

Types and Tokens: On Abstract Objects

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1 The Data

The distinction between types and tokens has widespread application. The present chapter will show just how widespread it is. Reference to types occurs not only in philosophy, logic, zoology and linguistics, but in most other disciplines. First we will look at the important role the type–token distinction plays in philosophy; then I will present the data that show that talk of types is thoroughly ensconced in ordinary and scientific language and theory. I will not argue in this chapter that, as a result of the truth of this type-talk, types exist; that is the thesis of chapter 2.

Nor will I argue here or anywhere else that there are no type-free statements logically equivalent to any of these type statements; I assume there often are. Chapters 3 and 4 will examine whether *all* of them can be so paraphrased. The purpose of chapter 1 is simply to present the multitudinous data that would require this nominalistic paraphrasing.

Type–Token Use in Philosophy

In *philosophy of language*, *linguistics*, and *logic* the type–token distinction is clearly important because of the central role played in all three by expressions, which come in types and tokens. Especially noteworthy is the debate concerning the relation between the meaning of a sentence type and the meaning of a sentence token (a relation that figures prominently in Grice 1969). So, for example, the sentence type ‘John loves opera’ means that John loves opera, but a speaker might say it sarcastically meaning by her token that John *loathes* opera.

In *philosophy of mind*, the distinction yields two versions of the identity theory of mind (each of which is separately criticized in Kripke 1972, for example). The *type* version of the identity theory (defended by Smart [1959] and Place [1956], among others) identifies types of mental events/

states/processes with types of physical events/states/processes. So, for example, it says that just as lightning turned out to be electrical discharge, so pain might turn out to be C-fiber stimulation, and consciousness might turn out to be brain waves of 40 cycles per second. On this type view, thinking and feeling are certain types of neurological processes, so absent those processes, there is no thinking or feeling. The *token identity* theory (defended by Kim [1966] and Davidson [1980], among others) maintains that every token mental event is some token physical event or other, but it denies that a type matchup must be expected. So, for example, even if pain in humans turns out to be realized by C-fiber stimulation, there may be other life-forms that lack C-fibers but have pains too. And if consciousness in humans turns out to be brain waves that occur 40 times per second, perhaps androids have consciousness even if they lack such brain waves.

In *aesthetics*, it is generally necessary to distinguish works of art themselves (types) from their physical incarnations (tokens). (See, e.g., Wollheim 1968; Wolterstorff 1980; Davies 2001.) This is not the case with respect to oil paintings like da Vinci's *Mona Lisa* where there is and perhaps can be only one token, but it seems to be the case for many other works of art. There can be more than one token of a sculpture made from a mold, more than one elegant building made from a blueprint, more than one copy of a film, and more than one performance of a musical work. Beethoven wrote nine symphonies, but although he conducted the first performance of *Symphony No. 9*, he never heard the *Ninth*, whereas the rest of us have all heard it; we have all heard tokens of it.

In *ethics*, actions are said to be right or wrong—but is it action types or only action tokens? There is a dispute about this. Most ethicists from Mill (1979) to Ross (1988) hold that the hallmark of ethical conduct is universalizability, so that a particular action is right/wrong only if it is right/wrong for anyone else in similar circumstances—in other words, only if it is the right/wrong *type* of action. If certain types of actions are right and others wrong, then there may be general indefeasible ethical principles (however complicated they may be to state, and whether they can be stated at all). But some ethicists hold that there are no general ethical principles that hold come what may—that there is always some circumstance in which such principles would prescribe the wrong action—and such ethicists go on to add that only particular (token) actions are right or wrong, not types of actions. See, for example, Murdoch 1970 and Dancy 2004.

The Data

The type–token distinction is also widely applicable outside of philosophy. The main point of the current chapter—apt to be denied, ignored or understated by most philosophers (even myself, before I did the research)—is that:

Talk of types is thoroughly ensconced in ordinary and scientific language and theory.

That is, we seem to *refer to* and *quantify over* types (and other abstract objects) with an astounding level of frequency in ordinary language, science, and art—whenever generality is sought. In such contexts, apparent references to types may well be the rule, rather than the exception. Even when the reference is ambiguous as to a type or a token—for example, in the title of the Pratt (1998) article “From the Andes to Epcot, the Adventures of an 8,000-Year-Old Bean”—it usually turns out it is the type being referred to. Witness how in the bean case the ambiguity was not cleared up until the fourth sentence of this paragraph:

What may be the world’s oldest bean has driven Daniel Debouck, a Belgian plant geneticist, in and out of Andean mountains and valleys from Bolivia to Ecuador for 20 years. Recently, the bean has embarked on an international circuit, from Peru’s Sacred Valley of the Incas to Epcot Center at Disney World, with stops in the Midwest and Japan. This is the story of the nuna, a 8,000-year-old bean. For most of its history, the nuna has been a bit player on the agricultural stage.

Since the ubiquity of type talk is somewhat contrary to what one’s philosophical training would lead one to expect, this entire chapter has been devoted to presenting it.

The ubiquity of type talk will be shown by exhibiting many examples from various sources and disciplines. To assuage the reader’s concern that perhaps these examples are not representative but constitute merely carefully culled “anecdotal evidence,” we shall use as our starting point an arbitrary copy of a science periodical. *Science* magazine might seem a good choice, because it is a general science periodical that covers numerous areas of science. A quick read of the July 7, 1995, issue (randomly selected) reveals that at least two-thirds of the articles clearly have apparent references to types. Unfortunately, it would take the rest of this book to wade through all twenty-eight articles.¹ And, with titles like “p34^{cdc2} and Apoptosis,” or “In Vivo Transfer of GPI-Linked Complement Restriction Factors from Erythrocytes to the Endothelium,” there is a risk of distraction by too much biomedical jargon. Hence my second choice: one issue of the

New York Times's "Science Times." It also covers general science—often relying on the same sources as periodicals such as *Science*—but it usually contains fewer than a dozen articles. Examining it will be a more manageable job. The selection was "random" since I had not looked at it before I selected it. What topics are touched on will dictate what topics we pursue in more detail after we've scrutinized the newspaper's presentation. I hope the reader will be impressed by the sheer volume of the examples, their ubiquitousness, and how ordinary, familiar and harmless they seem. Those for whom this point is obvious would do well to read the section on phonology in this chapter (for it will be useful later) and then proceed to chapter 2, where it is urged that we ought to conclude from the data that types exist. (If the reader is straining at the bit to offer type-free paraphrases of all the data, she should proceed at once to chapters 3 and 4, where it is shown that there is reason to think this cannot be done.)

