Generics, Laws and Context

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Abstract

Generics are sentences which abstract away from facts or events concerning individuals to state a general property of a kind of thing. They are typically understood as asserting the existence of some nomic (or lawlike) relationship between the subject and predicate.

While genericity has been studied in detail in the linguistics literature over the last twenty or so years, this phenomenon has been for the most part ignored by philosophers. This is unfortunate since generics are used in many areas of philosophy where their semantics and role are often oversimplified and misunderstood. In traditional philosophy of logic and language, generics have previously been assimilated to the category of universally quantified sentences. This ignores both their intensionality and their exception-tolerating property, both of which are vital in characterising their methodological role and thus in recognising their influence in the philosophy of science. Generics express nomic regularities, and while often used to express laws of nature and *ceteris paribus* laws, also express regularities in less formal contexts. A unified analysis of these suggests an extension into largely uncharted territory for the concept of 'law'.

This thesis is concerned with providing a philosophically motivated theory of the semantics of generics, by relating work in linguistics to work in philosophy and drawing out the philosophical issues involved. The results should be of interest to both disciplines.

In chapter one, I survey the literature on genericity and give a characterisation of generic sentences and their central properties. This is needed, since the many and varied analyses of their semantics create some confusion over what actually counts as a generic sentence. I defend a philosophically robust characterisation of generic sentences, a characterisation that I go on to employ in the rest of the thesis.

The nomic regularities expressed by generics have been most closely studied in the literature on laws of nature, Special Science laws, and *ceteris paribus* laws. I examine this literature in chapter two, and then, in my third chapter, relate this to the nomic features of generics. This leads me to make an important distinction between an exception and a counterexample to a generic, which I develop into an analysis of the semantics of generics in chapter four. In the process, I argue for a radical shift in thinking about laws of nature, and defend my claim that it is the nomic regularities expressed by generics, rather than traditional laws of nature, which play the most basic role in understanding the nature of regularities.

Finally, in chapter five I apply my account to restricted laws and generalisations by considering the extent to which traditional accounts of the effects of context on quantification apply to generics. I demonstrate that some new features of the bare plural claimed to exist in recent work in linguistics can be subsumed rather more simply under my account and also show that the semantics of the familiar English universal quantifiers are rather more complicated than philosophers often think.

Declaration

I declare that this thesis has been composed by myself and that the research reported herein is my own. This thesis complies with all the regulations for the degree of PhD at the University of Edinburgh, and falls below the requisite word limit specified.

Alice Drewery

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Acknowledgements

Writing a thesis is incredibly difficult, though it ought to be really easy. Offer an established academic three or four years to do research, free from teaching, and he or she will jump at it. The problem is that starting out in the academic community, one doesn't have much idea of what research is, and one has very little idea of how to tackle this enormous project and produce a thesis at the end of it.

I have grown up a lot during the last four years and now begin to see why doing a PhD isn't so bad after all! My primary debt of thanks for this must be to my department, the Centre for Cognitive Science, which has provided a stimulating working environment during my studies. A similar debt is owed to my supervisors, Paul Schweizer, Peter Milne and Sheila Glasbey, and to the Department of Philosophy where I have felt at home. For much support in an academic capacity I would also like to thank Tim Williamson and Matthew Elton, and in addition, for helpful discussions I would like to thank Ali Knott, Sarah Sawyer, Alexander Bird and members of the Monboddo Group. Joy Fuller proofread the entire thesis the day before I submitted, with the comment that she "would like to find out what I'd been doing for the last four years". I'm very grateful to her for deciding to find out in such an onerous way. I'd also like to thank Brenda Cohen for helping me tidy up the ends from Reading.

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Notational Conventions

- Words, phrases and sentences which are mentioned, rather than used, are enclosed in single quotes, hence:

  The word 'generic' has many different meanings.
  The sentence 'Domestic cats are tame' contains the bare plural 'domestic cats'.

- Double quotes are used for short quotations from other texts, and as scare quotes. Hence:

  According to *The Generic Book*, generics can be "generalisations over events" or "generalisations based on properties of individual[s]".
  Only "well-established" kinds have a generic reading with the definite article.

- Displayed quotations are given without quotation marks.

- 'If and only if' will be abbreviated in text to 'iff' and in formulations I will use the symbol $\Leftrightarrow$, sometimes subscripted thus $\Leftrightarrow_{\mathrm{df}}$ to indicate a definition.

- The asterisk is used to mark ungrammatical, or unfelicitous ("bad") sentences. One or more question marks are used for sentences which sound strange, and may be ungrammatical or unfelicitous. For example:

  *A dodo is extinct.
  ??All dodos are in the room.

Contents

1 Surveying Genericity **1**

1.1 The basic distinction 2

1.2 Recent literature 5

1.3 Generics and the universal quantifier 7

1.4 Properties of generics 10

1.5 Syntactic forms of generics 20

1.6 Habituals 22

1.7 A criterion of genericity 30

2 What are Laws? **32**

2.1 Laws and accidental regularities 33

2.2 Accounts of laws 41

2.3 The methodological role of laws 44

2.4 Extending the traditional view of laws 48

2.5 Summary 62

3 Nomic Regularities **63**

3.1 Laws, generics and nomic regularities 64

3.2 Applying traditional accounts to nomic regularities 70

3.3 Characterising exceptions 74

4 Exceptions **77**

4.1 Quantifier restrictions 78

4.2 Generics as restricted universal generalisations 82

4.3 Other approaches to restricting quantifiers 84

4.4 A semantic analysis 88

4.5 Conclusions 99

5 Context **100**

5.1 Forms of universal quantifiers 101

5.2 Generics and restrictions 110

5.3 Condoravdi's bare plurals 116
5.4 Conclusions 128

6 Conclusions **129**

A A Formalisation of the Semantics of Generics **131**
A.1 Syntax 131
A.2 Semantics 131

B A Compositional Formalisation **133**
B.1 A strongly compositional semantics 133

Bibilography **144**

List of Figures

1.1 Change in truth value of 'Cats have four legs' over time (left to right) 17
1.2 Generics, habituals and episodes 30

5.1 Every kitten has white paws 103
5.2 Students take exams (but not at the University of Carlops) 114

B.1 The LF syntax of 'Every man ponders' 134
B.2 The LF syntax of 'Men ponder' 138

Chapter One

Surveying Genericity

This thesis is concerned with the semantics of generic sentences, often simply referred to as 'generics'. Generics are sentences which abstract away from facts or events concerning individuals to state a general property of a kind of thing. They generally have no explicit quantifier, and contrary to what most basic logic textbooks say, are not equivalent to universal generalisations made in English using 'all', 'every' or 'any'. A classic example is:

(1.1) Birds fly.

The phenomenon of genericity has been discussed at length in the linguistics literature since the late 1970s. However, reference to this phenomenon can be found much earlier. For example, Jespersen (1924) discusses various generic forms in English and other languages (pp. 203 ff.). Discussion of some of the phenomena can be found as far back as Arnauld's "Port-Royal Logic" of 1662 and even in Aristotle.

While genericity has been studied in detail in the linguistics literature over the last twenty or so years, this phenomenon has been for the most part ignored by philosophers. This is unfortunate since generics are used in many areas of philosophy where their semantics and role are often oversimplified and misunderstood. In traditional philosophy of logic and language, generics have previously been assimilated to the category of universally quantified sentences. This ignores both their intensionality and their exception-tolerating property, both of which are vital in characterising their methodological role and thus in recognising their influence in the philosophy of science. Generics express nomic regularities (see section 1.4.2 below, and chapter two), and while often used to express laws of nature and *ceteris paribus* laws, also express regularities in less formal contexts. A unified analysis of these suggests an extension into largely uncharted territory for the concept of 'law'.

This thesis is concerned with providing a philosophically motivated theory of the semantics of generics, by relating work in linguistics to work in philosophy and drawing out the philosophical issues involved. The results should be of interest to both disciplines.

In this chapter, I survey the literature on genericity and give a characterisation of generic sentences and their central properties. This is needed, since the many and varied analyses of their semantics create some confusion over what actually counts as a generic sentence. I defend a philosophically robust characterisation of generic sentences, a characterisation that I go on to employ in the rest of the thesis.

The nomic regularities expressed by generics have been most closely studied in the literature on laws of nature, Special Science laws, and *ceteris paribus* laws. I examine this literature in chapter two, and then, in my third chapter, relate this to the nomic features of generics. This leads me to make an important distinction between an exception and a counterexample to a generic, which I develop into an analysis of the semantics of generics in chapter four. In the process, I argue for a radical shift in thinking about laws of nature, and defend my claim that it is the nomic regularities expressed by generics, rather than traditional laws of nature, which play the most basic role in understanding the nature of regularities.

Finally, in chapter five I apply my account to restricted laws and generalisations by considering the extent to which traditional accounts of the effects of context on quantification apply to generics. I demonstrate that some new features of the bare plural claimed to exist in recent work in linguistics can be subsumed rather more simply under my account and also show that the semantics of the familiar English universal quantifiers are rather more complicated than philosophers often think.

1.1 The basic distinction

Generic sentences are often introduced by comparing them with existential sentences. So we might compare the two readings of the following sentence:

(1.2) The cat has four legs.

One reading is existential: it claims that a particular cat (the cat we happen to be talking about) has four legs. However, the second reading is generic: it does not claim that any specific cat has four legs, but rather something along the lines of: members of the species 'cat' are quadrupeds, or cats in general, or typically, have four legs. This reading could be glossed as 'the cat is a quadruped'.

This contrast between a generic and existential reading can appear with various syntactic constructions, not just with definite subjects, but with indefinites as well, famously the bare plural, and also with the indefinite article. For example:

(1.3) A cat has four legs.

(1.4) Cats have four legs.

These can both mean either that some particular cat or cats have four legs, or that cats in general have four legs. Both readings may also occur with the triggering noun phrase in object position:

(1.5) Cath likes a tall man.

Strictly speaking, genericity actually picks out two different kinds of phenomena. Since I only plan to talk about one of them in this thesis, I will now distinguish them. "Reference to kinds", or "D-genericity", occurs in sentences such as (1.1), (1.2) and (1.4), and also:

(1.6) Dinosaurs are extinct.

D-genericity is a property of a noun phrase, rather than a sentence, and simply means that the NP in question refers to a kind, not an individual or individuals. In (1.6), the property predicated of the kind does not apply to the individual members of the kind.

Characterising sentences, or "I-generics", are exemplified by (1.1), (1.2)–(1.4) but not (1.6). They abstract away from facts or events concerning individuals to state a general property which is also a property of the individual. Characterising sentences may also involve reference to kinds, as in (1.1), (1.2) and (1.4), or not, as in (1.3).

I will only be discussing characterising sentences in the thesis, and from now on any reference to genericity should be taken as meaning I-genericity. I will abuse terminology slightly (as is common in this field) by referring to *generic sentences* or just *generics* when in fact I mean generic *readings* of sentences.

In the literature, what it means to say a sentence has a generic reading is almost always demonstrated by means of examples, as indeed I have done here. Yet how to characterise generic sentences is not obviously pre-theoretic, and various authors disagree as to whether certain sentences have a generic reading or not.[1]

A typical attempt to characterise genericity pre-theoretically is found in *The Generic Book*, Carlson and Pelletier (1995), on the back of which (paraphrased from the introduction) we find the quotation:

> ... a generic sentence reports a regularity that summarises groups of particular episodes or facts.

This in itself is clearly not enough to distinguish generics from universally quantified sentences or sentences of the form 'most Fs are Gs'. The words 'regularity' and 'summarises' seem to be doing some work here, but this work needs to be made precise.

There are more such general remarks in the first few pages of this introduction, including that generics can be "generalisations over events" or "generalisations based on properties of

[1] For example, there is disagreement about whether "habitual" sentences (discussed in section 1.6) are generic, and which sentences are habitual, and while many authors think of genericity as determined by surface form, there are those who think generics which state facts about classification (such as 'whales are mammals') are not really generic.

individual[s]", and that generic sentences are also called '(g)nomic',[2] 'dispositional', 'general' and 'habitual'. The term 'nomic' (which I will be using throughout the thesis) relates to laws of nature, the fundamental principles which govern the universe, and which are discussed in chapter two. Dispositional facts are those relating to the capacities or dispositions of things — those which may not always be manifested. For example, the fragility of glass consists in its disposition to break when struck. Habitual sentences generally also describe dispositions. It is not clear whether the claim above is that all nomic, dispositional and habitual sentences are generics (clearly this would not be true the other way round: plenty of generic sentences are not dispositional, for example). Dispositional and habitual sentences will be discussed in detail in section 1.6.

It would seem desirable to have a characterisation of generics — a set of criteria by which we could judge whether a sentence is really generic or not. In this chapter, I will critically examine the literature on generics, and discuss the properties of generics which are described there. As well as introducing the subject of the thesis, this will enable me to define the criteria by which we can define genericity which I will be able to use in the rest of the thesis. It will also, I hope, be of use in resolving some of the conflicting claims made about generics in the literature.

The properties which generics are claimed to have fall into three basic categories. First, they tolerate exceptions, *i.e.*, they are not equivalent to universally quantified sentences. Second, they are in some way intensional or modal, and thus support counterfactuals. This modal factor is often interpreted as similar to the modal force of scientific laws: generics are held to assert the existence of some kind of nomic or lawlike regularity, or even to predicate essential (as opposed to non-essential) properties. On a similar note, it is often claimed that they cannot be contextually restricted, which is sometimes interpreted as generics expressing "timeless truths". Third, they are interpreted as roughly equivalent in meaning to the corresponding sentences with the quantificational adverbs 'usually', 'typically' or 'generally' added.

In the following sections, after first describing some of the recent literature on genericity, I will examine these claims with an aim to producing a clear and defensible criterion for which sentences are generic and which are not.

[2]*Gnomic* — "relating to gnomes or aphorisms" where a *gnome* is "a short pithy saying or maxim expressing a general truth or principle" (Collins English Dictionary, 1986). This is a different root from the philosophical technical term *nomic* which means "pertaining to laws". Dahl (1975) points out that they should not be confused. The former term is used in Lawler (1972) and also in Schubert and Pelletier (1987) but I think this must just be a mistake.

1.2 Recent literature

In the earliest modern literature on genericity, we find a great variety of phenomena being discussed under this heading. Many authors include "habitual" sentences, such as 'John smokes', as generics (for example Lawler, 1973; Dahl, 1975); others only consider sentences of the form above (for example Nunberg and Pan, 1975; Smith, 1975). Lawler (1972) includes sentences such as

(1.7) The Vice-President succeeds the President, and the Speaker of the House succeeds the Vice-President.

(1.8) Doing syntax rots your brain.

which I find hard to interpret as generic, in the sense of quantifying over individuals or events. Smith (1975) suggests that abstract noun phrases cannot usually be interpreted generically, and thus rejects the following (which I find perfectly acceptable) as either ungrammatical or unavailable on a generic reading:

(1.9) The idea is alien to the undergraduate.

(1.10) Ideas are alien to the undergraduate.

(1.11) The idea is more perfect than the object.

The first major systematic study of the semantics of generics was Greg Carlson's Ph.D. thesis, Carlson (1977). Carlson studied bare plural constructions, where the plural occurs without an explicit quantifier or article, such as (1.4). He proposed that the different readings which arise for sentences such as (1.4) are not due to the bare plural being ambiguous, but because predicates may be ambiguous. It is, in fact, actually quite hard to get bare plural sentences where both readings appear, and with most sentences of the form of (1.4), there is clearly only one reading. Carlson used this observation to support his claim that all bare plurals denote kinds, and the ambiguity is located in the verbal predicate. For example, the following are clearly generic and existential respectively:

(1.12) Dogs are mammals.

(1.13) Dogs are barking.

Carlson divides the world into two types of thing: individuals and stages. Individuals comprise objects and kinds, which are considered to be a species of object. My desk is an object, as am I. Desks and Human Beings are both kinds. Stages are time-slices of individuals. A realisation relation holds between stages and the individuals they realise. For example, the time-slice of me which is sneezing realises the individual Alice Drewery, and the individual Alice Drewery realises the kind Human Being.

Carlson then introduces two kinds of predicates, individual-level and stage-level (abbreviated as 'i-level' and 's-level' respectively). I-level predicates apply to individuals, and s-level predicates apply to stages. Examples of i-level and s-level predicates respectively are:

(1.14) i-level: be a mammal, have red hair, tall, weigh(ing) 8 stone, French, be(ing) French, blue, love Mary, intelligent

(1.15) s-level: be smoking, sneeze, (be) tired, eating pizza, alone, be(ing) silly, drunk, walking to the office

Thus saying that John is intelligent involves predicating an i-level predicate directly of the individual John, whereas saying that John is drunk involves predicating an s-level predicate of a stage of John, *i.e.*, stating of some stage of John that it is a drunk stage.

Applying this to bare plurals, in (1.12) above, we predicate an i-level predicate of an individual — the kind 'Dogs'. This is a generic reading, since the predicate applies directly to the kind. However, in (1.13), we want to apply an s-level predicate to a kind. In order to do this, we must apply it to a realisation of the kind, which is a stage. The formalisation of (1.13) is then an existential quantification over stages of the kind 'Dogs' which have the s-level predicate 'be barking'.

Not all bare plural generics occur with i-level predicates, though. For example, as we have seen, 'bark' is s-level:

(1.16) Dogs bark.

Here, Carlson claims, a generic operator is functioning, which converts the s-level predicate 'bark' into an i-level predicate. This allows us to apply the predicate to the kind 'Dogs', and yields a generic reading of (1.16).

This is, of course, a rather simplified version of Carlson's theory,[3] but will suffice for our purposes here. This theory has many advantages in terms of explaining features of the syntax/semantics interface, and the behaviour of bare plurals in other contexts. However, it has faced criticism in this area, and also because it does not seem to be able to account for all the features of generics. For example, it says very little about the relationship between the truth of a generic sentence such as (1.16) and the truth of the sentences about its realisations: one would expect there to be some link between the truth of (1.16) and the barking behaviour of individual dogs.

[3] My treatment of Carlson's theory was greatly helped by the extremely clear presentation of it in Greenberg (1994).

An alternative approach, referred to as the "indefinites" theory, treats generics as quantified sentences, using the "tripartite" theory of quantification, which originally appeared in Lewis (1975) and was later developed by Heim (1982). The tripartite theory says that a quantificational sentence has three parts: the quantifier or operator, the restrictor, and the nuclear scope. The restrictor is what the operator ranges or quantifies over, and the nuclear scope is what the result of this applies to. So, for example, in the sentence 'every man walks', 'every' is the operator, 'man' is the restrictor, and 'walks' is the nuclear scope. 'Every' quantifies over men to yield the set of all men, and then 'walk' is predicated of this set. A more complex example might involve adverbial quantification: 'usually, when it rains, I forget my umbrella'. 'Usually' is the operator, 'it rains' is the restrictor, and 'I forget my umbrella' is the nuclear scope. We look for usual situations where it rains, and see if in them I forget my umbrella.

Applying this to the semantics of generics, for (1.1) the generic operator will relate 'bird' and 'fly' such that being a bird is part of the restrictor, and flying is part of the nuclear scope. An approach of this type is proposed by Wilkinson (1991), among others.

The account I propose in chapter four will also be of this type. I will motivate this partly by examining the similarities between the various kinds of lawlike sentences with universal force, including universally quantified sentences which state laws.

The work discussed so far sets up the background assumptions for current work in this area. Further literature will be discussed as issues arise, and I will return to particular features of the accounts outlined above later in the thesis. I will now consider the properties of generics, starting with their famous toleration of exceptions.

1.3 Generics and the universal quantifier

The class of universally quantified sentences is well-defined and reasonably well-understood. Generics resemble universally quantified sentences, since they have some kind of universal force. If generics were just analysable as equivalent to the corresponding universally quantified sentences, then the project to determine their properties would be fairly simple. For example, the naive philosophical account of generics, found in many elementary logic textbooks (although not seriously expounded by anyone), simply treats generics as universally quantified sentences. Unfortunately, however, generics are not equivalent to universally quantified sentences.

One reason for this is that generics may have exceptions, whereas universally quantified sentences do not. For example, the first of the following sentences, which is generic, may be true, and the second, which is universally quantified, false:

(1.17) Potatoes contain vitamin C.

(1.18) Every potato contains vitamin C.

There may exist a potato which contains no vitamin C, since it has been boiled for too long. While this makes (1.18) false, (1.17) may still be true.

This is the exception-tolerating property of generics. Sentences such as (1.17) certainly have universal force, as opposed to existential force, as in '*some* potatoes contain vitamin C'. However, they do not entail the corresponding universal generalisations. For a generic 'Fs are Gs' to be true, not every F has to be a G. Instead, G may be an essential or identifying property of Fs, or a typical property, or normally or usually Fs may be Gs. Thus the universal quantifier is too strong to express a generic.

