1 Intellectual Autobiography

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I did an undergraduate major in mathematics at Yeshiva College and went on to do graduate studies in philosophy at Columbia University in the 1950s. There I found that classical philosophical problems were studied as intellectual history and not as problems to be solved. That was disappointing but did not strike me as unreasonable; it seemed to me that tackling something like "the problem of free will" or "the problem of knowledge" could take up one's whole life and yield little of permanent value. I duly did a dissertation on Whitehead's process philosophy and was offered a teaching position at Columbia College. Thereafter I was free to do philosophical research of my own choosing. My instinct was to avoid the seductive, deep problems and to focus on finite projects that looked amenable to solution.

Looking back to discern some special thematic interest that may be said to characterize much of my philosophical activity, I find I was usually drawn to look for ways to explain one or another aspect of our cognitive competence. I once saw a father warn an eight-year-old boy who was approaching an aloof and unwelcoming dog not to pet him, by saying 'Not all dogs are friendly'. The boy, who did hold back, responded with 'Some dogs are unfriendly; don't you think I *know* that?' I admired how adeptly the boy had moved from 'Not all dogs are friendly' to its affirmative obverse, 'Some dogs are unfriendly'. I remember thinking that the boy certainly did not make this move by somehow translating 'Not all dogs are friendly' as something like 'Not: for every *x*, if *x* is a dog then *x* is friendly' and then, by (unconsciously) applying laws of "quantifier interchange" and some laws of propositional logic, quickly get to 'There is an *x* such that *x* is a dog and not: *x* is friendly'. I wondered how the boy actually did it. We are, generally, intuitively prompt and sure in most of our common everyday logical judgments, all of which are effected with sentences of our native language. Consider that the average, logically untutored person instantaneously recognizes inconsistency in a pair of sentences like (A) and (B):

(A) Every colt is a horse.

(B) Some owner of a colt isn't an owner of a horse.

Modern predicate logic (MPL) takes pride in its ability formally to justify such judgments—something that the older logic of terms was unable to do. But MPL's methods of justification, which involve translations into an artificial quantificational idiom, offer no clues to how the average person, knowing no logic and adhering to the vernacular, is so logically adept.

It later occurred to me that Frege's disdain of natural language as a vehicle for logical reckoning had served a strategic defensive purpose: if logic does not aim to explain how we actually think and reason with sentences of natural language—if, therefore, it is misleadingly characterized as a science that provides us with the "laws of thought"—its obvious inability to illuminate everyday deductive competence will not be deemed a defect. According to Michael Dummett, Frege's invention of the quantifier/variable notation for solving the problem of multiple generality more than compensates for the bad fit of his logical language to the language in which we actually reason. "Frege . . . had solved the problem which had baffled logicians for millennia by ignoring natural language."[1] Frege's disregard of natural language was not universally praised.[2] I would later join in dissent. But in the late 1950s I was still in thrall to the Frege–Russell–Quine way of doing logic, and it did not then occur to me to look for a cognitively adequate alternative.

The Category Tree

My first attempt at illuminating a common area of cognitive competence was not concerned with our deductive abilities but with our ability to avoid grammatical nonsense of the kind known as category mistakes, a term made popular by Gilbert Ryle. I was then studying Ryle's scintillating book, *The Concept of Mind*, and it struck me that we are leading charmed conceptual lives. Sentences like 'Saturday is in bed' and 'Some prime numbers are unmarried' are easily formed, but we never actually make the mistake of using them. Indeed, the overwhelming majority of grammatical sentences are category mistakes; this was actually established by computer programs at MIT that fed random vocabulary to a computer capable of forming simple grammatical sentences, generating far more sentences like 'The accident rejected the invitation' than sentences like 'Jane rejected the invitation'. How do we avoid them? It seemed plausible to me that we must be using some strategy to stay on the straight and narrow path of category correctness. I wrote to Quine about my idea of looking for constraints on categorial predicability, and he replied that he too had tried to construct a theory of predicability and categories but had given up on it. He nevertheless approved of my efforts and encouraged them. It was, he said, the kind of problem one could "get on with."

My search was complicated by the fact that a term like 'rational' seemed equivocally predicable of things like people and numbers (for we cannot say of this person that he is more rational than that number) whereas terms like 'interesting' are univocally predicable of things in different categories (we can say that flirting with women is more interesting to Tom than mathematics). After some months of speculation and intensive trial and error, I came to see that we organize our concepts for predicability on a hierarchical tree. At the top of the tree are terms like 'interesting', 'exists', and 'talked about', which are univocally predicable of anything whatever. At the bottom are names of things we talk about. And in between, going down the hierarchal tree, are predicates like 'colored', 'factorable by 3', and 'learned' that are predicable of some things but not of others.

Aristotle had already pointed out that terms are hierarchically ordered for predicability so that some pairs (e.g., {log, white}) are naturally predicable in only one direction ('Some log is white' is a natural predication but its logical equivalent, 'Some white thing is a log', is unnatural or *accidental*). Other term pairs are reciprocally predicable, for example, {Greek, philosopher}. Still others are mutually impredicable {philosopher, factorable by 3}. Aristotle's criterion for being naturally predicable in only one direction seems to be:

If *B* and *C* are mutually impredicable, and *A* is predicable of both, then *A* is naturally predicable of *B* and *C* and *B* and *C* are not naturally predicable of *A*.

For example, 'white' is naturally predicable of the mutually impredicable terms 'log' and 'sky', so both 'Some white thing is a log' and 'Some white thing is the sky' are unnatural or accidental predications. Looking for a category structure, I applied the Aristotelian criterion for natural predicability. Once we have a term like 'white' that is univocally predicable of mutually impredicable terms like 'sky' and 'rational', thereby establishing that 'white' is higher than 'rational', it will not be possible to find a term like 'prime number' of which 'rational' is predicable in the sense we use it in 'rational white man'. 'Rational' has two locations on the category tree, one predicable of men (who may be white), another predicable of numbers, which may be prime but cannot be white.