The January 2, 1996, copy of the *New York Times's* "Science Times" contains nine articles on a variety of topics: one on historical linguistics, two on environmental biology, two on human genetics (four altogether in biology), one on physics, two on computers, and one on chess. Even a casual reading shows that eight of the articles contain many apparent references to, or quantifications over, types (and the ninth is not without them). The references are "apparent" in that they appear in the surface structure. That is, in the surface structures of the sentences, there are many quantifiers that, if they quantify over anything, must be construed as quantifying over types rather than tokens (particulars with unique spatio-temporal locations)—unless we are to impute nonsense or falsity to the sentence. Similarly, there are many terms in the surface structure that qualify syntactically as singular terms—such as 'the Florida gopher tortoise', 'the same word', 'the long gene', or 'the D4 dopamine receptor gene'—which (in the context in which they occur) cannot be construed as referring to tokens, unless we are to be uncharitable to the author. (Singular terms include noun phrases like the ones mentioned, and proper nouns like 'Frederick the Great', 'Boston', and 'Alpha Centauri'. They purport to refer to a single thing, unlike general terms such as 'tree'. There will be a bit more discussion about singular terms in chapter 2.) The idea will be clear from the examples. The examples will be presented with a brief indication in each case as to why, if we assume the sentences are true and *if we take the surface structure seriously*, the referents of certain singular terms cannot be spatiotemporally located particulars—tokens—and the quantifications—construed straightforwardly—cannot be quantifications over tokens. The reader may be anxious to "analyze away" apparent type

talk in favor of talk of tokens by considering paraphrases that quantify only over tokens. Such paraphrases are useful and some will be examined as we go along. But patience is urged; the issue of paraphrasing away all references to types will be taken up in chapters 3 and 4. Similarly, for a discussion as to why we should take the surface structure seriously as a guide to ontology, see chapter 2, because there will be no such discussion in chapter 1.

Here are some of the more representative examples, where the apparent references to and quantifications over types have been italicized. (Italicized passages occurring in the original quote have been underlined instead.) The reader may notice occasional explicit apparent references to classes and properties in the examples. These have not been italicized. Compared to type-references, apparent references to classes and properties are few and far between. (Of course, since classes are abstract objects, like types, and properties have instances, as types do, and all have conventionally been considered “platonic objects,” references to classes and properties would also be welcome to the thesis of this book.)

1 Linguistics

Historical-Comparative Linguistics Linguistics is awash in apparent references to and quantifications over types. The situation in historical-comparative linguistics is analogous in many respects to that in evolutionary biology, except that *languages* are among the taxonomic units, not species. The analogy is made explicit in Johnson 1996, “New Family Tree Is Constructed for Indo-European Languages”:

In tracing the pedigree of languages, linguists face the same problems biologists confront in drawing taxonomic charts of the species. Similar traits do not necessarily imply common descent. . . . (p. B15)

I will argue in chapter 6 that the analogy is even stronger, because *words* should be viewed as real kinds, just as species are. As we saw earlier, it was by means of a *word* that Peirce first characterized the distinction and coined the expression ‘type-token’ for it. From the *Times*:

“Suppose two *languages* inherit the same *word* meaning ‘*winter*’, and both of them independently shift *its* meaning so that *it* means ‘*snow*’ instead,” Dr. Ringe said. “*Greek, Armenian and Sanskrit* actually did that.” (p. B15)

Since *the same word* is said here to occur in more than one language, and, unlike a word token, can shift its meaning, then *the same word* is a type. (I assume that ‘winter’ refers to a word, as in ‘meaning what “winter”

means'. If not, delete the italics.) And if word types are abstract objects, then so are the *languages* that contain them:

A proposed family *tree* of Indo-European *languages* would account for the development of the *Germanic tongues* from an *early offshoot of the ancestor of Slavic and Baltic languages*, which include *Lithuanian, Latvian, Russian, Czech and Polish*. (p. B9)

Since the languages referred to here are spoken by many people, they are types, not spatiotemporal particulars,² and so is the *tree* that accounts for their development.

When we shift our gaze from the newspaper to something more scholarly in linguistics, we see that apparent references to types, and quantifications over them, are even more frequent. All examples are from Collinge 1990, *An Encyclopedia of Language*, which consists of twenty-six articles. Author after author explains a subdiscipline of linguistics by making copious apparent references to types. There was no need to search painstakingly for examples; the articles most relevant to the question of what the ontology of linguistics is contain many examples on almost every page. It would perhaps surprise no one that *languages* should turn out to be abstract objects, but we shall see that even the most "concrete" and "physical" end of linguistics, *phonetics*, requires copious types. After that we shall proceed to *phonology*, and in chapter 6 to *lexicography*.

Phonetics In "Language as Available Sound: Phonetics," M. K. C. MacMahon explains (Collinge 1990):

Phonetics (the scientific study of speech production) embraces not only *the constituents* and *patterns* of sound-waves (ACOUSTIC PHONETICS) but also the means by which the sound-waves are generated.