Moreover, the universal quantifier is too weak. $\forall x(Fx \rightarrow Gx)$ is true if anything which has property F has property G, regardless of whether there is any connection between being an F and being a G. There may be a purely accidental correlation between Fs and Gs. For example, all the students in my class being right-handed generally does not imply that there is a reason for this; the fact that there are no left-handed students in a class is (usually) a matter of chance. In such a case, a generic reading for 'Students in my class are right-handed' will be false. A speaker with the knowledge that there is only an accidental correlation between being a student in my class and being right-handed cannot intend an utterance of this sentence to express the accidental generalisation. In this situation, a speaker asserting this sentence either intends it existentially, or deliberately makes a false lawlike assertion. Generics thus do not express accidental generalisations, but must express a regularity which holds for a reason. An extensional generalisation cannot capture this intensional or modal aspect of a generic.

So, generics are not equivalent to the corresponding universally quantified sentences. This is not, of course, to say that the universal quantifier has no place in their analysis. Some analyses of generics do make use of the universal quantifier, in one way or another. (See, for example, Asher and Morreau (1995), who interpret the generic operator of the indefinites theory as a restricted universal quantifier.)

Generics may have exceptions, but must they? Clearly the sentence (1.18) above is not generic, in virtue of its explicit quantifier. But what about sentences which look generic but which do not have exceptions? For example:

(1.19) Whales are mammals.

Asher and Morreau (1995) give an account of generics based on normality, but they dismiss any account of (1.19) in these terms: they claim (and this seems plausible) that this sentence cannot mean all normal whales are mammals. So they do not want to include sentences like these in their account of generics.

We should note that it is not just that a sentence like (1.19) contingently fails to have exceptions, *i.e.*, it just happens that it has no actual exceptions. For example, (1.20) Masters students take their exams in April.

may never have any actual exceptions, even though it is quite possible that one year a student, due to illness, would have to take exams in May. It just happens that this has never been the case, and it may well be that it never will be the case. This is not a sufficient reason to bar an example like (1.20) from counting as generic, since as we will see, generics are intensional, and make claims about how things might be. In other possible situations, this generic will have exceptions, even if it has none in the actual world.[4]

As opposed to this, we have examples like (1.19) above, and also truths of logic and mathematics:

(1.21) Whales are whales.

(1.22) Equilateral triangles are equiangular.

(1.19) is analytic; (1.21 and (1.22) are also logically or mathematically necessary. It is logically impossible that (1.21) or (1.22) could have exceptions. So it is not true that they *may* have exceptions. Should we count them as generic?

A point which counts against this along the same lines as Asher and Morreau's observation about normality is that it is often held that we can add 'usually', 'typically' or 'generally' to generics without (radical) change of meaning.[5] Hence

(1.23) Potatoes usually/typically/generally contain vitamin C.

is synonymous with (1.17). However, the following do not seem synonymous with their counterparts above:

(1.24) Whales are usually/typically/generally mammals.

(1.25) Whales are usually/typically/generally whales.

(1.26) Equilateral triangles are usually/typically/generally equiangular.

However, these adverbs are often used to 'hedge', for example, when a speaker does not know the extent to which Fs have a property G. Someone might say: 'Fs are usually Gs; in fact, perhaps they are all Gs'. It seems that 'usually' carries a conversational implicature that the speaker does not know that all Fs are Gs, and that is why the examples above sound strange. Adding the adverb does not result in any real change of meaning.

[4] In my analysis of generics in chapter four, I argue that we must take into account both actual *and possible* exceptions to a generic.

[5] These adverbs often do contribute subtly, and sometimes less subtly, to the meaning. This will be discussed further in section 1.4.4.

I will include examples such as (1.19), (1.21) and (1.22) in my analysis of generics, and therefore allow that there are generics which cannot have exceptions. I will, however, return to this question in chapter three. So, in any case, generics are not straightforwardly equivalent to universally quantified sentences, in part because they may have exceptions, although not every generic must have exceptions.

1.4 Properties of generics

1.4.1 Generics and intensionality

We noted in the previous section that generics do not express accidental generalisations or relationships. This was one of the reasons given for the generic operator not being the same as the universal quantifier. But if all the Fs turning out to be Gs is not enough to make 'Fs are Gs' generic, most of the Fs turning out to be Gs cannot be enough either. We can only get a generic reading when a modal claim is made about non-actual states of affairs.

Thus the fact that the universal quantifier is too weak applies to *any* extensional quantifier, not just the universal. If generics support counterfactuals, then any quantifier which only ranges over actual entities cannot represent the counterfactual-supporting properties of generics.

Intensional generalisations may arise by some kind of modal operator being explicitly present in a sentence. Consider the following examples:

(1.27) Visitors must take off their shoes [before entering the mosque].

(1.28) Frogs can stay under water for several minutes.

(1.29) Children should respect their parents.

These contain explicit modals: 'must', 'can' and 'should', and there are numerous other examples. Many generics without explicit modals are in fact interpreted in this way. For example, the reason (1.20) is interpreted as being non-accidental is because one assumes that there is a timetable according to which the masters exams take place in April each year. Hence (1.20) means something like 'Masters students should/must take their exams in April'.

The role of explicit modals will be developed further in later chapters. For now, we may safely treat the examples above as generic along with those which do not contain explicit modals.

1.4.2 The nomic properties of generics

Generics refer to Fs in general, rather than particular Fs, and so must state a general property of Fs. This, together with the intensional element just discussed, mean that generics are typically understood as asserting the existence of some nomic (lawlike) relationship between the subject and predicate.[6] In the following examples,

(1.30) Metals conduct electricity.

(1.31) Glaciers form U-shaped valleys.

(1.1) Birds fly.

(1.30), (1.31) and (1.1) do not just say that the world just happens to be this way, but that these sentences express fundamental relationships between properties which would hold even if things were different in many other ways.

Before looking at this in more detail, I will say a few words about terminology. In the paragraph above, and throughout the thesis, I use the term 'nomic' in a rather weak sense, to mean pertaining to laws in general. It has often been used in the philosophy of science in a stronger sense, to mean pertaining to laws of nature. Another term used frequently in this context is 'lawlike'. Traditionally, a lawlike sentence is one which, if true, expresses a law of nature. For example, (1.30) is lawlike; as it happens it is true and expresses a law of nature, but if the world were such that metals did not conduct electricity, (1.30) would still be the sort of sentence that would express a law if it were true. On the other hand, a sentence like 'all the coins in my wallet are silver' is not the sort of sentence which could express a law, whether true or not, and so is not lawlike. This usage is found in Goodman (1954) and reflects a picture of the world on which we can tell the differences between laws and accidental generalisations just by looking at the meanings of the terms involved. For example, laws are not supposed to involve reference to particular objects (such as my wallet). These claims will be examined in much more detail in chapter two. However, there are various other uses of 'lawlike' in the literature, not all of which carry the same metaphysical commitments as Goodman's position. It is hard to avoid using this term when discussing the issues in this thesis, given the extent to which it is used by other authors. Where I do use it, unless indicated otherwise, I do not intend the term itself to carry any metaphysical implications about how we determine the difference between laws and accidental generalisations. Moreover, its connection with laws should be interpreted in the same weak sense as that of 'nomic' above: a lawlike sentence is one which, if true, would express a law of some sort, not necessarily a law of nature. Whether this conception of law in general is defensible will be discussed in chapters two and three.

Returning to the above examples, what are the "facts about the world" which make these sentences express more than just extensional generalisations? I argued previously that generics do not express accidental generalisations. For now, I will roughly characterise the nomic

[6] *Pace* the simple regularity theory and its variants discussed in chapter two.

properties of generics by saying that a generic asserts the existence of some counterfactual-supporting regularity. I am using 'regularity' here to mean the relationship in the world described by the generic. Not all regularities support counterfactuals: for example, the regularity expressed by the true (universally quantified) sentence 'all of my office-mates are from overseas' is a purely *accidental* regularity. It does not support counterfactuals, since, for example, given Sarah is British, 'If Sarah were to move into my office, she would be from overseas' is false.

Of course, the fact that generics can have exceptions means that the truth of 'Fs are Gs' cannot guarantee that any individual F is a G; the best we can say is that we are likely to infer that it is unless we have evidence to the contrary. Moreover, should we infer that some individual F is a G and then later find out that it is an exception, we will withdraw the inference.[7]

Thus generics can only defeasibly support counterfactuals. 'If I were a bird, I could fly' seems to be true in virtue of (1.1), but one might respond to this with 'No, if you were a bird, you would be a penguin'.

1.4.3 Presuppositions of existence

In discussions of generics in the literature, it is sometimes claimed that generics do not carry with them presuppositions of existence. In other words, an utterance of a generic 'Fs are Gs' does not presuppose that there are Fs. For example, Condoravdi (1994) claims this (pp. 75–79) and it seems to be an underlying assumption in much of the literature, although no-one seems to discuss it explicitly.[8]

One fact about generics which is certainly true is that their intensional element means that they *may* be true or false independently of their instantiations in the actual world. For example, the existence of accidental regularities means that even when all Fs are Gs in the actual world, the generic 'Fs are Gs' is not necessarily true, and there are some true generics 'Fs are Gs' where no Fs are actually Gs, for example:

(1.32) Dyslexic students get an extra 30 minutes in the exam.

(1.33) Trespassers will be prosecuted.

(1.32) may be true without there ever having been any dyslexic candidates for the exam in question, and (1.33) may be true if there are never any trespassers. These are examples where

[7]This kind of inference is studied in Artificial Intelligence under the heading of default reasoning. See, for example, Ginsberg (1987); Brewka *et al.* (1997), and, for an approach which relates default reasoning to the semantics of generics, Asher and Morreau (1995).

[8]In fact, despite a thorough search of the literature, I have not been able to find any work directly addressing this issue.

the sentences 'Fs are Gs' may be true where there are no Fs, but we also have examples where there are Fs but none of them are Gs, and the generic is still true because all the Fs are exceptions to the generic. For example:

(1.34) Tigers have four legs.

Suppose as time goes on tigers become even closer to extinction than they are now, and in fact, there are only half a dozen left in zoos in various parts of the world. Suppose further that, due to some unfortunate accidents, each tiger has lost a leg. Thus, by sad coincidence, all the existing tigers in the world have three legs. This seems to be an accidental regularity, since it does not support counterfactuals: if one of these tigers gave birth to a cub, we have no reason to expect the tiger cub to have only three legs. Thus each of the three-legged tigers is an exception to (1.34), so (1.34) is still true, despite there being no tigers which have four legs.

These observations follow from the intensional or modal properties of generics. They do not, however, establish that generics in general do not presuppose the existence of instantiations. Not all generics are like the examples above. For example, the following generics do seem to presuppose the existence of instantiations:

(1.35) Students at Edinburgh are unhappy about their workload.

(1.36) Dinosaurs ate kelp.

(1.36) presupposes that dinosaurs existed in the past, not necessarily now, whereas (1.35) presupposes that there are students at Edinburgh now.[9] The tense of each sentence determines whether we presuppose that the objects exist, existed or will exist.

To some extent, this phenomenon has already been examined, but not in the generics literature. A similar problem arises for universally quantified sentences, and their presuppositions were first examined in detail in the modern literature by Strawson (1952). In modern first order logic, $\forall x(Fx \rightarrow Gx)$ is (vacuously) true if there are no Fs. In other words, it does not entail the existence of anything which is F. This is often queried by students of logic, who cite examples such as

(1.37) All John's children are asleep.

Surely, they say, this is false if John has no children. Comparing this with Russell's theory of descriptions, "John's son is asleep" (meaning "the son of John is asleep") would be false in these circumstances, since it entails that John has exactly one son.[10]

[9]Note that the explicit restriction to Edinburgh in (1.35) is not necessarily the cause of the presupposition that there are students at Edinburgh: we could modify (1.32) to restrict it to dyslexic students at Edinburgh, without creating a presupposition that there were any dyslexic students at Edinburgh taking the exam.

[10]These entailments and presuppositions of the existence of a unique son of John may of course be relative to a context: we may still talk about John's son if he has two sons but one is more salient in a certain context. See section 4.1.1 below and, for example, Neale (1990) for further discussion.

However, in Aristotelian logic, the universal "all Fs are Gs" does entail the particular "some Fs are Gs" (although it has been noted that Aristotle himself was not always clear on this point). Strawson suggests a presuppositional analysis for examples such as (1.37): this is a meaningful sentence, but utterances of it are neither true nor false if the subject term does not refer. This is exactly analogous to his presuppositional analysis of definite descriptions: "John's son is asleep" presupposes the existence of exactly one son of John's (see footnote 10 above) and if this presupposition fails then an utterance of the sentence is neither true nor false (or expresses no proposition, whatever one makes of that).

So, the universally quantified sentence of modern first order logic does not entail existence of members of the subject class. In Aristotelian logic, we would get such an entailment, and following Strawson we would get a presupposition of existence, exactly as with his treatment of definite descriptions.

However, the situation with the English universal quantifiers does not fit neatly into any one of these models. While some English universal quantifiers do seem to presuppose existence, as, for example, in (1.37), this is not always the case. Strawson remarks that his presuppositional account will not apply to law statements. More recently there have been papers on this subject by Horn (1997) and Moravcsik (1991). Both agree with Strawson that "lawlike" universally quantified sentences do not have existential presuppositions, whereas empirical or enumerative universally quantified sentences do.[11] Since generics are lawlike (certainly in the same sense as Horn and Moravcsik use the term)[12] we might expect them to behave in the same way as universally quantified sentences. In fact, all three authors treat lawlike 'all' sentences as roughly interchangeable in meaning with bare plural generics.

Horn's and Moravcsik's examples of lawlike universally quantified sentences are similar to my (1.32) and (1.33) above. They express rules or conventions, and as we have seen, do not presuppose existence of members of the subject class. This ties in with our intuitions concerning my examples above. But what about (1.35) and (1.36)? A note from Moravcsik about "biological species" (pp. 434–435) shows that he is at least aware of this issue. In fact, Strawson discusses it in some detail.

Strawson gives the following examples of law sentences which do not have existential presuppositions:

(1.38) All twenty-sided rectilinear plane figures have the sum of their angles equal to 2×18 right angles.

[11] Unlike Strawson, both go for a pragmatic rather than semantic account of this.

[12] Horn (1997) says:

> The rules, laws or principles motivating such import-free universals may be scientific or human, including laws of nature or of mathematics, definitions, judicial edicts, or official regulations.

(1.39) All trespassers on this land will be prosecuted.[13]

(1.40) All moving bodies not acted upon by external forces continue in a state of uniform motion in a straight line.[14]

Strawson does not consider any of the above to be subject-predicate sentences, as, for example, (1.37) is. To each of these, he gives a different analysis. Analytic propositions, such as (1.38), do not carry presuppositions of existence. They are of conditional form, and should be analysed as universally quantified sentences of first order logic, which can be vacuously true. (1.39) does not express a proposition at all, but a statement of intention; it is therefore not to be analysed as a proposition with presuppositions. (1.40), however, is more interesting. According to Strawson, this is part of physical theory, and can be correctly labelled "true" or "false". He makes a distinction between "idealised" law-statements such as (1.40) and ones which "have direct application to instances", such as the following:

(1.41) Metals expand when heated.

(1.42) All mammals are vertebrates.

The truth-conditions for the latter kind are, Strawson claims, no different from the truth-conditions of ordinary subject-predicate sentences such as (1.37). Thus, they *do* presuppose the existence of members of their subject classes. An idealised law-statement such as (1.40), on the other hand, derives its truth-value from the truth-values of "other law statements with which it is deductively connected and which do have direct application".

While it is no project of mine to try to cash out or defend Strawson's distinction between idealised and directly applicable law-statements, we can see the intuition which Strawson is trying to capture. Law-statements, or generics, which refer directly to the phenomena we observe, are formulated from observations of instances. Therefore to say that these may be true when there are no instances seems perverse. Of course, exactly what one means by observed phenomena is an old problem in the philosophy of science in which I do not wish to get embroiled here.

We can gather insights from each of Horn, Moravcsik, and particularly Strawson's treatments of the presuppositions of universally quantified (and hence generic) sentences. What is clear is that accidental generalisations do carry presuppositions of existence. While Horn and Moravcsik agree that lawlike generalisations do not carry presuppositions, this only seems to apply to some of our data.

[13]This example is from Russell (1956), p. 237, who cites Bradley as the original source. Thanks to Peter Milne for pointing this out.

[14]Strawson (1952), pp. 195–196.

If, as Strawson observes, some of our law-statements directly derive from observed instances, then they carry presuppositions that there are such instances. Into this class fall (1.41) and (1.42), and also (1.35) and (1.36) above. Note that the tense of the generalisation determines when the instances are presupposed to exist. If, on the other hand, a law-statement is an idealisation, then the relevant instances do not exist. (1.40) is an example of this.

But what is the status of the other generalisations here? And moreover, is this a grammatical matter, or a matter of interpretation? My suggestion is that in fact most lawlike generalisations are ambiguous between the two kinds of readings described above. We have two ways of stating laws: we can state them about ideal objects, for example, mathematical objects, or kinds, such as 'the tiger'. These generalisations do not carry presuppositions of existence. We can also make generalisations about the members of classes, from observations about their behaviour. This is more likely to happen if the class does not form a natural kind, such as 'students in Edinburgh' or 'tigers with three legs'. These generalisations do carry presuppositions of existence. An example here will help to show what I mean.

Dinosaurs were cold-blooded creatures which became extinct many millions of years ago. Which of the following two sentences would we use to state their cold-bloodedness?

(1.43) Dinosaurs are cold-blooded.

(1.44) Dinosaurs were cold-blooded.

Most people seem to go for (1.44), since dinosaurs existed in the past. But would this mean that in our sad tiger situation above, if all the tigers were male, say, and thus could not breed, we should say 'tigers *had* four legs' instead of 'tigers *have* four legs'? Perhaps: but there seems to be a sense in which we are still able to say the latter. Similarly, there is a sense in which (1.43) is fine. A palaeontologist describing the dinosaur as a kind might well say this, along with other facts about the timeless kind 'dinosaurs' which now no longer has instantiations, but which still has certain properties.

With examples involving kinds, which, one might say, have a life independently of their instances, we can either take the idealised interpretation, and make statements like (1.43), or we can take the (for want of a better word) individualised interpretation, generalising over actual and possible individuals of the kind, and make statements like (1.44). The examples above which can have more than one reading are (1.34), (1.41) and (1.42).

Some generalisations, of course, will only have one reading. Those which refer to ideal objects, such as (1.38) and (1.40), will never carry presuppositions of existence. Those which refer to classes which do not form a kind, in the sense described above, such as (1.35), will always carry presuppositions of existence.

This leaves examples such as (1.32), (1.33) and (1.39). These examples are not empirical but are rules or conventions, stipulated or laid down by some authority. While clearly they need not refer to kinds, they are clearly idealised statements of some form, since they do not (usually) depend on facts about particular individuals, but make a prescription about something which falls into a certain class. In case this seems rather *ad hoc*, it is actually possible to get individualised readings for these examples. If I meet two students leaving the exam hall long after everyone else has finished, I may discover the reason for their lateness is that they are dyslexic, and that they spend extra time on their exams. I then know (1.32) as a rule I have discovered empirically, rather than as a conditional statement about some class about whose members I have no knowledge. But since examples such as (1.32) and (1.33) are usually not conceived of in this way, the idealised reading is the preferred one.

Tense plays an interesting role in these cases. Since there are fewer laws whose scope is limited in time, there are fewer cases in which an idealised generalisation would be made in anything other than the present tense. However, there are examples, such as

(1.45) Dyslexic students got no extra time in the past.

This is idealised, and so carries no presupposition of existence. But usually when a lawlike generalisation is made in the past or future tense, it is because individuals are being generalised about, as in (1.36) or Moravcsik's example:

(1.46) All furniture brought into Kuwait will be subjected to intense heat.[15]

We can think about the presuppositions in time by considering the following diagram:

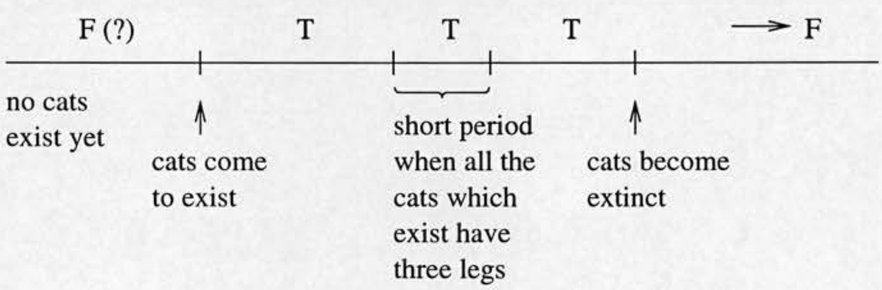


Figure 1.1: Change in truth value of 'Cats have four legs' over time (left to right)

When there have never been any cats, the generalisation makes no sense, and is therefore false, or meaningless. Once cats come into existence (given they are quadrupeds) the generalisation is true. This continues despite short periods when all the cats fail to satisfy it, and even periods when there might be no cats actually existing. Imagine that all the cats are dying out but that some fertilised eggs from a female are frozen and stored by scientists. At some time, after all the cats have died, they manage to implant the eggs into a carrier mother who subsequently gives birth to kittens. These kittens survive and breed and cats come to be common

[15]Moravcsik (1991), p. 432.

again. Throughout this time, it is plausible that the generic would be true. However, should cats actually become extinct, permanently, then gradually the generic will become false. People will continue to think of it as true for a while, but eventually will instead hold the truth of "cats *had* four legs". We do not say that dinosaurs *eat* kelp, but that dinosaurs *ate* kelp.

