmetry and temporal validity of each grammatical element had first be determined before being matched against the reality it represents.

This done, it became apparent that the operations and relationships of English have exact parallels in mathematical physics, thus enabling the data they carry to be given a precise mathematical formulation.

3. Time in English and Mathematics

However, although the Notating Systems of English and mathematical physics are essentially similar, they differ significantly in their representation of TIME. In Mathematics, time is frozen, it is static; it is symmetric and can be reversed. Thus, the mathematician can go from past to future, or from future to past by a simple change of sign. In other words, Mathematics puts the describer outside the one-way flow of time. English, however, puts the describer within it. Accordingly, any grammatical item in English which encodes change with time cannot be reversed since reversing it would send time backwards.

Thus, for instance, because of their different time models, the static-time copula, '=', of Mathematics is symmetric and can be read left to right or right to left, as $E = mc^2$ and $mc^2 = E$, whereas the copula IS of English which, like all verbs encodes the passage of asymmetric time, cannot be reversed. Hence, potatoes are vegetables does not mean vegetables are potatoes.

Indeed, it is found that the flowing-time model of English accounts for all the asymmetries in the language. For instance, it accounts for the asymmetry of preposition AT (i.e., a man at a bus stop ≠ *a bus stop at a man), the asymmetry of preposition BY (i.e., An announcement by midday ≠ *midday by an announcement), the asymmetry of the ING participle (e.g., He has shot, He is shot, He is shooting, but not *He has shooting). And as shown in "Symmetries and the Representation of Time" (pp 23-52) it also determines the orthogonal configuration of the tense system.

4. Temporal Validities

It is further seen that two contrasting temporal validities underpin the English language: THE INSTANT—which governs the Noun Phrase, and THE INFINITE—which governs the Verb Phrase.

As explained in "A Mechanistic Model"(*Linguistic Analysis* 18 1-2, 1988 p.18), it is these contrasting validities that determine our ability to say "A snapshot of an apple falling" but not *"A snapshot of an apple falls"; and "In this film, an apple falls" but not *"In this film an apple falling." In my articles I have shown how depiction by snapshots, films, or dioramas becomes a powerful analytic tool—as can be seen in "Verb BE and the Anomalies of the Passive Transformation" (pp 53-70).

Further, it was noted that this distinction between the instant and the infinite is the same singular vs. plural distinction which underpins the whole language and defines not only entities (a book vs. books), but also space (point vs. line) and time (the instant vs. eternity—which is an open plurality of instants).

With these features of the language established, the grammatical items of English could then be analysed. I begin here with a brief analysis of the noun phrase, the participles and the prepositions.

5. The Prepositions

To understand the system of prepositions, the fundamental prepositions of space are first identified. It is shown that according to the language, if, at some instant, two real 3D entities, say, a fly and an ice cube, can be perceived together, their spatial relationship is given

by BY, ON or IN. That is, the fly must be BY the ice cube, ON the ice cube or IN the ice cube. (The system is illustrated in Fig. 1.)

Fig. 1

However, the grammar of these prepositions can be understood only when it is recognised that the language treats the "BY, ON, IN" system, not as three discrete states, but as three stages of a continuum, BY→ON→IN.

5.1 Preposiotion IN

Preposition IN marks the last state of the continuum. It is the moment the surface is penetrated.

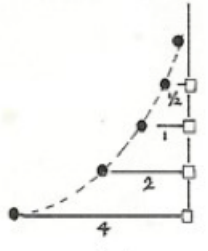
5.2 Preposition ON

Preposition ON defines contact. Contact however is symmetric, for instance, if "*a*" is in contact with "*b*" then "*b*" is in contact with "*a*." However, preposition ON is asymmetric (*a fly on a ceiling ≠ a ceiling on a fly*). So how does ON become asymmetric?

It becomes asymmetric because of its position in the continuum, BY→ON→IN, that is to say, it is [→ON]. And this requires the focus (*the fly*) to be the entity that approaches the reference (*the ceiling*). Hence flies are found on ceilings more often than ceilings on flies. Traditional Grammars fails to see how the language treats the fundamental spatial prepositions as a continuum. Consequently they are frequently wrong. For instance, according to *A Comprehensive Grammar* (Quirk et al p. 677), the fact that Humpty Dumpty sat ON a wall is a question of the "contiguity between a smaller and a larger object" (i.e., the smaller on the larger). Thus, the authors fail to note that, were the wall to collapse, the larger wall would be on the smaller Humpty Dumpty.