Hierarchical trees have apexes and consist of one or more "$\wedge$" structures. Between any two nodes on a tree structure there is only one possible path. On a hierarchical tree, a higher term is naturally predicable of a lower term and two terms are mutually impredicable when they are connected by a path that goes both up and down. For example, to get from 'even number' to 'explosion' one may go up from 'even number' to 'interesting' and down to 'explosion' in a $\wedge$ path. Most term pairs on a large language tree are thus mutually impredicable.

If a term (e.g., 'colored') is at a node on the tree, so is its contrary ('colorless'). The disjunctive term 'colored-or-colorless' (which I represent as '/colored/') "spans" (is truly predicable of) all things that have or fail to have some color or other, including the 'color' we call 'colorless'. Being /colored/—having Kolor (as I called it)—is an ontological attribute that raindrops and the American flag possess but things like numbers, skills, and accidents do not possess. A raindrop is colorless but a skill is neither colored nor colorless; it has no Kolor. Nor is it Kolorless. It's not as though it fails to be /colored/; there is just no procedure for testing whether a skill is orange or colorless, and so on. Nor is there any conceivable way to transform a skill into something that has Kolor. In general, if '/T/' is a category term spanning things that are or fail to be T, then /T/ *has no contrary*. Whatever has /T/ness possesses it essentially; whatever does *not* have /T/ness does not lack it. Nothing is privative with respect to a category attribute.

I used the fact that category terms have no contraries for another proof that the category structure must be a hierarchical tree. We may take it as a logical truism that if some *A* is *B* then either every *A* is *B* or some *A* is un-*B* or every *B* is *A* or some *B* is un-*A*. But where *A* and *B* are category terms, the second and fourth disjuncts are false. We are then left with the following law governing category terms:

If some /X/ is /Y/ then either every /X/ is /Y/ or every /Y/ is /X/.

This *law of category inclusion* determines that terms are distributed on a hierarchical tree for the purposes of categorially correct predication. For example, since some /red/ things /weigh five pounds/ it will either be true that all /red/ things /weigh five pounds/ or true that all things that /weigh five pounds/ are /red/. Since something like a red sky or a glow does not /weigh five pounds/ it is not true that all /red/ things /weigh five pounds/. It follows that all things that /weigh five pounds/ are /red/ so that 'red' is higher on the tree than 'weighs'.

Ontological Individuals

Ryle's book was critical of Descartes's view that a person is an ontological composite, consisting of a mind and a body. Many common things are ontological composites. We observe objects and we observe events. When we observe a flash of lightning at midnight, what we observe is not an ontological individual but an ontological composite consisting of an event (the electrical discharge) and the blue streak produced by it. We speak of Italy as a sunny democratic country but it is the Italian peninsula that is sunny and the Italian society that is democratic; Italy itself, as a society *cum* peninsula, is ontologically composite. Think of the M-shaped figure /\/\ as a figure obtained by joining two little trees. The term 'Italy' is at the middle node at the bottom. One side predicates 'sunny' of 'peninsula' and 'Italy', while the other predicates 'democratic' of 'Italy' and 'the Labor Party'. Peninsulas are /sunny/ but not /democratic/; The Labour Party is /democratic/ but not /sunny/. There are no M shapes on the category tree. In general, there can be no three individuals, a, b, and c, and two predicates, P and Q, such that P is predicable of a and b but not of c and Q is predicable of b and c but not of a. And when we find such a configuration in natural discourse, we must either deny that b is an ontological individual or deny that P and Q are univocally predicated. In the case of sunny democratic Italy, we maintain univocity and split the figure at the bottom, recognizing that Italy is a heterotypical entity, that is to say, a category composite—a peninsula-*cum*-society—composed of entities of different types.

The Cartesian argument for psychophysical dualism uses the very same reasoning, based on the notion of a psychophysical composite rather than a sociophysical composite as in the case of countries. Assume, says the Cartesian, that a human being is an ontological individual and not a composite. Our ontology would then contain things like pure egos that /think/ but are not /tall/. It would contain things like iron gates that are /tall/ but do not /think/. And it would contain persons like Descartes himself who is /tall/ and who also /thinks/. But this would violate the law of category inclusion. Since no individual can be both /six feet tall/ and /think/, Descartes must be a category composite, consisting of a thinking substance and an extended substance.[3]

More often than not, an inadmissible configuration (one that does not fit on the category tree) serves to show that some term is equivocal. Thus Aristotle argued that 'sharp' has different senses when said of a musical note and of a knife. Skies are /gray/ but not /sharp/. Knives are /sharp/ and /gray/. Thus 'gray' is higher than 'sharp' on the category tree. Musical notes are not /gray/. So when we speak of notes as sharp, we immediately realize that we are using a sense of 'sharp' in a location on the tree that is not the same as the one we use in describing knives. A similar example is the equivocation of 'tall' when said of stories. Skies are /gray/ but not /tall/. Buildings are /tall/ and /gray/. Thus 'gray' is higher on the tree than 'tall'. Our concept of a story is not that of something /gray/. Coming across 'tall stories', we immediately recognize that this use of 'tall' is not the one in which whatever is /tall/ is /gray/.

I harvested a number of philosophical fruits of the category tree in the early 1960s. For example, I realized that category attributes like Kolor, Texture (being smooth like some stones or rough like others), and Shape (having an identifiable shape like a person or a square or being shapeless like a jellyfish or a cloud of dust)—attributes with respect to which nothing is privative—stand in the way of successfully performing the empiricist thought experiment in which we are asked to conceptually strip an object like an apple of its attributes. This we do until we are left with 'something I know not what'—a featureless substratum that empiricists and transcendental philosophers arrived at but that idealists were soon happy to remove altogether. The stripping fails because, while we can think away its redness or smoothness, we cannot coherently think away the apple's Kolor, its Texture, or any other of its ontological attributes, since such attributes "have no contrary." Since I was by temperament a realist, this Aristotelian insight was congenial to me.