Finally, a word about generalisations about non-existent entities. Generalisations about unicorns, round squares and so on, clearly fall into the idealised generalisation class. The only way to discuss such things is via a specification of the class, exactly analogous to the rule/convention examples. Having claimed this, the following might seem to be a counterexample:

(1.47) In the fourteenth century, unicorns wore gold chains.

There are two approaches to this. One is to say that 'unicorns' here is merely denoting pictures of unicorns in books, manuscripts and so on, and this is a generalisation about representations of unicorns, rather than unicorns. The other is to say that since 'unicorn' is a concept derived culturally from literature, art and so on, this concept might change over time, and quite possibly the communal concept of unicorns in the fourteenth century is noticeably different from the one we have now. Perhaps these two approaches come down to the same thing. In any case, (1.47) is an example of a past tense idealised generalisation, exactly as (1.45) is.

1.4.4 Explicit quantification

A common claim about generics which I mentioned in section 1.3 is that one can test whether a sentence is generic or not by adding an adverbial quantifier like 'usually' or 'typically' to the sentence, and see if it results in a radical change of meaning. If not, the sentence is generic. For example, from Carlson and Pelletier (1995), p. 9:

(1.48) a. A lion has a bushy tail.

b. A lion usually has a bushy tail.

(1.49) a. A lion stood in front of my tent.

b. A lion usually stood in front of my tent.

While (1.48 a. and b.) mean roughly the same thing,[16] (1.49 a. and b.) say quite different things: one reports a particular event, the other reports a regular occurrence of a certain event.

However, generics do not always accept the addition of such adverbial quantifiers with little change of meaning. First, we must note that these quantifiers are adverbial, so qualify a

[16](1.48 b.) is perhaps slightly weaker, as it carries an implicature that the generalisation has exceptions, as outlined in section 1.3. Moravcsik (1994) thinks that when you add 'usually', 'typically' or 'generally' to a generic, the result is something which is no longer generic, because it becomes a purely extensional generalisation. This may well be true, but it is beyond the scope of this thesis.

verb. Generics generalise over individuals. So it is not obvious that the adverbial quantifier will always generalise over the same things as the generic. For example:

(1.50) Students usually understand the exam regulations.

This can mean *both* usually, if someone is a student, then she understands the exam regulations, *i.e.*, usual students understand the regulations, *and* students understand the exam regulations on usual occasions. In the first, the quantifier 'usually' replaces the generic quantifier. In the second, we still have the "generic" quantifier over students, and the 'usually' quantifies over occasions on which students consult the exam regulations. These could be represented, respectively, as follows:

(1.51) Usual(x)[student(x) $\rightarrow$ understand-the-exam-regulations(x)]

(1.52) Gen(x)[student(x) $\rightarrow$ usually-understand-the-exam-regulations(x)]

In (1.51) 'usually' quantifies over individuals (instead of the "generic" quantifier) and in (1.52) 'usually' presumably quantifies over events. Hence while (1.52) still has the same form as a generic, (1.51) does not, since the "generic" quantifier has been replaced by a different quantifier, albeit one which means something similar.

Carlson and Pelletier's claim is roughly that if we replace the generic quantifier with one of the adverbial quantifiers 'usually', 'typically' or 'generally', we get something which means roughly the same as the generic without the adverbial quantifier. So in the example above, (1.51) means roughly the same as 'students understand the exam regulations'. (1.52), on the other hand, means something rather different. So the test only works for generics where the adverbial quantifier actually replaces the generic quantifier.

Since we do not consider other explicitly quantified sentences where the quantifier ranges over the individuals to be generic, for example, (1.18), then strictly speaking, the reading of (1.50) representable as (1.51) is not a generic reading, even though it means something similar, as Carlson and Pelletier point out. There is clearly much interesting work to be done on the semantics of adverbial quantifiers, following on from Lewis (1975), but I will only be concerning myself here with genuine generics which do not contain only adverbial quantifiers over individuals. Perhaps the semantics of explicitly quantified sentences with these adverbial quantifiers are very close to those of generics, but I will not consider them in this thesis. On the other hand, the reading of (1.50) which is representable as (1.52) is genuinely generic.

In summary, the properties of generics discussed in this section are as follows: generics have an essential modal or counterfactual-supporting element, which can be glossed as nomic, *i.e.*, pertaining to laws, in some weak sense. Generics on one reading do carry presuppositions of existence, but on another do not. They are similar in meaning to sentences with certain adverbial quantifiers over individuals, but strictly, sentences with an explicit adverbial quantifier over individuals are not generic.

1.5 Syntactic forms of generics

Having considered some of the properties of generics, I will now briefly consider their syntactic form, and whether this makes any difference to the properties described in the previous sections. It was noted in section 1.1 that generics come in different syntactic forms. For example, recall (1.2)–(1.4):

(1.2) The cat has four legs.

(1.3) A cat has four legs.

(1.4) Cats have four legs.

Each of these is synonymous with the other two. But is this always the case? For example, compare the following:

(1.53) { Blue bottles are / A blue bottle is / The blue bottle is } expensive to produce.

(1.54) { Madrigals are / A madrigal is / The madrigal is } popular.

(1.55) { Students are / A student is / The student is } lazy.

While the first of each of these is fine, the second two seem less acceptable, with the second being generally more acceptable than the third. Both the second and third strongly prefer existential rather than generic readings, and it is quite hard to get generic readings, generally more so for the third than the second.

Another contrast comes with the sorts of properties involved in a generic. Compare the following:

(1.56) A madrigal is popular.

(1.57) A madrigal is polyphonic.

These examples are from Lawler (1973), who claims that we can get only an existential reading with (1.56) whereas we can get a generic reading as well with (1.57). Lawler's claim is that this is because (1.57) predicates an essential property of madrigals, whereas (1.56) does not. It just happens that madrigals are popular, but they must be polyphonic. This effect does not arise with the bare plural form of the generic.

However, it is certainly not the case that all generics using the indefinite article form involve predications of essential properties, however one interprets 'essential property'. For example:

(1.58) A student pays the reduced rate.

(1.59) A madrigal is popular at the Elizabethan Society dinners.

A similar phenomenon was noted by Carlson (1977). Only "well-established" kinds have a generic reading with the definite article. Compare the following, where (1.60) is much easier to understand than (1.61):

(1.60) The Coke bottle has a narrow neck.

(1.61) The green bottle has a narrow neck.

What exactly constitutes a "well-established" kind is not clear. Why should students or madrigals be less well-established than Coke bottles or cats? In a discussion of this problem in the introduction to Carlson and Pelletier (1995), the editors point out that when a generic reading is strongly implied by other contextual factors, we can accommodate by assuming the existence of such a kind (pp. 107–113). For example:

(1.62) The green bottle saved the lives of hundreds of children.

We might imagine that special green bottles were used to transport medicine to a remote disaster area or some similar scenario. However, this is not always the case. We do not assume a well-established kind exists in the following, which is nonetheless felicitous:

(1.63) The octagonal-shaped wing never became established in aeronautics.

Certain kinds seem easier to construe as definite generics than others. We have evidence for and against these kinds being the "well-established" ones. However, generally, it does seem that the form with the definite article is hardest to get. Whenever this form has a generic reading, there will also be a generic reading of the bare plural and indefinite article forms.

The definite generic form does seem to have different properties from the other forms. Unlike the other forms, its subject directly names a kind, rather than a member or members of a kind. However, it is often easy to transfer a property of a kind to its members. Hence 'the tiger is a fearsome creature' becomes 'tigers are fearsome creatures'. But since we started out with the kind, the abstract thing, rather than some set of instantiations, in using a definite generic we can abstract away from the actual properties of tigers and make idealised generalisations rather than individualised generalisations, as discussed in section 1.4.3. This might explain why it often seems that definite generics work better with "well-established" kinds.

To conclude, the three forms are basically synonymous, as long as a generic reading is available. Each form with a generic reading has a modal element and is similar in meaning if one of the adverbial quantifiers 'usually',' typically' or 'generally' is added. The only difference is possibly in which presuppositions arise, given that definite generics seem more likely to take an idealised reading. For these reasons, in the rest of the thesis I will almost entirely concentrate on the bare plural form of the generic, as in (1.4), since if any of the forms of some particular sentence has a generic reading, it will be this one.

1.6 Habituals

1.6.1 What are habituals?

So far, all the examples given have been of generics which quantify over individuals. We have seen that the noun phrase which is interpreted generically may be in subject or object position, or even in both, for example:

(1.64) Cats chase mice.

Habituals are often associated with generics, and quantify over events. They are supposedly like generics because while a generic 'Fs are Gs' asserts the existence of some regularity between being an F and being a G, a habitual 'a is F' or 'a Fs' reports a regular or habitual property F of a. Some examples of habituals given in the literature are

(1.65) John smokes.

(1.66) John smokes after dinner.

(1.67) John speaks French.

(1.68) John drinks whisky.

The thought seems to be that habituals are like generics because while a generic such as (1.64) means something like 'A typical cat chases mice' (ignoring the generic object for now), a habitual such as (1.66) means something like 'In typical after-dinner situations, John smokes'.

While habituals are often referred to in the literature as a subclass of generics, so that all habituals are also generics, I will reserve the term 'generic' for a sentence quantifying over *individuals*. Hence (1.65)–(1.68) are *not* generic, on my usage. This is at variance with a non-trivial amount of the literature, but in defence of my convention, there is no generally agreed upon term for this type of sentence, and in this thesis I will be mainly concerned with quantification over individuals.

I am not going to discuss habituals in the thesis, and since much of the literature on genericity includes treatments of habituals, I should explain why I take them to be an independent phenomenon. There are clearly similarities between some aspects of generics and some aspects of habituals, but I do not think these similarities are enough to warrant a unified analysis. Moreover, I think a lot of confusion about the nature of genericity has arisen because features peculiar to habituals have been assumed to hold of generics, and vice versa.

Intuitively, habituals are characterised by the predicate they involve. As well as having an individual as a subject, they may also have a plural term, with or without an explicit quantifier. Examples of these are

(1.69) The members of this club drink whisky.

(1.70) All professors drink whisky.

(1.71) Men drink whisky.

Some habituals, such as (1.71), are therefore generics. But as remarked above, not all habituals are generics (for example, (1.65)–(1.68) above). Are all generics habituals? For example, are the following habitual?

(1.17) Potatoes contain vitamin C.

(1.72) Dogs hate cats.

Neither of these appears to quantify over events. Either something contains vitamin C or it does not; (1.17) does not correspond to a summation of habituals about potatoes. Similarly, while there are events where a dog may display its hatred of a cat, this is not a realisation of a habitual property, as, for example, an event of John having a cigarette is a realisation of his habitual property of smoking. However, in order to clearly draw the distinctions which show that these are not generic, it is necessary to introduce some terminology.

Dispositional and occurrent properties

Above, a distinction has been made between what are called in the philosophical literature *occurrent* properties — the property of actually smoking a cigarette, figuring in the sentence 'John is smoking', and *dispositional* properties — the property of being in the habit of smoking, or being disposed to smoke in certain circumstances, figuring in the habitual sentence 'John smokes'.

This distinction finds early articulation in Aristotle and is later taken up by Ryle (1949), who discusses this at some length. Ryle characterises the distinction as follows:

> ... a number of the words which we commonly use to describe and explain people's behaviour signify dispositions and not episodes. To say that a person knows something, or aspires to be something, is not to say that he is at a particular moment in process of doing or undergoing anything, but that he is able to do certain things, when the need arises, or that he is prone to do and feel certain things in situations of certain sorts.
>
> ... we cannot say 'he knew so and so for two minutes, then stopped and started again after a breather', 'he gradually aspired to be a bishop', or 'he is now engaged in possessing a bicycle'. Nor is it a peculiarity of people that we describe them in dispositional terms. We use such terms just as much for describing animals, insects, crystals, and atoms. We are constantly wanting to talk about what can be relied upon to happen as well as to talk about what is actually happening. (p. 112)

Ryle points out that not all dispositional terms have episodic counterparts. He compares being a cigarette smoker with being elastic. While being a cigarette smoker is realised in only one way, that is, by smoking cigarettes, being elastic can be realised in various ways, such as contracting after being stretched, being about to expand after being compressed, or bouncing on sudden impact.

> In short, some disposition words are highly generic[17] or determinable, while others are highly specific or determinate; the verbs with which we report the different exercises of generic tendencies, capacities, and liabilities are apt to differ from the verbs with which we name the dispositions, while the episodic verbs corresponding to the highly specific dispositional verbs are apt to be the same. A baker can be described as baking now, but a grocer is not described as 'grocing' now, but only as selling sugar now, or weighing tea now, or wrapping up butter now. (p. 114)

The correct analysis of dispositions is an active area of research in philosophy, and the solution is not obvious. There are some connections between this project and the semantics of generics; for example there are counterfactual-type accounts of dispositions which analyse disposition statements as statements about what would happen in certain circumstances. More recently, this has included claims that this type of analysis can only work if "certain circumstances" are interpreted to include *normal* circumstances (see, for example, Bird, 1998a).

However, this kind of approach has traditionally only been applied to those dispositional properties which are the sort scientists are interested in (such as fragility, ability to conduct electricity and so on), rather than properties less amenable to scientific analysis such as

[17]Note that Ryle's use of the word 'generic' here is entirely incidental to the technical uses of the word in this thesis!

smoking or speaking French. It is not at all obvious how a counterfactual-type account of this kind would apply to these latter properties. Thus a philosopher's use of the term 'dispositional' may well be different to that of a linguist: linguists seem to be trying to apply this term rather more widely. I will now ask whether this extension is defensible.

Characterising habituals

Terminology varies throughout the literature. There seem to be several different ways of characterising habituals, under which different sentences count as habitual.[18] I have come across two main kinds of approaches, which I will briefly characterise and comment on.

One way of characterising habituals is that they are to events what generics are to individuals. A habitual 'John Φs' means something like: in typical situations, John has the occurrent property Φ. But this is restricted to cases where Φ is one of Ryle's "specific" dispositional properties, *i.e.*, there is an occurrent property which corresponds to the dispositional property, such as 'smoking'. Otherwise, with an example such as, say, 'being a good team player', which is realised by many different occurrent properties, which property would be realised in typical situations?

So on this view, a habitual is a sentence involving a predicate which is dispositional but has a corresponding episodic counterpart, for example (1.65)–(1.71) above. But not all generics are habituals. (1.17) and (1.72) above are generic but not habitual.

Another approach is to think of habituals as characterising dispositions. For example, Chierchia (1995) thinks of all i-level predicates (see section 1.2) as inherently generic, *i.e.*, on his view, inherently habitual, since he equates the two. Exactly how the problem of picking which lexical occurrent predicate applies to each dispositional predicate is not discussed; Chierchia suggests an analysis of 'Mary is a doctor' comes out something like 'for a typical situation s where Mary is in s, Mary is a doctor in s'. Moreover, Chierchia's account extends to i-level predicates which would not normally be termed dispositional: for example 'being tall'.

While this approach has much syntactic evidence on its side — Chierchia convincingly presents reasons why all sentences involving i-level predicates have importantly similar syntactic and semantic properties — it is not clear that it is genuinely explanatory, in the sense that attempts in the philosophical literature to explain dispositions, or attempts in the linguistics literature to explain habituals in the first sense (such as 'John smokes'), are. What does saying 'Mary is a doctor in s' come down to? Unlike 'John smokes', which would reduce to claims

[18]For example, Moravcsik (1994) differentiates between generics and habituals by claiming that habituals just describe what is usually or frequently the case but do not "describe parts of essences". By this one assumes he means that he takes generics to describe essential, and habituals to describe non-essential, properties of kinds. This is pretty far removed from any other use of the term 'habitual' which I have come across; most uses seem to be variants of the approaches I discuss here.

about situations in which John actually (occurrently) smokes, here no occurrent property is offered to which we can reduce Mary's being a doctor. Hence the account just seems vacuously circular.

This certainly does not address the philosophical issues of what dispositions come down to. While it is plausible that being a smoker comes down to particular facts about smoking cigarettes on certain occasions, what does being a doctor, or being fragile, come down to, and is there any such reduction? So rejecting Chierchia's view, we are left with the first view, that habituals are sentences which involve a dispositional predicate which has a corresponding episodic counterpart.

1.6.2 Habituals and generics

In the linguistics literature, it is very common to find unified approaches to the semantics of habituals and generics. It seems to be assumed that both generics which quantify over individuals, or parts of mass quantities, and habituals which quantify over events, should be treated in the same way, as both abstract away from particulars — the former from particular individuals, the latter from particular events.

This unified treatment is not found in the philosophical literature. Philosophers are often (probably justifiably) accused of taking a naive view of generics, for example, by translating a generic 'Fs are Gs' as $\forall x(Fx \rightarrow Gx)$, but this is not the treatment given to habituals, as we have seen in the previous sections. However, there are links in the philosophical literature between dispositions and laws.

I will now outline some similarities and differences between habituals and generics.

Modalities

Habituals can have very different meanings because they can express different modalities. Recall that we intuitively characterised habituals as quantifying over events: in typical situations, some occurrent property is exemplified. But what is a typical situation, and how much does it cover?

'John drinks beer' can mean that he will drink it (*i.e.*, that he has no strong objection to drinking it, or will drink it if there is nothing else) or that he often drinks it (but not usually that he constantly drinks it). The first of these is something like: there are situations in which John drinks beer. The second is more like our original paraphrase: in typical (or appropriate) situations, John drinks beer. The intonation of the sentence and the context of utterance play a role in determining which meaning is intended. Lawler (1973) introduces the terminology of existential and universal habituals, since these meanings seem to be so different. This echoes the distinctions between the meanings of modals made by Ryle (see Ryle, 1949, pp. 121–126) and Aristotle. According to Lawler, 'John drinks beer', meaning he will drink it, is existential, since there are situations in which he drinks it (although we might query the necessity of there actually being such situations). 'John drinks beer', meaning he usually does, is universal: a quantification over typical situations, in the terms often used to analyse such habituals.

These different readings do not, at least for the most part, arise with generics. 'Potatoes contain vitamin C' means something like 'all typical potatoes contain vitamin C'. Of course, generics which are also habituals will be subject to the ambiguity at the level of the habitual: 'Professors drink beer' will mean something like 'all typical professors drink beer', which may then be interpreted as an existential or universal habitual. But clearly here the ambiguities lie at the level of how we interpret the habitual: the interpretation of the generic is constant. (Lawler also points out that the two readings seem only to be available on the bare plural reading of the generic, and only the "universal" reading is available with definite or indefinite article generics.)

So here is a difference between habituals and generics: habituals are ambiguous between an existential and a universal reading, whereas generics are not, except when they inherit such ambiguity from a habitual predication.

Typical situations

While for both generics and habituals there are complex issues about what a typical individual or a typical situation consist in (and these issues will be discussed in detail in chapter four), these problems seem more complex for habituals. For example, supposing we wanted to analyse 'Tweetie flies'. According to the theory, this will come out as something like 'in typical situations Tweetie (actually) flies' or 'in typical situations Tweetie is flying'. But what is a typical situation here? Tweetie will not fly when she is asleep, or eating, or when she just does not feel like flying. It seems there is no non-circular way to pick out a typical situation.

It is not just that we are in difficulty trying to state the conditions under which Tweetie flies. For dispositional statements, an approach along the lines of typical or normal situations will just not cover every kind of case — from birds flying to individuals smoking cigarettes.

This is a symptom of the fact that it is much harder to determine what marks an event, as opposed to an individual, as an exception. Exceptions to generics seem much more clear-cut than exceptions to habituals. There can be "good reasons", for example, an independent explanation, why an individual F is not a G but yet 'Fs are Gs' is still true. For example, if Tweetie does not fly because she is a penguin, she is an abnormal bird with respect to flying. But if Tweetie is not flying now because, say, she just does not feel like it, this does not seem to be rule-governed in the same way. Again, the reasons why dispositions or capacities are realised at one time rather than at another are vastly complex, and a subject of serious study.

