Three Grades of Variable Involvement

1: Introduction

The development of the concept of the variable and its intimate associate, the function, is one of the glories of mathematics. Just how variables are to be understood, however, in the most scrutinised of formal contexts—first-order quantification theory—remains a topic of dispute. That issue will form the background to my present concerns, which focus on variables in relation to natural language, not formal languages. Variables appear to be an essential bit of kit for theorising about natural language, being generally appealed to in generative syntactic theory, semantic theory, and much of philosophy of language. It is not often reflected upon, however, just what commitments variables impose upon a theory that wields them, whether, in particular, variables are a mere artefact of the relevant theory or somehow 'real', part of linguistic phenomena. The question of realism has often arisen in linguistic theory, especially in regard to the putative 'psychological reality' of grammars and semantic representations, but the narrower issue pertaining to the status of variables is rarely broached.

It is crucial to note that the question here does not *directly* concern the values we take given variables to have, i.e., what domain of discourse there might be. The question pertains, rather, to the status the variables themselves have when we assess a theory. Think of it this way. Language itself is a representational system with a semantics and syntax, but it is also an empirical phenomenon, which we seek to understand by constructing another linguistic structure, i.e., a theory. Our question, therefore, is what status the variables posited by our theoretical structures have in relation to the

phenomena the theories target. This kind of question does not so starkly arise in physics, say, for we do not understand the phenomena physical theory targets to themselves have properties of the theory itself understood as a representational artefact. Still, the question that does arise in physics and all other branches of theoretical inquiry is what elements of a theory are merely notational or convenient or somehow metaphorical, and what elements are essential. This question pitched at linguistic theory, therefore, concerns the reality of variables when posited as if they were essential to the particular explanation at hand. There is, I dare say, no simple answer here, for the notion of a variable is used across many different theories across many different linguistic sub-disciplines. I hope, though, to be able to say something of general import even if my discussion will be necessarily restricted. I have three aims.

Firstly, I shall clarify and settle on an understanding of what a formal variable is in the context of first-order theories. I shall say that a variable is a 'positional gap' within a structure that can be either free or bound. This account will form the basis of the more critical discussion to follow. Secondly, armed with this notion of a formal variable, I shall distinguish three grades of variable involvement in linguistic theory, from a weak position, where variables are a mere notational artefact, through a second grade that views variables as essential to semantic interpretation, but which need not be syntactically represented, to the strongest position that claims that variables are syntactically projected, i.e., they are part of natural language syntax. The three grades are ranked as they are, for, obviously, to accept the strongest position is to accept that the variables are involved in semantic interpretation and are depicted in any adequate theory. The grades reflect, therefore, a scale of ascending realism *vis-à-vis* variables. Thirdly, I

shall argue that that the first grade can be happily indulged in precisely because of its lack of commitment regarding the phenomena. The second grade is currently an issue of dispute, about which I remain neutral. The third and strongest grade, however, I find to be wanting; in particular, I argue that there is no good evidence for variables in syntax and principled reasons to think that there can't be any. This issue will be taken up in the remaining chapters where I look at a range of phenomena that many theorists have investigated in terms of potential third grade variable involvement.

Natural language does, indeed, contain *variable-like* elements in the guise of pronouns and various covert items (phonologically-null projections), but it does not contain any variables proper, at least not if the putative linguistic variables are understood to be of the same species as the variables that occur in the familiar logical languages of, for example, lambda calculus and first-order logic. In a nutshell, my contention is that natural language does not contain elements ('positional gaps') that may be either free or bound, where such a duality is essential to formal variables.

Before we begin in earnest, let me post some preliminary qualifications that will be more fully spelt out as go along. Firstly, it may seem that the advertised position contradicts the standard position in generative syntax. In one respect it does, but only as regards the use of indexation to mark a free or bound construal of an overt pronoun. As regards covert items, I think that variables in the intended sense have never actually been sanctioned; at any rate, that is what I shall argue. The lack of variables and indexation becomes clear once certain minimalist strictures come into play. The theorists my position does contradict are Stanley (2000, 2007) and Martí (2006), both of whom explicitly appeal to syntactic items that may be bound or free. Many others *appear* to

sanction such items in the guise of 'unarticulated constituents', but this is merely an appearance, either because of a timidity or neutrality towards the nature of syntax (e.g., Perry, 1986; Taylor, 2001; Neale, 2007), or because an autonomous syntax is not assumed (e.g., Fillmore, 1986; Partee, 1989).[1]

Secondly, much recent interesting work has suggested that various languages contain overt variable-like items that do the same semantic job that the would-be covert variables are supposed to do in English; this apparent concord has led some authors to think that English realises syntactic options covertly that are realised overtly in other languages (cf., Matthewson, 2001; Martí, 2009; Etxeberria, 2009). This work need not detain us, for my purpose here is not to doubt that numerous variable-like, contextually valued items may be overt throughout the world's languages. My concern is only to question the existence of variables that may be free and bound and are covert and so may play the role of fixing the apparent context-sensitivity of many lexical items. None of the work cited offers evidence for this, even though the authors all talk freely of syntactic variables and cite Stanley (2000). For example, Etxeberria (2009) suggests that the Basque determiner *a/ak* (translated as *the*) serves as a domain restrictor on ('strong') quantifiers with which it may co-occur. There is no evidence from Etxeberria, however, that it may be bound; indeed, many thorny issues arise here about the relation of determiners to pronouns and where and how pronouns can be bound, if at all, if construed as determiners. As said, though, in the particular case at hand, the determiner looks as if it cannot be bound (it is one thing to construe a bound pronoun as involving a determiner; it is quite another to construe a determiner as a bound pronoun). Also note that the presence of the determiner is highly restricted in Basque, so it cannot possibly be the overt form of the would-be

covert variable that serves the end of contextual domain restriction across *all* DPs and beyond in the case of English. Similarly, Martí (2009) suggests that indefinite *some* in some dialects of Spanish comes in a context-sensitive (*algunos*) and context-insensitive (*unos*) form. Again, it is unclear, what it would be for such determiners to be bound, and so it is unclear how such things could be variables. Also, as before, the presence of this morphological difference is highly restricted (occurs just with the indefinite) so is not the overt form of something putatively general in the case of English.

It bears emphasis that these remarks are not directed against the interest and value of the work cited, but only against the significance of the work for advancing the case that variables occur in natural language.

Thirdly, it might seem that the advertised rejection of variables has already been established or at least made plausible by the work of Jacobson (1999, 2000) and others in forwarding a 'variable-free semantics', work which itself has a long heritage in categorical grammar and combinatorics. While I am sympathetic to this approach, my project is distinct in three crucial respects. Firstly, my concern is for syntax understood as a structure 'autonomous' of semantic interpretation. So, while there might well be a variable-free way of developing model-theoretic semantics, such success would not, by itself, establish anything about syntax, unless we antecedently thought of syntax as nothing more than structure that answers to certain interpretive demands, exactly as a formal language is designed to do. Jacobson assumes a categorical grammar framework as her theory of syntax, which is not semantic as such, but the mechanisms Jacobson proposes to do without variables essentially makes the grammar fit the interpretation (Jacobson, 2000, pp. 109-10). Secondly and correlatively, I think we can propose a

variable-free syntax upon the basis of generative assumptions, even though it looks as if such assumptions are up to their ears in variables. So, going variable-free need not involve a renunciation of the generative framework. Thirdly, my concern will be for putative *covert* variables, i.e., those that possess no morphophonemic signature. For present purposes, therefore, I am happy to be neutral about apparent overt variables, such as pronouns. As it is, and here I echo Jacobson (1999), it seems to me that pronouns are not syntactic variables at all, for they are syntactically invariant; they are merely variable-like in supporting bound and free readings, about which difference the syntax is free to be blind. The variable-like, if you will, is not our quarry. All that said, the great concord between Jacobson and the position to be elaborated is a commitment to locality over globality in matters of natural language, and the problem with variables, as we shall see, is that they are syntactically and semantically essentially global devices.

2: A little history

Differences of attitude towards the relation between formal and natural languages have fuelled much of the philosophy of language over the past hundred years or so. No simple story, and certainly not one that would comfortably fit within the compass of this article, can capture the fine granularity of the many varied disputes. Besides which, our focus is narrow. Still, a sketch of the history will be useful for orientation. Frege (1879), Russell (1903), the early Wittgenstein (1922), and numerous subsequent philosophers recognised that natural language constructions are essentially heir to categorical ambiguities and vagaries, not least because of a fundamental mismatch between the (supposed) subject-predicate grammar of natural language and the relational and polyadic structure of

modern logic. For example, in thinking of the properties of rational numbers, as opposed to naturals, we want to say that between any two numbers there is another number, but we cannot so much as express this claim in monadic logic; concomitantly, the vernacular conceals the scope difference between there being a particular number that occurs between any two numbers (an absurdity) and, for any two numbers, there being some or other number that occurs between them. More prosaically, when we say that whales are mammals, we do not take ourselves to be predicating mammalhood of the collection of all whales, which is an abstract object of some sort, but the form of our whale-statement looks the same as that possessed by *Willy is a whale*, where we precisely do predicate mammalhood to the referent of the subject.

It was a real achievement for such matters, and innumerable other subtleties, to be brought to light. There was very little effort, if any, however, to show *how* natural language could express the kind of propositions properly encoded in the logical formulae. It is one thing to recognise that natural language is 'systematically misleading' as to the propositions its sentences are apt to express; it is quite another to explain how we are not in the normal run of things actually misled at all. Austin (1961, 1962), Wittgenstein (1953), and others can be viewed as pressing this worry. They claimed, in their different ways, that the meanings our utterances express are not encoded in the form of a symbolism at all, either logical or grammatical, but arise from a panoply of factors to which speaker-hearers are sensitive, including their communicative intentions, shared beliefs, and recognition of salient features of the contexts of utterance. Without loss of the insights of Austin, *et al*., such an 'ordinary language' approach was squeezed in a pincer movement. On the one hand, Grice (1989) appeared to show that the kind of

informational complexity attendant to utterances is not really a matter of semantics (truth conditions) at all, but a matter of how speaker-hearers reason about each other's utterances, i.e., pragmatics. Pragmatics might turn out to be where most of the communicative action is, but such action, at least on Grice's picture, presupposes a notion of semantics that might well submit to the structures of modern logic. On the other hand, Montague (1974), Davidson (1984), and numerous others in philosophy and linguistics were questioning the very distinction between natural and formal languages, a distinction which seemed to give way once systematic enough formal techniques were employed that captured a whole range of logical phenomena of natural language. Here, natural language is not replaced by a formal surrogate, but is revealed to have a formal character all along as measured by the success (or, at any rate, promise) of the proposed semantic frameworks. In tandem with these developments, syntactic theory, both generative and post-generative, purported to show that the 'underlying' syntax of natural language was much like a logical language. From this perspective, it thus might be argued that Frege and Russell were correct, but drew the wrong conclusion: rather than disparaging natural language for not supporting the logical distinctions codified in logical languages, one might instead have looked to see if language beneath the surface actually did support the relevant distinctions. After all, if the kind of propositions encoded in formal languages are in fact what we express (or can express) in our vernacular, then, unless the relation between the two is to be adventitious or magical, some structural patternship must obtain between natural languages and what formal languages can express. In short, the correct Frege-Russell conclusion, as it were, is simply that 'surface' syntax is to be disparaged as a guide to, or the structure of, a sentence's semantic (truth-relevant) properties.

The current theoretical situation seems to me to be much as I described just above: semantics for natural language may be pursued as if it were semantics for a formal language, for the syntax of natural language, at the right level of analysis, has the requisite formal properties to support a formal semantics (Larson, and Segal, 1994; Heim and Kratzer, 1998). As I indicated above, my present ambitions are modest. I do not, in particular, fancy myself to be in a position to overthrow formal semantics, even were I minded to do so. My main critical ambition is to show that the role of the variable in formal language is not evidenced in natural language syntax. If this is true, a particular way of thinking of semantics is, indeed, unavailable, but many varied positions remain extant, and, suffice it to say, others are imaginable. I shall return to the broad implications of my stance later. What we need to do now is think about the different ways variables may be sanctioned and just what variables are, anyway.