His description of articulatory phonetics contains many apparent references to parts of *the speech organs*, for example:

The sound-waves of speech are created in *the VOCAL TRACT* by action of *three parts of the upper half of the body: the RESPIRATORY MECHANISM, the voice-box* (technically, *the LARYNX*), and the area of the tract above the larynx, namely *the throat, the mouth, and the nose*. . . . *The front of the larynx, the ADAM'S APPLE* . . . is fairly prominent in many people's necks, especially men's. Anatomically, *the larynx* is a complicated structure . . . it contains *two pairs of structures, the VOCAL FOLDS and VENTRICULAR FOLDS*. (p. 4)

There follow several more pages of painstaking descriptions of *the fifteen other parts* of the speech organs (*the tongue* has five parts), every one of which is referred to as 'the' such and such. (Interestingly, the author defends this way of speaking as follows:

X-ray studies of the organs of speech of different individuals show quite clearly that there can be noticeable differences—in the size of the tongue, the soft palate and the hard palate, for example—yet regardless of genetic type, all physically normal human beings have vocal tracts which are built to the same basic design. In phonetics, this assumption has to be taken as axiomatic, otherwise it would be impossible to describe different people's speech by means of the same theory. Only in the case of individuals with noticeable differences from this assumed norm (e.g. very young children or persons with structural abnormalities of the vocal tract such as a cleft of the roof of the mouth or the absence of the larynx because of surgery) is it impossible to apply articulatory phonetic theory to the description of the speech without major modifications to the theory. [p. 6]

What do *the speech organs* produce? *Words, syllables, and sound-segments*—types, that is:

Unless we are trained to listen to *speech* from a *phonetic point of view*, we will tend to believe that *it* consists of *words*, spoken as *letters of the alphabet*, and separated by *pauses*. *This belief* is deceptive. Speech consists of two simultaneous 'layers' of activity. One is *sounds* or *SEGMENTS*. The other is features of speech which extend usually over more than one segment: these are known variously as NON-SEGMENTAL, . . . OR PROSODIC features. For example, in the production of *the word above*, despite *the spelling* which suggests there are *five sounds*, there are in fact *only four*, comparable to the '*a*', '*b*' '*o*' and '*v*' of *the spelling* . . . but [there are] also . . . *two syllables*, '*a*' and '*-bov*'. Furthermore, *the second syllable*, consisting of *three segments*, is felt to be said more loudly or with more emphasis. (pp. 6, 8)

Not only do individual syllable types like '*a*' and '*-bov*' exist, but also *the syllable* itself exists as a theoretical unit in phonetics (much as *the species* does in Mayr's discussion below):

The nature of *the syllable* has been . . . a matter for considerable discussion and debate. . . . [M]ost native speakers of a *language* can recognise the *syllables* of their own *language*. . . . Various *hypotheses* have been suggested: that *the syllable* is either a *unit* which contains an *auditorily prominent element*, or a *physiological unit* based on respiratory activity, or a *neurophysiological unit* in the *speech programming mechanism*. *The concept of the syllable* as a *phonological*, as distinct from a *phonetic*, *unit* is less controversial. . . . (p. 8)

MacMahon's discussion of vowels clearly quantifies over *vowels* (types, i.e.):

The notion that there are *five vowels* in *English* is quite erroneous, and derives from a *confusion of letter-shapes and sounds*. Most *accents* of *English* contain about *40 vowel phonemes*, but the number of *actual vowel sounds* that can be delimited in any one *accent* runs into *hundreds*. (p. 19)

Obviously, if by "actual vowel sounds" he meant tokens, the number would run into trillions rather than hundreds. Similarly,

Jones's . . . contribution was to provide a set of *reference points* around the *periphery of the [vowel] area [of the tongue]* in relation to which any *vowel sound* of any language whatever could be plotted. These reference points are known as *the Cardinal Vowels*. Altogether there are *18 Cardinal Vowels* . . . (p. 21)

Notations and transcriptions are required to describe movements away from these *Cardinal Vowels*:

The *notation* of a *Southern English pronunciation* of *ah*, for example, could be [a^h]. . . . When making a *phonological transcription* . . . the use of a particular *Cardinal Vowel symbol* does not necessarily mean that *the phonological unit* represented by that symbol is a *Cardinal* in quality. (p. 21)

No doubt the reader gets the idea and can be spared the examples concerning consonants.

Phonology In “Language as Organized Sound: Phonology,” Erik Fudge (Collinge 1990) contrasts phonetics with phonology. This is an important distinction, and some of the facts mentioned below will prove crucial in chapter 3. For example, it is not generally appreciated outside of linguistics that some of the properties of a phoneme—its fricativeness, perhaps—may not be physically phonetically present in a particular utterance, as when ‘seven’ with its ‘v’ phoneme is pronounced [sem]. (‘Fricative’ characterizes the frictional passage of a breath against a narrowing at some point in the vocal tract—e.g., lips, teeth or tongue. Examples include the initial sounds in ‘fish’, ‘vine’, ‘thin’, ‘sit’.) Fudge explains that phonetics, unlike phonology, is independent of particular languages; it is concerned with “the observable” and is dependent on technical apparatuses for obtaining results (p. 30). Phonetics, he claims,

disproves a common fallacy about the nature of speech, i.e. the assumption that speech is made up of ‘sounds’ which are built up into a sequence like individual bricks into a wall (or letters in the printed form of a word), and which retain their discreteness and separate identity. (p. 31)

Moreover,

it is very rare for two repetitions of an *utterance* to be exactly identical, even when spoken by the same person. (p. 31)

(*Utterance* here is a type because if it were a unique space-time token, it would not be possible for there to be two repetitions of *it*.) Phonology on the other hand *is* concerned with particular languages; it is more dependent on its historical-philosophical contexts than on technical apparatuses; it assumes that many utterance (tokens) are “alike in form and meaning” (p. 31).