5.3 Preposition BY

In the continuum model (BY→ON→IN), "*a*-BY-*b*" ceases to be BY when "*a*" makes contact with "*b*" and becomes "*a*-ON-*b*." Thus, when describing two static points in space, as in "a man by a bus stop," BY is symmetric, [•↔•]. However, as explained in "Symmetries and Representations of Time" (pp 23-52) since time is asymmetric [•→•], when describing an approach in time, BY encodes an exponential approach to a limit (as illustrated in Fig. 2). And this is asymmetric . Hence "An announcement by midday ≠ Midday by an announcement."



An exponential approach curve

Fig. 2

In "Symmetries", it is further shown how asymmetric, exponential BY becomes the logical agent marker in English (e.g., a novel by Dickens ≠ Dickens by a novel).

Although, to a non-scientist, the idea of an exponential approach as an element of English grammar might seem incongruous, it is a pervasive feature of our world. It is the way the sound of a bell fades with time, the way we see railway lines converging as they stretch ahead of us, and it is the way we see the size of a vehicle departing into the distance. It is built into our sensibilities and our perception of the world. Moreover, as my research shows, an exponential approach to infinity defines the structure of all tensed verbs, while an exponential approach to the infinitesimal defines the temporal validity of the noun phrase and the prepositions.

5.4 Preposition AT (wrongly defined in Traditional Grammar).

Before discussing preposition AT, a serious error in Traditional Grammar needs to be named and shamed. According to Traditional Grammars (and here I use Quirk et al. 1985 p. 673, as an example), the fundamental prepositions of space are given not as "BY, ON, IN" but as "AT, ON, IN", and the system is presented as (a) in Fig. 3.

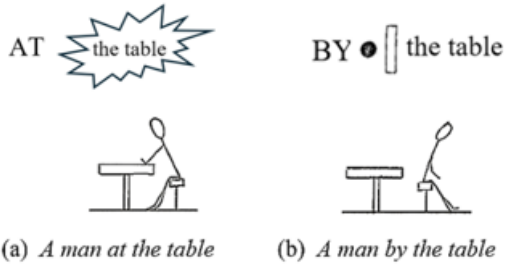
Fig. 3

Thus Quirk, along with all other Traditional Grammars, defines "a-AT-b" as the symmetric relationship between the ball and the cross shown in Fig. 3 (b).

But AT is not a symmetric relationship: *A man at a bus stop* is not **A bus stop at a man*, and *A meeting at midday* is not **Midday at a meeting*. The AT relationship, therefore, is asymmetric. And since English is a coherent notating system in which a symmetric relation on paper stands for a symmetric relation in reality, the symmetric spatial relationship between the ball and the cross in Fig. 3 (b) above cannot be given by the asymmetric relationship AT. This symmetric spatial relationship is correctly given as BY, i.e., *The man is by the bus stop* and *The bus stop is by the man*.

6. A Functioning Relationship

What "a-AT-b" defines is not a spatial relationship but a relationship in which the reference "a" functions in some way for the focus "b." Thus, in the case of the man and the bus stop, the bus stop is functioning for the man (it is stopping buses for him) but the man is not functioning for the bus stop. Similarly, as Fig. 4 (a) illustrates, the man is "AT the table" because the table is functioning—it is actively supporting his lunch plate or laptop, but swivel him round on his stool so that the table becomes a mere landmark and he would be described as "BY the table" (This is analysed fully in "Symmetries.")



(a) *A man at the table* (b) *A man by the table*

FIG. 4

This error is highlighted because, for the ESL student it creates serious learning problems. English prepositions are difficult enough without the student being fed information which is patently false. However, while this error has appeared in English grammar books for decades and continues to be propagated by the multitude of Internet teaching sites, in *A Comprehensive Grammar*, the authors, Quirk et al., compound their incorrect AT-ON-IN system by claiming that:

> When we use a preposition to indicate space, we do so in relation to the dimensional properties, whether subjectively or objectively conceived, of the location concerned.

And they further explain that in *My car is at the cottage*, AT treats the cottage as zero-dimensional, and that in *There is a new roof on the cottage*, ON treats the cottage as two-dimensional.