One obvious response to this is to ask whether this is in fact the right way to analyse habituals. Perhaps 'Tweetie flies' just does not mean 'in typical situations Tweetie is flying'. If this were the correct response, it would break the connection between generics and habituals which many people writing in this field seem keen to make.

Adverbial quantifiers

Another difference between habituals and generics is the effect of explicit quantifiers. If we add a quantifier to a generic which quantifies over the individuals over which we are generalising, the result is no longer generic. Compare the sentences below, where (1.4), which has no explicit quantifier, is generic, but the five following sentences have an explicit quantifier and are no longer generic:

(1.4) Cats have four legs.

(1.73) All cats have four legs.

(1.74) Cats all have four legs.

(1.75) Most cats have four legs.

(1.76) Cats mostly have four legs.

(1.77) Cats often have four legs.

(1.78) Some cats have four legs.

Adding another quantifier over individuals to a generic results in a sentence which is no longer generic.[19]

However, if we add a quantifier to a habitual, this does not happen. Consider the habitual (1.66) and four variations with explicit quantifiers:

(1.66) John smokes after dinner.

(1.80) John always smokes after dinner.

(1.81) John mostly smokes after dinner.

[19]Note that generics may have quantifiers added to them and remain generic, as long as the quantifiers do not quantify over the individuals being generalised over. For example:

(1.79) Cats always land on their feet.

is still generic, as long as 'always' is interpreted as quantifying over situations in which cats fall. So this paraphrases as 'Generally, if something is a cat, then it always falls on its feet'. There is another (less likely) reading which paraphrases as 'All cats land on their feet', and this is not generic.

(1.82) John smokes after most dinners.

(1.83) John often smokes after dinner.

(1.84) John sometimes smokes after dinner.

In the literature, all of the above variations are considered also to be habitual. On our criterion, that a habitual was a sentence involving a dispositional predication which had an episodic counterpart, I was deliberately vague by using the word 'involving', since all of these sentences involve such a predicate. But of course, there is no episodic counterpart to 'always smoking after dinner'.

Should we consider these examples to be habitual? If habituals were exactly analogous to generics, then we probably should not. (1.66) means something like: in typical after-dinner situations, John smokes. (1.80) means something like: in every after-dinner situation, John smokes. If exceptions to habituals (the non-typical after-dinner situations) are supposed to be determined in the same way as exceptions to generics (the non-typical individuals) then adding a universal quantifier rules out exceptions, and thus should make a habitual non-generic, since it no longer has exceptions. However, the reluctance in the literature to classify (1.80) as other than habitual suggests that what people are really interested in is the involvement of the habitual property, rather than the exact analogies between generics and habituals.

1.6.3 Summary

Thus there does seem to be a clear distinction between generics and habituals. Habituals cover a range of complex phenomena, the analysis of which is highly contentious. Generics, on the other hand, seem to be merely a way of generalising over individuals in a relatively simple and generally consistent way. While it is still hard in some cases to determine exactly what constitutes an exception to a generic, it is an order of magnitude harder to determine what constitutes an exception to a habitual.

My approach in this thesis will be to concentrate on the relatively unproblematic phenomenon of genericity and not to attempt to apply this account to habituals. I leave it as an open question whether habituals are similar enough to generics to warrant a parallel treatment, or whether their complexities render such an account impossible. I certainly hope I have shown that it is not obvious that an account of generics should carry over to habituals, nor that habituals themselves are a clear-cut, well-defined semantic category.

Finally, the following diagram gives the relationships between generics (top), habituals (middle) and episodes (bottom). An event of an individual having some occurrent property is evidence in favour of that individual having a disposition, which in turn is evidence for a species under which that individual falls to have the disposition generically. In the opposite direction, that a species has some property generically provides grounds for a defeasible inference that some member of that species will have that property (see section 1.4.2) and given that an individual has a dispositional property, this provides grounds for a defeasible inference, given the actualising conditions for the disposition to be realised, that the individual will realise a corresponding occurrent property. As far as my thesis discusses habituals, it will be concerned with the relationship between the middle and the top, and I will not address the relationship between the middle and the bottom.

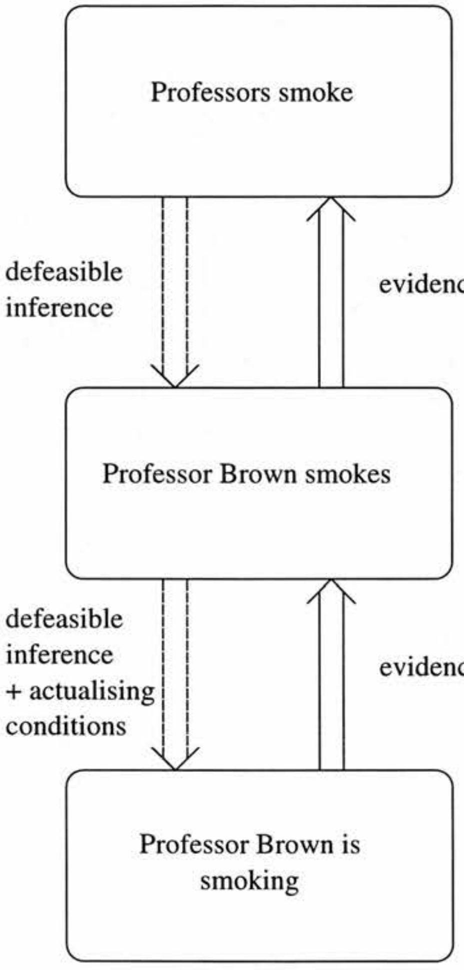


Figure 1.2: Generics, habituals and episodes

1.7 A criterion of genericity

The properties of generics which I have discussed in this chapter may be summarised as follows:

- Generics generalise over individuals, but have no explicit quantifier over individuals.
- A generic sentence may or may not have exceptions.
- Generics express nomic regularities; they support appropriate counterfactuals.

I will use this criterion throughout the thesis.

Chapter Two

What are Laws?

In the previous chapter, we saw that generics express nomic regularities, roughly characterised as counterfactual-supporting regularities. Since nomological matters have been most closely studied in the philosophy of science, I will now turn to this literature to explore the nature of laws of nature and Special Science laws.

Laws of nature are typically thought of as the basic principles which govern the workings of the world and include, for example, the laws of physics. On many views of science, they are the objects of research and discovery; they allow us to give scientific explanations and make predictions. Some authors have argued that the status of laws is fundamental to the philosophy of science, specifically in the areas of explanation and causation. For example, laws of nature play a central role in Carl Hempel's models of explanation (see, for example, Hempel, 1965). It is often argued that the activities of explanation and prediction in general rely on the existence of laws of nature (for example, Bird, 1998b).

I will reserve the term 'law' on its own for traditional exceptionless laws, however they are stated. Metaphysical questions about the nature of laws have a long history. Laws are typically stated by universally quantified sentences, which we arrive at by induction: we generalise over observed instances and make predictions about future unobserved instances. Hume famously argued that our evidence for the truth of an inductive generalisation 'all As are Bs' is no more than observed constant conjunctions of As and Bs: that all observed As have been Bs. The regularity view of laws takes laws just to be universal regularities, which gives rise to the central question: are laws just regularities, and if not, how do we distinguish genuine laws from mere accidental correlations?

In this chapter I will discuss various analyses of laws of nature, Special Science laws and *ceteris paribus* laws. I will start by discussing the regularity theory and the central question above of how to distinguish laws from accidental correlations. Traditional semantic accounts of this distinction ultimately fail. I will then spend some time outlining some more modern accounts. However, most of the accounts examined up to this point make two basic assumptions: that laws are exceptionless, and that only physical laws really count as genuine laws. I will question these assumptions by examining the methodological role of laws in areas other than physics, where laws with exceptions do seem to occur. I will follow this by presenting some of the literature on Special Science and *ceteris paribus* laws which defend a meaningful extension of traditional thinking about laws to the Special Sciences and even beyond.

My aim is to examine the extent to which the same notion of a law applies to various kinds of activity, including physics, the Special Sciences and even common sense reasoning. This involves asking whether the notion of a law with exceptions is coherent, and whether laws with exceptions are fundamentally different from exceptionless laws of nature.

I have already observed in the previous chapter that generics express some kind of nomic regularity. I will claim in chapter three that generics can be used to express laws of nature, and so discussion of this literature will give us a start on how to analyse what it is that some generics express. I will go on to argue that this is more than just a start. Many features of traditional exceptionless laws are shared by the nomic regularities expressed by all generics, which may not be exceptionless. My aim is to explore the possibilities for extending a treatment of traditional exceptionless laws to cover all nomic regularities expressed by generics.

2.1 Laws and accidental regularities

In this section, I will start by considering the regularity view of laws, which says there is nothing more to laws than a constant conjunction of kinds of events. However, we do distinguish between purely accidental correlations and those which we believe express a real feature of the world. Here I will look at semantic attempts to distinguish laws and accidental correlations: statements of laws have various semantic properties which accidental generalisations lack.

2.1.1 The regularity theory

Most analyses of laws take as their point of departure the simple or naive regularity theory. Following Hume, the simple regularity theory says that there cannot be more to laws than the constant conjunction of types of event, for what else is there for us to observe? A very naive version of this theory simply equates statements of laws and true universal generalisations. Universal generalisations, such as $\forall x(Fx \rightarrow Gx)$, state that a certain regularity holds — in this case, that every F is a G. On this naive view of laws, laws are just those regularities which do hold.

As it stands, this view is clearly wrong. The most obvious problem is the existence of regularities which are not laws: accidental regularities where, for example, all Fs are Gs, but it is not a law that Fs are Gs. For example, all the students in a class being right-handed rarely means that there is some law ensuring this is the case. The same point can also be made by saying that laws support counterfactuals, whereas accidental regularities do not. It is (presumably) not the case that it is impossible for a left-handed student to enrol for the class, or that were this to happen, the student would suddenly become right-handed.

Many modifications of the simple regularity theory exist which add extra conditions to prevent all regularities counting as laws. For example, we would want to exclude made-up regularities which we state by just enumerating things which have a certain property. Hence ruling out reference to particular objects will stop these statements counting as statements of laws. In the rest of this section, I will discuss some approaches along these lines.

2.1.2 Goodman and lawlikeness

Goodman (1954) offers an account of lawlikeness which has been highly influential. Goodman defines 'lawlike' as follows:

> I shall use the term 'lawlike' for sentences that, whether they are true or not, satisfy the other requirements in the definition of a law. A law is thus a sentence that is both lawlike and true.... (Goodman, 1954, p. 27)

Lawlikeness, then, is whatever distinguishes laws from accidental regularities. On its own, this definition does not tell us much: we need to know what the "other requirements" are. Goodman equates laws and statements of laws, but for reasons that will become clear, I will attempt to keep these separate.

What I will call a "semantic account" of lawlikeness determines these "other requirements" by the semantics of the terms involved. Thus, the predicates used in a sentence determine whether that sentence is lawlike or not. Since meanings remain constant across possible worlds, this view entails that if a sentence is lawlike in one possible world, it is lawlike in all possible worlds. Goodman is often interpreted as holding this view, although, since he does not think of modality in this way, he does not state such a view explicitly.

An initial argument against a semantic account suggests that this is just the wrong way to characterise lawlikeness. Consider the following sentences:

(2.1) All emeralds are green.

(2.2) All emeralds are colourless.

(2.3) All of my office-mates are from overseas.

(2.4) Everything that is in my pocket is silver.

(2.1) and (2.3) are true sentences; (2.2) and (2.4) are false.[1] Intuitively, the first two sentences are lawlike: they look like the sorts of sentences which express laws; whereas the last two are

[1] The suspicious reader will just have to take my word on (2.3) and (2.4).

not: they look like the sorts of sentences which express accidental generalisations. This is the intuition which a semantic account of lawlikeness is trying to capture.

A semantic account says that if things were different, (2.2) rather than (2.1) might be a law, but the only way either sentence could fail to state a law would be if it were false. Neither could be a true accidental generalisation. Similarly, if things were different (2.4) rather than (2.3) might be true, but neither of these could ever state a law, even if true.

However, this seems a strange conception of lawhood. It fails to allow that a sentence could state both a law (in some possible world) and an accidental generalisation (in some other possible world). Certainly on the weak interpretation of 'nomic' from the previous chapter, there are nomic regularities which could well be accidental regularities in other possible worlds: for example, we can imagine worlds in which (2.3) or (2.4) might be a law, since it is conceivable it might be departmental policy to have only one British student per office,[2] or it could be true that everything ever put into my pocket had to be silver, and had I ever tried to put a non-silver object into my pocket, I would have failed. But even restricting lawhood to, say, laws of physics, such as (2.2) and (2.1) are supposed to state, this conception allows that the laws of physics might be different, since the universal generalisations they entail might be false, but does not allow that a law of physics could just turn out not to be a law, but an accidental regularity.

Returning to Goodman (1954); in order to cash out the "other requirements" from the quotation above, he suggests that lawlike statements, unlike accidental statements, have the following properties:

1. they are used for making predictions (p. 26),
2. and thus they are not vacuous (p. 27),
3. and they do not refer to particulars (pp. 28–9).

He characterises these three properties in terms of the last one as follows:

> A sentence is lawlike if[3] its acceptance does not depend on the determination of any given instance. Naturally this does not mean that acceptance is to be independent of all determination of instances, but only that there is no particular instance on the determination of which acceptance depends. (p. 28)

This will include (2.1) and (2.2) as lawlike, but exclude (2.3) and (2.4), since acceptance would demand examination of each of my office-mates, or all things in my pocket. The idea here is that laws express timeless truths which hold over all circumstances, *i.e.*, sentences which do

[2] This would not, of course, make (2.3) a law of *nature*, but lawlike in a rather different sense. Different ways of interpreting lawlikeness will be the subject of chapter three.

[3] I suspect Goodman means 'if and only if'.

not change their truth-values over time. If there could be such a thing as a law which only held over a limited space or time, then acceptance of this law would depend on determination of given instances: those in the restricted space or time. So, by contraposition, not depending on this kind of determination implies that lawlike sentences cannot range over limited parts of space or time. I will leave discussion of whether there could be restricted laws of this kind until the next section.

On a semantic account of lawlikeness, it is difficult how to see a difference between an unrestricted law and an unrestricted universal generalisation. We cannot distinguish between the two, because they are both lawlike. This demonstrates the verificationist nature of the semantic account: on a verificationist picture, what observations could make the difference between the two? However, it does seem plausible to want to draw a difference between these. Goodman's condition 1 above, that lawlike statements are used for making predictions, seems a candidate for making this distinction. Yet Goodman is most unclear about what this comes down to: in most places, he seems to think that the above formulation will incorporate condition 1. As we have seen, this is not the case.

Consider the following thought experiment: suppose emeralds can be either green or colourless, and this is determined by some fact about what impurities are present when they form, and it just happens that only the impurities which lead to colourless emeralds have ever been present or ever will be present when all the emeralds form. Thus all emeralds are colourless, but this is only an accidental generalisation. Moreover, 'all emeralds are green', if true, would also only be accidental.

Whether a scenario like the one above is convincing of course depends on one's metaphysical commitments (presumably, it would not be convincing to a verificationist). However, if, as argued below, we do want to reject a criterion of lawlike sentences as unrestricted, we are left with the picture that lawlikeness is determined purely by meaning, which is extremely counter-intuitive.

2.1.3 Properties of laws of nature

The kind of semantic conditions on laws of nature set out by Goodman above have found their way into many treatments of laws. Following Armstrong (1983), I will use the clear definition given by Molnar (1969), who presents the regularity theory of laws in order to give an argument against it. Molnar characterises the regularities which this theory identifies with laws of nature as follows:

> *p* is a *statement* of a law of nature if and only if:
>
> (i) *p* is universally quantified
>
> (ii) *p* is omnitemporally and omnispatially true

(iii) p is contingent

(iv) p contains only non-local empirical predicates, apart from logical connectives and quantifiers.

On this definition, laws of nature are those regularities with certain properties, informally, the universal, timeless, contingent ones. Condition (iv)'s "non-local" predicates constraint rules out examples such as Goodman's (2.4) which contains reference to a "local" object — the speaker's pocket. These properties are intended to define a set which contains all and only laws. However, we discussed above that there may be regularities in this set which are not laws, since one might imagine accidental regularities which satisfy all these properties. Moreover there could be laws which do not have these properties, for example if (2.3) or (2.4) stated a law. I will now examine and criticise each of these conditions in detail, following Armstrong in arguing that this definition does not succeed in delimiting the set of laws from the set of accidental regularities.

Statements of laws are universally quantified

Most analyses of laws of nature claim that the fact that it is a law that Fs are Gs entails the corresponding universal generalisation $\forall x(Fx \rightarrow Gx)$. This is the conception of law which Popper used in his falsificationist methodology for the philosophy of science (see, for example, Popper, 1959). Rejecting inductive reasoning, Popper argued that the hallmark of science was that its propositions were capable of falsification, and that while we could never have knowledge of the certain truth of a generalisation, we could know it to be false by simply producing a counterexample — an F which was not a G.

If laws were not universally quantified, and had exceptions, then not every F which was not a G would be a counterexample to the law Fs are Gs, clearly counter to the falsificationist methodology described above. A more technical question can be asked about what it means for statements of laws to be universally quantified. It is generally held that laws *entail* universal generalisations, but criticisms of the regularity theory rest on laws and universal generalisations not being the same thing. Certainly a universally quantified sentence of first order logic does not support counterfactuals, for example.

While some authors claim that it is part of the definition of a law that it entails a universal generalisation, there have been suggestions that the concept can be extended to cover nomic relationships which do not. In the Special Sciences, in particular, regularities which play a similar role to laws may have exceptions. These are often called '*ceteris paribus* laws' because they state that it is a law that *ceteris paribus* Fs are Gs: Fs are Gs other things being equal. While of course one can reserve the term 'law' for an exceptionless regularity, it could be argued that the metaphysical status and also the usage of regularities in a science, rather than their specific logical form, should determine their status. If their metaphysical status and usage are the same across various sciences, then it looks as if we might have "laws" with exceptions.

In fact, I will argue later in this chapter that the similarities between traditional exceptionless laws and Special Science and *ceteris paribus* laws are worth pursuing, and we can meaningfully talk about "laws with exceptions", due to the similarity of methodological role of traditional and Special Science or *ceteris paribus* laws. I will go on to claim in the next chapter that it is possible to extend the traditional conception of laws to cover laws with exceptions, so that there is a unified class of nomic regularities including *ceteris paribus* laws and other types of laws which have exceptions, and that there is no metaphysical difference between exceptionless laws and laws with exceptions.

Laws of nature are contingent

It is generally held that laws of nature are logically and metaphysically contingent, *i.e.*, the world could be such that any law might fail to hold. If a regularity holds necessarily (*i.e.*, in all possible worlds), for example, that the sum of two even numbers is even, then this is not a candidate for empirical or scientific investigation, and thus is not considered to be a law of nature. However, what for us is physically possible is often defined as what holds in possible worlds where the laws of nature are the same as ours. Thus since our laws of nature are the same at every physically possible world, they are physically necessary. So the sense in which laws of nature are contingent must be stronger than physical possibility — by saying that laws are contingent we must mean that it is logically possible (*i.e.*, it does not violate the laws of logic) or at least metaphysically possible (*i.e.*, it is possible within some metaphysical theory) that they fail to be laws.

If regularities are supposed to be the objects of empirical or scientific enquiry, they will be *a posteriori* truths rather than *a priori* truths. However, since Kripke (1980), metaphysical necessity and *a prioricity* have been dissociated and the existence of necessary *a posteriori* truths has become relatively uncontroversial. Kripke's example

(2.5) Gold has atomic number 79.

is *a posteriori* because it is discovered using empirical methods, but it is necessary because nothing could be gold which did not have the same atomic structure. Something could look a lot like gold but unless it had the right kind of constitution, it would not actually be gold.

It seems plausible that the rationale behind the stipulation that laws of nature are contingent is that they are supposed to be the sorts of things scientists discover in the course of scientific activity. *A priori* truths do not have the same kind of relationship with science. But it is the mode of enquiry rather than the necessity or contingency of the putative law that seems important for this insight. (2.5) seems much more of a plausible candidate for a law of nature than 'Gold is gold'.

If we allow that laws of nature are *a posteriori*[4] rather than contingent, then two consequences follow. One is that *a priori* generalisations, 'Gold is gold', or from the previous chapter:

(1.21) Whales are whales.

(1.22) Equilateral triangles are equiangular.

are not going to be laws of nature. The second is that the kind of modality involved in laws of nature need not be the same. It appears that some laws may be physically necessary (such as that stated by (2.1)) whereas others will be metaphysically necessary (such as those above). I will conclude here that while there is no agreement about exactly how to delineate the modal or epistemological status of laws, it is their *a posteriori* status, rather than their contingency, which more closely captures the insight about laws which gives rise to the kinds of considerations discussed here.