[l] is much more reasonable to regard *the phonological representation* [of an utterance] as being *a string of individual, discrete elements* much like letters in a printed word. (p. 31)

These discrete elements are, of course, the standard theoretical units of phonology, *phonemes* and *allophones*. Fudge illustrates the relationship between them in type terms:

In *standard English* as spoken in England, *the l of feel* [dark [l]] is pronounced differently from *the l of feeling* [clear [l]]. . . . *The technical term for the former articulation* is 'velarised'. . . . Other varieties of English do not exhibit this difference: many Scots and American varieties have dark [l] in both *feel* and *feeling*. . . . [T]he difference between clear [l] and dark [l] is completely predictable from *the phonetic context* in which *the l* appears. . . . [so] we say that they are *allophones* of the same PHONEME. (p. 32–33)

Other examples he gives rely heavily on types:

[P]in is pronounced [PHIN], whereas spin is [spIn]. *The strongly aspirated* [ph] never occurs after /s/, and *the unaspirated* [p] never occurs at the very beginning of a syllable . . . an utterance-final /p/ (as in Come on up!) is quite likely not to be released at all. (pp. 33–34)

English /r/ has at least four different *allophones*. . . . (p. 34)

For many speakers *the 'long o' phoneme* has a much more 'back' pronunciation before dark [l] than before other sounds. (p. 34)

Allophones are not to be confused with *alternations*:

In the feel/feeling case which we considered earlier, *the two words* concerned are closely connected . . . : *the difference* may be described as an ALTERNATION. . . . *Allophones of the same phoneme* often participate in *alternations* in this way. However, it is not necessary to have an *alternation* in order for *two sounds* to be *allophones of the same phoneme*. . . . Conversely, the existence of an *alternation* does not necessarily indicate that the alternating sounds are *allophones of the same phoneme*. . . . [A]lternations . . . [between distinct phonemes] are often termed MORPHOPHONEMIC alternations, because they are *alternations* between *phonemes* with morphological relevance. (pp. 37–38)

One reason that phonology is concerned with particular languages is that *sounds* which are *allophones of the same phoneme* in *one language* may in other languages operate as distinct *phonemes*. (p. 33)

Thus one cannot "read off" the phonological representation of a particular utterance from a comprehensive phonetic representation. This fact will prove important in chapter 3. The relationship between phonetic differences and phonemic differences is complex; phonetic differences do not always give rise to phonemic differences:

Where a particular phonetic difference does not give rise to a corresponding phonemic difference, we say that this phonetic difference is NON-DISTINCTIVE. . . . [D]ifferences which can give rise to a change of meaning, i.e. phonetic differences between *phonemes*, are referred to as DISTINCTIVE. The difference between [p] and [b] in English for example, is distinctive: *pit and bit, ample and amble, tap and tab*, are pairs of distinct *words*, not alternative *pronunciations*. (p. 35)

To make matters worse (for someone opposed to types), “phonologically relevant properties connected with the utterance are [not] necessarily physically present in the utterance” (p. 32):

Take, for instance, *the English word seven* (phonetically [sevən] in careful speech). The fricativeness of *the segment after the [e] vowel* would certainly be taken as an essential property . . . of *that segment*: in English the difference between [b] and [v] is distinctive. . . . In informal speech *the word* might be pronounced something like [sebm], where *the segment after [e]* is a plosive . . . not a fricative; the essential distinctive feature of fricativeness . . . can no longer be found in the speech signal at this point. Indeed, in very colloquial speech *the pronunciation* might well be simplified to something like [sem], in which what was originally the fricative has no separate existence of its own in the speech signal. (p. 43)

This suggests that the “phonologically relevant properties connected with an utterance” are best understood as properties of utterance types, which some, but not all, tokens possess. At any rate, the phonemes themselves are easily describable as types:

The net result . . . is that *the phonemes of English* fall into classes from which the distinctive features form convenient *labels*: /p t tʃ k f θ s ʃ h/ are the class of ‘voiceless’ sounds in English, /t d s z θ ð l n ʃ ʒ ʒ r/ are the ‘coronals’ . . . , /m n ŋ/ are the ‘nasals’, /i e æ ɒ v ʌ/ are the ‘short vowels’, and so forth. (p. 35)

As with *the species* and *the syllable*, *the phoneme* itself (and not just this or that phoneme) may be considered a type of types:

Some scholars have viewed *the phoneme* as a family of sounds (allophones) in which (i) the members of the family exhibit a certain family resemblance, and (ii) no member of the family ever occurs in a phonetic context where another member of the family could occur. (p. 33)

Many more examples of types in linguistics could be exhibited, but I expect the above will suffice.

2 Biology

As I said, there were four articles on biology: two on environmental biology and two on human genetics.

Environmental Biology Species are natural kinds (more on this in chapter 6) that have members. I will argue that a species is best understood as a type, not as a set or class (understood in the usual extensional mathematical sense), and that its members are tokens. The following examples from Dicke 1996, “Numerous U.S. Plant and Freshwater Species Found in Peril,”³ are quite characteristic of discussions of particular species.

The ivory-billed woodpecker, once North-America’s largest and most spectacular, was declared extinct. Less than a century ago, *it* was found across the South. *Its* last confirmed sighting in the United States was in Louisiana in the 1950s.

The banded bog skimmer, a rare dragonfly, was found for the first time in Maine. *It* was the first time *it* had appeared so far north.

The Tarahumara frog, which lived in Arizona, has disappeared from the United States. However, *it* is still found in Sonora, Mexico. (p. B12)

Obviously, no particular flesh-and-blood ivory-billed woodpecker token “was found across the South a century ago” and now is extinct. ‘It’ refers to a *type* of woodpecker. Similarly, no particular banded bog skimmer is rare, and no particular Tarahumara frog disappeared from the United States—a certain *type* of dragonfly and *type* of frog has those characteristics.

But, it might be asked: how does a species come by such characteristics as *being found across the South* if a species is an abstract object? And the obvious and correct answer is: by virtue of facts about its tokens. *The ivory-billed woodpecker* was “found across the South” because there were tokens of it in all parts of the South; it was relatively easy to find a token most anywhere in the South. *The banded bog skimmer* was found for the first time in Maine because a token of it was found. *The Tarahumara frog*, which lived in Arizona, can be said to have “disappeared from the United States,” because although there used to be Tarahumara frogs in the United States, there are none in the United States anymore. It is very important to note that I am not claiming that *there are no sentences equivalent to the above sentences but which do not appear to refer to types and quantify only over tokens*. Nor am I denying that facts about types are in large part dependent on facts about tokens. If the ivory-billed woodpecker is extinct, it is because there are no more of them.⁴ The present point is only to show that *apparent* references to types are extremely common. (Note also that I am not trying to argue in *this* chapter that *types exist*; that will be the job of chapter 2.)