Each age has its characteristic trees. Sometimes entities that do not easily fit onto the "ordinary language tree" are introduced into the ontology. 'God' creates problems when theologians insist that terms like 'merciful' and 'just' cannot have their ordinary sense when said of 'God'. This leads some to negative theology. Sometimes empirical science calls for revolutionary reconfigurations. Early in the twentieth century the newly minted notion of electrons presented difficulties directly related to the tree requirement for conceptual coherence. Electrons were an anomaly because they had features that normally applied to events and other features that normally applied to physical objects. This initially led some physicists to talk of 'wavicles' or 'event-particles', a composite category. This dualist conception of electrons was not acceptable to physicists; on the other hand, neither was it acceptable to postulate different concepts of frequency when talking of waves and electrons or different concepts of mass when talking of stars and electrons. The solution adopted by some philosophers calls for a revolutionary conceptual shift that reconstrues all physical objects as a subcategory of events. It became acceptable to affirm event predicates of physical objects. Nelson Goodman speaks somewhere of a table as a 'monotonous event'. Alfred North Whitehead built his process philosophy on this new way of talking about physical objects, calling them 'actual occasions'. The avoidance of ontological dualism for elementary particles has led to radical relocations of fundamental categories that have yet to be assimilated.

Sometimes social developments cause us to reconfigure our ontology. Since the invention of corporations as economic institutions, we are able to say of a fence and of a person that it is tall and of a person and of a corporation that it owes money. Here we face the prospect of regarding persons as an ontologically composite category, having a corporate as a well as a physical individuality (persons as fictional corporations).

In general, the tree structure provides a kind of pure cartography we can use to chart conceptual differences between contemporaneous cultures or, historically, for mapping conceptual changes over time. The category tree structure has yet to be systematically applied in doing conceptual history or comparative philosophy. Even individual persons change conceptually as they mature. As children our concept of the sky is such that we well understand Chicken Little's alarm that it is in danger of falling. As adults we find the idea of a sky falling to be a category mistake. The cognitive psychologist Frank Keil appears to have successfully applied category tree theory in his studies of the conceptual development of children.

Logic as "How We Think"

In the mid-1960s I turned to the problem of our deductive competence. How, for example, do ten-year-olds, innocent of "logic," recognize the logical equivalence of 'No archer will hit every target' and 'Every archer will miss some target'? What makes everyone instantly certain that (A) 'Every colt is a horse' and (B) 'Someone who owns a colt doesn't own a horse' are jointly inconsistent?

Modern predicate logic (MPL) formally justifies such common, intuitive logical judgments, but its justifications do not explain how we make them. In proving that (A) and (B) are inconsistent—something traditional term logic had not been able to do—MPL uses its canonical idioms of function and argument, quantifiers and bound variables, to translate (A) and (B) respectively as:

(A*) For every thing *x*, if *x* is a colt then *x* is a horse.

(B*) There are things *x* and *y* such that *y* is a colt and *x* owns *y* and such that for everything *z*, if *z* is a horse then *x* does not own *z*.

and proceeds in about twelve to fifteen carefully chosen steps to derive a contradiction from (A*) and (B*). The syntax of the canonical formulas of MPL is not that of the vernacular sentences in which we actually reason, and MPL's formal justifications of our intuitive deductive judgments cannot serve as accounts of our everyday reasoning. So I confronted the question: What would a cognitively adequate logic—a "laws-of-thought" logic that casts light on what we actually do when we use natural language in thinking deductively—be like?

Unlike MPL such a logic must, as Patrick Suppes points out, be variable-free, its syntax closely conforming to the syntax of the sentences that figure in actual reasoning. Its mode of reasoning must be transparent, since everyday reasoning is virtually instantaneous. In that respect, I realized, it would be very much like elementary algebra. A ninth grader who judges 'No archer will hit every target' to be logically equivalent to 'Every archer will miss some target' does so with the same speed and confidence that he judges '$-(a + b - c)$' to be equal to '$-a - b + c$'. Syntactic naturalness and ease of reckoning are two essential features of a cognitively adequate logic that would cast an explanatory light on the celerity with which we reason with sentences of our natural language. The logical language of a cognitively adequate logic would therefore

(i) not radically depart from the syntax of the sentences we use in everyday reasoning;

(ii) have simple, perspicuous rules of reckoning that are instantly (if unconsciously) applicable (e.g., by older children).

Because modern predicate logic possesses neither of these necessary features, it casts no light on the way we actually reckon. And so, for all its logistical merits for grounding mathematics, I concluded that MPL cannot be regarded as the logic we use in everyday reasoning.

Seeking to learn what makes us deductively so adept, I looked at hundreds of examples of ordinary deductive judgments with special attention to the common logical words that figure in them, in the belief that words like 'not', 'every', and 'some' must somehow be treated by us in ways that make reckoning with them as easy and perspicuous as our reckoning with elementary algebraic expressions.[4] For just as a ten year old moves easily and surely from '–(a + b)' to '–a + (–b)', so she moves from 'No boy is perfect' to 'Every boy is imperfect'.[5]

The solution came to me in Tel Aviv where I was teaching in the spring of 1967. I found to my surprise that the familiar logical words 'some', 'is', 'not', 'and', 'every', and 'if', words that figure constantly in our everyday deductive judgments, behave and are treated by us as plus or minus operators. Specifically:

'Some' ('a'), 'is' ('was', 'are', etc.) and 'and' are plus-words;
'Every' ('all', 'any' . . .), 'not' ('no', 'un-' . . .), and 'if' are minus-words.

The discovery that these key natural language logical constants have a plus/minus character is an empirical one. It involves the claim that the boy who hears his father say 'Not all dogs are friendly' and recognizes it as tantamount to 'Some dogs aren't friendly' is automatically treating his father's sentence as something like:

–(–Dog – Friendly)

and so instantaneously reckoning it equivalent to

+Dog – Friendly.