Laws of nature are universal

Statements of laws of nature are not supposed to refer to particulars. This was discussed above in connection with Goodman's account of lawlikeness, and recurs here, with an example due to Michael Tooley (1977):

(2.6) All the fruit in Smith's garden are apples.

In the circumstances where any fruit grown from any kind of tree in Smith's garden is an apple, and any fruit which is brought into Smith's garden becomes an apple, Tooley and Armstrong agree that (2.6) appears to be a law.

However, not only does it refer to a particular object (Smith's garden) which poses a problem for a traditional account of lawlikeness, it is restricted in space (and probably also in time), in that it only applies to a restricted part of the universe. The intuition is supposed to be that we do not get laws which hold only in certain locations, or laws which hold at one time and not at another.

Two kinds of examples seem to show that this constraint is too strong. First, it has been suggested that the laws of nature might be different in different "cosmic epochs". For example, Whitehead (1933) (referred to by Armstrong) says:

[4] Armstrong does not think that all *a posteriori* generalisations are laws. He argues that theoretical identifications, for example, that water is H_2O, while *a posteriori*, are not laws. This is a consequence of his view that laws are relations between universals and cannot be relations between the same universals. See his (1983), chapter 10, section 1.

> ... since the laws of nature depend on the individual characters of the things constituting nature, as the things change, then correspondingly the laws will change. Thus the modern evolutionary view of the physical universe should conceive of the laws of nature as evolving concurrently with the things constituting the environment. Thus the conception of the Universe as evolving subject to fixed, eternal laws regulating all behaviour should be abandoned. (p. 143)

Physicists have also advanced the idea that the gravitational constant G may change over time. While Whitehead's conception of evolving laws is not really relevant to the conception of lawhood Armstrong is discussing, thoughts along these lines in the philosophy of biology are currently quite popular. If these suggestions hold, then not all laws will hold throughout time, although re-expressing them as an overarching law which is a function of time might get around this problem.

Second, there may be laws which hold only of a certain restricted class of things. Armstrong gives the following example:

> ... suppose ... that uranium found in Australia behaves in a slightly different manner from uranium found elsewhere, but does not differ from other uranium in any of its identifying quantum-mechanical and other properties. (p. 26.)

These sorts of example, like (2.6), suggest that there may be laws which do not hold throughout space or time, although were we seriously to consider either the uranium example above or (2.6) to describe laws, we would want to look to see if there were deeper underlying principles explaining them, which one might hope would not be spatiotemporally restricted.

If these examples are to count as laws, it appears we must relax the omnispatial and omnitemporal constraint on laws and just hold that laws must be true. But is every generalisation, whether it refers to particulars or not, going to be a law? In some sense the most extreme kind of reference to particulars is if we allow $x = a$ to count as a property which can be the antecedent or consequent of a universally quantified conditional which expresses a law. For example,

(2.7) $\forall x(x = a \rightarrow Fx)$

states that all things identical to a are Fs, which is equivalent to Fa. If this could be a law then we can have laws which necessarily could only ever have one distinct instance.[5] Statements such as (2.7) might follow from laws, but it seems perverse to call them laws themselves.

However, there is a view in the philosophy of biology about the nature of species which might lead us to query even this. Adherents of this view argue that there is no plausible candidate for the essence of a species. What makes two individuals both horses is not having

[5]There may be genuine laws which actually only have one instance, but that they only have one instance is presumably not necessarily the case.

certain genes or certain phenotypic features but being part of the horse lineage. This leads Hull (1978) to argue that biological species are not classes defined by some set of essential properties, but individuals, since as they function in the evolutionary process, they are necessarily spatiotemporally localised individuals, with their instantiations as parts. For anyone who thinks that genuine laws cannot refer to particulars, and specifically that we cannot have laws of the form of (2.7), this would mean we could have no laws about species. This is unfortunate, since we generally believe such laws do exist, and use them to explain and predict. Hull points out that there are many generalisations in biology and other Special Sciences which do make reference to particulars rather than just to spatiotemporally unrestricted classes, and one might want to allow that these do play a similar role to laws in some sense. However, he argues that they cannot be laws in the same sense as laws of physics which do not use such spatiotemporally restricted properties.

The problem with laws of the form of (2.7) may stem from our idea of the methodological role of laws as expressing generalisations which enable us to explain or predict. Something of this form cannot figure as a generalisation under which to subsume a particular fact. If individuals of a species are *parts* of it, then this generality reappears, presumably in the guise of some mereological theory.

In conclusion here, it seems difficult to lay down a criterion for lawlikeness in general based on whether or not a sentence contains reference to particulars. Whether sentences which contain no reference to particulars determine any metaphysically significant class also seems unclear. Perhaps a criterion of lawhood relies more on an intuitive grasp of what constitutes a regularity than on syntactic constraints.

Conclusions

The regularities specified in Molnar's definition do not seem to determine a class of laws. We may cast doubt on whether statements of laws need be universally quantified, whether they are contingent or rather *a posteriori*, and whether it makes any sense to talk about them being spatiotemporally unrestricted. None of these properties seems essential in *characterising* laws; I will now move on to consider some other approaches to analysing laws which do not rely on the semantic criteria discussed here.

2.2 Accounts of laws

Having examined the properties of laws of nature, I will now present two more modern accounts of what laws are and why they have these properties. These accounts go beyond the regularity and semantic accounts of laws. While I am not here particularly concerned with the metaphysical status of laws, and thus have no particular concern to arbitrate between the views given, I will show how these accounts distinguish between laws and accidental regularities, and how they explain the properties of laws.

2.2.1 Armstrong-Dretske-Tooley

The Armstrong-Dretske-Tooley view is so called because it was advanced at around the same time by Fred Dretske (1977) and Michael Tooley (1977) as well as by David Armstrong. I will concentrate on Armstrong's formulation of the view, since it is the most extensively worked out, in Armstrong (1983).

Armstrong holds that laws are relations between universals, that is, that laws are more than just collections of instances, but involve the properties themselves. There is a modal connection between being an F and being a G which the regularity theory denies: the fact that it is a law that Fs are Gs should be analysed as something like 'it is physically necessary that Fs are Gs'. Armstrong claims this leads to a realism about universals.

> We are now saying that, for it to be a law that an F is a G, it must be *necessary* that an F is a G, in some sense of 'necessary'. But what is the basis in reality, the truth-maker, the ontological ground, of such necessity? I suggest that it can only be found in *what it is to be an* F and *what it is to be a* G. (p. 77)
>
> ... there is something identical in each F which makes it an F, and something identical in each G which makes it a G. Then... *being an* F necessitates *being a* G and, *because* of this, each individual F must be a G. But this is to say that the necessitation involved in a law of nature is a relation between universals.

Armstrong expresses the necessitation between universals which comprises a law as follows: $N(F, G)$ means that the second-order relation (a relation of universals) N (for necessitation) holds of the first-order universals F and G. Armstrong argues that the following hold (where $\Rightarrow$ is an entailment relation):

$$N(F, G) \Rightarrow \forall x(Fx \rightarrow Gx) \tag{2.8}$$

$$\forall x(Fx \rightarrow Gx) \not\Rightarrow N(F, G) \tag{2.9}$$

(2.8) holds in virtue of the nature of the universals F and G, which will be explained in more detail below. (2.9) holds because of the existence of accidental regularities: there are plenty of regularities which are not laws, and so where there is no relation of necessitation between the universals involved.

Armstrong's theory of universals is complex, and while I do not want to go into it in too much detail here, I will explain how he claims it justifies (2.8). This relies on the fact that $N(F, G)$ is, as well as a relation between universals, also a state of affairs. Rab is a relation between particulars, and also a state of affairs. Are all states of affairs particulars? Rab is, Armstrong, argues, since it states a relation between a first-order universal, R, and first-order particulars a and b. But $N(F, G)$ states a relation between a second-order universal N and second-order particulars (first-order individuals) F and G. Thus $N(F, G)$ is a second-order particular, *i.e.*, a first-order universal.

Since $N(F, G)$ is a first-order universal, its instances will be first-order particulars which are states of affairs, of the form (a's being F, a's being G). The relation N of necessitation which holds between universals is the same as the first-order singular necessitation holding between a's being F and a's being G in instances of the relation $N(F, G)$. So the fact that $N(F, G)$ holds for some F and G entails that for any a, a's being F necessitates a's being G, and thus all Fs are Gs. So (2.8) is justified.[6]

So, on Armstrong's theory, the regularities between Fs and Gs are explained by the existence of a law that Fs are Gs, but not every such regularity will be a law. Accidental regularities are distinguished from laws because there is no relation of necessitation holding between the relevant universals. Only when a necessitation relation holds between F and G does the generalisation 'Fs are Gs' support counterfactuals, since the necessitation relation would not be affected if an object a which is actually not an F were an F.

Armstrong's theory thus accounts for the properties of laws, but at the price of introducing a metaphysically primitive necessitation relation, which remains unexplained. It also relies heavily on Armstrong's metaphysical theory of universals. A theory which does not come with so much metaphysical baggage is that of David Lewis, which I will discuss next.

2.2.2 Ramsey-Lewis

David Lewis outlines a theory of laws of nature in his (1973), deriving from a theory developed but rejected by F. P. Ramsey in the 1920s–30s. Ramsey's original theory stated that laws are

> consequences of those propositions which we should take as axioms if we knew everything and organised it as simply as possible in a deductive system. (p. 73)

A deductive system is a set of deductively closed, true sentences, and there are many such systems. Some can be axiomatised more simply than others. For example, the fact that all bodies obey Newton's Law $F = ma$ can either be written as an infinitely long list of particular sentences saying that a particular force on an object is equal to the object's mass times its acceleration, or can be written as a single schema or axiom. Clearly any system in which this is done the latter way is simpler. Similarly, some systems are stronger than others in that they

[6] Armstrong actually does not think (2.8) holds in all cases, but only when $N(F, G)$ is an "iron law". I will discuss this further in the next chapter.

contain more facts. The best systems will be as strong and as simple as possible: the best balance which can be achieved. Thus Lewis reformulates Ramsey's theory as follows:

> a contingent generalisation is a *law of nature* if and only if it appears as a theorem (or axiom) in each of the true deductive systems that achieves a best combination of simplicity and strength. (p. 73)

By definition, Lewis's laws entail universal generalisations, since they are universal generalisations. Moreover, they are by definition contingent. We distinguish laws from accidental regularities since including an accidental generalisation in the system would detract from simplicity but would not add to strength. For example, (2.3) (on page 34) is an accidental generalisation because it does not figure as an axiom or theorem in a best deductive system. Adding this generalisation would detract significantly from simplicity, but would add hardly anything in terms of strength.

Lewis's laws will also support counterfactuals, in virtue of Lewis's theory of counterfactuals. It is assumed that close worlds have a similar "best axiomatisation" and so if it is a law that Fs are Gs, in the closest world in which a is F, 'Fs are Gs' will still be a law. Thus while not presupposing the full-blown theory of universals as Armstrong's account does, we are relying to some extent on Lewis's theory of counterfactuals, itself not without metaphysical commitments.

An important feature of Lewis's analysis is that laws are such in virtue of their being theorems or axioms of a deductive system which is a description of the world. This reflects our intuitions that laws are laws *of a theory*, even if only an ideal theory, that is, laws are useful in describing the world with reference to some explanatory framework.

So, to summarise this section, both of the views above make laws entail universal generalisations, and distinguish laws from accidental regularities by demonstrating that laws support counterfactuals whereas accidental regularities do not. Both also make laws metaphysically contingent generalisations, therefore presumably excluding necessary *a posteriori* generalisations such as 'water is H_2O'. Lewis's account also realises our intuition that laws are part of a theory. What I will say in the rest of the thesis will not depend on which, if either, view is preferred; I am more concerned here to present a working account of laws of nature which can account for their properties and distinguish between laws and accidental regularities.[7]

2.3 The methodological role of laws

I have so far in this chapter been mostly considering what laws *are*, rather than what laws are *for*. This second question will now be addressed. In the introduction to this chapter I said

[7] In writing this section I was greatly helped by the clear summary in Beebee (1998).

that laws were important in explanation and prediction, and I have previously mentioned that the exact form of a sentence expressing a law seems less important than the role laws play. So what is this role, and why should philosophers be interested in laws? A central concept in the philosophy of science is that of *explanation*, and I will start by discussing Hempel's models of explanation, which are the best known analyses of this concept, and constitute the point of departure for other accounts. Explanation is not, of course, the only important area of philosophy of science in which laws play a role, but I will concentrate on this, and then briefly mention some other areas.

Science is in the business of giving explanations of phenomena, and one way of giving an explanation of an event is to show that it is an instance of some general principle. For example, we may explain why the metal spoon in my tea is hot to touch, while the plastic spoon is not, by the laws of heat conduction: in this case that metals conduct heat very much better than plastics.

Hempel (1965) gave his "covering-law" model of explanation based on exactly this concept. In order to explain an event, we subsume it under some covering law, *i.e.*, some law which covers the phenomenon. Hempel provides two models of explanation: the deductive-nomological (hereafter D-N) model, applying to cases where a covering law plus initial conditions deductively entail the phenomenon to be explained, and the inductive-statistical (referred to as the I-S) model, where we may inductively infer from a statistical correlation that the phenomenon was highly likely to occur. In both cases, explanations are arguments, with laws as their premises. I will briefly describe the D-N model only, since this is most relevant to my concerns here.

A D-N explanation is a valid deductive argument of the form:

$$\text{(2.10)} \qquad \frac{\begin{array}{c} C_1, C_2, \ldots, C_k \\ L_1, L_2, \ldots, L_r \end{array}}{E}$$

where $C_1, C_2, \ldots, C_k$ are statements describing the particular facts concerning the event to be explained, and $L_1, L_2, \ldots, L_r$ are general laws, and E is a statement describing the event to be explained, called the *explanandum* or *explanandum event*. E should not follow from any proper subset of the premises.

Hempel gives the example[8] of some glass tumblers taken out of hot soap suds and put upside down on a plate. Soap bubbles emerged from under the tumblers' rims, grew for a while, came to a standstill, and finally receded inside the tumblers. The explanation for the emergence and subsequent disappearance of the soap bubbles can be given as follows:

[8] Hempel takes this example from John Dewey.

> Transferring the tumblers to the plate, he had trapped cool air in them; that air was gradually warmed by the glass, which initially had the temperature of the hot suds. This led to an increase in the volume of the trapped air, and thus to an expansion of the soap film that had formed between the plate and the tumblers' rims. But gradually, the glass cooled off, and so did the air inside, and as a result, the soap bubbles receded. (p. 336)

Hempel then analyses this as described in (2.10) above. The $C_1, \ldots, C_k$ include the facts that the tumblers had been immersed in soap suds of a temperature considerably higher than that of the surrounding air, they were put, upside down, on a plate on which a puddle of soapy water had formed, providing a connecting soap film, *etc.* The $L_1, \ldots, L_r$ include the gas laws and

> various other laws concerning the exchange of heat between bodies of different temperature, the elastic behaviour of soap bubbles, and so on. While some of these laws are only hinted at ... and others are not referred to even in this oblique fashion, they are clearly presupposed... (p. 336)

From these initial conditions, which are of the form of atomic sentences, and the various laws, which are of the form of universal generalisations, we are to get a valid deductive argument with the explanandum as the conclusion.

The D-N model was developed with physics (and perhaps also chemistry) in mind, but it can also be applied to other fields of enquiry. The same kinds of methodological principles seem to apply in the so-called Special Sciences (biology, psychology, economics, geography and so on), and perhaps even in normal everyday reasoning. In as much as the Special Sciences are considered to have laws, these laws are assumed to give rise to explanation in the Special Sciences which conforms to the D-N model, as much as explanation in physics. This is because even if Special Science laws contain *ceteris paribus* clauses, we can have a deductive argument of the form of (2.10) where the $C_1, C_2, \ldots, C_k$ include the condition that the *ceteris paribus* conditions are satisfied.

On Hempel's models, laws have a central role in explanation, since they are required in the premises of any argument which constitutes an explanation. However, the D-N model has been subject to much criticism, and alternative models have been proposed to meet these. For example, one criticism is that there is no guarantee that a D-N argument of an event will actually include the cause of that event. Pre-emptive causation occurs when although a causal chain from A to B was in process, another event C occurred prior to B, and caused B itself. For example, suppose it is a law that anyone who eats a pound of arsenic dies within twenty-four hours. Jones eats well over a pound of arsenic at time t, but shortly after this, is run over by a bus. An argument citing the above law and the fact that Jones ate the arsenic, whose conclusion is that Jones died within twenty-four hours of t, will be a D-N explanation for Jones's death, since Jones did die within twenty-four hours of t. The problem is that it is not the explanation of Jones's death, since the arsenic was not the cause.[9] There are other standard criticisms of the D-N model which also point out that it lets in too many arguments as explanations;[10] as with the example above, not all D-N explanations are what we actually want to count as explanations.

While these kinds of criticisms are telling against Hempel's *formulation* of the D-N model, they are not criticisms of the role of laws in explanation. Attempts to extend the model or to rework it, in order to save it from these criticisms still retain the basic form, with laws as premises (for example, Friedman, 1974; Bird, 1998b). However, there are alternative accounts which do reject the necessity of laws in all explanations. Many of these instead include a causal condition, that the explanation should include the cause of the event to be explained (for example, Salmon, 1984). While the subject of how causation should be analysed is well beyond the scope of this thesis, it is not obvious that any account of causation will be able to do entirely without laws, and David Lewis's influential account (Lewis, 1986a) in fact analyses causation in terms of laws.

An account which is only partially causal, and which rejects the necessity of laws in all explanations, is that put forward by Ruben (1990). However, Ruben still acknowledges that laws have an important role to play in science and in explanation, even if not always *as* explanations themselves. Laws resolve puzzles, in that they allow us to fit phenomena into a more general pattern. Moreover, theories, which consist (perhaps *inter alia*) of laws, supply a vocabulary for identifying or redescribing phenomena or mechanisms which account for them. Laws are thus vital for introducing a new vocabulary in which to unify what seem like different phenomena under one law. While Ruben holds that unification and explanation are different things, unification is still a necessary part of science, and indeed is necessary for the activity of explanation to take place at all.

This discussion has shown that while the analysis of explanation is an ongoing area of research in the philosophy of science, all accounts give a central role to laws, whether as part of explanations or as part of what makes explanation possible. Since explanation and prediction are closely connected, it follows that laws will also have a central role in prediction. Indeed, independently of its connection with explanation, prediction is dependent on laws as Achinstein's example of Jones and the arsenic shows; the prediction that Jones will die within twenty-four hours holds due to the law, even though the argument does not explain his death.[11] As Salmon (1984) notes, laws form part of the network of regularities which help us make sense of the world:

> If the universe is, in fact, deterministic, then nature is governed by strict laws that

[9] This argument is due to Peter Achinstein.

[10] For more details, see Ruben (1990), chapter 6.

[11] Thanks to Alexander Bird for suggesting this point.

> *constitute* natural regularities. Law-statements describe these regularities. Such regularities endow the world with patterns that can be discovered by scientific investigation, and that can be exploited for purposes of scientific explanation. To explain an event — to relate the event-to-be-explained to some antecedent conditions by means of laws — is to fit the explanandum-event into a discernible pattern. (p. 80)

I will draw on this conception of the methodological role of laws in chapter three.

2.4 Extending the traditional view of laws

In this section, I will consider the metaphysical status of "laws" with exceptions, and those which are not strictly laws of nature since they cover other kinds of phenomena. Can we extend the accounts of laws discussed previously to cover these nomic regularities? First, I will consider some objections to the claim that Special Science laws have the same metaphysical status as laws of nature. Then I will give an account of some recent literature on *ceteris paribus* laws and arguments for and against the claim that we can non-vacuously cash out *ceteris paribus* clauses.

2.4.1 Special Science laws

Smart (1963) claims that biology does not have any laws because the only candidates are not universal in scope – they refer to particular types of things found in particular regions, and if they were made completely general, then they would not be true. He claims that in the following example,

(2.11) Albinotic mice always breed true.

'mice' are defined by their place in the evolutionary tree of the creatures found on Earth. Defining mice in this way therefore carries implicit reference to a particular thing, namely the planet Earth. On this definition, (2.11) cannot therefore be a law in the strict sense. We saw previously that a more subtle version of this view is popular in the philosophy of biology, and that on this view, species such as mice are not definable at all except by reference to their history, making them analogous to individuals.

Smart contrasts biology with physics and chemistry which are supposed to have laws in the strict sense, *i.e.*, which apply everywhere in space and time and can be expressed in general terms.[12] The propositions of biology are then explained by these physical and chemical laws. According to Smart,

[12] Smart's definition of "in general terms" is "without making use of proper names or of tacit reference to proper names".

> The difference is that between using propositions of observable fact in order to test laws and using laws in order to test propositions of observable fact. (p. 60)

In physics we make observations and thereby test laws; in biology we already have the (physical and chemical) laws and use these to explain why things (genes, cells, animals) behave as they do.