The use of *singular terms* to refer to particular species also appears in the Stevens (1996) article, “Wildlife Finds Odd Sanctuary on Military Bases”:

At Eglin Air Force Base, under the flight path of A-10 warplanes, rare *species* like *the endangered red-cockaded woodpecker* . . . and *the imperiled Florida gopher tortoise* . . . thrive in a habitat of *longleaf pine*. (p. B9)

(Again, it might be asked: if a species is an abstract object, how can it be said to “thrive in a habitat of longleaf pine”? And the same sort of answer presents itself: the predicate applies to the species in virtue of facts about members of it. Obviously, the members of it need not thrive in order for the species to thrive; all that is needed is that a sufficient number of members of it live long enough to reproduce for the species to be said to thrive.)

Quantifications over species also occur. In Dicke 1996, for example, we find:

Of 20,481 *species* examined, about *two-thirds* were secure or apparently secure, while 1.3 percent were extinct or possibly extinct, 6.5 percent were critically imperiled, 8.9 percent were imperiled, and 15 percent were considered vulnerable. (p. B12)

It is clear that the 20,481 things examined are not particular organisms, but types of organisms, species. Again, it is facts about tokens that make these claims true (although I for one do not know what those facts are). The point is that what is being quantified over are types, not tokens.

Human Genetics In Angier 1996, “Variant Gene Tied to Love of New Thrills,” we find:

Maybe it is appropriate that *the first gene* that scientists have found linked to an ordinary human personality trait is *a gene* involved in the search for new things. (p. A1)

Obviously “the gene” in question is not a particular gene from one cell of one person, but is a gene many of us have tokens of—in fact many tokens of (i.e., a token in each cell in our bodies).

The gene encodes *the instructions* for the so-called *D4 dopamine receptor*, one of *five receptors* known to play a role in *the brain’s response to dopamine*. (p. A1)

If *the gene* is a type, then so are *the instructions* it encodes and *the receptor* for which it encodes the instructions, and *the brain* that responds and *its response*. (That the receptors are not tokens is clear anyway from the quantification over them, since obviously each individual brain has many more than five receptor *tokens* that are able to respond to dopamine.) Because if *the gene* is a type—one that Bill Clinton, say, has many tokens of—then *the dopamine receptor* for which it encodes instructions cannot be one of Clinton’s many dopamine receptors, but must be a type of receptor, of which Clinton has many tokens.

As it turns out, novelty seekers possess a *variant of the D4 receptor gene* that is slightly longer than *the receptor* of more reserved and deliberate individuals. In theory, *the long gene* generates a *comparatively long receptor protein*, and somehow *that outsized receptor* influences how *the brain* reacts to dopamine. (pp. A1, B11)

Again, since *the D4 receptor gene* is a type, so are its two variants, *the long gene* and *that of more reserved and deliberate individuals*—also, *the proteins* that each generates. (Only a token of a gene can generate a token of a protein.) Similarly, in what follows, since the gene is a type, so is *the report* of the link:

It is also *the first known report* of a link between a *specific gene* and a specific normal personality trait. . . . [T]he *gene* does not entirely explain the biological basis for novelty seeking. . . . Scientists say *the dopamine receptor* accounts for perhaps 10 percent of the difference in novelty-seeking behavior between one person and the next. . . . [W]e would expect maybe four or five *genes* are involved in the trait. (p. B11)

The last sentence above quantifies over gene types.

In Fisher 1996, “Second Gene Is Linked to a Deadly Skin Cancer,” we find similar apparent references. Clearly, scientists don’t waste their time naming particular gene tokens; CDK4 is a gene type, as is *its normal form*, its *mutated form*, its *protein*, and so on:

Researchers have found a *second gene* responsible for malignant melanoma. . . . [S]cientists . . . have identified a defect in a *gene known as CDK4*. . . . Their *findings* appear in *this month’s issue of the journal Nature Genetics*. . . . In *its normal form*, the *CDK4 protein* inhibits the *p16 protein* and so prevents *the cell* from dividing. But in *the mutated form of the CDK4 gene* its *protein product* too is changed. . . . The scientists . . . found *the defect* to be a *germline mutation*, meaning that *it* can be passed down from parent to child. (p. B18)

Admittedly, it may be possible to pass a particular gene token—one particular gene in one particular gamete—from parent to child; but since the same gene token does not get passed on to the next generation also, much less from other parents to their children, the *it* referred to in the final sentence above must be a gene type. Notice too that *the journal* referred to is a type, as is each of its *issues*, of which there is only one this month (with presumably many tokens).

When we turn from the *New York Times* to a more scholarly work in biology, we can see that the apparent references to/quantifications over biological types exhibited above are not peculiar to the newspaper. Ernst Mayr 1970 (*Populations, Species, and Evolution*) is a good follow-up because it is about both species and genetics. Opening it to a page chosen at

random reveals an unbelievable amount of “type talk.” The sheer volume of such talk shows that anyone who wants to “analyze away” type talk in favor of talk about tokens had better offer a systematic reduction of talk about types (something that, I will argue in chapters 3 and 4, there is ample reason to think cannot be done). For example, here are some of the dozens of quantifications over *species* and *subspecies* we find on this randomly selected page from Mayr:

As a first approach to a study of intraspecific variability one may analyze the presence and frequency of *subspecies* in various groups of animals. The number of *subspecies* correlates, by definition, with the degree of geographic variability and depends on a number of previously discussed factors. . . . Degree of variability may differ quite strongly in *families* belonging to the same *order*. For instance, among *the North American wood warblers* (Parulidae) only 20 (40.8 percent) of the 49 *species* are polytypic [have several *subspecies*], while among *the buntings* (Emberizidae) 31 (72.1 percent) of the 43 *North American species* are polytypic. The difference is real and not an artifact of different taxonomic standards. Of *the species of passerine birds in the New Guinea area* 79.6 percent are polytypic, while only 67.8 percent of the *North American passerines* are polytypic. Among the 25 *species of Carabus beetles from central Europe*, 80 percent are polytypic, while in *certain well-known genera of buprestid beetles* not a *single species* is considered polytypic. . . . Classifying *species* as monotypic or polytypic is a first step in a quantitative analysis of phenotypic variation. Another way is to analyze the subdivisions of polytypic *species*: What is the average number of *subspecies* per *species* in various groups of animals and what is their average geographic range? There are believed to be about 28,500 *subspecies of birds* in a total of 8,600 *species*, an average of 3.3 *subspecies per species*. It is unlikely that this *average* will be raised materially (let us say above 3.7) even after further splitting. The *average* differs from *family to family*: 79 *species of swallows* (Hirundinidae) have an average of 2.6 *subspecies*, while 70 *species of cuckoo shrikes* (Campephagidae) average 4.6 *subspecies*. . . . (p. 233)

Mayr also refers to higher-order types, for example *the species*, to convey higher-order generalizations. That is, in characterizing *the population structure of species* generally, instead of referring to an individual *species*, for example *the ivory-billed woodpecker*, he writes of “*the species*”—and consequently of its *central populations*, its *peripheral populations*, its *epigenotype*, its *border*, and so on, all of which are types if *the species* is:

These marginal *populations* share *the homeostatic system, the epigenotype, of the species* as a whole. *They* are under the severe handicap of having to remain coadapted with *the gene pool of the species* as a whole while adapting to local conditions. *The basic gene complex of the species* (with all the *species-specific canalizations and feedbacks*) functions optimally in *the area* for which it had evolved by selection, usually somewhere near *the center*. Here it is in balance with *the environment* and here it can afford

much superimposed genetic variation and experimentation in niche invasion. Toward the periphery *this basic genotype of the species* is less and less appropriate and *the leeway of genetic variation* that it permits is increasingly narrowed until much uniformity is reached. These *peripheral populations* face *the problems* described in the discussion of “species border”. . . . Environmental conditions are marginal near *the species border*, selection is severe, and only a limited number of *genotypes* is able to survive these drastic conditions. (p. 232)

3 Artifacts

Computers In Lewis 1996, “About Freedom of the Virtual Press,” we are told

The personal computer is now officially grown up. In January 1975, *the Altair 8800 kit*, considered *the first true personal computer*, made its debut on *the cover of Popular Electronics*. . . . Today, having reached the age of 21, *the personal computer* is only now beginning to reveal *its true value and greatest potential*. . . . (p. B14)

It is clear that *the personal computer* being referred to here is a type of computer, rather than the first token ever made, because it has a twenty-one-year history which only begins with *the Altair 8800*—a subtype with spatiotemporal tokens—but doesn’t end there. Similarly, the other computer article in the issue of *Science Times* we’re considering, “Sometimes Achieving Simplicity Isn’t Cheap and Isn’t So Easy,” is devoted to another subtype of personal computer, *the PN-8500MDS Super Powernote*, said to be a “cheap nonstandard computer with limited functions” (p. B11).

Human artifacts lend themselves well to type talk. Of course, when only one machine of a certain type gets built—the Cassini spacecraft bound for Saturn in 1997, for example—it may be tempting to say that here there is no type; there is only the “token.” But far more common is the situation where there is more than one token, as with the *Altair 8800*, or *the Volvo 850*:

The 850GLT, the latest addition to Volvo’s menu in the U.S., is all new from *the kisser to the tail*. . . . [T]he 850 was conceived in the late 1970s, and design work began in 1986. . . . (*Car and Driver*, November 1992)

The reference here surely is not to a particular 850, which would not warrant so much attention and design work, but rather to a type.

I trust such type talk is familiar enough that it is not necessary to produce the countless other examples that might be given. Just one more example of a quote about a human artifact needs to be mentioned here; and that is of a *work of art*. A case can be made that all apparent references to paint-

ings are to particular physical objects uniquely located in space and time⁵ and not to types; but a great deal, perhaps most, other apparent references to works of art, in other art forms, do not so refer. When Charles Rosen (1972, p. 186), for example, in a very characteristic passage, writes that

The opening of the E flat Quartet K. 428 shows how widely Mozart could range without losing the larger harmonic sense. . . . The opening measure is an example of Mozart's sublime economy. It sets the tonality by a single octave leap . . . , framing the three chromatic measures that follow. The two E flats are lower and higher than any of the other notes, and by setting these limits they imply the resolution of all dissonance within an E flat context

—by ‘the E flat Quartet K. 428’ he does not intend to be referring to a particular performance (or to any other particular object or event) but to the E flat Quartet itself—something that was performed in Mozart’s day and also today. Wollheim (1968), Wolterstorff (1975, 1980), and Davies (2001) have argued that the work itself—what Mozart composed—is an abstract object. I agree. What Mozart composed is best understood as a type, and when it is performed, one hears a token of it. Of course, if *the E flat Quartet K. 428* is a type, then so is *its opening*, *its opening measure*, and each of *its other measures*, *its tonality*, *its first interval*, *each occurrence of E flat*, and so on.

(See chapter 7 for a discussion of occurrences.)

Chess It should come as no surprise, then, that the Byrne 1996 column in *Science Times* about chess, another human invention, contains many apparent references to types, even though the article is ostensibly about a particular chess game played in the 1995 United States Championship:

Accepting *the Queen's Gambit with 2 . . . dc* has been known since 1512. In the early days, *Black* tried to keep *the pawn*, but after some bad positional and tactical knocks, *the strategy* has aimed for a semiopen board with free piece play and pressure against *the white d4 pawn*. No more 3 . . . b5? 4 a4 c6 5 e3 Bb7 6 ab cb 7 b3 with the fall of *the pawn* and superiority for *White*. *Black* must be watchful in *this opening*. Thus, *the pawn snatch* with 10 . . . Nd4 11 Nd4 Qd4 is too risky. For example, 12 Rd1 Qg4 13 Qg4 Ng4 14 Bb5! forces mate. But *White* has to be precise, too, after 10 . . . Be7, and play 11 a4 b4 12 Rd1. Instead, Dzindzichashvili took too much for granted in continuing to gambit his d4 pawn. After 11 c3? Nd4! 12 Nd4 Qd4, he could have tried 13 Rfd1, but 13 . . . Qg4 14 Qe3 Bb7 15 f3 Qb4 is safe enough for *Black*. He could also have tried 13 Qf3. . . . (p. B18)