3: Formal variables as gaps and positions

In this section, the notion of a formal variable will be clarified. What I take to be the standard account of a variable involves two claims due to Frege (1879/1967, 1891/1980, 1904/80). Firstly, a variable does not describe or refer to a quality or thing. When, for example, we say that $f(x)$ decreases as x increases (take f to be a negative exponent function, say), we do not mean to claim that there is any quality or thing that is changing, as if x referred to a deflating balloon. Instead, the variable serves as a generalising device over a domain of entities. We are saying that there is a general correlation f over a domain of entities such that each entity stands in an f-relation to some entity. Variability pertains to the entities that can stand in the f-relation. The variable itself is merely a

device for talking about any of the relevant entities without having any particular one in mind, as it were.

Secondly, since a variable does not refer to anything, either in particular or in general, an occurrence of a variable in a formula does not contribute anything definite to the meaning of the formula. In effect, the position of the variable marks a gap where something definite might go—a mere placeholder. This is signalled by the fact that the symbolisation of a variable *appears* to be entirely arbitrary.

This two-part picture is not without its problems; in particular, it appears to face what Fine (2007a) refers to as the *antinomy of the variable*. I shall return to this putative paradox shortly, but first let us note an obvious pair of problems with the apparently gappy nature of a variable. If variables are gaps, then how can they contribute to the meaning of a formula, for a gap is not a something, but a nothing? Likewise, how can one variable be distinguished from another in the one formula, for one gap is as empty as another?[2] The two problems are obviously related. If variables are to contribute to the meaning of their hosts, then they must be distinguished, unless, absurdly, we take all variables within a formula to have the same significance. Equally, if variables are distinguished, then that signals a contribution to the meaning of their hosts insofar as distinct variables potentially make a distinct contribution to the meaning of their hosts. Let us exhibit the situation with a simple example.

Consider the two well-formed formula (open relations):

(1)a $x > y$

b $x < y$

If we take the relations to be defined over the natural numbers, say, then the two relations (/functions) determine different sets of pairs of numbers. It follows that '*x*' and '*y*' do not refer to any particular numbers at all, since no number is both greater than and less than some given number. On the other hand, being well-formed, we should be able to conjoin the relations in (1) to form coherent complex relations:

(2)a $x > y \wedge x < y$

b $x > y \rightarrow x < y$

Both of these relations should hold over the natural numbers, if variables were mere gaps. As it is, the relative positions and type identity of the variables clearly indicates that variables must be distinguished, for no pairs of numbers do satisfy these relations. To restore coherence, in (2a) it suffices to substitute '*z*' for '*x*' or '*y*' in just one of the conjuncts; and in (2b), one may invert the variables in either antecedent or consequent, but not both (one may also invert in (2a), of course).

What this situation appears to tell us is that variables *are* gaps insofar as they are not referential, but they are not mere gaps, for their relative positions and type identity matters. Variables, we might say, are *type-interpretable positions* in a relation. Tokens of the same variable type within a single formula trivially cannot mark the same position, but mark the fact that the same value (a natural number, say) can be disgnated by an expression occupying the positions occupied by the token symbols (this requires greater precision, as we shall see). So, the number of variables within a formula regardless of

their type marks the adicity of a function/relation by the number of positions the variables occupy, and the type of a variable marks the distinctness of the positions, how the values are to be understood relative to each other within a relation.

All of this, of course, is a prelude to Frege's great insight into how to be explicit about polyadic logic, for variable positions count as distinct insofar as they can be bound by different quantifiers, and chains of variables count as being of the same type insofar as they can be bound by the one quantifier. To be sure, phrasing the matter in such a way is somewhat around the houses, for we simply adopt the typographical convention that different variable types mark positions to be quantified into by distinct quantifiers, but there is nothing in the convention itself that captures the difference between the positions; that is to say, the difference in variable type is nothing other than a reflection of the fact that distinct quantifiers can bind the respective positions. The variables remain gaps which we mark as if quantifiers were waiting to bind the positions.

Dummett (1973/81, chp. 3) expresses the latter point well in terms of a variable not being an essential part of a relation, but only an aspect of an argument-function analysis of the host structure that features argument positions open to quantification. Consider a natural language example:

(3)a Frank loves Ava

b, *x* loves Ava

c Frank loves *y*

d *x* loves *y*

(3b-d) are in no sense part of (3a): no '*x*'s or '*y*'s occur there. What is true, though, is that the subject and object of (3a) can be quantified into, which means that the remainder can be treated as a potential predicate, regardless of its syntactic status. Dummett's point here can be captured by the thought that a variable is a global property of a sentence or formula, a property that comes with a particular analysis of the sentence as a whole, as opposed to a property to be found in the sentence that any analysis must respect. The thought here is in line with Quine's (1960a) notion of a variable being an 'abstractive pronoun', i.e., a variable allows us to abstract any predicate we wish from a formulae/sentence.

Fine (2007a) poses much the same problem of how to understand variables as I presented above, but arrives at a somewhat different conclusion. He refers to the problem as the *antinomy of the variable*, but it is really just the puzzle of how variables can be treated as semantically equivalent and distinct, depending on their occurrence with other variables. As we saw above, the semantic roles of '*x*' and '*y*' are exactly the same when we consider the formulae in (1) independently. A simpler example, even, is that substituting '*x*' for '*y*' in '$y > 0$' does not affect the interpretation of the formula in any way. So, variables are the same. In distinction, though, sequences of variables are not the same. As we saw in (2), it matters what variables are interpreted together. So, in some sense, the pair '*x*... *y*' differs from the pair '*x*... *x*'. The *antinomy* or, at any rate, puzzle is to explain how this can be.

Fine's proposed resolution of the puzzle involves a rejection of the thought that individual variables ever have intrinsic semantic features that set them apart from other variables. Fine's crucial point is then to note that this denial is perfectly consistent with

the thought that there is an irreducible intrinsic semantic difference between pairs of variables that are type-identical and type-distinct, even if there is no difference between individual variables. Thus: 'the intrinsic semantic features of x and y… are the same, though the semantic features of the pairs x, y and x, x… are different' (Fine, 2007a, p. 32). The point here is that sequences of variables have intrinsic semantic features qua sequences of variables, notwithstanding the semantic equivalence of the constituent individual variables of the sequences. So, the antinomy is resolved by acknowledging that relations between variables can be constitutive of the semantics of the relata. The examples above fall into line on this conception, for a pair of distinct variables flanking a given relational expression, such as '<' or '>' , have their semantic features as such relata, not as independent variables. Fine presents his account as an alternative to what he calls the 'instantial approach', which is a variant on the 'positional' account offered above. I think, though, that Fine underestimates the resources of this account both to withstand the considerations he brings against it and also, indeed, to resolve the antinomy without giving up on semantic intrinsicness of variables. I shall first discuss Fine's arguments against the 'instantial approach'. In each case, the conclusion will be that, as properly stated, the Frege-style account offered above remains unscathed. Showing this will lead us to see how the antinomy may be resolved without forsaking semantic intrinsicness.

Fine, with Dummett (1973) in mind, understands the 'instantial approach' to be one that essentially denies that free variables are semantically interpretable; instead, free variables are mere abstractions to arbitrary reference from singular terms. So, the semantic features of 'φ(*x*)' depends upon the semantic features of 'φ(a)', for some name

‘a’. Yet, Fine objects, free variables surely have independent semantic integrity. For example, we can understand ‘2*n*’ as picking out the range of even numbers, given a specification of the natural numbers as the domain, and so on for endless other cases.

The instantial approach Fine rejects does not, I think, correspond to what Frege, or Dummett on his behalf, presented. I take the abstractionist approach not to be one that claims that free variables depend upon names for their semantic properties, but that free variables are not parts of the judgements that the logic is formalising, being mere gaps for possible generalisation. Free variables arise from the various options for decomposing a judgement as exemplified above. Once a particular decomposition is offered, then, of course, the free variable has its semantic properties as part of the interpreted formal system independently of any name, if any, in the relevant expression of the judgements at hand. So, one may motivate the formal language by way of a story about abstracting from names, but once the language is set up, the abstraction is, as it were, the ladder one kicks away. This point is clear, I think, where no name is in the offering. If we start with, for example, a universal statement, such as *Every man breathes*, then, according to the Frege model, we would begin by forming the conditional compound of two open formulae—‘man(*x*)’ and ‘breath(*x*)’—with the universal quantifier binding into both positions. Since no particular man is at issue, we cannot begin with a particular name. We may, of course, begin with an ‘arbitrary name’, but to do so is not mandatory and such a move, anyway, would not amount to an abstraction from a given name, since, just as with starting with free variables, there is no particular name at all. Free variables and arbitrary names simply mark the semantic position in a predicate or relation.

So, I think the abstractionist or instantial position may accommodate the independent integrity of free variables in the sense of accepting that, for example, '2*n*' picks out the even numbers without use of the open formula presupposing any given value of *n*. Fine is right, however, to claim that the instantial position does presuppose closed or gapless formulae corresponding to open formulae. Since we have already ruled out names as being what free variables depend upon, the only alternative is that we understand free variables by way of formulae involving the variables being bound by some or other operator. This is precisely what I intended above by saying that free variables mark the positions into which the relevant quantifiers may bind. Fine, though, has an objection to this kind of manoeuvre.

Patently, if we are to take free variables to be abstractions from formulae, and names are not to be presupposed, then particular quantifiers cannot be either. '2*n*' in some sense picks out the even numbers without, as such, saying anything about all, some or none of them.[3] What is required, therefore, is some abstraction operator, such as set abstraction—$\{x: 2x\}$—or λ-abstraction—$\lambda x.2x$. The problem Fine (2007a, p. 15) now raises is that there appears to be nothing whatsoever about the semantic features of '2n' that decides between the two options or others, even though the options are quite distinct. So, it would appear to be 'arbitrary' and 'gratuitous' to make the decision.

Fine is correct that the decision is arbitrary insofar as a mere variable does not determine what it may range over, but the decision is not gratuitous precisely because fixing on some operator settles what we take the variable to range over, for implicit in the operators is some domain over which they range. So, we may take set abstraction to tell us that '2*n*' picks out the subset of the natural numbers that have 2 as a multiple and λ-

abstraction to tell us that '2*n*' picks out the function from the natural numbers to those that have two as a multiple (or as being the property of having 2 as a multiple). So, the decision is arbitrary, but only because there are numerous ways of picking out the even numbers by way of '2*n*', which our understanding of the open formula presupposes in that we do take it to pick out the even numbers, but '*n*' alone cannot pick anything out at all; it can only do so when in composition with some interpreted expression, and the various possible operators are merely ways of understanding the result of such composition.

Fine (2007a, p. 15) may now be read as having an objection to this further point. It is clearly correct to say that the value of '*n*+1' is always greater than the value of '*n*', as opposed to the value of '*m*'. If we assume all variables to be implicitly bound, though, then such a banality appears to be unavailable for expression because we would have two distinct formulae. The obvious response, of course, is to say that both variables are simultaneously bound, which we would express by way of the single formula '$(\forall x)[x+1 > x]$'. Fine (op cit.) objects as follows:

> [I]t seems bizarre to suppose that one must create this artificial context in which both terms occur in order to explain the semantic relationship between them. What kind of strange semantic relationship between the terms is it that can only be explained by embedding them in a richer language? Indeed, the proposed explanation of the semantic relationship presupposes that the relevant semantic features of the terms are preserved when they are embedded in the context of a single sentence; and so unless we had some independent way of saying what the

semantic relationship was, we would have no way to say what the presupposition was or whether it was correct.