Smart is making two points here. One is that a difference between biological (and other Special Science) laws and genuine (physical and chemical) laws is methodological. He may well be right about the difference between the role of physical and chemical laws in physics and chemistry, and in biology and other Special Sciences. But this is not to say that if there were biological laws, their role in biology would be different to the role of physical laws in physics.

Smart's other point concerns the nature of lawhood. While his criterion of lawhood does seem to rule out biological laws, the view of biological kinds proposed seems similar to the Kripke-Putnam indexical view of natural kinds (see, for example, Putnam, 1975b). On this view *all* natural kind terms are indexical. So 'water' refers to whatever it is that has *this* chemical constitution (or other essential property), where "this chemical constitution" is whatever the chemical constitution of water on Earth is. Given this, on Smart's view propositions which contain the word 'water' cannot be laws. This would not be a consequence Smart would accept happily.

However, while 'water' is *introduced* as an indexical term on the Kripke-Putnam view, once this has happened, its reference remains constant. We can therefore still substitute for it the coreferential chemical formula for water in any generalisations about water. We do not want to make generalisations in physics about the (possibly variably realised) communal concept of water, but about the chemical stuff, that is the liquid: pure H_2O. However, if Hull's position is right, we can make no such substitution for a term like 'mice' — there is no such essence. The term 'mice' is not unrestricted and timeless in the sense that 'H_2O' is.

We have previously discussed how much notice we should take of reference to particulars in laws. Restricted laws such as Tooley's

(2.6) All the fruit in Smith's garden are apples.

have a reasonably strong claim to be laws (even if only derived laws).[13] Moreover, laws in Special Sciences which may contain unavoidable reference to individuals, as discussed above,

[13] The particular to which this putative law refers is Smith's garden. I will later argue (in chapter five) that in fact, this example should *not* be taken to be a law, because its logical form is that of plural predication: sentences of the form 'All the Fs are Gs' are merely enumerative rather than making a counterfactual-supporting claim. However, this does not concern the present argument, which would go through if we changed the example above to

(2.12) All fruits in Smith's garden are apples.

which, being of the form 'All Fs are Gs', I argue is lawlike.

similarly have a strong claim to be treated like laws in virtue of their methodological role. Against this we have to balance the genuine differences there seem to be between unrestricted timeless laws of physics and those in biology and so on.

I have already mentioned cases where the laws of physics seem to be restricted in this respect, for example, the gravitational constant changing over time, and it is certainly logically possible that this could happen. We do privilege physics in some respects, in virtue of its seemingly unchanging basic laws. Nonetheless, it is important to note that as yet we have no unified theory of everything, and while we would be more upset if physics was found to vary elsewhere in the universe, than if we discovered a planet with completely different biological features, it is not impossible that our foundations could be shakier than we commonly think.

2.4.2 *Ceteris paribus* laws

Neither Smart nor Hull has done enough to show that there is an important difference between laws of physics and Special Science laws. A stronger argument that there is a real difference turns on the claim that Special Science laws hold only *ceteris paribus*. They do not state strict generalisations, but have exceptions, and only hold in certain circumstances. Some analyses of *ceteris paribus* laws hold that this is enough to make a metaphysical difference between them and strict laws.

Nancy Cartwright (1983) famously argues that the laws of physics are blatantly false, and that what we use in explanation are not these ideal, theoretical laws, but *ceteris paribus* laws. In other words, they only hold other things being equal — they include a *ceteris paribus* clause. But what are *ceteris paribus* laws? Can we always cash out the *ceteris paribus* clause, and if we cannot, does it not make the putative law either vacuous or indeterminate to the extent that it becomes useless?

For example, Schiffer (1991) asks whether sentences containing *ceteris paribus* clauses express propositions:

> The sentence
>
> > If a person wants something, then, all other things being equal, she'll take steps to get it.
>
> is deceptive. It looks as though it's expressing a determinate proposition, because it looks as though 'all other things' is referring to some contextually determinate things and 'equal' is expressing some determinate relation among them. But one would be hard pressed to say what the "other things" are and what it is for them to be "equal". Yet if 'all other things being equal' doesn't make a bona fide contribution to a proposition expressed by [the example above], then [the example above] is really tantamount to
>
> > If a person wants something and . . . , then she'll take steps to get it.

> which is good for nothing, as it expresses no complete proposition, nothing that could even be believed, let alone play some explanatory role. (p. 2)

Before considering Schiffer's example, I will say something about reduction. Reducing a discipline or field of enquiry to another one in some sense consists in giving translations of the terms of the first discipline into those of the second. So, for example, it is a famous question in the philosophy of mind whether the mental is reducible to the physical: is every mental event a physical event; could we explain mental events in terms of physical events?

We should distinguish two kinds of reductionism. Ontological reductionism holds that theory A is reducible to theory B if every event referred to by theory A is identical with some event we can refer to in theory B. So we might hold that meteorology is reducible in this sense to physics, since every meteorological event (a storm, for example) is identical to some physical event (very low atmospheric pressure resulting in high winds, electrical discharges from friction caused by violent vertical motion in the clouds, and so on). Explanatory reduction, on the other hand, holds that theory A is reducible to theory B if every explanation in theory A is reducible to an explanation in theory B. For example, a meteorological explanation of the storm would cite meteorological laws concerning pressure, cloud formations, and so on. For meteorology to be reducible to physics in this sense, there would have to be an explanation of the collection of physical events which constitute the storm in terms of the physical translations of the meteorological laws. This is clearly a much stronger thesis, since, given that explanation relies on laws, it implies that there are laws in physics from which every Special Science law can be derived.

One argument against explanatory reductionism is that of variable realisation. For example, we can psychologically explain a desire to buy chocolate by the generalisation that if a person wants chocolate, has money, is reasonably near a shop, is not on a diet, and so on, then that person will desire to buy some chocolate. However, it might well be the case (and it seems likely) that a desire for chocolate can be physically realised in completely different ways in different people. It might be the case that all that these brain states (or whatever) had in common was that they resulted in a desire to buy chocolate. Similarly, wanting chocolate, being reasonably near a shop, and so on, might again be physically realised in completely different ways in different people. So there would be no general non-circular physical explanation of the desire for chocolate in these terms; the corresponding physical "explanation" would include conditionals involving (possibly infinitely) long disjunctions of possibilities. Irreducibly disjunctive "generalisations" cannot be laws, and so cannot play the role of laws in explanation.

One reason that explanations in the Special Sciences may not be seen to have the same status as those in physics is perhaps because while it is commonly thought that Special Sciences ontologically reduce to physics, it is a highly controversial claim that an explanatory reduction can be achieved. Moreover, because Special Science laws often contain *ceteris paribus* clauses, the Special Sciences are considered to be incomplete in a sense which physics is not. For example, Papineau (1993) says:

> ...physics, unlike the other special sciences, is *complete*, in the sense that all physical events are determined, or have their chances determined, by prior *physical* laws. ...A purely physical specification, plus physical laws, will always suffice to tell us what is physically going to happen, insofar as that can be foretold at all. (p. 16)

An event in a Special Science will have a partial explanation in terms of that science, but only by including the *ceteris paribus* clause.

For example, consider a possible candidate for a law of theoretical reasoning:

(2.13) If A believes p and A believes that (p $\rightarrow$ q) then (*ceteris paribus*) A believes q.

The *ceteris paribus* conditions here might be cashed out as:

(2.14) If A believes p and A believes that (p $\rightarrow$ q) then barring confusion, distraction, *etc.*, A believes q.

which are all in the vocabulary of the relevant Special Science, namely (commonsense) psychology. But there will be other conditions packaged up in the "*etc.*". The prefrontal cortex in the human brain is responsible for planning, problem solving and so on. If this is damaged then, for example, a person might be capable of preparing different dishes separately but not be capable of executing a plan to cook a whole meal.[14] So, if A is hit on the head, causing damage to the prefrontal cortex, then A may be prevented from making the inference from p and (p $\rightarrow$ q) to q. Thus we need to include conditions such as "barring confusion, distraction, damage to the prefrontal cortex...". Ontological reduction tells us that there will be some description of each such condition, but not that this will be in the right vocabulary. Here we no longer seem to have a law of purely commonsense psychology.

However, it is true that the law may be stated in the vocabulary of the Special Science as long as the *ceteris paribus* clause is present. As long as we know the *ceteris paribus* clause can be cashed out in some terms, we do not need to state what they are: that is the point of including the *ceteris paribus* clause in the first place. As Fodor (1987) puts it:

> Exceptions to the generalisations of a special science are typically *inexplicable* from the point of view of (that is, in the vocabulary of) that science. ...But, of course, it may nevertheless be perfectly possible to explain the exceptions *in the vocabulary of some other science*. In the most familiar case, you go "down" one or more levels and use the vocabulary of some more "basic" science. (p. 6)

[14]Thanks to Al Reid for this interesting example.

Let us return to Schiffer's example. Schiffer claims that we cannot have *ceteris paribus* laws because we cannot cash out their *ceteris paribus* clauses. This is because these clauses will not be specifiable in the vocabulary of the Special Science. But then the only way to cash them out will be in some more basic science where variable realisability will mean that the cashed-out *ceteris paribus* law will be disjunctive and moreover have possibly infinitely many disjuncts. It will then no longer count as a law of the relevant Special Science, or even as a law at all.

A response to Schiffer is to argue that ontological reduction is enough — we do not need explanatory reduction as well. As I have argued in the previous section, explanations in the Special Sciences rely on the laws of the Special Sciences themselves, rather than any underlying physical processes or explanations. For the purposes of explanation, self-standing Special Science laws are more than up to the job.

A critic might argue that this ignores important facts about explanations. An explanation using a *ceteris paribus* law is fine *as long as the* ceteris paribus *conditions hold.* But so far I have not said anything about how we might go about cashing out *ceteris paribus* conditions non-vacuously. As Fodor (1991) agrees, we need to be able to explain *ceteris paribus* clauses without making *ceteris paribus* laws empirically empty, that is, we need to acknowledge:

> ... the difference between "it'll fly *ceteris paribus*", which I take to be genuinely optimistic, and "it'll fly unless it doesn't", which I take to be merely cynical. (p. 22)

Cartwright's answer to how we do understand regularities in science, given that we only have *ceteris paribus* laws, is that we are not looking for laws, but seeking to discover the *natures of things*. This is glossed as what the powers or capacities of things are, and how predictable behaviour results from particular arrangements of capacities in particular kinds of circumstances. She argues that what determines the *ceteris paribus* conditions cannot be part of the law itself. *Ceteris paribus* laws are a consequence of

> ... the repeated operation of factors that have stable capacities (factors of this kind are sometimes called 'mechanisms') arranged in the "right" way in the "right kind" of stable environment. The image is that of a machine with set components that must be assembled and shielded and set running before any regular associations between input and output can be expected. (Cartwright, 1995, pp. 277–278)

Cartwright calls this kind of set-up a *nomological machine*. This conception is based on her view that the covering-law model of explanation discussed in section 2.3 is wrong for fields which use *ceteris paribus* laws. Her view is that explanation has to stop at some level. While in physics it is considered at least plausible that there are regularities "all the way down", in, say, economics, we cannot explain the natures or capacities of things by using covering laws.

One of her main arguments for this is that there are no regularities involving the economic capacities themselves: mechanisms do not function on their own, and so we cannot formulate regularities about them.

She argues that there is thus a metaphysical as well as an epistemological difference between strict laws and *ceteris paribus* laws. The laws of physics, say, are supposed to be primary: they are the objects of discovery, and the phenomena are instances of them. (Cartwright's own view is that while many people suppose that the laws of physics are like this, in fact there are no such primary laws, and the laws of physics are also just *ceteris paribus* laws.) *Ceteris paribus* laws are results of the operation of a nomological machine. The *ceteris paribus* conditions state how to set up the environment in which the machine can operate; the laws are what the machine produces. They are thus secondary: they are constructed rather than discovered, from knowledge about capacities and how they behave in certain configurations.

Whereas this represents the traditional view of laws of physics as strict laws, as mentioned before, Cartwright holds that the laws of physics hold only *ceteris paribus*, and are also generated by a nomological machine. This claim is argued for in her (1997). Thus on her view there are no strict laws, just nomological machines and the regularities they generate.

While Cartwright's claim that most, if not all, laws hold only *ceteris paribus* is one with which I am sympathetic, I find her rejection of *ceteris paribus* laws in favour of nomological machines unhelpful. If there are no regularities involving the capacities of things, how can we study them? For any particular capacity, there may be no regularities involving *only* that capacity — it may be inextricably linked to other capacities — but what governs this linkage? In order to understand the set-up, we must idealise, and the way we do this is by using *ceteris paribus* laws. We are not committed to giving full descriptions of what is in the *ceteris paribus* clauses when we use a *ceteris paribus* law in explanation. The following defence of *ceteris paribus* laws demonstrates that this intuition is a coherent one.

Pietroski and Rey (1995) argue that *ceteris paribus* laws can be non-vacuously cashed out as long as the explanations of exceptions rely on independent factors — those which are not there purely to save the law. They explain the notion of independence in terms of explanatory role: basically an explanation of X is independent of X if it explains something else as well as X. For example, endorsing Boyle's gas law that pressure is directly proportional to temperature divided by volume commits one to the possibility of explaining deviations by citing factors other than pressure, temperature and volume, for example, the electrical attraction between molecules. These factors play an explanatory role in physics independently of Boyle's law. If for any law such an independent explanation of exceptions cannot be given, then the law is vacuous. I will now present a simplified version of their account in more detail.

The canonical form of a *ceteris paribus* law is:

(2.15) $\text{cp}[\forall x(Fx \rightarrow Gx)]$[15]

Conditions are "C-normal" with respect to (2.15) when and only when there are no Fs which are not Gs; any F which is not a G is a "C-abnormal" instance of (2.15). So, C-normally, (2.15) holds. The task is now to characterise C-normalcy in a non-vacuous way. As mentioned above, this is done in terms of explanatory independence, which is defined as follows:

(2.16) x plays an explanatory role independent of y iff ∃z (x explains z and
z is not a logical/analytic consequence of y and
z does not causally depend on the occurrence of y)

So x plays an explanatory role independent of y if x explains something other than y and moreover something which does not logically follow from y or causally depend on y. (Pietroski and Rey assume some legitimate notion of scientific explanation and therefore make use of the two-place predicate 'x explains y'.) A sufficient condition for non-vacuity of *ceteris paribus* laws can now be given in terms of independence, with the following motivation:

> ...our view is that scientists state cp-laws in an attempt to focus on particular factors and thereby 'carve' complex phenomena in a theoretically important way. If a putative cp-law is such that all its C-abnormal instances can be explained by citing independent factors the original 'cut' was a good one; *i.e.*, the cp-law is true. But if there are inexplicable C-abnormal instances, the putative cp-law is either vacuous or false. (p. 92)

The formal condition for non-vacuity can be glossed as follows:

(2.17) $\text{cp}[\forall x(Fx \rightarrow Gx)]$ is non-vacuous, if:

(i). for any exception (C-abnormal instance)[16] Fa & ¬Ga, there is a fact which plays an explanatory role independent of ¬Ga, and **either** explains ¬Ga itself **or** together with the putative cp-law explains ¬Ga, and

(ii). there is a b such that **either** Fb & Gb, and Fb together with the putative cp-law explains Gb, **or** there is a fact which plays an explanatory role independent of ¬Gb, and either explains ¬Gb itself or together with the putative cp-law explains ¬Gb.

[15] Pietroski and Rey actually take it to be as follows: $\text{cp}[\forall x(Fx \rightarrow \exists y Gy)]$ but using the simpler version does not affect the argument here.

[16] In their paper, Pietroski and Rey use the term 'exception' to mean a falsifying counterexample, that is, for them, even *ceteris paribus* laws should be exceptionless. Any C-abnormal instance of a putative cp-law should have an independent explanation; if not, it is an exception, and the putative cp-law is not a law. This diverges from my use of the term 'exception'. I use the term to refer to any C-abnormal instance, and will later distinguish between exceptions and counterexamples, with only the latter falsifying a putative law or *ceteris paribus* law.

Condition (i) ensures that there is a fact which explains each exception, which is independent in the appropriate way, and condition (ii) ensures that the law is not completely contentless, in the sense that it can never explain anything (presumably the sort of example like 'all whales are whales').

Pietroski and Rey characterise exceptions as independently explicable phenomena. This is an important intuition: it means that we cannot just make up *ceteris paribus* laws and then use *ad hoc* hypotheses to save the law. However, it is important to note the limitations of the analysis given here. This is an analysis which rules out *vacuous* laws, that is, those which rely on *ad hoc* hypotheses to avoid falsification. There are other putative *ceteris paribus* laws which we may not think are useful (and which we possibly may not think are even true) which their account cannot rule out. For example, they themselves give the example of tossing a coin; statistically, a fair coin will come up heads half the number of times it is tossed. But for every toss which does not come up heads, we can give an explanation of why, in terms of the forces acting on the coin, and so on. Since this explanation is independent in the required sense, the putative cp-law:

(2.18) cp[All tosses of coin c come up heads]

is non-vacuous. Similarly, for any two properties F and G where some Fs are Gs, and where there is some reason independent of F and G themselves which explains why each F either is or is not a G, both

(2.19) Fs are Gs.

(2.20) Fs are not Gs.

will be non-vacuous *ceteris paribus* laws on Pietroski and Rey's account. For example, 'metals are solid at twenty degrees centigrade' and 'metals are liquid at twenty degrees centigrade' will both be non-vacuous in this sense.

Pietroski and Rey appeal to "the *interrelationships* of competing cp-laws, and perhaps the underlying metaphysics of explanation" to argue that their account does give the right results in cases like these. I agree with them that the problem with these putative cp-laws is not their vacuity but something else, and that their account does serve a useful purpose in ruling out vacuous *ceteris paribus* laws. For now, it is enough to note that we can defend *ceteris paribus* laws against charges of vacuity. I will come back to the further question of what to do about examples such as (2.18) in chapter four.

2.4.3 Summary

We have looked at the metaphysical status of Special Science and *ceteris paribus* laws and whether it differs from that of laws of nature. While some have suggested that there is a difference in metaphysical status, I have argued that this is not the case. We might summarise the thrust of the chapter so far by the observations that laws of all kinds have a similar role to play in explanation and prediction, and that we may not be able to draw a clear line between the various kinds of laws there are supposed to be. Moreover, we have discussed the important question of whether there is a non-vacuous analysis of *ceteris paribus* laws, and concluded that such an account is possible.

Finally, I will look at a different kind of account which attempts to take the notion of regularity itself as a primitive, and formalise various kinds of laws in these terms.

2.4.4 Barwise and Seligman on regularity

Recently, Jon Barwise and Jerry Seligman[17] have suggested the idea of taking 'regularity' as a primitive. Their aim is to give an account of regularities as both reliable and fallible, to explain and expand on Dretske's idea of the flow of information in the world (see Dretske, 1981). For example, a flashlight signal can carry the information that a climber is in trouble, and a blip on a screen can carry the information that there is an aircraft at a certain position in the sky.

Barwise and Seligman (1997) provides a formal working out of their theory and some applications, but here I will concentrate on their more philosophical work (1994), where the viability and philosophical motivations for their theory of fallible regularities (*i.e.*, laws with exceptions) are discussed.

The basic claim which distinguishes this theory is that defining regularities as relations between types will not allow them to be fallible. Their account — channel theory — allows regularities to be both reliable and fallible because although a channel asserts the existence of regularities between types, it also takes into account particular causal relations between individuals, which may be instances of the regularity, but may also fail to be instances, because of abnormal conditions.

I will first outline what channel theory is, then critically examine its philosophical foundations.

What are channels?

Barwise and Seligman extend the relation between a property and its instances to the relation between a regularity and its instances.

They start with the formal definition of a classification which, given two sets, one of 'objects' and one of 'properties', defines a relation on them such that an object is related to a property if and only if it has that property. In this case, the object is *classified* by the property.

This is realised formally as follows:

[17] See Barwise and Seligman (1994) and their recent book, Barwise and Seligman (1997).

A *classification* A is a triple, $\langle \mathrm{tok}(A), \mathrm{typ}(A), R_A \rangle$ consisting of a set of types, a set of tokens, and a binary relation on the Cartesian product of these sets.

Note that this is not intended to be a partition of the world into two types of things, objects and properties, or tokens and types; properties themselves may be as tokens of "higher order" types, although there is no type theoretical hierarchy governing this.