Two Conceptions of Predication

A standard predication in modern predicate logic consists of a singular noun-phrase subject and a verb-phrase predicate. These two constituents are not syntactically interchangeable. Nor are they mediated by any logical tie. My work in category theory had led me to adopt the classical, terminist view of predication, according to which (i) general as well as singular statements are predications; (ii) the two parties tied in predication are not a noun-phrase subject and a verb-phrase predicate but two syntactically interchangeable terms; and (iii) these constituents are connected by a predicative expression—a term connective—such as 'some . . . is' or 'all . . . are'. Aristotle often preferred to formulate predications by placing the terms at opposite ends of the sentence and joining them by a predicating expression like 'belongs-to-some' or 'belongs-to-every'. Typical examples of terms thus tied in predication are 'Some Athenian is a philosopher' [⇒ Philosopher belongs-to-some Athenian] and 'Socrates is a philosopher' [⇒ Philosopher belongs-to-every Socrates]. We may abbreviate a terminist predication by eliminating the grammatical copula, writing 'Some *S* is *P*' as '*P* some *S*' (in scholastic notation, '*P*i*S*') and 'Every *S* is *P*' as '*P* every *S*' (*P*a*S*). These formulations give 'some' and 'every' pride of place as logical copulas (term connectives).

In formulating inference rules for syllogistic reasoning, Aristotle focused attention on universal propositions of the form '*P* every *S*'. However, he gives 'some' definitional priority over 'every', defining '*P* every *S*' as 'not: non-*P* some *S*':

> We say that one term is predicated of all of another when no examples of the subject can be found of which the other term cannot be asserted.[6]

In effect, '*P* every *S*' [*P*a*S*] is defined as 'Not: non-*P* some *S*' $[-((-P)iS)]$.[7] Defining '*P* every *S*' by taking 'some' and 'not' as the primitive logical constants is strictly analogous to taking 'and' and 'not' as primitive connectives in propositional logic and defining '*q* if *p*' as 'not both not-*q* and *p*'. It is also analogous to taking the binary plus operator and the unary minus operator as primitive algebraic functors and then going on to define a binary subtractive operator:

$$b - a =_{def} -((-b) + a).$$

Representing 'P some S' as 'P + S' and then defining 'P every S' reveals that 'every' is a binary subtractive operator:

$P - S =_{\text{def}} -((-P) + S)$

In principle, '*P*i*S*' or '$P + S$' is the primitive form of terminist predication, '$P - S$' being defined as '$-((-P) + S)$'. In practice, both '*P*i*S*' and '*P*a*S*' may be regarded as the two primary ways of predicating one term of another.[8]

By contrast to MPL's unmediated, nonrelational, asymmetrical version of predication, the mediating expressions in the terminist version are transparently relational. To be sure, the predicative connectives 'some' and 'every' that join the predicate term to the subject term in a monadic proposition are not dyadic relational expressions like 'taller than' or 'sibling of'; they nevertheless function as genuine relations with formal properties like symmetry, transitivity, or reflexivity. Specifically, 'every' is transitive and reflexive but not symmetrical: '*P* every *M* and *M* every *S*' entails '*P* every *S*', and '*S* every *S*' is logically true, but '*P* every *S*' is not equivalent to '*S* every *P*'. 'Some' is symmetrical but is neither transitive nor reflexive: '*P* some *S*' entails '*S* some *P*', but '*P* some *M* and *M* some *S*' does not entail '*P* some *S*', nor is '*S* some *S*' a logical truth.

Regarded algebraically, the symmetry of the I-functor in '*P*i*S*' could just as well be viewed as the commutivity of the plus-functor in '$P + S$'. The general form of categorical propositions in the algebraic version of term functor logic (TFL) is:

$\pm(P \pm S)$

in which the outer sign represents the positive or negative quality of judgment and the inner sign represents the term connectives 'some' (+) or 'every' (–). When two propositions that have the same logical quantity (both being particular or both being universal) are algebraically equal, they are logically equivalent.

In a language like English, the predicating expressions are split in two, the word 'some' or 'all' preceding the subject term and the word 'are' or 'is' preceding the predicate term. That splitting has unfortunately obscured the unitary role of 'some . . . are' and 'all . . . are' as term connectives analogous to unitary propositional connectives like 'both . . . and' and 'if . . . then' in propositional logic. However, we get a more natural, albeit formally less elegant, term functor logic if we directly transcribe 'some *X* is *Y*' as '$+X + Y$', reading the first plus sign as 'some' and the second as 'is'. Similarly, we transcribe 'every *X* is *Y*' as '$-X + Y$'. The general form of categorical statement in TFL is an affirmation or denial that some or every *X* is or isn't *Y*:

yes/no: some/every X/non-X is/isn't Y/non-Y

$\pm \; (\quad \pm \quad \pm X \quad \pm \quad \pm Y)$

Two categoricals are logically equivalent if and only if they are covalent (both being particular or both being universal) and algebraically equal. Valence for categorical propositions is determined by whether the first two signs (the judgment and quantity signs) are the same (yielding a positive valence/particular proposition) or different (yielding a negative valence/universal proposition). A term may be negative (e.g., 'noncitizen'), it may be compound (e.g., 'gentleman and scholar'), it may be relational (e.g., 'taller than every Dane'). Two compound or two relational expressions are logically equivalent if and only if they are covalent as well as equal; but here valence is determined not necessarily by the first two signs but by the overall sign of the term (every term having a positive or negative 'charge'), and the quantity sign within the term.[9]

I was enjoying the fruits of Russell's observation that a good notation is better than a live teacher. The motto of TFL is "transcription, not translation." Of course even transcription requires some "regimentation" of the vernacular. Coming across 'The whale is a mammal' we must rephrase it for algebraic transcription. Regimenting it as 'Every whale is a mammal', we transcribe it as '–W + M'. Regimenting 'Only mammals are whales' as 'No nonmammal is a whale' we may transcribe it as '–(+(–M) + W)' and show it equivalent to '–W + M'. The regimented forms are simple natural language sentences that contain only formatives we can algebraically transcribe.

The plus/minus character of the logical constants extends also to propositional connectives. That 'and' like 'some' is a plus word soon led to me to see that 'if' is a minus word. For we may define '*q* if *p*' as the negation of 'not-*q* and *p*'. Transcribing 'if' as '–' and 'and' as '+':

$q - p =_{\text{def}} -((-q) + p)$

If p then $q =_{\text{def}}$ not both p and not q

$-p + q =_{\text{def}} -(+p + (-q))$

Basic inference patterns like modus ponens, modus tollens, and the hypothetical syllogism are transparent when algebraically represented:

Modus ponens	Modus tollens	Hypothetical syllogism
$-p + q$	$-p + qT$	$-p + q$
$\underline{p}$	$\underline{-q}$	$\underline{-q + r}$
q	$-p$	$-p + r$

Syllogistic Reckoning and Singular Sentences

Term functor logic offers a very simple decision procedure for syllogisms. A classical syllogism has as many (recurrent) terms as it has sentences. Only two kinds of syllogism have valid moods:

(i) syllogisms all of whose sentences are universal; and

(ii) syllogisms that have a particular conclusion and exactly one particular premise.