Both of these objections strike me as topsy-turvy.

Firstly, note that the initial statement I made concerning the successor function by way of two tokens of the variable 'n' did *not* occur in any formal language at all, but in English (just as it does in Fine's text). It is simply not true, therefore, that the single universally quantified formula is in a 'richer language'. I don't know how to compare richness of languages when what we colloquial refer to as English is one of them, but however we manage it, I hardly reckon that first-order logic is richer than English.

Secondly, the abstractionist response to which Fine is objecting need not be couched in terms of an appeal to the first-order quantified formula, but simply by the acknowledgement that the variables must be co-interpreted in the context of the statement of the successor function because they are of the same type and occur in the same sentence, or the relevant semantic context, such as an inference. There is nothing in the semantics of 'n' itself that tells us that it must take the same value in '2n' and when alone, which is just as it should be, for '$n < 1$' and '$n > 1$' are both perfectly fine and can both be satisfied (but not together). So much is agreed upon by all. What, therefore, co-ordinates 'n' with its other token in '2n' is the syntactic fact that they are tokens of the same type, which must be bound together, if at all, by any quantifier that binds one of them; so, they must be co-interpreted in the same semantic context. In other words, since what we want to say is that the successor of a given number is greater than the given number, the tokens must be co-interpreted or bound together, which is just what the syntax of token variables provides for. So, Fine's second objection is exactly the wrong

way around. It is because of the type-identity of the variable tokens occurring in the same semantic context that they are co-interpreted. It is this that is presupposed by the English sentence Fine uses to state the problem initially; if the variable tokens were not presupposed to be in the same semantic context, then we would have no basis to think of them as co-interpreted. This issue bears on the resolution of the 'antinomy of the variable'.

Recall that Fine's antinomy (or puzzle) is how to reconcile the semantic identity of type-distinct token variables when occurring alone with the need to distinguish pairs (or sequences) of type-identical token variables from pairs (or sequences) consisting of type-distinct token variables ('*x*..., *x*' is not the same as '*x*..., *y*'). Fine resolves the puzzle by rejecting semantic intrinsicness, i.e., a pair of variables may be semantically distinct from another pair without consisting of variables that are semantically distinct. As we saw, such a resolution is intended to be available without recourse to any abstractionist account of variables, which, according to Fine, is forlorn anyway. It seems to me, however, that the abstractionist has the resources ready to hand to resolve the 'antinomy' without forsaking intrinsicness. We might want to reject some such doctrine on independent grounds, but not in order to resolve the 'antinomy'.

As we saw just above, tokens of the same variable type within a formula or inference (which can be rendered as conjunction of formulae) are co-interpreted. This tells us enough to know that '*x*..., *x*' and '*x*..., *y*' are semantically distinct, because the variables in the first pair will be co-interpreted, while those in second pair won't be. This is evident with quantification. It would signal syntactic confusion to think that '$(\forall x)[\phi(x, x)]$' is an open formula, for it is a syntactic condition on interpretation that variables of the same

type are co-interpreted, so if one is bound, so must the other one in the scope of a higher operator. Just so, '$(\forall x)[\phi(x, y)]$' must be an open formula. Furthermore, the semantic equivalence of individual variables in distinct contexts remains untouched, for individual variables are neither co-interpreted or not; only when variables severally occur in the same semantic context is it necessary to establish relations of co-interpretation. So, we understand the difference between the pairs in terms of the difference between the interpretation of type-identical and type-distinct variables in relation to possible operators or instantiation, such as quantification, which treat the variables differently. Thus, closed formulae are explanatorily primitive relative to open formulae.

Semantic intrinsicness is preserved because the only principle we have appealed to is that variables of the same type in the same semantic context are co-interpreted, where a variable being of a type is the most intrinsic feature one could imagine, it being merely syntactic. So, although we do, indeed, have to appeal to a semantic context featuring several variables in order to account for the difference between pairs of identical and distinct variables, the explanation of the difference devolves upon just the intrinsic features of the constituent variables, their being of the same or distinct syntactic type. A way of putting this point is to say that the intrinsic property of being of a type a variable token possesses only becomes semantically relevant when the variable is in a context, but the property remains intrinsic. One could, of course, set up a language without the relevant syntax-semantic interface, where type-identical variables need not be co-interpreted, but such a language would be useless unless there was some other way to distinguish between closed and open formulae. If this is right, then Fine's mistake is to

insist on explaining a semantic phenomenon with a semantic property, whereas the solution is to see that syntax encodes co-interpretability.[4]

So, at least a plausible resolution of the 'antinomy' is in-line with the abstractionist account of variables outlined above. The crucial point here is that we distinguish open positions in terms of possible quantification into them, or, as suggested above, we take some abstraction operator to be implicit in our very identification of the open positions. Since it is a syntactic condition that type-identical variables are bound together, whereas type-distinct variables cannot be, sequences of type-distinct variables must be semantically distinct because no possible quantification into their positions will be uniform, but individual variables are not semantically distinct simply because quantification is indifferent to type-distinct token variables when not occurring in sequence.[5]

Hereafter, I shall assume the notion of a formal variable as explained. Mind, all that will be crucial to the following is that formal variables have an essential duality of being free or bound, which is a uniform feature of the various accounts of variables we have so far discussed. The interpretation of the variable differs between the two cases just in the respect that the presence of a binding operator places a condition on the interpretation of the sub-formula containing the relevant variable. So, '$\phi(x)$' is satisfied by every object of the domain that is ϕ, whereas '$\exists x[\phi(x)]$' is satisfied by every object so long as at least one object is ϕ; and so on in the familiar way for the other quantifiers. So, the interpretation of a variable is dependent on the nature of the containing formula as to whether or not the relevant quantifiers occur. Such duality of the variable makes it a *global* feature of the formulae precisely in the sense that whether a token variable is free or bound is a

property of the host formula, i.e., whether it contains the relevant quantifier or not. It is this property of formal variables that natural language 'variables' do not possess, or so I shall contend. Before seeing the different ways in which variables are of use in our thinking about natural language, we need to pause over the idea of a 'free variable'.

A free variable in logic is understood to take a universal interpretation in the sense of the variable ranging over the entire domain of discourse, so that 'φ*x*' is interpreted as picking out the set of objects that are φ (or the characteristic function). The free variable is not understood as an indexical that may pick out a definite but arbitrary object. For that role, in a system of natural deduction, say, we appeal to an arbitrary name. In natural language, I take the notion of a variable to slide between these two notions. I shall say something more on this below. *Pro tem*, note that my claim that free variables presuppose certain closed formulae that express an abstraction over the variable does not mean that there aren't *really* any free variables. A free variable is one that is not bound by an operator; my claim concerned how we would understand the interpretation of such a variable, *viz*. by way of an operator that defined the variable over a given domain, but the open formula remains open. This point is worth emphasis, for as we shall see and as noted, my principal thought is that natural language does not exhibit the duality of being bound or free characteristic of formal languages. Free variables as understood in much of the semantic literature to be discussed are identified with indexical elements. As indicated, this is not the way free variables are interpreted in formal languages, but the essential duality of variables is a common feature and that will be my focus.

4: Variables, natural language, and explanation

So far we have focused on variables in the context of a formal language, but how are we to understand them in relation to natural language? The traditional answer is along Dummett's (1973/81) lines, a position also held by Quine (1960a, 1960b), Montague (1974), and Davidson (1984), notwithstanding other significant differences between them. The position is that variables exist in the formal analogue of the target language and reflect the choice of a certain analysis of the language, i.e., which predicates we wish to abstract. Whether or not it is thought that a single right analysis is expected or even possible is another matter.[6] What the variable notation does capture is the pattern of inference that is supported in the target language. For Quine (1960a), this is reflected in the variable notation—a logical form—being constrained to amount to an acceptable paraphrase of the target sentence, a paraphrase that makes explicit the inferential standing of the particular paraphrased sentence within the language (more on this below). Consider the simple example:

(6)a Every whale is a mammal

b $(\forall x)[\text{Whale}(x) \rightarrow \text{Mammal}(x)]$

c Everything is such that if it is a whale, then it is a mammal

The point of the paraphrase in this case is that the pronouns in (6c) serve as proxies for the bound variables in (6b). Similarly, we find Davidson (1967) introducing event variables:

(7)a Bill kissed Mary and Mary liked it

b $(\exists e)$[Kissing(Bill, Mary, *e*) $\wedge$ Like(Mary, *e*)]

c There was a kissing by Bill of Mary and Mary liked it

Again, the pronoun in the paraphrase of (7a) serves as a bound variable, which makes sense of how *it* in (7a) can be apparently bound by the event of the kissing even though no appropriate nominal occurs in the first conjunct.

No matter how much we might find the paraphrases from the target sentences into Quinese accurate, they fail to explain why the target sentences have the semantic properties they possess, as opposed to any others; why, that is, competent speaker/hearers understand the target sentences the way they do. Such a lacuna is not a shortcoming given the theoretical assumptions of Quine *et al*., but it is patent that a descriptive conception of variables or logical form does little explanatory work; after all, we might well ask why the paraphrases hold in the first place. In order to answer this querry a more 'cognitively real' conception is required. For present purposes, the realism of such a conception amounts to a way of viewing the semantically significant linguistic structure (syntax) in a way that is abstract and independently motivated rather than just an unexplained paraphrase, an association of one 'surface form' with another. The cognitive aspect of the conception, therefore, is simply that such an abstract structure might be attributed to speaker/hearers as the way they represent or process sentences such that they understand them one way rather than another. The bare idea of such cognitive realism does not involve the claim that variables are cognitively real, i.e., feature in the representations that enter into the cognitive processes of linguistic production and consumption. First off, even if variable notation were somehow essential to the description of the target

phenomena, it wouldn't follow that variables were *real* in the intended sense. All that would follow is that the variable notation places an indefeasible constraint on an adequate theory; just how such a theory would satisfy such a constraint is perfectly open. As it is, the variable notation is not essential, as Quine (1960a) himself argued, and has been shown in detail in so-called 'variable-free semantics' (e.g., Jacobson, 1999). We can capture the kind of inference pattern that traditional logical form depicts without the employment of variables.[7]

What all of this signals is different grades of commitment to the variable talk of our theories.

4: Three grades of variable involvement

There are three possible ways, I suggest, of appealing to variables in thinking of natural language, where, to repeat, a variable is an expression that is either free to be valued from any entity from a domain (given an assignment function that maps entities from the domain onto the variable) or else is bound by a higher operator, which fixes the interpretation of the variable over the domain. So, what are the three grades of modal involvement?

(i) *Variables as artefacts of theoretical representations*

The least committing and so the most innocent involvement a theorist may have with variables is to view them as mere artefacts of a theoretical representation. On this conception variables are part of the means of representation a given theory employs without such means being understood to represent the phenomena the theory is about. One clear way this might be is if the relevant notation is known to be one of a number of

equally good alternatives. Even if no alternatives are known, it still might be understood that the relevant notation is merely notational because it carries no empirical content: the notation would be as good however the facts pan out. Of course, it might also be that one simply doesn't know one way or the other at a given stage of inquiry. I take it that examples of these kinds of scenarios are rife within the history of science and mathematics; especially striking in this regard is the discovery of equivalences between different systems of representation, such as in the characterisation of effective computation, the equivalence of matrix and wave mechanics in quantum physics, and the relation between classical and non-standard analysis. In a lot of current science, however, I take it to be obvious that the parties just don't know if they are dealing with an artefact or something 'real' (witness the much covered disputes about string theory).