If *accepting the Queen's Gambit with 2 . . . dc* has been known since 1512, clearly it is a type of opening, since the only token that Byrne might be referring to, Patrick Wolff's doing so in the 1995 U.S. Championship, has

not “been known since 1512.” (For the same reason, Byrne could not be referring to a *possible* event-move of Wolff’s, since it too could not have “been known since 1512.”) So too *the Queen’s Gambit* itself is a type, a token of which Dzindzichashvili played. *Black* cannot be Wolff, because Wolff did not play the game “in the early days” or receive “bad positional and tactical knocks.” Therefore *the strategy* referred to, Black’s strategy, cannot be the token of it that is Wolff’s alone, nor can *the pawn* referred to be any particular pawn token in Wolff’s possession. Most impressive of all is the sheer number of sequences of moves referred to, like *the pawn snatch, 10 . . . Nd4 11 Nd4 Qd4*, no token of which occurred in the actual Wolff-Dzindzichashvili game. It was pointed out to me that “the pawn snatch, 10 . . . Nd4 11 Nd4 Qd4” might be read as referring to a nonactual but possible token, the possible event of Wolff’s snatching the pawn, rather than to a type of move, and similarly for the moves that Dzindzichashvili “could have tried.” But the passages in question read better when interpreted as referring to types of moves; that is, doing so is more consistent with the rest of the paragraph and better achieves the level of generality the analysis of the game is seeking (as indicated by the use of the terms ‘White’ and ‘Black’). If I am right, then although the game (token) itself is described move by move in the article, most of the sequences of moves referred to above did not occur in the game at all; they are not tokens, but types of sequences of chess moves. (And if I am wrong, replace ‘most’ by ‘some’ in the preceding sentence.) Tokens of them may or may not exist. They are plays in other *versions* of *the Queen’s Gambit*—and these too are types. So Byrne 1996 is “about” a chess game (token), but the explanations offered in chess theory involve apparent references to types of chess moves.

4 Physics

Not even something as knock-down drag-out physical as football is safe from abstract types. In Leary 1996, “Physicists See Long Pass as Triumph of Torques,” we are told that

“It turns out that *the flight of a football* is almost as complicated as *the flight of an airplane*,” said Dr. Rae. . . . Dr. Rae has done computer simulations of *the forces* acting on a flying ball and developed mathematical *equations* explaining *the interactions*. . . . [T]hree different kinds of torque are shaping its motion, he said. *The wobble*, which causes *the front end of the football* to trace out a circular *pattern* in the air as it travels, appears to keep *the ball* on track. . . . Dr. Rae said he discovered that *the Magnus force*, which results in areas of high and low pressure on opposite sides of *the football*, produces a *torque* toward *the rear* that pushes *the nose of the ball to the right*. (pp. B9, B16)

Of course particular footballs are located in space and time, but *the football* is a type of object. (So although the first sentence might be viewed as a quantification over particular footballs, I italicized it anyway, because of the many other references to ‘the football’.) And if *the football* is a type, then so is its *front end*, *rear end*, *nose* and *opposite sides*, its *wobble*, and all three of the *different kinds of torque* shaping its motion, not to mention the *forces* that produce them.

One of the forces cited as acting on the football was the Magnus force. Let us leave the newspaper behind, and see what physicists say about forces generally. Are there both particular forces and types of forces? Michael Faraday (1860) explains what he means by a “force, or power”:

Suppose I take this sheet of paper, and place it upright on one edge, resting against a support before me . . . and suppose I then pull this piece of string which is attached to it. I pull the paper over. I have therefore brought into use a power of doing so—the power of my hand carried on through this string. . . . (p. 16)

Clearly, the power—the force—mentioned is supposed to be particular to Faraday’s hand, and therefore is a token force. Similarly, a bit of water has a force in it, and each piece of shot, he tells us, has “its own gravitating power”:

Here, for instance, is some quick lime, and if I add some water to it, you find another power or property in the water. It is now very hot. . . . Now that could not happen without a force in the water to produce the result. (pp. 22–23)

I have here a quantity of shot; each of these falls separately, and each has its own gravitating power. . . . (p. 31)

So there clearly are particular forces (token forces), according to Faraday. And if each piece of shot has its own gravitational force there would have to be very many different forces, or powers—zillions of them. But Faraday says there aren’t:

We are not to suppose that there are so very many different powers; on the contrary, it is wonderful to think how few are the powers by which all the phenomena of nature are governed. [The earth] is made up of different kinds of matter, subject to a very few powers. . . . (p. 19)

I explained that all bodies attracted each other, and this power we called gravitation. (pp. 44–45)

A simple way to reconcile these apparently conflicting claims of how many forces are involved is to say that, according to Faraday, there are many force tokens, but very few force types.

A notion related to *force* is *field*. Einstein (1934) credits Faraday (along with Maxwell) with first conceiving of *the field*:

Faraday conceived a new sort of real physical entity, namely *the "field,"* in addition to *the mass-point* and its motion. (p. 35)

Since 'the mass-point' must here refer to a type (if it refers at all) because there is more than one mass-point, this suggests that 'the field' also refers to a type—unless, that is, Einstein thinks there is *only one* field. However, he does not, for he says

[F]ields are physical conditions of space. (p. 68)

The electro-magnetic fields are not states of a medium but independent realities, which cannot be reduced to terms of anything else and are bound to no substratum, anymore than are the atoms of ponderable matter. (p. 104)

Yet Einstein often refers to *the electromagnetic field*, as, for example, in these passages:

The Maxwell-Lorentz theory of *the electro-magnetic field* served as the model for the space-time theory and the kinematics of the special theory of relativity. (p. 103)

Something of the same sort confronts us in *the electromagnetic field*. (p. 105)

Besides the gravitational field there is also *the electromagnetic field*. This had, to begin with, to be introduced into the theory as an entity independent of gravitation. (p. 73)

The last sentence suggests that *the electromagnetic field* exists, according to Einstein. And indeed he writes that

By the turn of the century the conception of *the electromagnetic field* as an ultimate entity had been generally accepted. . . . (pp. 43–44)

The electromagnetic field seems to be the final irreducible reality, and it seems superfluous at first sight to postulate a homogeneous, isotropic etheric medium. . . . (p. 106)

Once again it seems reasonable to reconcile these claims in terms of types and tokens: for Einstein, *the electromagnetic field* exists, it is a type of field, and it has many tokens.