A syllogism is valid if and only if it has a valid mood and the sum of its premises is equal to its conclusion.

In the logical language of MPL, a singular sentence like 'Socrates is an Athenian' and a general sentence like 'Some philosophers are Athenians' have different logical forms. The syntax of function and argument uses predicate letters and individual symbols (proper names and variables) that play distinct syntactic roles. In terminist logic, term letters, whether general or singular, play the same syntactic roles and may be interchanged. According to Leibniz, 'Socrates is an Athenian' is elliptical for either 'Some Socrates is an Athenian' or 'Every Socrates is an Athenian'. Because 'Socrates' is a uniquely denoting term (UDT), we are free to assign either quantity to 'Socrates is an Athenian'. In general, where '*X**' is a singular term, '*X** is *Y*' has *wild quantity*. Since either quantity may be assigned, ordinary language does not specify a quantity for singular statements.

For logical purposes, however, it is often necessary to assign one or the other quantity. For example, in the inference 'Socrates is an Athenian; therefore no non-Athenian is Socrates', we must assign universal quantity to the premise, thereby regarding the inference as 'Every Socrates* is Athenian; therefore no non-Athenian is Socrates*'. By contrast, in the inference 'Socrates is an Athenian; therefore some Athenian is Socrates', the premise must be particular: 'Some Socrates is an Athenian'. Because singular propositions have wild quantity, term logic can syllogistically derive the conclusion 'Some Athenian is wise' from the two singular premises 'Socrates is wise' and 'Socrates is an Athenian': +S* + W; –S* + A; ∴ + A + W. (The same inference in MPL invokes a special principle, namely existential generalization.)

TFL's singular advantage over MPL is particularly evident in the way the two logics deal with the kind of singular predications we call identities. For the terminist logician an identity is a monadic categorical proposition distinguished from other categoricals only in having uniquely denoting terms in *both* subject and predicate positions. For example, 'Tully is Cicero' is a monadic categorical statement of form 'C*iT*' (+T* + C*) or 'C*aT*' (–T* + C*). In MPL, by contrast, 'Tully is Cicero' is represented as 'I(t,c)' or 'T = C'. Because MPL construes all identities dyadically, its account of inferences involving identity propositions must appeal to special principles, known as laws or axioms of identity, explicitly asserting that the dyadic relation in '$x = y$' possesses the formal properties of symmetry, reflexivity, and transitivity. In term logic these are properties that routinely characterize the predicative relations that mediate the terms of I or A monadic categorical propositions, general as well as singular, nonidentities as well as identities. I-forms are symmetrical, A-forms are reflexive and transitive; because identity statements in TFL involve wild quantity for both terms, they come out reflexive, symmetrical, *and* transitive. Thus term logic has all the inference power it needs for dealing with identity propositions. For example, the indiscernibility of identicals is demonstrated by ordinary syllogistic reasoning. The following argument shows that since Tully is Cicero, whatever is true of Tully (e.g., that he is a senator) is true of Cicero:

Tully is Cicero	Some T* is C*
Tully is *P*	Every T* is *P*
Cicero is *P*.	Some C* is *P*.

Multiply General Sentences

Traditional term logic was inferentially weak in being unable to cope with relational arguments. MPL replaced traditional term logic in the twentieth century because, in Dummett's words, "[i]t stands in contrast to all the great logical systems of the past . . . in being able to give an account of sentences involving multiple generality, an account which depends upon the mechanism of quantifiers and bound variables."[10]

Term functor logic, however, has no problem with multiple generality. Following a suggestion of Leibniz, TFL treats the relational term in 'some boy loves some girl' as a Janus-faced expression '${}_1L_2$' that turns one face to 'some boy' as 'lover' and the other to 'some girl' as 'loved'. According to Leibniz, such a sentence contains 'some boy loves' and 'some girl is loved' as subsentences. One may transcribe the sentence as '$+B_1 + L_{12} + G_2$', which indeed entails '$+B_1 + L_{12}$' (some boy loves) and '$+G_2 + L_{12}$' (some girl is loved).[11] Note that the common numerical index shows how terms are paired for predication. Thus 'Paris$_1$ is a lover$_1$' and 'Helen$_2$ is loved$_2$' are two subsentences of 'Paris loves Helen' (⇒'$P^*_1 + L_{12} + H^*_2$'). Terms that have no index in common cannot properly be paired. Thus 'P_1, H_2' is not a proper term pair and 'Paris is Helen' is not an implicit subsentence of 'Paris loves Helen'. Transcribing 'Paris loves Helen' as '$+P^*_1 + L_{12} + H^*_2$' and 'Helen is loved by Paris' as '$+H^*_2 + L_{12} + P^*_1$', term functor logic (which I sometimes call *algebraic* term logic) can express the equivalence of 'Paris loves Helen' to 'Helen is loved by Paris' as

$$+P^*_1 + L_{12} + H^*_2 = +H^*_2 + L_{12} + P^*_1$$

TFL copes with relational as well as classically syllogistic arguments by applying Aristotle's *Dictum de Omni* as the basic rule of inference:

Whatever is true of every *X* is true of any (thing that is an) *X*

The dictum validates any argument of the form:

P(−M)
. . . M . . .
―――――
. . . P . . .

whose "donor" premise, P(−M), asserts or implies that being P is true of every M, and whose "host" premise contains an algebraically positive ("undistributed") occurrence of the middle term, M. Given two such premises, we may adduce a conclusion by adding the donor to the host, thereby replacing the host's middle term by P, the expression the donor claims is true of every M. For example:

(1) Some boy envies every astronaut	$(+B_1 + E_{12}) - A_2$	$+B_1 + E_{12}(-A_2)$
(2) Some astronaut is a woman	$+A_2 + W_2$	$. . . A_2 . . .$
(3) Someone some boy envies is a woman	$+(+B_1 + E_{12}) + W_2$	$. . . (+B_1 + E_{12}) . . .$

The conclusion (3) is formed by adding (1) to (2) and replacing 'astronaut' by 'some boy envies' $(+B_1 + E_{12})$, which (1) claims is true of every astronaut.