Given the fractious and relatively immature state of linguistics—at least syntax and semantics as currently pursued—we are in no kind of position to be confident about what is and isn't an artefact of a given theory. Consider, for example, the choice between traces in the so-called government and binding theory (e.g., Chomsky, 1981) and the slash/categories of generalized phrase structure grammar (e.g., Gazdar, *et al*. 1985). Even if we were to assume that both accounts work equally well at capturing the relevant phenomena, a host of wider and far thornier issues arise concerning simplicity, economy, consistency with background assumptions, and the support the accounts might receive from related inquiries in studies of deficit, parsing performance, and language acquisition.[8] Suffice it to say, none of these issues are going to be settled soon.

It does not follow from any of this that a 'variables as artefact'-position cannot be held in good faith. One may, like Jacobson (1999, 2000), appeal to variables as a

notational convenience, as might anyone else, should the variable notation not distort the truth conditions one is proposing for the construction at hand. There have also been numerous theorists who think of a system of representation as thoroughly notational. Davidson (1980, p. 140), for example, has this to say about his conception of logical form in the context of defending his 'eventish' semantics of so-called action sentences:

> I am happy to admit that much of the interest of logical form comes from an interest in logical geography [what sentences a given sentence entails and is entailed by]... The location must be given relative to a specific deductive theory; so logical form itself is relative to a theory. The relativity does not stop here, either, since even given a theory of deduction there may be more than one total scheme for interpreting the sentences we are interested in and that preserves the pattern of entailments... Seen in this light, to call the paraphrase of a sentence into some standard first-order quantificational form *the* logical form of the sentence seems arbitrary indeed.

So, for Davidson, the variable notation has a double relativity or artificiality, both in regard to a chosen background theory and in regard to the choice of that theory as opposed to some other one. Of course, as explained above, this is not to say that the phenomena (the 'logical geography') is in anyway unreal, but it does leave it unexplained, merely described.[9]

Quine (1960a, p. 159), the chief influence on Davidson, has this to say:

> The artificial notation of logic is itself explained, of course, in ordinary language. The explanations amount to the implicit specification of simple mechanical operations whereby any sentence in logical notation can be directly expanded, if not

> into quite ordinary language, at least into semi-ordinary language... [T]o paraphrase a sentence of ordinary language into logical symbols is virtually to paraphrase it into a special part still of ordinary or semi-ordinary language; for the shapes of the individual characters are unimportant.

Quine is here suggesting an essentially descriptive conception of logical form ('regimentation'), for a translation of a class of constructions into another, more narrowly focused class of constructions of the same language will hardly amount to an explanation of the character of either class. We should heed Quine's remark, though, that the mere invention of a notation does not necessarily take us away from natural language, for a variable might simply be a pronoun, albeit of a different 'shape'. As we saw above, similar views go right back to Frege.

What these views share is a certain conventionalism or anti-realism, not about the phenomena itself (Frege, at least, was as realist as they come), but about the system of logical representation used to capture the phenomena (entailments within meaningful language). For the purposes of the present discussion, I shall take no stand on this general position save for two points. Firstly, although the governing conception is solely descriptive, it does not at all follow that it is pointless; of course not, for descriptions themselves can be true, even if 'relative'. So, for example, I take it that Davidson was absolutely right to be interested in the 'action sentence' inferences that drove him to posit event variables and that his analysis is, at least to a first approximation, true. Secondly and correlatively, just because a particular theorist offers an analysis as a mere description or paraphrase, it doesn't follow that it may not serve as a constraint on a more cognitively ambitious account; on the contrary, if we take some analysis to be

(approximately) descriptively accurate, then it records the structure of the relevant phenomena, so must be respected. Still, we are here dealing with the weakest grade of involvement with variables simply because they are construed to be part of the theorist's machinery alone, not aspects of the phenomena itself.

(ii) *Variables as components of semantic interpretation*

A second and higher grade of variable involvement is to take variables themselves to be semantic kinds that constitute the meaning of natural language expressions. The picture is what Jacobson (1999) refers to as the 'standard view'. Here, variables are not merely part of a notation employed to describe or explain semantic phenomena, but part of the phenomenon itself. Take a semantic theory to be an assignment function that maps elements from a domain onto expressions of the language, where the values of such assignments compose to account for complex expressions. A variable, on this model, enters into the theory in case the assignment for an expression is non-constant, i.e., it varies relative to a determinate range of factors. Personal pronouns, demonstratives, and temporal and spatial adverbs are the paradigm, but the model can and has been extended to a whole range of other linguistic phenomena that appear to exhibit non-constant interpretation, such as quantifier noun phrases, gradable adjectives, relational nouns, weather reports, and many other kinds of construction. Crucially, these apparent variables may be free or bound, and so appear to be much like the variables that occur in formal languages. Also note that the variables may be covert in the sense of possessing no morphophonemic signature. An adjective like *big*, for example, is not associated with any morpheme or peculiar pronunciation that signals that its interpretation is relative to a

comparison class (nothing, so the thought goes, is simply big); likewise, no morpheme signals that the value of *enemy* or *neighbour* must be relative to some person (one can't just be an enemy or neighbour, period). So, to adopt a familiar example, looking at a group of would-be basketball players, a coach might say 'He is too small', pointing at Jimmy, where the audience understands this utterance to mean that Jimmy is too small to be a basketball player, which the coach could well have made explicit by uttering 'He is too small to be a basketball player'. After all, Jimmy might well stand at over 6.2", say. The infinitive phrase here provides the variable content,

My intent is to leave mostly unmolested the idea that a proper semantics must deal with variable assignments. That said, as indicated by the last chapter's discussion of weather reports, I don't think it is at all obvious that such variable readings are mandatory, and so their provenance appears to be non-linguistic. That is to say, if the variable construal is optional, then it would appear to be a feature triggered by wider cognitive effects, that might well be constrained by linguistic factors but not dictated by them. Thus, variable semantics might be challenged if it is assumed that syntax provides the variables to support the variable assignment function. The defender of what Jacobsen calls the 'standard view' may, though, retreat to a neutral position that retains a variable semantics but doesn't treat it as an interpretation of syntactic structure; perhaps the semantics describes a level of language-independent thought, or the variable construals are an aspect of lexical understanding that does not project into the syntax. The general plausibility of these positions, beyond what was said in the previous chapter, is a matter for another day.

(iii) *Variables as interpretable syntactic constituents*

The third and most committing grade of variable involvement is to consider variables to be interpretable syntactic items. Of course, such a position is equivalent to the semantic variable position, only if syntax is viewed as a projection from semantics, i.e., semantic types and their composition determines syntactic types and their composition into 'grammatical' forms. If, though, we assume that syntax is autonomous of semantics, i.e., a distinct system of structures with their own principles of organisation, then the position becomes much stronger than our second grade of variable involvement. This is because the presence of variables in syntax would be an independent parameter, which, when in accord with a semantic account, would provide an independent source of confirmation for some given account of the relevant linguistic phenomenon, such as a locative variable for weather reports or a comparison class variable for gradable adjectives. The problem facing a defender of such an account, however, is to provide *syntactic* evidence or rationale for the presence of the variables in syntax. If no such support is forthcoming, then the syntax will not provide independent evidence for the account at hand; indeed, it would appear that the putative syntax is just a species of semantics and the account would collapse into our weaker second grade of involvement. Here is Chomsky (1979, p. 166-7) on the issue:

> [A] logic with variables and a logic without variables have the same expressive power. But if logical form is derived step by step, it turns out that a logic with variables is required to express certain general principles which explain facts of language... [A logic without variables] do[es] not furnish the types of representation appropriate for formulating rules that relate the surface structure to logical form in the most general way... As far as I can see, certain significant generalizations

require a classical logic containing variables, where at times the variables reflect the presence of a trace in surface structure.

Chomsky (1980, pp. 163-5) makes similar remarks. Chomsky's point here is not, as is clear, to dispute the formal equivalence of different logics or, indeed, their semantic equivalence under some intended interpretation, but to suggest that the notation of quantifier-variable is important insofar as this might reflect processes that bear on syntactic operations that lead to structures that are semantically interpreted. The alternative Chomsky has in mind is Montague's (1974) treatment of quantification (particularly as elaborated by Partee (1975)). This treatment takes quantifier phrases to be syntactically composed in correspondence with their semantic interpretation, so that quantifier phrases are composed in their scopally relevant positions, rather than undergoing movement in order to scope over the material semantically dependent upon them, such as a pronoun or an object position. In effect, therefore, the Montague treatment does not create a quantifier-variable relation within syntax. Still, some such relation can be recovered in the translation of the semantic interpretation into familiar first-order terms.[10] We shall see examples of this below.

The important point for now is that Chomsky takes the variable notation of classical logic to reflect the real structure of syntax independently of how that syntax is interpreted. This is because the notation allows for generalisations bearing on the relation of syntax with semantics, not merely generalisations within semantics. It appears, therefore, that Chomsky is committed to our third and strongest grade of variable involvement. I shall later argue that this situation requires some serious qualification, for we need to distinguish between quantifier-variable relations and the presence of variables

tout court. That is to say, Chomsky's claims appear to rest on syntax reflecting quantifier-variable relations of co-interpretation, not on syntax reflecting variables that may be bound *or* free. So, according to our formal notion of a variable, syntax might well not contain variables, at least as far as Chomsky is concerned. As we shall see, Stanley (2000, 2007), Marti (2006), and numerous others are explicit in their suggestion that syntax contains variables that are either bound *or* free. This will turn out to be a crucial difference, for merely bound items are unproblematic.

As hopefully made clear, these three grades of involvement should not be seen as distinct, contrary positions. One could occupy the first and weakest position out of simple modesty, and not venture any claims about the underlying semantics or syntax. The latter two positions admit combinations too. One may support a variable semantic theory independent of any commitments to an autonomous syntax; one might, that is, support a variable semantics without making any claims at all about syntax. Of course, this does raise the issue of how the two systems interface, but, again, one might think of semantics as a far richer system than syntax, which does not require any kind of isomorphism with syntax. Equally, one might, in effect, collapse syntax onto semantics so that the third option becomes empty, i.e., syntax just is the form of semantics. Finally, one might hold that a variable semantics is the interpretation of the syntax, replete with the relevant variables. This is the option that commits to the strongest grade of variable involvement. It will be our focus hereafter.

5: Variables in natural language syntax

Within generative syntactic theory, various elements appear to be akin to variables in the sense that they can be free or bound. I think appearances are misleading. First, though, let us consider why the idea is tempting.

Let me raise a topic now only to ignore it hereafter. The notion of LF representation in generative theory does not equate to logical form in the sense explained above, even though 'LF' was initially proposed as an acronym for 'logical form'. LF is simply a level of syntactic representation that encodes structure relevant to interpretation, as opposed to phonology. The name was suggested, I take it, because it is the level where quantifier movement occurs, resulting in various scope resolutions. It certainly doesn't follow from this that LF contains variables; it simply contains the resources structurally to depict bound readings.[11] Nothing in the following turns on a proper separation of logical form, which implies truth conditions, from LF, which is simply syntax. So, all future uses of 'logical form' are to be read in the semantic sense, with the understanding that logical form so intended is delivered by way of the interpretation of syntax.

Syntax looks as if it trades in covert variables quite freely; that is, variable-like items that have no morphophonemic signature but are essential to the construal of the host sentence (they are a species of *empty category*). Consider (8):

(8) Who does Mary want to succeed?