Another discovery credited to Faraday is that of *the electron*. Heisenberg (1979), for example, writes:

Faraday's investigations, his discovery of *the electron* (i.e. *the atom of electricity* and radio-active radiation) led us finally to Rutherford and Bohr's famous atomic model and thus introduced the latest epoch of atomic physics. (p. 99)

Edward Teller (1991) explains that

Faraday did not measure *the size of the copper atom*, nor did he measure *the charge of the electron*; he measured the ratio of *the two*. (p. 100)

The *two* Teller is referring to are types: *the size of the copper atom*, and *the charge of the electron*. With this we are brought to atomic physics, where a good deal of type talk is to be encountered—for example, in the title of Ernest Rutherford's important 1911 paper, "The Scattering of α and β Particles by Matter and *the Structure of the Atom*." Teller chronicles Rutherford's activity as follows:

To study *the atom*, the English physicist Rutherford shot electrically charged particles through thin foils. The particles went through the material as if nothing were there. A few of the fast charged particles (which were actually α particles produced in the radioactive decay of heavy elements) were sharply deflected. Rutherford succeeded to explain his results in a quantitative way by a simple model of *the atom*. (pp. 133–134)

It is clear that *the atom* of Rutherford's theory is not only a type, but a very important one, a model of a high order of abstraction. As Teller describes it:

In *the Rutherford model*, *the atom* consists of a *heavy nucleus* whose radius is less than one ten-thousandth *the radius of the atom*. *The nucleus* carries a positive charge which is a multiple of the charge of *the electron*. (p. 134)

If *the atom* is a type, so is its *nucleus*, its *radius*, *the proton*, and *the electron*. Similarly, *the helium atom*, its *nucleus* (an α particle), *the hydrogen atom*, and so on, referred to in the following, must be types.

The bombarding α *particles* are themselves *nuclei of the helium atom* (with a charge of 2 units). The α *particles* carry so much energy that they cannot be deflected by *the light electrons* (whose *weight* is 1/1840 of *the hydrogen nucleus* and even less compared to *the four times heavier helium nucleus*). . . . From the distribution of the deflection angles that he found, Rutherford deduced that Coulomb's Law, $F = e_1 e_2 / r^2$, is valid down to a *distance* less than 1/10,000 of *the radius of the atom* as a whole (which is about an *Angstrom unit* or 10^{-8} cm). From this, Rutherford conjectured that *the hydrogen atom* looked like an *electron* rotating about a *proton* with the ratio of the masses 1 to 1840. *The electron and proton*, of course, carry charges which are equal but opposite. (p. 134)

In addition to atoms and molecules, many subatomic particles have been discussed in type terms. Richard Feynman (1995) chronicles their discovery and classification in a few pages in *Six Easy Pieces*, using copious amounts of type talk to do it:

We have a new kind of *particle* to add to *the electron, the proton, and the neutron*. That new particle is called a *photon*. . . [Quantum electrodynamics] predicted [that] . . . besides the electron, there should be another *particle* of the same mass, but of opposite charge, called a *positron*. . . (p. 37)

The question is, what are *the forces* which hold *the protons and neutrons* together in *the nucleus*? . . . Yukawa suggested that the forces between neutrons and protons also have a *field* of some kind, and that when *this field* jiggles it behaves like a *particle*. [A]nd lo and behold, in cosmic rays there was discovered a particle of the right mass! It was called a *π-meson*, or *muon*. (p. 38)

Obviously, by ‘it’ he means a *type* of particle, not a particular particle. Owing to its length, I consign to an endnote Feynman’s description of approximately thirty different particles and their interactions. Suffice it to say that his description relies almost exclusively on type talk.⁶ After his description is as complete as he could make it, he comments that “This then, is the horrible condition of our physics today” (p. 44). Feynman was saying this in the 1960s, before *the quark* had been discovered and long before the (1996) headline: “Tiniest Nuclear Building Block May Not Be the Quark”:

Scientists at Fermilab’s huge particle accelerator 30 miles west of Chicago reported yesterday that *the quark*, long thought to be the simplest building block of nuclear matter, may turn out to contain still smaller building blocks and an internal structure.

Conclusion

Type talk is *pandemic*. It is not occasional; it is not unusual; it is the norm. So much so—and this has been the point of the present chapter—that it deserves to be taken more seriously than it usually is. It cannot be casually dismissed as “just a way of speaking about tokens” (even if after careful discussion it were to be so analyzed). As the following example from “New Element: Zinc’s Heavy Kin” makes clear, *even when there is only one token* the talk may revolve instead around the type:

Scientists at a German research institute have added *a new element* to the periodic table: *element 112*, a heavier, still unnamed relative of *zinc, cadmium and mercury*.

A team of German, Russian, Slovak and Finnish physicists detected a single atom of *the new metal* on Feb. 9, the Society for Heavy Ion Research in Darmstadt announced today. They made the element by bombarding *lead*, which is *element 82*, with *zinc, element 30*, until two atoms fused as a new substance with as many protons as the two together. . . .

The heaviest element in nature is uranium, which has 92 protons. . . . But 112 will remain nameless for the time being.

We have to face the responsibilities posed by such talk of types: either concede that types exist, or give a systematic semantics for claims apparently referring to types. This book attempts to make the case for the greater plausibility of conceding that they exist.