This explanation, however, is pseudo-scientific nonsense for nothing in our real world is zero dimensional or even two dimensional. Zero-dimensional entities are not only non-existent but unimaginable, and two-dimensional entities exist only as images on the surface of some three-dimensional screen or object. Indeed to say that *in a car at the cottage*, preposition AT treats the cottage as dimensionless is like saying that *in a big cottage, BIG treats the cottage as colourless*.

7. Preposition AT and Participle ING

Returning to preposition AT, since in "a-AT-b," the reference is functioning, it is active, albeit virtually. And this means that it carries the data $\delta p/\delta t > 0$ where "p" is a defining property of the reference. It is then noted that preposition AT and participle ING carry exactly

the same data which is why, for example, at play is equivalent to playing, and at rest to resting.

$$\textit{At play} = \quad [\delta p/\delta t > 0 + \text{PLAY}]$$

$$\textit{Playing} = \quad [\text{PLAY} + \delta p/\delta t > 0].$$

Fig. 5

It should be noted here that a vanishingly small, virtual change, 'δp/δt', also defines the mechanism of Verb BE. This is analysed in "Verb BE and the Anomalies of the Passive Voice" (pp 53-70).

8. The Tenses

Since contradictory information is disallowed in a coherent notating system, to avoid contradictions with time adverbials in statements such as *Yesterday* (past), *up comes John* (non-past), the data that distinguishes the tenses cannot be non-past vs. past time. As demonstrated in "Symmetries," the data carried by the tenses is not about time but about completion, it is "event not completed" vs. "event completed" which, in a continuously flowing time model, is objective, time independent, and defined by discontinuity.

8.1 Temporal Validity of the Tenses

Since it is possible to say "The universe expanded from the beginning of time until now" or "The universe expands until the end of time,"each tense has an infinite validity which is achieved by treating the event's evolution as an exponential approach to completion. For the past tense, the event's evolution has arrived at completion from an ever-receding initial state (0%) in the infinite past. For the non-past tense, the evolution is forever approaching completion (100%) in the infinite future.

Fig. 6

And since the perceived size of an object varies as the tangent of the angle it subtends at the eye, the approach of the non-past tense to its present completion, or the tail back of the past tense to its past initiation, exactly matches the way, say, a truck is perceived as it approaches or recedes from the observer. This is illustrated in Fig. 7

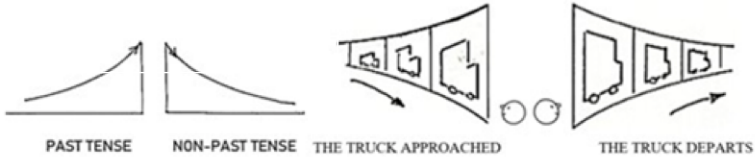


Fig. 7

And once more in this research it becomes apparent that the English language model of reality not only matches the mathematical model but also mimics the way reality is perceived.

9. Configuration of the Tenses

Since an event passes smoothly from non-past time to past time in reality, it must pass smoothly from the non-past tense to the past tense in its configuration, a condition requiring symmetry at the ING | EN crossover (i.e., the interface between the tenses) In "Symmetries," it is shown that this can only be achieved by adopting a rectangular hyperbolic configuration, as shown in Fig. 8.

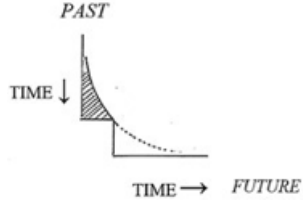


Fig. 8

In this configuration, the past-time X-axis is swivelled through 90° to become an orthogonal, imaginary-time Y-axis, just as in Mathematics, multiplication by $\sqrt{-1}$ swivels a real X-axis through 90° to become an "imaginary Y-axis." Now since the Y-axis in English is at

the same time both a past-time axis and an imaginary or mind-time axis, the past-tense can describe both real events in past time (*It fell yesterday*) and imaginary events in any time (*If it fell tomorrow*).

Again, it is noted that both the orthogonal representation of past time in English and imagined time in Mathematics match the way events are perceived and recorded in our minds (as illustrated in Fig. 9).