(8) is ambiguous between a reading where the subject of *succeed* is being questioned, with *succeed* construed intransitively, and a reading where the object of *succeed* is being

questioned, with *succeed* construed transitively, *Mary* being the understood subject. We may take the structures in (9) to notate the two readings:

(9)a Who_i does Mary want t_i to succeed

b Who_j does $Mary_i$ want PRO_i to succeed t_j

(Here I assume a treatment standard in the so-called *government and binding* framework; we shall consider a different framework shortly). Traces (t) may be understood to be like bound variables coordinated with their index-mate, in this case *who*, which functions like an operator. PRO, similarly, appears to be variable-like in, again, being referentially dependent on an antecedent, in this case *Mary*. Rendered into Quinese, the structures in (9) become

(10)a Which person (*x*) is such that Mary wants him (*x*) to succeed

b Which person (*x*) is such that Mary wants herself to succeed him (*x*)

As a second class of examples, consider the constructions in (11):

(11)a Bill seems to be happy

b Kant is hard to read

c Mary is happy to read

(11a) has the paraphrase in (12):

(12) It seems that Bill is happy

This indicates that *Bill* is not the 'semantic subject' of (11a), for the subject of *seem* in (12) is an expletive—Bill doesn't seem, whatever that might mean. We take *seem*, therefore, to be a predicate of the state of Bill's being happy. Put into Quinese, then, (11a) becomes something like (13a), with (13b) depicting the trace of *Bill*:

(13)a Bill is such that it seems he is happy

b Bill_i seems t_i to be happy

In both cases an element (pronoun or trace t) referentially dependent on *Bill* is explicitly the subject of the monadic predicate *happy*.

(11b) is somewhat different. *Kant* is understood as both the subject of the predicate *is hard to read* and the object of *read*, which requires a subject as well. This gives us the paraphrase in (14):

(14) Kant is such that it is hard for one to read him

Syntactically, a standard approach to such so-called 'tough constructions' is to posit a covert operator, *OP*, whose trace may serve as the object of the embedded verb and whose landing position serves to fuse the complex predicate in its scope so that the matrix subject may serve as its subject (free PRO serves as the embedded subject):

(15) Kant_i is [OP_i hard PRO to read t_i] .

(11c), constituting a minimal pair with (11b), is quite different again. In particular, (16) is patently not a paraphrase:

(16) Mary is such that it is happy for one to read Mary

Indeed, (16) is gibberish unless we take *it* to be referential, whereas in (14) *it* must be an expletive. (11c) is simply a 'control structure' with the subject of the embedded infinitive a PRO indexed to matrix *Mary*. Crucially, the embedded verb, *read*, is construed intransitively:

(17) Mary_i is happy [PRO_i to read]

There are, suffice it to say, other types of empty category posited in syntactic theory and many other kinds of construction where their presence is crucial to the construction's construal.[12] The relevant properties of the above cases, however, generalise, so the above will serve our purposes.

So far, we have looked at covert (empty category) variable-like elements. There are also, of course, overt variable-like elements, such as the pronouns occurring in the Quinese examples above. The overt items may be divided into two kinds. Reflexives and reciprocals are essentially anaphoric, i.e., they are referentially dependent on another item

and do not possess a free or deictic construal. In this respect, they are context insensitive. Pronouns, on the other hand, exhibit a duality, being able to be bound (referentially dependent) or free/deictic. The difference is easily seen in the following contrast:

(18)a Every philosopher loves himself/herself

b Every philosopher thinks he/she is a genius

(18a) is unambiguous with the single Quinese paraphrase:

(19) Every philosopher *x* is such that *x* loves *x*

(18b) is ambiguous between a bound and free construal of the pronoun:

(20)a Every philosopher *x* is such that *x* thinks *x* is a genius

b Every philosopher *x* is such that *x* thinks *y* is a genius

The value of the pronoun on the free construal is contextually determined on the occasion of a tokening of (18b), Kant or Plato, say.[13]

Pro tem, this is all we need to know about the syntax of variable-like elements in natural language syntax. The important point is that language appears to contain syntactic items, both covert and overt, that display variable-like properties, i.e., they may either be free like PRO or bound like a trace. *Prima facie*, therefore, positing covert variables or open argument positions in syntax is perfectly legitimate. As we shall see, the matter is

not so simple, for the covert items that are posited are intended to have both free and bound occurrences depending on context. We have to observe whether anything with such duality is syntactically realised. I shall argue that it is not, so no covert item is actually variable-like.

I mentioned above that the idea of a variable in natural language slides between a genuine free variable in the sense of an item that takes a universal interpretation and an arbitrary name, as an item that takes a definite but arbitrary value. This conflation should be obvious from the above cases. It is uncontentious, I think, that we do not find universally interpreted free variables in natural language. To do so would effectively be to find predicative fragments as part of the language. As Frege and Quine noted (see above), in analysing natural language in function-variable terms, the variable is a feature of our abstracting to such a fragment, but the fragment is not there anyway. Still, what we do appear to have are items that can be either bound or take definite but arbitrary values like arbitrary names. This situation has no precise analogue in the formal case, for arbitrary names are precisely variables that cannot be bound, as it were. What we can say, therefore, is that natural language appears to feature variables in the sense that if they are not bound, then they are arbitrary names. As we shall see, this wrinkle does not affect the general point I wish to make.

5: Syntax and free variables

What I shall propose is that syntax contains no empty categories that may be both bound and free. There are bound items, but these are necessarily bound, and there are what we might think of as free items, too, insofar as they are not referentially determined, but they

are not free in the relevant sense, for these items cannot be bound. Stanley thinks that the very point of positing variables in syntax is to capture the duality between bound and free readings (Stanley, 2000, p. 53). If I am right, syntax cannot contain any such covert variable items. Effectively, Stanley has simply conflated logic with syntax. It is well to note that my claim here does not affect the bare claim that so-called relational items (nouns and verbs) admit both a bound and free reading. Partee (1984, p. 171) remarks: 'I don't know of any cases of implicit arguments which can be interpreted *only* as bound variables or *only* as indexicals'. That thought is right. The question at hand is whether it is also right to claim, as Stanley does, that syntax needs to represent an item with such duality. For her part, Partee (1989, p. 265) commends 'a rather holistic' account of the phenomena, one that integrates different facets of linguistic understanding at the level of the sentence as used rather than the simple valuation of a variable at 'some syntactic level such as a level of deep structure or a level of logical form'.[14] So, while my approach to these matters differs somewhat from Partee, I am in broad agreement with her stance. Partee indulges in second-level variable involvement, not third-level.

Also, as previously mentioned, the position I have on variables has an obvious resonance with the work of Jacobson (1999) and others on so-called 'variable-free semantics'; indeed, as will become clear, the problem with the idea of a linguistic variable is that it is *global*, which is precisely one of the reasons why Jacobson's rejects variables in favour of a strictly *local* variable-free semantics. That said, Jacobson's concern is for a model-theoretic semantics, not syntax; for Jacobson, syntax simply follows, rule-by-rule, its semantic interpretation. Furthermore, for present purposes, at least, I am more concessive about variables than Jacobson. For instance, I acknowledge

overt or 'surface' variable-like elements, such as free/bound pronouns, and traces. It is worthwhile to note, though, that Jacobson's real objection is to open formula being subject to interpretation. We can agree on this without adopting the variable-free approach *in toto* (for example, traces may be interpreted as elements of a chain, which forsakes a strict localism but retains the interdiction against open formulae). So, while my background assumptions differ from Jacobson, I take it that our conclusions are compatible.

My method will be to go through a range of cases as advertised above and show that their standard explanation does not appeal to variables as items that may be free or bound.

First consider traces. Traces function precisely like bound variables in that they mark positions in which the binding item is also interpreted. Transparently, though, a trace cannot be free/unbound precisely because it arises from the movement of the binding item. The situation is different in first-order languages where an *n*-place predicate is understood to contain *n* variable positions independent of whether any of these positions are bound or quantified into. In syntax, a predicate does not contain any traces or gaps independently of the moved item interpreted into the trace-marked position. For example, *wh*-movement may be understood as a rule that targets a *wh*-item in an argument position and moves the item to a non-argument position that scopes over the original position now occupied by a trace. Thus, we go from (21a) to (21b):

(21)a Mary loves who

b Who_i does Mary love t_i

Crucially, the predicate *love t* does not occur in (21a). Such a predicate is the result of the movement operation and its constituent trace is necessarily bound. On the other hand, in the language of first-order logic, variables are understood to be constituents of the predicate, bound or not. In more recent years, in fact, traces have been dispensed with as superfluous technology to be replaced by copies of the very items that have moved (Chomsky, 1995). Under copy theory, therefore, there is nothing resembling a variable at all. Copies come for free, as it were, for copies are just tokens of a single type within different structural positions of a phrase. The type/token distinction is essential to any conception of language, whether in terms of use or cognitive representation, insofar as the one lexical item type can be tokened indefinitely many times within a given sentence. Traces, on the other hand, must be posited as items over and above the lexical items that comprise the lexicon. In effect, therefore, a trace looks as if it is simply a theory-internal item to record a bound reading of a sentence rather than an item that must be a part of the language itself. Alternatively put, traces are posited to meet global interpretive conditions on structures, properties whole structures possess. Copies are essentially local in the sense that they meet conditions that hold between structurally adjacent lexical items, simply because they are lexical items, not unique items designed to express sentence-level internal relations. So, the trace in (21b) fails to meet any local condition pertaining to the verb phrase, for *love t* is simply not a constituent independent of the prefixed/moved *wh*-item. On a copy construal, on the other hand, *who* in object position meets the local conditions of case assignment and object selection, and thematic marking without any special assumptions whatsoever. Whether one goes for copies or traces,

though, it remains clear that the items do not possess a variable-like duality of being free or bound.

Next consider PRO. When in a position to be bound, PRO is necessarily bound. For example:

(22) Sam tried [PRO to win]

Here, we have the one obligatory reading, where Sam tried to bring it about that Sam himself won. It is impossible to read PRO as unbound, where (22) might express the thought that Sam tried to bring it about that someone or other won or that a specific discursively salient person is who Sam tried to have win. PRO may occur unbound, but not as the subject of a subordinate infinitive:

(23)a PRO Smoking is anti-social

b Jill thought [that PRO to talk so freely was asking for trouble]

These occurrences are free in the sense of being unbound, but they are not contextually referential or deictic; rather, they are necessarily indefinite or generic. Put otherwise, PRO is not an arbitrary name, even when unbound. (23a) does not have a reading where PRO designates a salient individual, even though one may use (23a) precisely to talk of some individual. PRO here is interpreted akin to *one's*. Similarly, the PRO in (23b) is necessarily indefinite. Imagine that the topic of discourse is Harry, who always talks in the most impolite terms about senior colleagues to junior colleagues. In such a context,

one may utter (23b) and intend to be understood as making a comment about Harry, but PRO does not designate Harry, for the thought attributed to Jill is not about Harry as such but his kind of talk whether spoken by Harry or not. For (23b) to be true in the imagined context, it suffices that Jill would hold the same thought about anyone who spoke in Harry's manner. Note that forcing a bound reading will always fail.

(24) Jill thought that [PRO to talk so freely was damaging to him/Harry]

We might here construe who is talking to be Harry or the value of deictic *him*, but such a construal is dependent on the speaker's intention, not on the syntactic position of PRO. For the structure to be coherent, it suffices that the talker is indefinite, and so PRO has no bound or contextual value as a matter of saturation. Whoever is talking freely determines Jill's thought to be true or false, but the thought would remain true or false whoever is speaking so long as they were speaking freely in the relevant manner. Arbitrary PRO is indefinite in such cases much like the use of *one* by Queen Elizabeth II.[15]

So far, then, we have found empty categories to be either bound or indefinite. What we don't witness are phonologically null items that are either bound or free to be contextually definite as a matter of saturation like arbitrary names. Perhaps our diet is too thin.

Many theorists posit *pro* (little pro), principally to serve as the subject in structures that allow subject deletion in finite clauses, common in Italian and Spanish. The interpretation of *pro* is not bound or controlled, unlike the interpretation of its big brother (PRO). The interpretation of *pro* is not deictically free, though, either. *pro* is interpreted

relative to its verb, whose morphology dictates its interpretation as regards number, person, and gender. Its value is not contextually definite, but is inherited from its verb.