In a TFL argument middle terms cancel out algebraically. A monadic sentence like 'Some astronaut is a woman' is not normally given pairing subscripts since its two terms are obviously paired with one another. We may, however, arbitrarily use any number as a pairing index for the two terms of a monadic sentence. When one of the terms is a middle term in an argument that has a relational premise, we assign both middles the same number, so that they will be uniformly represented for cancellation.

My explanation of why we intuitively and instantly judge that (A) 'Every colt is a horse' and (B) 'Some owner of a colt is not an owner of a horse' are jointly inconsistent assumed that we intuitively apply the dictum in everyday reasoning. We see immediately that adding (A) and (B) together entail 'Some owner of a horse isn't an owner of a horse':

(A) Every colt is a horse	$-C_2 + H_2$	$H_2(-C_2)$
(B) Some owner of a colt is not an owner of a horse	$+(O_{12} + C_2) - (O_{12} + H_2)$	$\ldots C_2 \ldots$
(C) Some owner of a horse is not an owner of a horse	$+(O_{12} + H_2) - (O_{12} + H_2)$	$\ldots H_2 \ldots$

By contrast, any MPL proof that (A) and (B) lead to self-contradiction requires quantificational translation and many further steps; no such proof casts light on why we instantly see inconsistency in (A) and (B).

Reference

A central aspect of my work on term logic concerned reference.[12] In MPL, definite reference by proper names is the primary and sole form of reference. In TFL, by contrast, indefinite reference by subjects of form 'some S' is primary reference and definite reference (e.g., by 'the S' or by a proper name) must be construed as a variant of the primary form. The doctrine I presented in *The Logic of Natural Language* was that definite referring subjects are pronominal in character, borrowing their reference from antecedent indefinite subjects. The logical form of a pronominal sentence is 'Some *S** is *P*', in which '*S**' is a UDT introduced to denote 'the thing (e.g., person, place) in question' originally referred to by an indefinite subject (such as 'an infant', 'a king', 'a lake', etc.) of the anaphoric background proposition.

Strawson had persuasively argued that 'The present king of France is bald' implicitly harks back to an antecedent proposition like 'France has a king'. He was in effect pointing to a sequence like 'France has a king . . . the present king of France is bald'—a pronominalization of form 'An *S* is *P*; it is *Q*'. The falsity of the antecedent sentence should not, however, lead us to deny a truth value to a pronominal sentence like 'He is bald' or 'The king is bald'. Both antecedent and pronominal sentence should then be regarded as false. *The Logic of Natural Language* extended the pronominal account of definite reference to proper names. The origin of a proper name harks back to contexts like 'We have a wonderful baby', moving on to 'The baby is healthy', 'It is asleep', and so on, and later on settling on a fixed way of referring to the baby by replacing 'it' and 'the baby' with a special-duty pronoun such as 'Eloise' or Richard'.

Realism and Truth

With the publication of *The Logic of Natural Language* in 1982, I felt I had gone a long way to reconstituting the old logic of terms as a viable "laws-of-thought" (cognitively adequate) alternative to modern predicate logic. My dissatisfaction with MPL had increased with my growing suspicion that it was inadequate as an organon for general philosophy. I am an unregenerate metaphysical realist—the kind Hilary Putnam is always inveighing against and allegedly refuting. For Putnam, a belief in correspondence is integral to being a metaphysical realist.[13] I believed (and still do) that true statements correspond to facts that make them true. We may refer to any fact by means of a phrase of the form 'the existence of *x*' or 'the nonexistence of *x*'. For example, 'Some horses are white' and 'Every U.S. senator is a U.S. citizen' are made true by the existence of white horses and the nonexistence of U.S. senators who are not U.S. citizens (the respective facts to which these statements are said to correspond).

Unfortunately for the fate of realist philosophy in the twentieth century, modern logic's treatment of 'exists' is resolutely inhospitable to facts as referents of phrases of the form 'the (non-)existence of φ'. Frege regarded the existence of horses as a property of the concept *horse*. Citing Kant, Frege says, "Because existence is a property of concepts, the ontological argument for the existence of God breaks down."[14] I accepted Kant's negative thesis that existence is not a property of anything that is said to exist, but could not accept Frege's positive thesis that the existence, say, of the Earth's moon is a property of the concept *terrestrial satellite*, namely, its having an instance. Russell has a similar view of what existence comes to: to say that horses exist is to say that '*x* is a horse' is sometimes true. These ways of construing existence seemed to me badly deficient in that 'robust sense of reality' demanded of an acceptable logical theory. The existence of the moon or of horses and the nonexistence of Twin Earth are characteristics of reality, not characteristics of concepts or open sentences. In any case, such ways of construing existence cannot give us the truth-making facts. (That '*x* is a horse' is sometimes true cannot serve as the fact that makes 'There are horses' true.) Along with truth-making facts, Frege rejected the correspondence theory of truth. These negative views were endorsed by the majority of Anglo-American analytic philosophers including, notably, Quine, Strawson, Davidson, and Putnam (for whom facts are just true statements).[15]

Hence facts as objective, truth-making correlates of true statements were metaphysical orphans in twentieth-century analytical philosophy. Davidson's view is typical: "The realist view of truth, if it has any content, must be based on the idea of correspondence . . . and such correspondence cannot be made intelligible. . . . [I]t is futile either to reject or to accept the slogan that the real and the true are 'independent of our beliefs.' The only evident positive sense we can make of this phrase, the only use that consorts with the intentions of those who prize it, derives from the idea of correspondence, and this is an idea without content."[16] This strong doctrine—that the very idea of truth-making facts is *incoherent*—should have aroused more suspicion: I wondered about the cogency of a challenge to produce *X* followed by the communiqué that *X* is not the sort of thing that could possibly be produced. The rejection of metaphysical realism left American philosophers in thrall to an unattractive pragmatism of the kind I had had my fill of at Columbia. It reopened the road back to John Dewey's and Richard Rorty's view that knowledge is not "a matter of getting reality right, but rather . . . a matter of acquiring habits of action for coping with reality."[17]