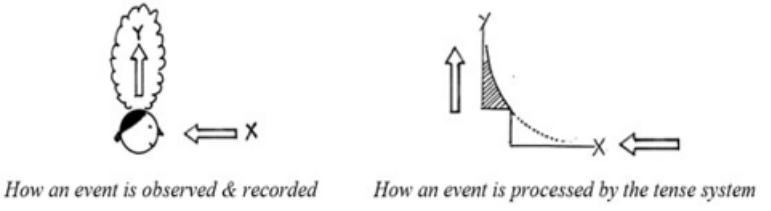


Fig. 9

10. The Transitive Event

In "Symmetries," it is shown that as each instant of a transitive event crosses the interface from ING to EN, the rectangular-hyperbolic configuration turns it upside down and inverts it left-right, as shown in Fig. 10 (a), before it is recorded orthogonally on the imaginary time Y-axis, as in Fig. 10 (b). An inversion and rotation which exactly matches the way an image is transformed when passing through the lens of a camera or the human eye before being recorded vertically out of real time. It is then noted that, according to the language, the present instant becomes an event, as illustrated in Fig. 10 (c).

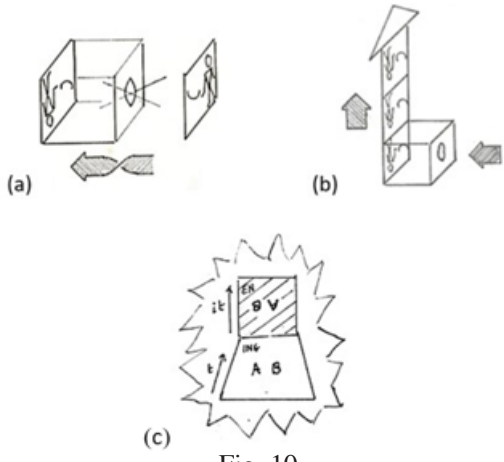


Fig. 10

Furthermore, as each instant of the event crosses the interface it does not change in itself, i.e., each element on the ING-side becomes an identical element on the EN-side. What does change is the axial system describing it. That is, at the present instant, the time-axis becomes the property-axis, and the property-axis becomes the time-axis.

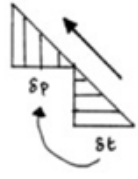


Fig. 11

Thus, according to the language, at the present instant, time is experienced as a change in some property, and a change in property is experienced as the passage of time. Once again, the mechanism of the language matches our experience of the world.

11. Verb BE

The verb BE is nothing more than a descriptive device. In analogous terms it works like this: A present describer takes a Noun Phrase, e.g., *a lamp on a table* and selects an element of it, e.g., *a lamp*.

The describer then displaces this element as if on elastic; with the "stretched elastic" affirming that the subject belongs back in the noun phrase as illustrated in Fig. 12 (a). By treating this virtual displacement as vanishingly small, and by allowing the subject to return to its original position exponentially, IS or WAS establishes the truth of the original Noun Phrase over time, as illustrated in Fig. 12 (b). Verb BE is analysed in detail in "Verb BE and the Anomalies of the Passive Transformation" (pp 53-70).

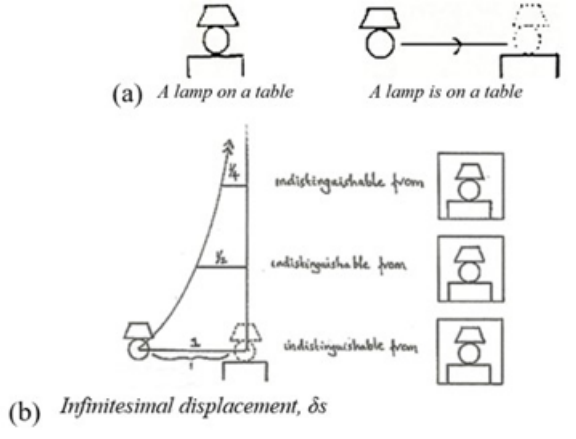


Fig. 12

And again we note the equivalence between an operation in English and an operation in Mathematics. For, the use of virtual displacement to turn a static into a dynamic was known to Greek mathematicians as "The Law of the Lever," and in modern times was given precise definition by Bernoulli in 1715.