A much more heterogeneous class is made up of so-called *implicit arguments*. There is little consensus about what implicit arguments are, or even if they are syntactically projected. What is essential, however, is that they have syntactic effects. In this sense, 'implicit argument' in the present context is not the same notion as the homophone used by Fillmore (1986), Partee (1989), and many other semanticists.[16] One may, like Fillmore and Partee, happily talk of implicit arguments without assuming that they have any syntactic position (see above). Our current concern, though, is precisely with the plausibility of finding an explicit syntactic position for the putative implicit variables or positions often hypothesised, regardless of the views of particular theorists. A survey of putative implicit arguments is beyond my scope.[17] I shall be content to make a general point and consider some representative examples.

The most important general desideratum on implicit arguments is that they should be syntactically licensed, i.e., an implicit argument should satisfy a syntactic condition, not merely a semantic construal. Stanley (2000) does suppose that the fact that a binding construal is available means that the syntactic representation must contain a bindee, which would appear to license implicit variables in a fairly liberal fashion. Stanley, however, offers no *syntactic* argument for this claim, which appears to be independently implausible (Collins, 2007; Neale, 2007; Pupa and Troseth, 2011). Our present concern, though, is not directly for the syntactic status of the positions posited by Stanley and others, but only for the general lack of positions within syntax that may be free or bound.

The kind of positions the 'standard view' requires, therefore, will be precluded on general grounds.

As a first example of an implicit argument, consider the understood agent of a passive predicate:

(25) The boat was sunk to collect the insurance

The familiar thought here is that whoever collected the insurance sunk the boat. It looks, therefore, as if passive *sunk* requires an agent to be the controller of the PRO in the subordinate clause. The passive agent is here a potential implicit argument licensed by the demands of control. This reasoning is somewhat dubious, not least because it is not obvious that (25) is a control structure (Landau, 2000; Collins, 2007). Let that pass, though. The important point is that the implicit argument that is reckoned to be present in (25) is not one that can be bound or free; rather, it is simply indefinite: the one who sank the boat is also the one who collected the insurance. So, here we do not have an example of a variable that may be bound or free.[18]

Next consider what I think is a more problematic case:

(26) Bill said to wait

Who is waiting here is the addressee, not some arbitrary person or persons (*Bill said for you/us to wait*). The addressee, however, is certainly contextually fixed. I am not sure what to think of this case. I am tempted to think that it turns on the general implicitness

of the second person in imperatives. The crucial factor here is that the subjects of imperatives are not variables in the intended sense, for one cannot bind the position of the subject without losing the imperative mood.

Let us next consider two interesting examples from Landau (2010). The first one goes by way of Landau's notion of partial control, i.e., control where the controller of PRO is singular, but the predicate containing PRO is collective (ibid., p. 369):

(27) Mary found it exciting to meet at the top of the Empire State Building

Mary cannot meet herself, so the PRO subject of *meet* must be collective, but its only possible controller is the singular implicit experiencer (the agent who experiences the excitement) identical to Mary. For the nonce, let us accept partial control.[19] Again, however, this is not a case where we find a variable with the potential to be both free and bound. Were the implicit controller here free, (27) would support a reading equivalent to, say:

(28) Mary found it exciting for him to meet at the top of the Empire State Building

Mary lives her life vicariously; she fantasises about the romantic dalliances of a colleague. No matter how coherent (28) might be, it is not expressible by (27), whose implicit controller needs to be bound by the matrix subject, *Mary*.

Next consider:

(29) John rarely serves the dessert

Landau (2010, p. 378) describes this case as one where an eventish implicit argument serves as a free variable that is existentially bound: it is the event of John's serving desert that is rare. It is unclear to me why Landau describes the case in this way. If we assume a mandatory event variable introduced by the verb, then the adverb *rarely* doesn't introduce an eventish implicit argument, but serves as a secondary predicate of the event. Such, at any rate, is the standard eventish way with adverbs.[20]

Finally, Martí (2006) also suggests that syntax contains items that are variable-like in having a bound or unbound duality. She writes:

> I postulate a phonologically null variable in the syntax of sentences with *rain* and *eat*, and that variable can be either free or bound. However, that is not the whole story, because [weatherman-like scenarios[21]] must be explained. In order to do that, I claim that these silent variables are adjuncts, i.e., they are optional. They can, but don't have to, be generated in the syntax of [the relevant] sentences. (ibid., p. 141).

My present concern is not to worry about whether such optional silent elements will do the work Martí asks of them, but instead to worry about the license for the very idea of elements of the kind postulated.

Adjuncts are indeed optional in the sense that a structure being acceptable or unacceptable is invariant between the presence or absence of an adjunct; that is, there are no syntactic (including lexical) principles that demand the presence of an adjunct. Semantically speaking, if we view adjuncts as essentially conjunctive, then whatever the adjunct modifies retains its unmodified meaning. So, in the case that Martí mentions, if

the locative reading of *rain* is adjunctive (i.e., if a location for a raining event is added as further information about the event), then it will be optional, with *rain* meaning rain (if you will) in a case where the location is truth-conditionally relevant and in a case where it is not. This seems to explain the possibility of two such readings of *It's raining*. Furthermore, the explicit locative *here* in *It's raining here* seems to be an adjunct. So, I think that Martí is right to think that *if* there are optional variables in syntax, then they will be adjuncts, not arguments (ibid., p. 146). The problem, however, is that because adjuncts are optional, there appears to be no *syntactic* basis at all for thinking that an adjunct is present unless it is explicitly provided, i.e., the adjunct will be invisible to all syntactic tests. In other words, appeal to a phonologically null adjunct looks like a stipulation of the syntax on the basis of purely semantic or pragmatic considerations. What we are after, though, is a syntactic basis for thinking that anything truly variable-like occurs in syntax. Martí (ibid., p. 150) does suggest the following proposal:

> Whether a [variable] is generated in the syntax or not is left completely free, just because adjuncts generally are not necessary. The system tries out different derivations, and only those that comply with all the principles of grammar, including Gricean principles, are successful.

The proposal appears to be that the language 'system' may crank through a number of derivations, including ones that feature the relevant adjunct and ones that do not, and so the system furnishes the relevant structures, i.e., ones that include a covert adjunct variable to support a locative construal of *It's raining* and ones that contain no such variable to support non-locative construals of It's raining. It is difficult, though, to this as any kind of elaboration or defence of the idea of covert variables. Since adjuncts are 'not

necessary', then no narrow syntactic or lexical principle will demand their presence, which is just to say that, as far as syntax is concerned, all relevant derivations in Martí's model will be successful. What must make the difference, therefore, is the wider system inclusive of 'Gricean principles'. If it is the Gricean principles that crucially select one derivation over another, then we are being asked to think that essentially pragmatic principles intrude into syntactic derivations. In itself, this might not be a crazy idea, for Chierchia (2004) has persuasively argued that certain generalized implicatures (e.g., from *five* to *exactly five*) are syntactically encoded. That account, though, works on the basis of the implicatures being lexically licensed and locally computed within the relevant phrase. Martí's proposal is quite different, for since the putative variables are adjuncts, they are, *qua* optional, not lexically licensed at all and would be globally computed as a function of what a speaker intendeds given the context. So, if we are looking for syntactic reasons for, or just an example of, variable-like elements within syntax, Martí's adjuncts hardly do the job; for, however the pie is cut, they are pragmatically licensed.[22]

6: Syntactic variables with a semantic rationale

In light of the above considerations, it might be thought that syntactic variables such as trace/copy and PRO are indeed never free in the relevant sense (always bound or indefinite), but only because such items serve a wholly structural or syntactic role. What is required in order to prove my case, so the thought continues, is an analysis of variables that putatively occur in syntax but which have a semantic rationale. I think the initial motivation for this thought is wrong-headed insofar as trace/copy, PRO, and the other items discussed above all have a semantic role to play. Nevertheless, the challenge to cast

my net wider is well-taken. I shall consider three hypotheses of variables designed to capture certain semantic phenomena, but which are also supposed to be syntactically realised. Each of the cases will be shown to support my general contention that syntax doesn't tolerate free variables, even where the variables are posited for wholly semantic reasons. Of course, there are probably hundreds, if not thousands, of distinct proposals one could survey. I discussed Stanley's idea of free event variables in the previous chapter as well as the notion of a locative argument for *rain*. There is also the much discussed case of quantifier domain restriction, which I have discussed at length elsewhere (Collins, 2007; cf., Neale, 2007; Pupa and Troseth, 2011). My present concern, though, is to see if there is any good case of a syntactic 'variable' that can be bound or free. It is no good for people just to posit items with exactly such duality and then claim them as evidence for what is at issue.

My method is to highlight two proposals that explicitly posit variables in syntax to satisfy semantic conditions. That is, such cases parallel the methodology of Stanley and Martí. The crucial difference, or so I shall contend, is that whatever the independent syntactic plausibility of these variables may be, they are at least plausible as syntactic items because they cannot occur free.

6.1: Heim and Kratzer on QR

Heim and Kratzer (1998, pp. 178-88) pose the familiar problem of quantifier phrases in object position.[23] For example:

(31) Bill offended every linguist

The problem is that there appears to be a type-mismatch. Assume that transitive *offend* is of type <e, <e, t>> (i.e., a function from an object to a function from an object to a truth

value) and that the DP *every linguist* is of type <<e, t>, t> (i.e., a function from a function from an object to a truth value to a truth value). Patently, if these are the semantic types, then *offend* can't semantically compose with *every linguist*, for *every linguist* would have to be of type <e>, not type <<e, t>, t>. The solution Heim and Kratzer propose is that the QR-movement of *every linguist* from object position creates a variable, which serves to satisfy the type requirements explained above. Thus:

(32) $[_{TP}\ [_{DP}$ Every linguist$]_1\ [\lambda_1\ [_{TP}$ Bill offended $t_1]]]$[24]

The type mismatches are now resolved. *Offend* may now take the trace (t_1) as its argument, which is of type <e>. The DP *every linguist* requires an argument of type <e, t>. Since TPs are type <t>, a projection is required to render the TP as type <e, t>. The abstraction operator serves this end, presenting the TP as a function from the set of individuals to Truth just in case Bill offended the individual. I have already questioned the syntactic assumptions underlying this otherwise elegant proposal in the previous chapter. My present concern is just to highlight a feature of this analysis.

Although Heim and Kratzer understand the trace of the QR-movement as a variable that is not merely co-indexed with the moved DP, the variable is still necessarily bound by the introduced λ-operator. Without the operator, a type-mismatch would occur between the DP and the TP. The variable, therefore, cannot be free. This is clear enough anyway, given that the variable is a trace. My point is that the introduced operator mediates this relation rather than usurps it. So, although the motivation for the additional structure is purely semantic, it still cleaves to the syntactic conditions I have been spelling out.[25] A more troublesome case arises with the analysis presented by Percus (2000).

6.2: Percus on world variables

Percus (2000) hypotheses that indexed variables or 'silent pronouns' that have 'situations' or 'worlds' as values mandatorily occur within full verbal projections (selected by the head verb) and within DPs (selected by the determiner or nominal) (ibid, p. 183). He writes:

> If we accept the popular view that pronouns function as variables over individuals, then there is independent motivation for the idea that the syntax contains indexed items that function as variables as far as the interpretation procedure is concerned. The only real difference between the pronouns on the popular view and the world variables I have posited here is that the world variables are unpronounced. There is also independent motivation for the existence of unpronounced items that are interpreted in the same way that pronouns are: this is the common view of traces and PRO.

On the face of it, therefore, Percus appears to be precisely claiming that the variables have bound and free occurrences just like overt pronouns. Percus's lead motivation to posit the variables is to account for certain ambiguities or possible construals much as we find in the familiar principles of binding theory. In the case of situation/world variables, however, the relevant construals bear on the class of individuals lexical items take as their values. Consider (i):

(33) If every semanticist owned a villa in Tuscany, what a joy this world would be

(33) is ambiguous between an *transparent* and an *opaque* reading. The former reading bears on the set of semanticists at a given world; if the actual world, then the set {Partee, Higginbotham,…}. The latter reading bears on the set of semanticists at any given world.