The relationship between properties and objects is then extended to regularities and their instances by defining a type of classification called a *channel* which links two classifications:

if $A = \langle \mathrm{tok}(A), \mathrm{typ}(A), R_A \rangle$, $B = \langle \mathrm{tok}(B), \mathrm{typ}(B), R_B \rangle$ are classifications, and C is a channel from A to B then

$$C = \langle \mathrm{tok}(C), \mathrm{typ}(C), R \rangle$$

where $\mathrm{tok}(C) \subseteq \{a \mapsto b : a \in \mathrm{tok}(A), b \in \mathrm{tok}(B)\}$, and $a \mapsto b$ is a *connection* between the tokens a and b, $\mathrm{typ}(C) \subseteq \{\mathcal{A} \to \mathcal{B} : \mathcal{A} \in \mathrm{typ}(A), \mathcal{B} \in \mathrm{typ}(B)\}$ and $\mathcal{A} \to \mathcal{B}$ is a *constraint* between the types A and B and $R \subseteq \mathrm{tok}(C) \times \mathrm{typ}(C)$. Connections are the particular (normally causal) links between tokens, for example, a particular individual A's being B. Constraints are the links between types which are themselves regularities. Connections are classified by a constraint if they are instances of it.

An example here will help to show what Barwise and Seligman have in mind. Channels are used to describe families of regularities, for example, by linking the types 'having mass m' and 'having weight w' for appropriate values of m and w. Another example is the *Rey Channel*, named after the inventor of the liquid-filled thermometer.

Barwise and Seligman's Rey Channel contains constraints between a particular height of mercury in a thermometer and a particular temperature which is read off as its types, and as connections, an event of a thermometer having a particular height h, and an event of a patient having temperature t. This connection will be classified if particular conditions are satisfied, for example, if the thermometer was in the patient's mouth long enough, is not broken *etc.*, otherwise it will not be classified. The regularity exists independently of whether it has any instances or not. We could have a situation where no connection was classified by some constraint.

Two further notions are required: that of an *exception* and a *pseudo-signal*. Implicit in the notion of the regularity is the way tokens in the world must be connected to each other in order to instantiate the regularity. So for the regularity linking 'having mass m' and 'having weight w', the tokens must be identical, whereas the regularity linking an event of a thermometer having height of mercury h and an event of a patient having temperature t, h and t must be causally connected in the right way, *i.e.*, the patient must have had the thermometer in his or her mouth for a certain amount of time. These relationships between tokens can sometimes fail to hold, for example if the patient has not had the thermometer in his or her mouth, the height of mercury may indicate something, but not that patient's temperature. Such indications are called pseudo-signals. For a channel linking an object's weight and mass, though, this cannot happen, as the relationship in this case is identity, which cannot fail to hold. If the relationships do hold, and the connection still fails to be classified by the regularity, the connection is called an exception. For example, if the thermometer reads wrongly as it is faulty, this is an exception.

Regularities as classifications

Barwise and Seligman's account defines regularities as constraints, which are links between types. In this respect, their regularities resemble Armstrong's laws as relations between universals. But whereas Armstrong's whole theory of universals provided a backdrop to, and, to some extent, a justification for regarding laws in this way, Barwise and Seligman simply take the notion of regularity as primitive and state that their theory

> ...does not claim to settle the issue of which regularities there are in nature. (p. 333)

How, then, do they distinguish between genuine regularities and accidental generalisations? One answer seems to be that an accidental generalisation is *not* a regularity; if it is an accidental generalisation that all Fs are Gs then the constraint $F \rightarrow G$ is not a regularity.

Since regularities may be fallible, the constraint $F \rightarrow G$'s being a regularity does not entail $\forall x(Fx \rightarrow Gx)$. Any channel which contains this regularity as a constraint will also say which individual events are objects which instantiate this regularity. There could be regularities with no instances, for example. So is channel theory purely descriptive — describing which regularities there are and which particulars are instances of them? In this case, it seems the theory has not provided any insight into the nature of regularities.

Some remarks which Barwise and Seligman make suggest that they do have deeper aims. They make several comments about natural and non-natural classifications. Unnatural classifications are ones such as

> ...the classification which groups together every spherical volume of the Earth's atmosphere, radius 1m, which contains a prime number of molecules; Goodman's example of the colour "grue", which is green until the year 2001 and then blue thereafter. (p. 341, fn. 7)

Moreover, on regularities they say:

> The question "What makes a regularity natural?" is, in general, as difficult to answer as the question "What makes a classification natural?" and no answer will be attempted here. However, since regularities are to be understood as components

> of channels, which are a species of classification, the former question reduces to the latter: what makes a regularity natural is that it is part of a natural classification. (p. 343)

There are two points here. The first concerns the nature of unnatural classifications. The second concerns the application of this to regularities. The quotations above suggest that by a "natural regularity" or "natural classification", Barwise and Seligman mean a non-accidental regularity, and that they are trying to suggest an answer to what characterises natural regularities, and thus identify genuine nomic regularities from accidental generalisations. However, this interpretation would mean rejecting the assumption made above that an accidental generalisation is *not* a regularity. On this picture channel theory ceases to be purely descriptive, and arbitrary regularities may exist, some of which will be natural (nomic regularities) and some unnatural (accidental generalisations). Can they give criteria for distinguishing between natural and unnatural regularities?

Unnatural classifications are defined by example as above. One interpretation of this kind of definition is that Barwise and Seligman are trying to take a Goodman- or Smart-style line on laws and disallow reference to particulars or only allow projectible predicates[18] to act as types. We have seen the difficulties of this kind of approach, and we are not given any pointers here as to how Barwise and Seligman intend to improve on it. Another interpretation is that the notion of "natural classification" is in some way intuitive and pre-theoretical. Indeed, they suggest that what determines the factors involved may only be answerable by research in psychology, if at all. While this may be true, it does not advance us very far in providing some content to this notion. I conclude that Barwise and Seligman do not have anything interesting to say about what makes regularities natural and so are left with a purely descriptive theory.

As described previously, channels, which are themselves classifications, contain regularities as constraints or types. However, the initial characterisation of classification was given through pre-theoretic intuitions about when an object instantiates a property. Examples given are colour, shape, having a psychological state, giving a particular kind of reading, and so on. Even though not all of the things classified need be particulars in a strict philosophical sense of the term, it is still clear that what we have are properties and their instances. Questions of vagueness aside, a is classified by a property P if and only if a is P.

How is this notion of classification to be applied to regularities and their instances? We do not have the apparatus of Armstrong's theory of universals to fall back on and equate a regularity with a second-order property. In order to convert a regularity into a property, we must do some work!

Consider an example of a connection $a \mapsto b$ being classified by a regularity $\mathcal{A} \to \mathcal{B}$. What is the relationship between the connection and the regularity? According to Barwise and

[18] See Goodman (1954).

Seligman's "flow condition",[19] $a \mapsto b$ is classified by $\mathcal{A} \to \mathcal{B}$ if and only if a is classified by $\mathcal{A}$ and b is classified by $\mathcal{B}$, the right (possibly causal) connection for the regularity holds between a and b, and $a \mapsto b$ is not an exception to the regularity. *I.e.*, $a \mapsto b$ is classified by $\mathcal{A} \to \mathcal{B}$ if and only if $\langle a, b \rangle$ is an instance of the relation $\mathcal{R}$:

> $\mathcal{R}xy =_{\text{df}}$ x is an $\mathcal{A}$ and y is a $\mathcal{B}$ and x is related to y in the right way (for the regularity $\mathcal{A} \to \mathcal{B}$) and $x \mapsto y$ is not an exception to the regularity $\mathcal{A} \to \mathcal{B}$.

Does this relation R yield a natural classification? $\mathcal{R}$ is a rather complex relation. Of course, trivially, the connections classified by the regularity $\mathcal{A} \to \mathcal{B}$ also satisfy the simpler property 'being classified by the regularity $\mathcal{A} \to \mathcal{B}$', but this is hardly explanatory. On the criteria given above, $\mathcal{R}$ does not look very natural. Moreover, it is hard to see how the same criteria of naturalness *could* apply to both classifications of particulars and of instances of regularities.

Finally, it is not at all clear what the role of channels in all of this is. Channels are supposed to group together regularities which have something in common. But this intuitive notion is not explained. There seem to be no formal or philosophical reasons to prefer channels which consist of one regularity or the union of all channels which presumably contain them all. We get no philosophical insights from which types a channel contains.

While these issues have no formal consequences, it does seem to undermine the claimed philosophical significance of the notion of classification. Barwise and Seligman cannot claim to have shed any light on the problem of distinguishing laws from accidental regularities, and their theory remains purely descriptive.

The indispensability of tokens

Barwise and Seligman claim that it is not possible to analyse regularities as fallible purely with reference to types, and that therefore reference needs to be made to tokens. I will challenge this claim both briefly here, and in the next chapter, where I argue for an analysis which does not refer to tokens.

We have already seen that accounts of *ceteris paribus* laws described above do not explicitly make reference to tokens, and do provide accounts of laws which have exceptions. What these kinds of account have in common is that they (attempt to) provide a reason why exceptions to a regularity do not cause us to reject it as invalid. There must be a reason why the regularity is produced (Cartwright) or an independent explanation of the exception (Pietroski and Rey).

These accounts rely on the exceptions themselves being regular. If things were not so, we could not distinguish between genuine regularities and happenings which were unrelated to

[19] This states that if $a \mapsto b$ is classified by $\mathcal{A} \to \mathcal{B}$ then a is classified by $\mathcal{A}$ and b is classified by $\mathcal{B}$. See Barwise and Seligman (1994), p. 343, fn. 10.

each other. The regularity of the exceptions is described by the reasons and explanations given by these accounts.

But Barwise and Seligman seem to be rejecting this picture altogether. They reject any account which purely correlates types. Including tokens allows a channel to be described as a regularity *plus the things which are instances of it.* There need be no reason why certain things are instances and others are not. So a connection between tokens could be an exception to a regularity without there being any reason why this is so. But this seems to contradict all our intuitions about regularity in the first place.

2.5 Summary

In this chapter I have discussed various approaches to the problem of how to analyse laws of nature and distinguish them from accidental regularities in nature. I argued that a semantic account was inadequate, since it would not allow the same sentence to be both a law at one possible world and an accidental generalisation at another. Two accounts which could achieve this were discussed and compared with respect to their treatments of the properties of laws.

I then looked at the methodological role of laws within their own sciences, in order to defend a conception of laws based on their roles, rather than specific sets of properties (such as entailing universal generalisations). On this basis I concluded that both laws of nature and Special Science laws play a similar methodological role and deserve to be analysed in a similar manner. I then defended such laws against claims that they are inferior in some way, or have a different metaphysical status.

I finally looked at an account which attempts to analyse some properties of laws by taking a primitive notion of regularity and basing a formulation on this. I argued that amongst other problems, this could not capture the important insight that in order to non-vacuously characterise a law with exceptions, there must be an account of why particular exceptions arise.

In the next chapter, I will take for granted that we can defend some notion of a law with exceptions. I will compare the various kinds of counterfactual-supporting regularities, and will show that there is a class of sentences expressing these regularities — generic sentences — which share many important properties. I will argue that this allows us to extend the notion of a law and to apply it to fields outside physics and even outside science in general.

Chapter Three

Nomic Regularities

In the previous chapter I looked at the philosophical literature on laws and, in particular, whether the notion of a law with exceptions is a coherent one, and whether the notion of a law can be extended to fields other than physics. A problem with terminology has arisen: while many authors reserve the term 'law' for exceptionless laws which are unrestricted and timeless, as I have previously attempted to do, we have also encountered the terms 'Special Science law' and '*ceteris paribus* law', which in this sense of 'law' are not laws. The fact that the term 'law' appears in this latter sense might just be a terminological confusion, or might be due to some real similarity between the concepts. I take the latter view, and have attempted to show that this is correct in the previous chapter.

To clear up the issue of terminology first, while I have previously attempted to sidestep this issue by calling the non-traditional "laws" *nomic regularities*, I have not given a very clear characterisation of what a nomic regularity is. Let us call traditional laws of nature which do not have exceptions *laws*, and Special Science, *ceteris paribus* and other counterfactual-supporting generalisations such as those described in chapter one *nomic regularities*. *Nomic* regularity here is intended to contrast with *accidental* regularity, since nomic regularities support appropriate counterfactuals, while accidental regularities do not. Then Special Science and *ceteris paribus* "laws" are not laws but nomic regularities.

While it is useful to be clear about terminology, there is a deeper issue here. What *are* laws and nomic regularities? Traditionally, Special Science and *ceteris paribus* "laws" are seen as only honorary laws, or worse, even as sub-standard laws. This probably arises because analyses of them are given in terms of laws, which are seen as the basic category. I will argue in this chapter that it is not laws, but nomic regularities which are the basic class. This broader class of regularities, which share many properties, particularly those to do with their methodological role, includes Special Science and *ceteris paribus* "laws", and also traditional laws as a special case.

In the previous chapter, I concluded that it would be perverse to look for an analysis only for laws, and that we should look for an account which could be extended to cover the whole class of nomic regularities. In this chapter I will attempt to give such an analysis, by extending the accounts I discussed in the previous chapter, and by considering other kinds of accounts. I will show that extensions of accounts of laws will fail, because the primary class is that of nomic regularities. I will argue, moreover, that the paradigmatic means of expressing nomic regularities is the generic sentence, and that all generics express nomic regularities. By laying down some parameters for an analysis of generics, we can begin to give an account of nomic regularities.

3.1 Laws, generics and nomic regularities

In order to defend nomic regularities as a more basic class than that of laws, let us consider their properties. I will argue that while traditional laws have further properties not shared by Special Science laws, it is the core properties which are shared by both types. These core properties lead us intuitively to think of Special Science laws as the same kind of things as traditional laws.

Then I will discuss what generics express, and argue that they also share the core properties with traditional and Special Science laws. Following this, some potential counterexamples and problem cases will be discussed.

3.1.1 Laws and nomic regularities

We may define nomic regularities as counterfactual-supporting regularities expressed by generalisations over individuals or events. They support counterfactuals in virtue of being necessary in some suitable sense. In addition, they have a methodological role within theories, scientific or otherwise. They are important in explanation and prediction, due to the fact that a body of laws can form a network of regularities which itself constitutes a theory.

Traditional laws of nature, interpreted as laws of physics (and possibly also laws of chemistry), are also unrestricted, do not contain reference to particulars, entail universal generalisations, and are physically necessary. Special Science laws and *ceteris paribus* laws may be local or restricted, and may contain reference to particulars. They do not always entail universal generalisations, since they may have exceptions. Both traditional and Special Science laws are *a posteriori*, and logically contingent. (Whether *a posteriori* but metaphysically necessary truths (such as 'Water is H_2O') count as laws is controversial.)

I have given an account in the previous chapter of how we might non-vacuously cash out *ceteris paribus* clauses and argued that there is no difference in the metaphysical status of laws of nature and *ceteris paribus* laws. Reference to individuals and restrictions may also occur in laws of physics. Hence there is not much difference between the two classes described above. Moreover, they have a lot in common — most importantly, the purposes for which laws are used, that is, in explanation and prediction. This is a sufficient reason to try to give an account which unifies them. To conclude, the properties I will take to define sentences which express nomic regularities, which include sentences expressing traditional and Special Science laws, are the following two: (i) they are counterfactual-supporting generalisations over particulars, and (ii) they form part of a connected theory. These are the core properties shared by both types of law.

3.1.2 Generics express nomic regularities

We saw in chapter one (section 1.4.2) that generics can express nomic relationships. Recall the examples given there:

(1.30) Metals conduct electricity.

(1.31) Glaciers form U-shaped valleys.

(1.1) Birds fly.

These are respectively a law of nature, a weaker Special Science law, and a regularity which is not a part of any formal science. Recall that we noted that these sentences entail the existence of fundamental relationships between properties which would hold even if things were different in many other ways. These nomic relationships were roughly characterised as an ability to (at least defeasibly) support counterfactuals. Having discussed laws of nature and Special Science laws, we can now say that the nomic properties shared by (1.30) and (1.31) are that they support appropriate counterfactuals, and form part of a connected theory.

But generics only sometimes express laws of nature or Special Science laws. What is the status of a regularity like that expressed by (1.1)? If all generics express nomic regularities, in what sense is this regularity nomic? I will now explore this question, arguing that the two properties listed above are involved in each of (1.30), (1.31) and (1.1). Generics are clearly generalisations over particulars, but their counterfactual-supporting properties and role in theory require some further discussion.

Nomic regularities support counterfactuals

The fact that nomic regularities support counterfactuals and are therefore useful for prediction is one of the most striking things they have in common with traditional laws. In chapter one we noted that generics do express counterfactual-supporting generalisations, but left the precise nature of this rather vague.

Special Science laws defeasibly support counterfactuals, and many generics express either Special Science laws or commonsense approximations of them. Examples of these were given in chapter one, including (1.1) above and

(1.4) Cats have four legs

(1.17) Potatoes contain vitamin C.

The notion of counterfactual-supporting here is relatively unproblematic. While we may only defeasibly infer from a nomic regularity 'Fs are Gs' that if a is F then a is G, we know that if a does turn out to be an exception, we will have an explanation of why that is.

Some generics, however, do not express laws of any kind of science, but rather what we might term rules or conventions (in the previous chapter, (2.3), page 34 already appeared as a potential example of this). Examples of these from chapter one are:

(1.20) Masters students take their exams in April.

(1.27) Visitors must take off their shoes [before entering the mosque].

(1.29) Children should respect their parents.

(1.32) Dyslexic students get an extra 30 minutes in the exam.

There is a difference here between those which are descriptive, in that they describe a rule, for example (1.20) and (1.32), and those which are prescriptive, in that they describe what *should* or *ought to* happen, for example (1.27) and (1.29). (1.32) does not just say that dyslexic students *should* get extra time, but that, on the whole, they do.

Of course, there is a connection between the various senses of 'must'. For example, we can distinguish physical necessity, deontic necessity,[1] conventional necessity and so on, and each can be modelled similarly. The usual way to do this in a modal logic is to restrict the worlds which each sense of 'must' quantifies over by using an accessibility relation. If something is physically necessary, you quantify over the physically possible worlds; if deontically necessary you quantify over the 'morally perfect' worlds. For a worked out treatment of such a logic, see Kratzer (1977, 1980).

However, we do not need to get into the mechanics of different kinds of modal logics here. We have already noted (section 1.4.1) that some generics have a different kind of modal force to others. Generics support appropriate counterfactuals: whether this means that the truth of the antecedent (defeasibly) entails the truth of the consequent at physically possible or morally perfect worlds.

Nomic regularities as part of a theory

In section 2.2.2 we saw that Lewis's account of laws treats laws as the generalisations which appear as axioms or theorems of the best deductive system describing the world. This is a strong

[1] A proposition is deontically necessary if it ought to hold in virtue of some moral principle. For example, 'We must treat others as we would like to be treated'.

conception of laws as part of a theory — on Lewis's view the laws are the complete determination or specification of a theory by an omniscient observer. However, even on a weaker view where laws determine part of a theory, or partially characterise it, this is an important intuition.

Special Science laws play a similar methodological role to laws of nature in explanation and prediction, and it is plausible to treat them as at least a partial specification of the relevant Special Science. As we saw in section 2.3, nomic regularities are a way of idealising the world, and of fitting things into patterns. As a means of unifying diverse phenomena, Special Science laws are just as valuable as laws of nature.

Moreover, this conclusion can be extended further to the nomic regularities which state principles of commonsense reasoning. As Pietroski and Rey (1995) point out about science:

> The actual world is too complex to study all at once, so one proceeds by ignoring some aspects of the world in order to understand others. ...However, such abstraction guarantees a loss of descriptive adequacy in any generalisation we lay down... *ceteris paribus* laws are a vehicle of such abstractions. (p. 89)

This is clearly not just true about science, but about any principles of reasoning which we employ in everyday life. Thinking about normal traffic flow and the time one should set off, writing notes to oneself to remind oneself to do things, making a plan to meet friends in the pub: all these require knowledge of rules and norms governing behaviour and events in the physical world, which we have formulated to ourselves in order to be able to make sense of our environment.

Nomic regularities are true in virtue of a systematic approach to the world (maybe not a science, but some way of making generalisations about the world). A body of knowledge can be theory-like, without necessarily having to be part of physics or even of any explicit science.

3.1.3 The differences between generics and law statements

Having argued that nomic regularities are similar to traditional laws, in that they share the two core properties, I will now examine the ways in which they differ.

The regularities expressed by generics, that is, nomic regularities, share the two core properties. We thus have a unified class including both traditional laws of nature and common sense generalisations such as (1.1): 'birds fly'. However, there are some differences between types of nomic regularity in this class. First, I will discuss the fact that generics have exceptions and whether this is the same phenomenon as Special Science laws having exceptions. Then I will look at the fact that there are generics which express regularities which are non-scientific in that they express truths of mathematics or logic, and which are therefore *a priori*.