12. Language Models

In the afterword to "A Mechanistic Model of the English Language" (cf. *Linguistic Analysis*, 18 1-2, 1988 p.55), I briefly discussed my own and other language models from the point of view of mechanism, I wrote:

> The expressions (1) *Jim is drawing a circle*, and (2) *A circle has been drawn by Jim*, both label the same event but from

different points of view in time and space. Now, extracting the constant, DRAW, from each and writing them symbolically as (1) "J is (-)ing C" and (2) "C has been (-)en by J" shows us that both expressions define relationships between the same two elements, J and C. And we can further reduce these to (1) "J R_1 C" and (2) "J R_2 C" where R_2 is an inverse relation.

We now look at three possible models and ask:

(Model 1). Are R_1 and R_2 merely different labels on which essentially meaningless symbols (ING, EN, IS, HAS, BEEN and BY) are arbitrarily arranged to tag two different situations? Just as we might arbitrarily label one car by a registration GVF and another by AVG. If so, then the way the symbols are selected and rearranged in going from R_1 (is drawing) to R_2 (has been drawn by) tells us nothing about either the structure of the reality labelled, or about the structure of the mental processes involved in the selection of the labels. In such a case, it would be merely accidental that we say: *A circle has been drawn by Jim*, and not **Jim being has drawing of a circle been*. Clearly this model can be rejected.

(Model 2). Are the symbols written on these labels selected and arranged strictly in accordance with a set of rules preprogrammed into the human brain? If so, then the selection and rearrangement of symbols in going from R_1 to R_2 might be telling us something about the structure of the users' mental processes. Indeed, if we could manage to construct an entire system of rules that puts the right symbols in the right places on all occasions, then we might have learnt something significant about the circuitry in that bit of the cerebral cortex which deals with language and is unique to Man. I say "might," because it is possible that we would have constructed nothing more than a language orrery which puts words in the right places at the right time, but whose mechanism has nothing in common with the system it seeks to imitate (as the clockwork of the celestial orrery has nothing in common with the mechanism of celestial motions).

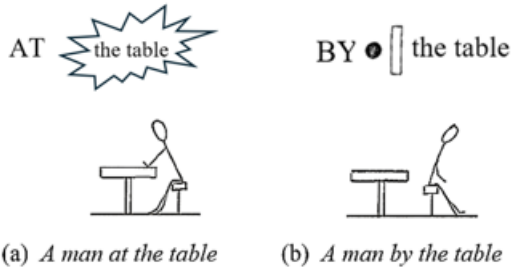
(Model 3). Do the symbols on the labels stand for operations, operations taken from a system of operations? A system that has internal cohesion and coherence as, for example, the operations multiplied by, divided by, squared, square root of, cosine, and log, form part of an internally coherent and consistent system of operations in the language of mathematics. Do the ENs, INGs, BYs, BEENs and HAVEs of the English notating system allow us to go from one point of view to another (and back again), from "Jim is drawing a circle" to "A circle has been drawn by Jim," and from "A cake has been eaten by Jane," to "Jane is eating a cake," in the same way as the operations of Mathematics let us go from the point of view of x in "$x = z^2/k$" to the point of view of z in "$z = \sqrt{kx}$", and back again?

And further, when we apply these operations to a description of reality as seen from one point of view and then let the system generate the description as it would be seen from another, is the new description consistent with our experience? Do the pictures generated by the operations tally with the way we actually perceive the world?

Back in 1988, my answer was "Yes," and, after forty years of research, it continues to be "Yes."

13. Teaching English

While seeking knowledge for its own sake is laudable, as I search through the vast Linguistic literature, I find that little of the Linguistic research reported in the literature actually helps in any practical way in the classroom. It does not, for example, answer any of the "WHY questions" I posed at the start of this introduction. Accordingly, having first revealed the exact data carried by the grammatical items of English, I have developed a way of applying this information to help the ESL student master the grammar. In this method (tried and tested with my students), diagrams, drawings, and icons (which depict as far as possible the data the grammatical item stands for) are used to visualize the "rules" of Traditional Grammar. These rules—which until now a student has had to memorize without understanding—are replaced by "visualizations" of the Grammar as, for example, in Fig. 13 below, where the active, functioning reference defined by AT is shown within "a flash" while a simple proximity icon "visualises" preposition BY.



(a) *A man at the table* (b) *A man by the table*

Fig. 13

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