So, the *if*-clause on the transparent reading enjoins us to evaluate the main clause relative to Partee, Higginbotham, etc., and the *if*-clause on the opaque reading enjoins us to evaluate the main clause relative to the semanticists at any world, i.e., semanticists as such. To see the difference, consider the conditional in (34):

(34) If *every* semanticist owned a villa in Tuscany, there would be no field at all

One might accept (34) on the basis of thinking that the semanticists one knows are not the kind of people who would own villas in Tuscany and be semanticists. Given such a judgement, there would be no field of semantics were such people as Partee *et al*. to own villas in Tuscany. Thus, one would be reading the *if*-clause transparently. If one were reading the *if*-clause opaquely, then any world in which there is at least one semanticist, such as the actual world, would be a world in which there *is* a field of semantics. Thus, one wouldn't accept (34) (Percus, 2000, p. 176-7). Percus seeks to employ situation/world variables to capture such a difference in readings. The basic idea is that each variable occurs with a bindable index such that the same worlds/situations are determinable of the truth conditions of the host structure if the same indexes occur within the lexical projections of the host's constituents; otherwise not. So, the two readings of (33) can be notated as follows:

(35)a λ_0 [TP_1 . . . $_0$ . . . If [TP_2 λ_1 [TP_3 . . . every semanticist . . . $_0$ . . . owned a villa . . . $_1$ . . .] . . . what a joy . . .]

b λ_0 [TP_1 . . . $_0$ . . . If [TP_2 λ_1 [TP_3 . . . every semanticist . . . $_1$ . . . owned a villa . . . $_1$ . . .] . . . what a joy . . .]

(35a) depicts the transparent reading, where the semantic assignment to '0' (*g*(0)) fixes a set of semanticists at that world such that the interpretation of the *if*-clause is a function from those worlds in which those semanticists own Tuscan villas to Truth, just in case the semanticists own Tuscan villas; the value is False otherwise. The whole conditional, therefore, expresses a function to Truth just in case every world in which those semanticists in 0 own a Tuscan villa is a joy. On the other hand, (35b) depicts the opaque reading, where the *if*-clause expresses a function from the worlds where every semanticist in those worlds owns a Tuscan villa to a truth value. The whole conditional, therefore, expresses a function to Truth just in case every world in which every semanticist owns a Tuscan villa. As may be noted, the difference is a function of whether the variable in the DP is locally or non-locally bound (transparent, if locally bound; opaque, if non-locally bound).

My present concern is not to question the semantics or the syntax Percus proposes. I shall assume that Percus's assumptions and arguments in both domains are sound.[26] My concern, rather, is whether, in fact, on offer is a case of covert ('unpronounced') variables functioning exactly the same as their overt cousins, as Percus claims in the quotation above. The situation is somewhat hard to disentangle. The crucial question is whether the situation variables have a free reading as well as a bound reading.

Let us restrict ourselves to the verbal case. Percus assumes that a situation/world variable 's_n' is projected from the verbal root within the full thematically saturated projection (a *v*P) [Percus assumes that any additional functional material that embeds the *v*P will be interpretively irrelevant to the variable (ibid., p. 188). This seems right, so we may ignore higher functional material and just consider the *v*P projection.] For example:

(36) [$_{vP}$ s_1 [$_{v'}$Bill [$_{v'}$ *v*+kick [$_{VP}$ <kick> the ball]]]][27]

Here, the phrase expresses a function from worlds that are the values of 's_1' to truth values (Truth, if those worlds are such that Bill kicks a ball; False otherwise). The variable is bound by an adjoined operator that extends the *v*P. Thus:

(37) [$_{vP}$ λ_1 [$_{vP}$ s_1 [$_{v'}$Bill [$_{v'}$ *v*+kick [$_{VP}$ <kick> the ball]]]]

Our concern, therefore, may be expressed simply as: is the operator necessary for the interpretability of the variable such that the variable unbound can take no free value? Percus is somewhat unclear on the matter. That the operator is an adjunct would appear to render it optional, such being the nature of adjuncts (ibid., p. 201, n.21); after all, according to Percus, no item within a projection selects for the operator. This scenario, however, can't be right.

First off, the operator structure *is* selected by (*inter alia*) propositional attitude verbs that take the structures as complements, which indicates that the operator is not an adjunct but a complementiser that categorises the clause as a proper constituent to be selected as opposed to an open formula. This fits with Percus's account, according to which the operator maps the function from worlds to truth values expressed by the initial *v*P onto *propositions*, i.e., a determinate set of worlds. Furthermore, Percus (ibid., p. 201, n. 20; pp. 226-8) is happy to assimilate his account with that of Heim and Kratzer's

(1998) discussed above, where, as we saw, the variable is mandatorily bound as a function of the movement of the relevant DP.

The matter may be resolved, I think, by considering the following remarks of Percus (ibid., p. 201, n. 21):

> [I]n cases where we find λs adjoined to VPs containing a single situation pronoun [a variable], *J* [the interpretation function] will yield the same value for this adjunction structure that it yields for the sister of the situation pronoun alone [i.e., the VP minus the variable]. But it would be wrong to think that the additional structure that the λ and the pronoun provide is always interpretively redundant: it isn't in cases where the VP contains a second situation pronoun coindexed with the λ.

Clearly, the operator and the variable come as a pair for Percus, for the function they express just is the function expressed by the phrase on which they operate. The requirement for them, as Percus explains, is where more than one variable occurs in the host structure. In effect, here we witness the 'paradox of the variable' again, although Percus doesn't generalise the point. When two or more variables occur in a structure, higher-order operators are required to interpret them as the same or different. Moreover, given the equivalence of the VP minus the variable and the VP with the 'adjunction structure', it can't be the case that the variable may take a free value such as overt *she* or *he* may take in a structure in the absence of any higher operator. If it could, then the equivalence would not hold, for the full 'adjunction structure' expresses a function from a set of worlds/situations to a proposition, not a function from a particular world/situation

to a proposition; a particular world/situation may only be the value of the variable relative to its being bound non-locally in relation to another variable, as explained above.

Much more could be said about empty categories and variable-like items in syntactic structure. I shall, in particular, look in detail at the curious case of indefinite DPs in the following chapter, but before doing so, I invite you to generalise from the cases presented, to reach the conclusion that syntax contains no covert free variables as items that may be either bound or be contextually valued.[28] The obvious question is why this should be so.

7: Variables: local and global

Let us assume that the generalisation of the above reasoning is correct: natural language syntax contains no items that may be free or bound in the way formal variables enjoy such a double-life. Now, we may just take that to be a brute fact. Such an attitude would amount to the thought that natural language syntax is simply not a formal language of logic. There is, in short, no good a priori reason to expect language to feature free variables. The result that it doesn't is a mere empirical fact about natural language. Although true, if I am right, it is hardly satisfying, for it is a curious property and should be linked to a deeper understanding of natural language. I think the shape of a deeper answer is available.

Free variables in logic, as explained above, are effectively positional gaps abstracted as a feature of the structure or formula understood globally as a completed thing; that is to say, the formula containing the variable is interpreted relative to some domain over which

the non-variable part has a fixed (intended) interpretation. The gaps construed locally to their host sub-formula do not intrinsically carry any content save for ranging over the domain. Thus it is that they may be free or bound depending on whether the relevant operator is present in a formula that contains the variable formula as a part. Syntax, however, cannot be gappy, no more than a formal language can be literally gappy; a formal language represents something else as gappy, in order, say, to depict the adicity of a predicate, but does not do so by being gappy itself: the variables fill the gaps. With natural language, however, each item in a syntactic structure is intrinsically contentful in the sense that it poses demands that must be met by other items with which it may merge to form complex expressions. Unlike a variable, qua positional or abstractive gap, a syntactic item must be interpretable locally independent of higher operators as a feature that goes to determinate the nature of its host structure. Just what such locality amounts to in syntax is a controversial question, but one which can here be sidelined, for the relevant contrast is that in natural language an item is determinately interpreted in its immediate position local to whatever it is combined with, which is not affected by how that local structure might be further combined into a more complex structure.

Alternatively, we may say that syntax is not a language waiting to be interpreted, but a structure already interpreted insofar as all its effects on content are determinate. Variables are our theoretical way of generalising or abstracting, but what we are generalising or abstracting over is not itself abstracted from anything at all. As Fine notes, we can speak generally without having any particulars in mind that realise the property we are speaking about.

Chomsky (1995, pp. 152-3), in fact, makes the analogous point in regard to tough constructions discussed above.[29] Consider (38):

(38) John is too clever to catch

This is interpreted as John is so clever that an arbitrary person/thing will not catch him. It does not have the interpretation of the object of *catch* being free or generally bound, as in *John is too clever to catch him/it/someone,* etc. The acceptable reading is captured in the following way

(39) John is [OP_i too clever PRO_j to catch <OP_i>]

The posited empty operator (OP) is necessarily bound by the matrix subject, *John*. Chomsky (ibid., p, 153) concludes that 'language does not permit free variables'. Chomsky doesn't explain why this should be so, but the reasoning I have offered above lets us see why. In a tough construction like (38), the predicate *too clever to catch* appears to be missing an argument (the object of *catch*). On the face of it, then, the predicate contains a free variable, because the argument position cannot be bound locally within its phrase, i.e., *John* interprets the position, which is outside of the phrase. But if this were so, (38) would have a free variable interpretation along with the bound interpretation, where *too clever to catch* would mean too clever to catch something or other. In order to rule out this reading, therefore, all interpretational relations must be local. Hence, we posit the empty operator, which itself must be bound locally; it must, therefore, move to the SPEC position of the predicate in order to be bound by *John*, which, in turn, via the operator now being local to it, binds the object position of *catch*. So, we get the effect of variable binding as a global condition with all the interpretational relations determined locally with no free variables.

The general moral is that if interpretational relations are local, then there cannot be free variables, for such variables might be free locally, but bound in the context of the global structure that subsumes local relations such as that between a verb and its arguments. Whether the variable would be free or bound would depend on the presence or absence of the relevant operators. It is just such an arrangement that appears not to hold, precisely as we would expect if syntax works in a strictly local fashion, not permitting the change in interpretation of a local relation because of a global property of the structure.

The argument just presented would be sunk, of course, if (38) did have a free variable interpretation, or, indeed, if all transitive verbs with elided objects had a free variable reading. As we shall see in the next chapter, Recanati (2010, pp. 115-7) discusses such a possibility, without endorsing it. For (38), all we apparently need to do is be sufficiently clever in constructing a scenario for the free variable reading. Imagine, then, that a group of boys including John, are playing a game, where one drops or catches a ball being passed around depending on some formula pertaining to the number of times it has been previously dropped or caught. The idea of the game, then, is to keep track of the maths. In this setting, one could utter (38) and mean that John is very good at the game, he is too clever to catch on those occasions when he should drop the ball. One can easily proceed in a like manner for other cases. For example, *Bill is too heavy to lift* can be construed such that Bill is so obese that he should have an office job rather than be on the shop-floor. Such cleverness, however, does not argue for the presence of free variables.

The free interpretations are not lexicalised, as they are with *eat*, *read*, *drink*, and so on. In these cases, the 'missing object' is not a syntactic constituent at all, but part of the lexical content, i.e., to eat is to eat food, to drink is to drink fluid, to read is to read a book, and so on. As Mittwoch (1982) pointed out, transitive and intransitive *eat* differ in aspect. Intransitive *eat* is an activity verb with no marked termination (to eat is not necessarily to finish eating something), but transitive *eat* is an accomplishment with a termination (to eat an apple is to finish the apple). The same holds, more or less, for the other relevant verbs.[30] If these verbs had a free variable object, they should, contrary to fact, be accomplishments. These cases, therefore, do not offer a model from which to generalise to free variable interpretations in cases like (38).