Strawson, more cautiously, had denied that there are any such things as facts *in the world*, saying: "It is evident that there is nothing else in the world for the statement itself to be related to. . . . The only plausible candidate for the position of what (in the world) makes the statement true is the fact it states; but the fact it states is not something in the world."[18]

Unlike Davidson, Strawson had left it open that a true statement like ‘Some cats are mangy’ may correspond to a feature of reality that is not, strictly speaking, “in the world.”[19] I would later avail myself of this opening and say the existence of mangy cats—the fact that makes ‘There are mangy cats’ true—though not a property of anything *in* the world, is nevertheless a real property.

Of What Existence Is a Property

In the 1990s I wrote several papers[20] explicating a notion of existence needed for a realist notion of (truth-making) facts to which true statements correspond. Any statement is a claim of φ-existence or ψ-nonexistence made about some domain under consideration (DC). A world or domain is a totality of things characterized by the presence of certain things and by the absence of certain things. The contemporary world is positively characterized by the existence of mangy cats and lifeless planets and characterized negatively by the nonexistence of saber-toothed tigers and Santa Claus (facts that make ‘Some planets are devoid of life’ and ‘Saber-toothed tigers are extinct’ true). The domain of natural numbers is characterized by such facts as the existence of an even prime number and the nonexistence of a greatest prime number. Very often the domain of the truth claim consists of objects in one’s field of vision, as when I point to a bird and say ‘That’s a cardinal’. Any φ-presence or ψ-absence that characterizes the DC is a property of that domain. The DC may be quite circumscribed, as when I say ‘There is no hammer’ when looking in a drawer; the absence of a hammer is a negative existential property of the totality of objects in the drawer that constitutes the DC of my assertion.

Suppose there are *K* things in the DC but no *J* things. Such a domain is ‘{*K*}ish’ but ‘un{*J*}ish.’ By construing the existence of *K*-things ({*K*}ishness) and the nonexistence of *J*-things (un{*J*}ishness) as attributes of the domain under consideration, one takes the decisive step in demystifying truth-making facts.[21] A fact is an existential characteristic *of* the domain; it is not something *in* the domain. To search for truth-making facts *in* the world is indeed futile.[22] The presence of Tony Blair in the world (its {Tony Blair}ishness) is a truth-making fact, but while *Blair* is present in the world, (the fact of) his *presence* is not, no more so than the fact of Santa’s absence. Neither fact is an item in the real world (in that sense neither fact exists) but both are existential properties *of* the real world (in that sense both facts obtain and are real). Nothing in the world is a fact. But facts as positive or negative properties of the world are the correspondents of truth-bearers in a realist metaphysics.[23]

Modern logic's powerful influence is not always progressive. If the above views on existence, facts, and propositional contents have not (yet) attracted much attention, this may be because they do not readily comport with the Frege–Russell view of existence suggested by the role of the existential quantifier in modern predicate logic. Similarly, because TFL challenges the currently accepted dogma that genuine logic is a matter of quantifiers and bound variables, the discovery—now more than three decades old—that 'some' is a *plus* word and 'every' a *minus* word (and the associated claim that the +/– character of the natural logical constants is the key to explaining how we actually reason with the sentences of our native language) tends to be dismissed or ignored. The sentences that figure in everyday reasoning are largely variable-free. That several generations of philosophers should so easily have jettisoned the classical conception of logic as the science of how we think and reason with such sentences shows that the revolution in logic has made MPL the only game in town.

MPL holds some very good thinkers in thrall. Noam Chomsky famously demands of any adequate theory of our use of language that it account for the extraordinary linguistic competence of native speakers, including, presumably, their deductive competence. Chomsky never questions the authoritative status of quantificational logic, so we find him saying that "the familiar quantifier-variable notation would in some sense be more natural for humans than a variable-free notation for logic."[24] At one point he claims that "there is now some empirical evidence that it [the brain] uses quantifier-variable rather than quantifier-free notation."[25] This fanciful and baseless bit of speculative neuroscience is forced on him because he is in the grip of two dogmas, one correct and one incorrect. He rightly believes that deductive competence is an innate endowment. But because he wrongly believes that MPL is *the* canonical human logic, he would account for our competence in everyday reasoning by postulating a "module" in the brain with the syntactic structure of the quantifier-variable language of modern predicate logic.

A Pedagogical Note

MPL replaced the older term logic because the latter could not cope with such phenomena as relational inferences, for example the valid inference of 'Every horse is an animal, so every owner of a horse is an owner of an animal'. I believe, however, that term logic will once again become "the logic of the schools." For I expect that twenty years from now, many students will know that 'Every horse is an animal' reckons like '–H + A'; they will know that if they conjoin (add) '–H + A' to a tautological premise, '–(O + H) + (O + H)' (Every owner of a horse is an owner of a horse), they can cancel and replace the positive middle term H with A, thereby immediately deriving '–(O + H) + (O + A)' (Every owner of a horse is an owner of an animal). It will not be easy to persuade such students that it is vital for them to learn the language of quantifiers and bound variables and to apply rules of propositional and predicate logic in a lengthy and intricate proof that '$(\forall x)(Hx \supset Ax)$' entails '$(\forall x)((\exists y)(Hy \& Oxy) \supset (\exists z)(Az \& Oxz))$'.

Although the short-term prospects for reviving term logic in the universities are admittedly not bright, the continued preeminence of predicate logic is by no means assured.

Notes

1. M. Dummett, *Frege: Philosophy of Language* (Cambridge, Mass.: Harvard University Press, 1981), p. 20.

2. Here is one complaint: "How did it come to be that logic which, at least in the views of some people 2,300 years ago, was supposed to deal with evaluation of argumentation in natural languages, has done a lot of extremely interesting and important things, but not this?" (Yehoshua Bar-Hillel in J. F. Staal, ed., "Formal and Natural Languages: A Symposium," *Foundations of Language* 5 [1969]: 256–284).