Most damning of the proposal, though, is that one can do the interpretational trick with any verb in the 'tough' construction. In which case, therefore, unless we are given reason to think otherwise, every argument position should admit a free reading unless overtly occupied, as if it contained a free variable. This is not the case, though. It doesn't work for subjects, datives, prepositional and complement arguments, or, indeed, unaccusative object positions (see chapter cvc). What is really going on in these forced cases, it seems, is a form of abbreviation, where the object position is being read in terms of a contextually salient item as if a term for it were the used object. What one doesn't find is an indefinite, something or other, reading that one should find with a free variable in the absence of context. As said, if the trick works for one verb, it should work for all, but the effect is evidently not productive, in that a scenario has to be precisely specified for each case to enable the reading.

The matters arising here concerning the role of context and lexical content in relation to syntax are highly complex, and cannot be discussed here, let alone settled. Still, I hope a prima facie case has been made for the absence of variables in syntax and why this should be so.

8: Concluding remarks

My aim has not been to overthrow any particular way of pursuing syntactic or semantic theory, but rather to cast doubt on a way of conceiving of the relation between the two. The relation, I think, is not as intimate as many philosophers of language imagine. As Partee puts it, some matters of interpretation appear to be 'rather holistic' bearing on the sentence as a whole, but syntactic matters seem to be local. One signature of this is the absence of variables proper in syntax. If I am right, therefore, we should happily indulge in first-level involvement with variables. The second-level involvement is a more complex matter, for it seems as if much of the work of variables can be done in their absence. The third-level involvement should be avoided, which casts doubt on the second-level involvement too, assuming that semantics should interpret or at least be constrained by syntax. In the following three chapters, I shall look at some case studies of the putative role of variable items within natural language: weather reports, indefinites, and predicates of personal taste. In each case I shall argue that variable involvement of the third level is unsupported.

Notes

[1] I am not here concerned with whether such attitudes are acceptable; I assume that they are. Sennet (2011) does a good job, though, in arguing that some structural conditions must be placed on 'unarticulated constituents' if they are to be stably associated with sentence types.

[2] Jacobson (1999, p. 127) makes essentially the same point, which she credits to Partee, that 'x_1' and 'x_2' 'never make a different semantic contribution' when being hosted by distinct predicates.

[3] It doesn't 'say', in particular, that even numbers are multiples of 2; instead, it simply picks out the multiples of 2.

[4] After arriving at this resolution of the 'antinomy', I was happy to find Kellenberg (2010) offering much the same account by way of what he calls a 'semantic rule': 'if there are several occurrences or tokens of one and the same variable type within one and the same sentence or context, then these occurrences or tokens must assume the same value at a time' (ibid., p. 232). As made clear, I think it preferable to think of the relevant condition as being syntactic, much like Tarski's indexation of variables. This is because, as demonstrated, tokens of type-identical variables in a context must be bound together; so, one gets the relevant distinction merely by way of the syntactic difference between an open and closed formula, regardless of semantic value. Furthermore, Kellenberg, like Fine, goes wrong in thinking that the same demand of co-interpretability holds for type-identical names in a context. It is plain that the two occurrences of *Sam* in the following sentence need *not* be co-interpreted: *Sam met Mary, Joe, and Sam at the disco*.

[5] An issue I have here eschewed is the putative neutrality of relations, a position Fine (2000) has elaborated. According to this position, relations are not instantiated as

intrinsically ordered, but are instead neutral as regards the positions of their relata (see MacBride, 2007, and Fine, 2007, for discussion of problems with the view). Fine's key argument turns on the thought that one doesn't want a superabundance of relations in the world that, effectively are the same relation, save for the order of the relata. For present purposes, I am happy to be neutral about the matter, for the possibility of neutral relations arises just for ontology, not their symbolic or linguistic realisation; after all, a linguistic system can have as many distinct relations as one wants that are made true by the one kind of state of affairs, so parsimony is not an essential condition on language the way it is on the world. That said, Fine (2000, p. 6-7) correctly notes that one could imagine an 'unusual' graphic system which expressed the dyadic property of *x* loving *y* in a way that wasn't distinguishable from the expression of *y* being loved by *x*, i.e., no relation of order or some other signature marked the lover from the loved. The fact is, though, that no such system exists or would be adopted, because any symbolic system must distinguish argument roles.

[6] Notoriously, Montague abstracted to the 'worst case' in the sense of treating every expression within a category as being of the same general type that works for every instance of the category.

[7] Of course, there might well be far broader and sounder reasons for thinking that human cognition involves the representation of variables (Gallistel and King, 2009). Indeed, language cognition essentially involves variables in the sense that linguistic tokens are thought of according to discrete types. Just such a conception is the basis of the difference between a finite-state machine and a phrase structure grammar. My present point solely concerns semantically interpreted variables as syntactic items.

[8] For discussion, see, for example, Grodzinsky (1990) and Fearthson (2001).

[9] Davidson (1986, p. 438), it is worth noting, does not deny the feasibility of a more 'cognitively real' theory but suggests that 'it does not add anything' to the choice of a theory of logical form to say that it corresponds to something real in the speaker/hearer. What is added, I suggest, is an explanation of precisely why the theory holds of the speaker/hearer, even if the theory itself is not thereby enriched descriptively.

[10] Chomsky (2012, pp. 16-7) speculates that standard quantification theory is relatively accessible to us, easy to teach, because it mimics the way natural languages determine scope; variable-free combinatorics is much harder to teach, even though the systems are equivalent. As Chomsky suggests, this could be empirically tested. Although intriguing, Chomsky's position is not so obvious. Firstly, variable-free combinatorics is simply notationally more complicated as there is the need for more primitive function symbols to capture the polyadic structures within a uniform unary format, which disguises the underlying content, as it were. This difference is measurable independent of considering the nature of human language. Secondly, in a language such as English, where movement for scope determination is covert, one would predict that a system that made scope uniformly overt would be difficult to learn. As it is, from many years teaching first-order logic, I have found many students incapable of grasping the mechanisms.

[11] For explicit reasoning to this effect, see, for example, Chomsky and Lasnik (1977), May (1985), and Huang (1995). For an excellent discussion of the difference between LF and logical form, see Lappin (1991).

[12] According to standard generative accounts of the past twenty years or so, any tensed clause (finite or infinite) will feature the movement/copying of the SPEC of the verb

phrase to the SPEC of the tense phrase. For discussion of the semantic significance of this generalisation, see author 1.

[13] I do not here say that pronouns *are* variables, either semantically or syntactically. Trivially, pronouns are not *literally* variables because each pronoun belongs to an invariant type, whereas variables are distinct relative to their positions within a formula.

[14] Three features of Partee's position should be noted. Firstly, Partee does not deny the relevance of syntax to the interpretation of implicit arguments; her point is that syntax *constrains*, but doesn't *determine*, the available readings. Secondly, the phenomena which most concern Partee are relational nouns, verbs, and adjectives discussed above, not weather reports. Still, she sees such phenomena as 'probably the tip of an iceberg' (Partee, 1989, p. 261). Thirdly, the arguments Partee offers against a syntactic rendering of implicit arguments strike me as convincing, although the position she imagines is not quite Stanley's, if for no other reason than that Stanley's position remains obscure in its detail.

[15] The status of PRO is currently controversial. The Movement Theory of Control (MTC) seeks to reduce control phenomena to generic movement. Trivially, if MTC is right, then control structures do not suggest variables that may be either free or bound, for the controller-controlee relation reduces to copying, not the binding of an independent element. For discussion of MTC, see Hornstein (1999), Landau (2003), Davies and Dubinsky (2008), Hornstein and Polinsky (2010), and Boeckx, *et al*. (2010)

[16] I here assume, following Partee (1989), that the construal of relational items, such as *local*, *enemy*, etc., is not a syntactic matter.

[17] See Bhatt and Pancheva (2006) and Landau (2010) for excellent surveys of positions on the status of implicit arguments.

[18] The same holds for more marginal cases of implicit arguments, such as the *experiencer* of predicates of personal taste (see Chapter bnn).

[19] For alternative analyses of the data and critical discussion of partial control, see Bowers (2008), Boeckx, *et al*. (2010), and Urigereka (2012).

[20] This results in an analysis along the following lines:

(i) $(\exists e)$[serving(e) $\wedge$ AGENT(John, e) $\wedge$ THEME(dessert, e) $\wedge$ rare(e)]

[21] 'Weatherman scenarios' are ones where utterances of, for example, *It is raining* can be construed without reference to a definite location. See Recanati (2004, 2007, 2010) for discussion of such cases.

[22] If this reasoning is correct, then the adjuncts proposed by Martí are effectively items of free enrichment in Recanati's sense, which is a doctrine Martí takes herself to be rejecting.

[23] See Glanzberg (2006) for further discussion.

[24] This tree is somewhat different from Heim and Kratzer's (1998, p. 186) example, but the difference makes no difference to the present issues.

[25] The same reasoning holds for Fox's (2002) analysis of QR which places a variable in the lower copy (as opposed to a trace).

[26] As it happens, I think Percus's syntactic argumentation is weak. Firstly, there is no independent reason to posit the variables as selectional requirements of VPs and DPs; they support, for instance, no thematic or phi-checking properties. Secondly, the indexes of the variables are syntactically unmotivated, for they appear as global features rather

than features that could be locally determined within a verbal or determiner projection. Thus, there appears to be nothing about a given DP that would determine that its variable is coindexed or not with the variable of the containing VP, i.e., the relation between the indexes in a structure is an interpretive condition, not a generated syntactic relation. Thirdly, the position of the operators is quite obscure. If they are adjuncts, then they are always optional, but they can't be optional precisely because of the selctional requirements they satisfy. If they are not, therefore, adjuncts, then they must be complementiser items of some sort, but complemtisers do not serve as operators that bind. More work is in order to resolve these issues.

[27] Here I elaborate on Percus's (2000) sketch of the relevant structures to make them cohere with his assumptions, for the structures he offers leaves the relevant projections hard to discern (ibid, p. 187). I assume, for instance, that the variable is not in an adjoined position, which would render it an item unselected by the verbal root. Thus, it must fall under the *v*P and not extend it.

[28] With all due caution, Glanzberg (2009) suggests that Kennedy's (2007) account of a functional degree head construed as a *standard* in gradable adjectives might count as a variable in possessing both free and bound occurrences. Bound readings are putatively exemplified in (i):

(i) Most species have members that are small

Here, the quantifier phrase (*most species*) is supposed to bind the standard of size relative to each species. Stanley (2000) and Scharzschild (2002) also appeal to the same kind of phenomenon without any appeal to syntax. The case is unconvincing, I think. Firstly, the data are marginal at best, for I can see no semantic or syntactic injunction against the

thought that, if one wants a standard-relative construal of (i), one will have to insert the adjunct *for the species*. It is not incoherent, after all, to respond to an utterance of (i) with *Well, no whale is small*. Similarly, the following discourse strikes me as perfectly coherent, perhaps even predictable:

A: Most basketball teams have members that are small

B: No they don't – they are all giants

As Glanzberg readily notes, the absence of clear *syntactic* tests casts the semantic construal under a pragmatic shadow. Secondly, the notion that a functional head might be a bindable variable is somewhat odd precisely because the position being bound into is not an argument position.

[29] Tough constructions have been variously interpreted over the years, but nothing I say below depends upon matters of controversy, just the interpretation of the constructions and a proposal as to why they are so interpreted.

[30] The activity/accomplishment distinction is not entirely clear in all cases. One can say *Mary went fishing, but Bill read a book instead*, without suggesting that Bill finished the book. Familiarly, too, the accomplishment reading depends on the object being count; a mass object renders the transitive case an activity.