3. Nondualists avoided Descartes's conclusion by denying the possibility of a pure (bodiless) ego.

4. Because the way these logical words figure in natural syntax is lost in canonical (MPL) translation (which translates 'Every colt is a horse' as a conditional formula involving two atomic sentences '*x* is a colt' and '*x* is a horse') I reverted back to the logic of terms, which, whatever its shortcomings, did not move away from the syntax of the sentences with which we reckon in everyday reasoning.

5. I was trying to devise a formal, terminist logical language that would transcribe sentences of natural language as algebraic formulas. I had, in 1967, proposed an algebraic algorithm for syllogistic reasoning that represented 'Every *M* is *P*' as a fraction '*M*/*P*' and 'Some *M* is *P*' as $(M/P^{-1})^{-1}$ (not every *M* is not-*P*). BARBARA syllogisms were represented as deriving the conclusion '*S*/*P*' from '*M*/*P* x *S*/*M*'. The fraction algorithm proved of limited value for handling relations. Nor did it cast much light on how we actually reckon, since we do not reckon 'Every *M* is *P* and every *S* is *M*, hence every *S* is *P*' by thinking in terms of fractions and reciprocals. I was nevertheless convinced that our intuitive way of reasoning was probably algebraic in nature. See "On a Fregean Dogma," in I. Lakatos (ed.), *Problems in the Philosophy of Mathematics* (Amsterdam: North-Holland, 1967), pp. 47–62.

6. *Prior Analytics*, 24b29–30.

7. The range of the definition is limited to the case where there are *S* things. If neither '*P* some *S*' nor 'non-*P* some *S*' is true, then both '*P* every *S*' and 'non-*P* every *S*' are undefined. For Aristotle, 'some' is primitive, 'every' is defined. By contrast, Frege takes the universal quantifier as primitive and uses '–(∀*x*)–' where we use '∃*x*'.

8. I regarded the negative forms '*P*e*S*' (⇒ 'No *S* is *P*') and '*P*o*S*' (⇒ 'Some *S* is not *P*') as derivative, '*P*e*S*' (e.g., 'No creature was stirring') being construed as 'not(*P*i*S*)' or '–(*P* + *S*)' ('Not: a creature was stirring') and '*P*o*S*' as '(not-*P*)i*S*' or '(–*P*) + *S*'.

9. For example, 'hit every target' (⇒ $+(H_{12} - T_2)$) is equivalent to 'did not miss a target' (⇒ $-((-H_{12}) + T_2)$], but not to the divalent term 'hit some nontarget' (⇒ $+(H_{12} + (-T_2))$)). The first two terms both have negative valence (an overall + and a – sign of quantity in the first; an overall – and a + sign of quantity in the second), whereas the third term has a positive valence (an overall + and a + sign of quantity, 'some nontarget').

10. *Frege: Philosophy of Language,* pp. xxxi–xxxii.

11. See "Predication in the Logic of Terms," *Notre Dame Journal of Formal Logic* 31 (1990): 106–126.

12. See *The Logic of Natural Language* (Oxford: Clarendon Press, 1982), chapters 3, 4, 5, and 11.

13. Thus he says of Quine that he cannot be a metaphysical realist in my sense since he does not accept the correspondence theory of truth; see *The Many Faces of Realism* (La Salle: Open Court, 1987), p. 31.

14. Gottlob Frege, *Die Grundlagen der Arithmetik* 53 (trans. Austin, *The Foundations of Arithmetic* [Oxford: Basil Blackwell, 1952]). For an excellent discussion of the doctrine that existence is an attribute of concepts, see C. J. F. Williams, *What Is Existence?* (Oxford: Clarendon Press, 1981), chs. 2–3.

15. See, for example, W. V. O. Quine, *Word and Object* (Cambridge, Mass.: The MIT Press, 1960), p. 247; P. F. Strawson, "Truth," in his *Logico-Linguistic Papers* (London: Methuen, 1971), pp. 194–195.

16. "The Structure and Content of Truth," *Journal of Philosophy* 87 (1990): 279–328, at 304–305.

17. Richard Rorty, *Objectivism, Relativism, and Truth* (Cambridge: Cambridge University Press, 1991), p. 1.

18. P. F. Strawson, "Truth," pp. 194–195.

19. Strawson's purpose, in which he succeeded, was to refute Austin's version of the correspondence theory in which true statements correspond to situations locatable in the world. Like Kant, Strawson left us the question: To what, if not to something in the world, does a statement asserting the existence of a mangy cat correspond?

20. See: "'The Enemy Is Us': Objectivity and Its Philosophical Detractors," in H. Dickman (ed.), *The Imperiled Academy* (New Brunswick: Transaction, 1993); "Naturalism and Realism," *Midwest Studies in Philosophy* 19 (1994): 22–38; "Existence and Correspondence to Facts," in R. Poli and P. Simons (eds.), *Formal Ontology* (Dordrecht: Kluwer, 1996), pp. 131–158; "Putnam's Born-Again Realism," *Journal of Philosophy* 94 (1997): 453–471.

21. Nontrivial existence as an attribute of the world is always specified presence (elk-existence); nontrivial nonexistence is specified absence (elf-nonexistence). Anything in a world under consideration is a thing, a mere "existent," in the uninformative sense that Kant derided. In the *informative* sense, to exist or to fail to exist is to characterize the world by *specified* presence or absence.

22. Austin's version of truth-making facts, which located them in the world, was thus rightly rejected by Strawson.

23. Compare, by contrast, Davidson's view: "the real objection [to correspondence theories] is rather that such theories fail to provide entities to which truth vehicles (whether we take these to be statements, sentences or utterances) can be said to correspond" ("The Structure and Content of Truth," p. 304).

24. Noam Chomsky, *Rules and Representations* (New York: Columbia University Press, 1980), p. 165.

25. Chomsky, *Lectures on Government and Binding* (Dordrecht and Cinnaminson: Foris, 1981), p. 35.