Exceptions

A statement of a traditional law of nature entails a universal generalisation; that is, the fact that it is a law that 'Fs are Gs' entails $\forall x(Fx \rightarrow Gx)$. This is not the case with most generics, which may have exceptions. For example, there are many exceptions to (1.1): 'birds fly', such as penguins, ostriches and so forth. Yet (1.1) is still true: somehow the exceptions just do not count when we are talking about birds flying. Ordinary usage does not insist that an exception falsifies a generic. Obviously this contrasts strongly with the conception of laws on which a falsificationist model of scientific progress is built, where any exception is a falsifying counterexample.

However, as we have noted in the previous chapter, Special Science laws may have exceptions, or may only hold *ceteris paribus*. That this is a coherent notion was defended by giving an account of *ceteris paribus* laws. It might be objected that exceptions to nomic regularities which are not part of any science cannot be explained on such an account, since they are less regular; in other words, they are not explainable by principles in the same way as exceptions to laws. Of course, we may not know what the explanation of exceptions is, and we may never employ the resources found within formal science in finding out. Ordinary life is not subject to the same kind of principles of controlled experiment as scientific enquiry. This does not mean that there are no such explanations, or that we cannot begin to give explanations of them. If our commonsense principles were constantly being violated and we had no idea of the reasons why, we would soon reject them as principles.

On this picture, it seems arbitrary to include Special Science laws as nomic regularities, but reject the principles of commonsense reasoning such as (1.1). They are as much a part of a theory as other kinds of nomic regularity, albeit a less formal theory.

A priori generics

Some generic sentences are *a priori*. Recall the examples from chapter one:

(1.21) Whales are whales.

(1.22) Equilateral triangles are equiangular.

These sorts of examples are not laws of nature, since laws within the context of a science are the subject of enquiry, and not the sorts of things we know *a priori*, as we noted in the previous chapter. However, (1.21) and (1.22) are counterfactual-supporting generalisations, and it can be argued that they do form part of a theory. (1.22) forms part of mathematics, which can certainly be seen as having theorems and axioms, although they are all necessarily true as opposed to the weaker necessity of physical theories. Similarly on any plausible treatment of generics, (1.21) is a law of logic.

3.1.4 Conclusions

Many of the properties associated with traditional laws extend to all nomic regularities. In view of the methodological role of nomic regularities, in fact, this wider class is more useful to us than the narrower class of laws, and rather than being some type of sub-standard "law", nomic regularities are just as relevant in explaining behaviour, and therefore as worthy of analysis, as laws.

In fact, many of the sentences which we take to express laws instead express nomic regularities, simply because we do not bother to enumerate all the exception cases, or worse, because we just cannot enumerate them, and so assume some kind of *ceteris paribus* conditions. The level at which laws really are exceptionless, if there is one, is pretty far down, at the level of electrons and such like, rather than at the level of medium-sized physical objects. As Giere (1988) says:

> If these "laws" are to be regarded as universal generalisations, they hover between falsity and vacuity. If stated with sufficient precision to be informative, they are always subject to some exceptions... If stated with sufficient generality or qualification to avoid exceptions, they cease to be usefully informative. (p. 17)

While I agree with Giere's first claim that most laws are subject to exceptions, my point is that the notion of a nomic regularity, glossed as a law with exceptions, is a useful concept and, moreover, one we cannot afford to do without. We can state laws, or rather nomic regularities, in an informative way, because we understand the *ceteris paribus* clause as doing the work for us in avoiding exceptions.

When generalisations are made in ordinary discourse, and also in less ordinary discourse, including philosophy, their form is frequently generic. The interest in the semantics of generics by researchers in Artificial Intelligence who are trying to model "commonsense reasoning"[2] is itself a clear pointer to the fact that generics, and so also the nomic regularities which they express, are a common feature of ordinary language and reasoning, respectively.

This should not surprise us: a plausible reason already given for why we use generics to express nomic regularities rather than explicitly quantified sentences is that the latter would be long and complex to state, or just unavailable, because it is difficult, indeed, it may even be impossible, to list exceptions.

[2]Commonsense reasoning is a species of default reasoning. For references, see footnote 7 in chapter one (page 12).

3.2 Applying traditional accounts to nomic regularities

We have seen that nomic regularities form a unified class; now we can investigate how we should analyse them. First, I will discuss whether any of the accounts of laws from the previous chapter might be extended to cover all nomic regularities. I will conclude that this is not possible, since, as I have been arguing before, laws are not the basic class. I will then discuss how one might begin to analyse nomic regularities as a class in their own right.

3.2.1 Necessitation accounts

Armstrong (1983) has a conception of law which does allow exceptions in a particular sense. He differentiates between "iron laws" and "oaken laws".[3] Iron laws are those which hold without exception. Oaken laws are of the form 'All Fs are Gs, except those Fs which are Hs which are not Gs'. Do we have to be able to specify the H or Hs? Armstrong suggests not:

> ... it is not contrary to reason that there should be an infinite number of factors such as H, factors lacking any common factor but each preventing an F from being what it naturally tends to be in the absence of interfering factors: a G. (p. 148)

He gives as an example Newton's First Law which states that a body continues in its present state of motion or rest unless acted upon by a force. Here the law explicitly allows for forces to interfere with the previous state of the body in question. Other examples are conservation laws which state that the energy of a system is conserved provided "nothing interferes".

Armstrong further claims that oaken laws can always be, at least in principle, represented as iron laws, which might have to be of infinite length.

> It appears, then, that if $N(F, G)$ is an oaken law, then all that is entailed is that *for all x where interfering conditions are absent*, if x is F, then x is G. The interfering conditions will be a perfectly determinate set of conditions, but it is logically possible that there are an infinite number of them. (p. 149)

Because Armstrong does not recognise negative universals, he cannot represent an oaken law Fs are Gs as a relation between Fs which are not interfered with and Gs since the former will not be a universal, being a conjunction of a universal and a negative universal. Armstrong weakens the claim that $N(F, G)$ entails $\forall x(Fx \rightarrow Gx)$ to the claim that it entails only that all uninterfered-with Fs are Gs.

The point here is that the necessitation seems to have been weakened so that $N(F, G)$ no longer entails $\forall x(Fx \rightarrow Gx)$. But Armstrong wants the same N relation to hold of both iron and oaken laws, and thinks he can achieve this by spelling out the full conditions. From the

[3] Chapter 10, section 4.

completeness of physics, it follows that this ought to be possible. But in a Special Science, as we have seen, the interfering conditions will not be specifiable in the vocabulary of the Special Science.

Starting from an analysis of traditional exceptionless laws, we are trying to account for exceptions. It is not clear how this will work — there are not enough resources within Armstrong's theory and we will have to provide most of the account on exceptions on top of Armstrong's analysis. While I am not claiming that this would be impossible, it seems to be approaching the problem the wrong way round. We should start from an account of nomic regularities, in which we can easily treat laws of nature as a special case.

3.2.2 Systematic accounts

Another approach would be to try to adapt Lewis's systematic account of laws to deal with nomic regularities. Lewis discusses (small and large) miracles which may break laws of nature (see, for example, Lewis, 1986b). But the exceptions we want to analyse are not miracles, but everyday occurrences.

Recall that a law is a generalisation which appears in the best deductive system as an axiom or theorem. This seems a more promising approach than Armstrong's to account for nomic regularities. Generics do play an important role in reasoning, and, as we have already noted, form part of commonsense theories about the world, as well as some being part of more formal scientific theories.

However, there is a problem, in that patterns of deductive reasoning with generics are not as well understood as those involving sentences which are formalisable as universal generalisations, as Lewis presumably considers laws to be. We have already seen that knowing that Fs are Gs and that a is an F only leads one to defeasibly infer that a is a G. Could we build a descriptive deductive system based on a defeasible consequence relation? It would, one assumes, not be quite what Lewis had in mind. While this might be a possible approach, again, Lewis's theory does not provide the resources we need, and as I said of any attempt to extend Armstrong's analysis, this seems to be approaching the problem from the wrong direction.

3.2.3 Probabilistic accounts

If nomic regularities may have exceptions, could we develop a probabilistic account of them, so that instead of entailing universal generalisations, they entail that some probabilistic correlation holds? This would entail weakening the requirement on laws that they entail universal generalisations, and instead merely requiring them to entail some probabilistic correlation.

One suggestion might be that nomic regularities *are* just probabilistic correlations. So, 'Fs are Gs' just means that some proportion of (but possibly not all) Fs are Gs. Thus, if 'Fs are

Gs' is a nomic regularity, it means 'most Fs are Gs' or 'more than $X\%$ of Fs are Gs'.

This kind of account may give part of the epistemological story about how we come to learn generics. It is plausible that in some cases, at least, we come to believe 'Fs are Gs' by observing Fs which are Gs, and so are more likely to learn this regularity if more Fs are Gs than not. However, this cannot give the whole story. It is inadequate because it cannot tell us which generics are true and which are false. In fact, we can show that a simple probabilistic account is both too strong and too weak: it is too strong as it fails to predict that certain generics will be true which are true, and too weak as it lets in generics as true which are not. I will concentrate here on an account based on 'most', but analogous arguments can be constructed for any probabilistic account.

The 'most' account is too weak simply because of the problem of accidental regularities which resurfaces for 'most' statements. There are plenty of cases where most Fs are Gs and where there is no regularity. For example:

(3.1) Teachers are either Geminis or Aquarians.

(3.2) Books on the third shelf have green covers.

That most teachers are (or rather were, at the time of the survey) either Gemini or Aquarius was revealed by a Sunday newspaper in the 1980s, possibly in an attempt to show that there is something in astrology after all. Nonetheless, the more cautiously minded would probably want to deny lawlike status to (3.1) and thereby conclude that it is also false. Sitting at my computer, I suddenly noticed that nearly all the books on the third shelf of my bookcase have green covers. Since, at least as far as I know, the books are arranged completely at random on the shelf, since I put them there haphazardly after moving offices in a hurry, there is no reason for (3.2) to have any kind of lawlike status.

Compare the situation with that of laws. While 'Fs are Gs' being a law entails $\forall x(Fx \rightarrow Gx)$, $\forall x(Fx \rightarrow Gx)$ may be true where 'Fs are Gs' is not a law, because of the existence of accidental correlations, where there is no nomic connection between Fs and Gs.

Similarly, (3.1) and (3.2) describe accidental near-correlations. This shows that any account of nomic regularities based on a modification of the simple regularity theory of laws will be inadequate. We cannot weaken the condition that we have a (universal) regularity to a condition that we have some statistical correlation, and get out what nomic regularities are.

Could we strengthen the 'most' account by adding in some more sophisticated conditions on which 'most' statements count as expressing nomic regularities? Could we perhaps modify some of the more sophisticated regularity theories to extend them to treat all nomic regularities?

We saw that the 'most' account was too weak, but it is also too strong. We can have true generics 'Fs are Gs' where most Fs are not Gs. Consider the following examples:

(3.3) Turtles are long-lived.

(3.4) Peacocks have brightly coloured tail feathers.

(3.5) Dutchmen are good sailors.

Most turtles actually die in infancy as they rush from the hollow in the sand where their mother laid her eggs to safety in the sea. So most turtles are not long-lived, but we still regard (3.3) as true. Somehow the ones which fail to make it through the first half hour of life do not seem to count against the truth of (3.3).

Similarly, we can imagine (3.4) being true even if, due to economic reasons and the demand for peacock eggs, there were only one male to every hundred female peacocks. Most peacocks would be female, and therefore would not have brightly coloured tail feathers. The fact that when we talk about the property of having brightly coloured feathers, we must mean the males, somehow rules out female peacocks as relevant — again they do not seem to count.[4]

Finally, in (3.5), we clearly do not mean that any randomly chosen Dutchman is a good sailor, we mean that Dutchmen who sail are good sailors. Most Dutchmen are not sailors, so cannot be good sailors. Yet again, it is quite clear which Dutchmen we are talking about.[5]

Thus it seems clear that it is neither necessary nor sufficient for the truth of a generic 'Fs are Gs' that most Fs are Gs. Moreover, even if we could incorporate some modal element into the 'most' account, so that generics were interpreted as probabilistic laws, we would have to look at very bizarre worlds for it to be more probable that any turtle lived to old age than for it to die in infancy. These worlds might well even be biologically impossible: it seems unlikely that the natural environment would support most turtles surviving to adulthood.

It is therefore not possible to analyse generics on either a probabilistic account based on the simple regularity theory of laws, or a more complex necessitation based account.

A diagnosis of why it is that a 'most' account cannot deal with the examples above helps us to see a way forward. In these examples, we are not quantifying over all Fs, but are focusing on particular subsets of Fs. Since 'most' cannot pick out which these are, it does not give us the correct subset. This is borne out by the following examples which on a 'most' account would come out true, but which we think of as false:

(3.6) Turtles only live for a few minutes.

(3.7) Primes are odd.

[4]It might be objected that strictly speaking it is only peacocks which have brightly coloured tail feathers: the others are peahens. However, we seem quite happy to talk about peacocks as a species of bird, and even to say that peacocks lay eggs, so I will take it that we can use 'peacocks' to refer to both the male and female of the species.

[5]This famous problem for the semantics of generics is referred to as the Port-Royal puzzle, since it first appeared in Arnauld's "Port-Royal Logic" of 1662, mentioned in the introduction to chapter one.

While most turtles only live for a few minutes, they are the wrong ones, and similarly, since (3.7) is a mathematical example, it implies that all primes are odd, which is false; most of them being odd is not enough here.

The conclusion to be drawn from this discussion is that it is not the quantity of Fs which are Gs that matters, it is *which* Fs are Gs. In these examples we have seen that we are only quantifying over certain Fs, which are somehow more relevant. We therefore need to look for a qualitative account of nomic regularities, rather than a quantitative one.

3.3 Characterising exceptions

I will now consider how exceptions can be categorised. The fact that 'Fs are Gs' is a law entails the universal generalisation $\forall x(Fx \rightarrow Gx)$; if '$F$s are Gs' is a nomic regularity this may not be the case. But a nomic regularity 'Fs are Gs' does entail some extensional relationship similar to, but weaker than, a universal generalisation. This section will explore some candidates for this extensional relationship between Fs and Gs entailed by the nomic regularity 'Fs are Gs'.

A generic 'Fs are Gs' may have exceptions: Fs which are not Gs. If a generic entails a true generalisation, the set over which this generalisation is made must exclude all exceptions. Generics may also have counterexamples; were this not the case, all generics would be true. For example, in the false generics (3.6) and (3.7) there are counterexamples — elderly turtles and the number 2 respectively — thus generics are falsifiable, but not necessarily by any F which is not a G. Exceptions to 'Fs are Gs' cannot therefore just be the Fs which are not Gs: this would make the truth of all generics trivial.

For now, let us assume we have some way of distinguishing which of the Fs which are not Gs are exceptions and which are counterexamples to 'Fs are Gs'. We can then formulate some weakened generalisation in terms of exceptions: for example, 'Non-exceptional Fs are Gs'.

However, this is a little over-simple. This presupposes that there is one subset of Fs which are the non-exceptional Fs, which are therefore those we generalise over every time we use a generic 'Fs are Gs'. This cannot be the case.

For example, here is a (slightly adapted) argument due to Greg Carlson (see Carlson, 1977, pp. 64–65): suppose 'Fs are Gs' entails 'All non-exceptional Fs are Gs'. Now, take the generic 'Chickens lay eggs'. This then entails that all non-exceptional chickens lay eggs. But clearly, if a chicken lays eggs, it must be a female. Therefore, by the transitivity of entailment, all non-exceptional chickens are female. So, if 'Chickens lay eggs' is true, all non-exceptional chickens are female. Something has clearly gone wrong here; we cannot be using this set of non-exceptional chickens in every generic of the form 'Chickens Φ'. Hence the fact that there is no one set of non-exceptional Fs which is the domain of the quantifier in every generic 'Fs are Gs' is known as the "chicken problem".

Assuming the existence of a set of non-exceptional chickens does not give the right results. As noted in the previous section, we restrict ourselves to a certain set of individuals when deciding if a generic is true or not, and clearly here, we need different sorts of non-exceptional chickens depending on whether we are talking about egg-laying or, say, moulting.

Similarly, there is no one set of non-exceptional birds which we consider for every generic involving birds. For example, we do not consider the same set in the following generics:

(1.1) Birds fly.

(3.8) Birds lay eggs.

Birds which are exceptional with respect to flying (penguins, ostriches and so on) are not the birds which are exceptional with respect to laying eggs (the males and immature females and so on).

This conclusion is supported by another similar concern raised by Carlson. This is the problem now known as "graded normality": an individual can be normal or non-exceptional in one respect without being normal or non-exceptional in others.

> It would seem that if dogs are mammals, and if Fido is a dog, then Fido must be a mammal. But let us look a bit closer at the proposed analysis of 'dogs are mammals'. It would say that all normal dogs are mammals. But what if there is something quite abnormal about Fido (*e.g.*, she has two heads, or three legs)? It seems that we would still wish to be able to conclude that Fido is a mammal from the knowledge given above, but the proposed analysis does not give us this entailment. (pp. 65–66)

If 'Fs are Gs' means that non-exceptional Fs are Gs, then if an F is not a non-exceptional F for some completely unconnected reason to being a G, we cannot conclude that it is a non-exceptional F, and therefore a G.

So the solution is to relativise being an exception to the predicate. We can talk about non-exceptional birds, but only relative to some property, for example, flying or laying eggs as in (1.1) and (3.8) above. This allows an individual to be exceptional in some respects but not others. For example, a mature female penguin will be an exceptional bird with respect to flying, but may be a non-exceptional bird with respect to laying eggs.

So 'Fs are Gs' entails that all Fs which are non-exceptional with respect to being Gs are Gs. This is the weakened generalisation which we were looking for.

This discussion has given us some constraints on how exceptions should be dealt with. We have determined that the concept of an exception should not be accounted for probabilistically, and has to be relativised to both the subject and the predicate of any generic.

An important difference between nomic regularities in general and traditional laws is that nomic regularities may only entail some kind of restricted or weaker-than-universal generalisation. I showed that this cannot be explained purely quantitatively: any approach must take account of the qualitative factors. In the next chapter I will present an analysis of nomic regularities based on a formalisation of the above insight.

3.3.1 Conclusions

In this chapter I have argued that there is a unified class of nomic regularities which have a similar role in reasoning about the world, whether within the context of a formal scientific theory or in everyday action. Laws of nature are a special case of this class. Nomic regularities are identified by their counterfactual-supporting properties and the fact that they form part of a theory.

I have then attempted to analyse nomic regularities by extending accounts of laws from chapter two. I argued that no account based on the simple regularity theory would suffice, since nomic regularities are essentially intensional, and a purely extensional account will not yield their counterfactual-supporting properties. While it might be possible to extend either Armstrong's or Lewis's account of laws to cover nomic regularities, it is not obvious how this would be achieved.

The central feature in analysing nomic regularities, I claimed, is the distinction between an exception and a counterexample. In order to analyse nomic regularities we need to make this distinction. This is why it is hard, if not impossible, to analyse nomic regularities in terms of laws: since laws are exceptionless, this distinction does not exist, since every exception is a counterexample.

Having laid the foundations for an analysis of nomic regularities in terms of this distinction, in the next chapter I will discuss various methods of formalising this insight.

Chapter Four

Exceptions

In the previous chapter we looked at analyses of laws with exceptions and how we might characterise exceptions as opposed to counterexamples. In this chapter various approaches to formalising the distinction between exceptions and counterexamples will be examined, some attempts to do this will be rejected, and my own theory will be proposed.

In chapter one I discussed Carlson's theory of genericity and various "indefinites" theories. Carlson says very little about how properties of individuals relate to properties of kinds. On his theory, a generic 'birds fly' just means that the kind 'bird' has the property of flying; we can draw no conclusions from this about the behaviour of individual birds. "Indefinites"-type theories argue that generics should be represented using a "generic quantifier", under the tripartite theory of quantificational structures. On this approach, we can determine the relationship between the truth of 'birds fly' and of statements that individual birds fly. Moreover, we can more easily compare the semantics of generics with the semantics of other quantified sentences, including universally quantified sentences which state laws. I will return to this last point in chapter five.

As we have seen, any theory which interprets this generic quantifier so that this means something like 'for all x, if x is a normal bird, x flies' will run into problems, for reasons explained in the previous chapter. We want a generic 'Fs are Gs' to entail that all Fs which are non-exceptional with respect to being Gs are Gs. One approach which does come down to analysing generics as quantification over normal individuals is that of Asher and Morreau (1995). They consider Carlson's "chicken problem" discussed at the end of the previous chapter, and suggest that determining *which* of the normal chickens lay eggs is the same problem as occurs in many semantic accounts of natural language: that of how to determine quantifier restrictions. If someone says 'Everybody is here', somehow it is contextually determined who we are quantifying over (presumably not everybody in the universe). It is a common move to suggest that contextual mechanisms determine which individuals generics quantify over. I will first discuss some ways natural language quantifiers can be restricted and then investigate whether and how this may be applied to generics.

4.1 Quantifier restrictions

Natural language quantifiers can be restricted by context. When English quantificational expressions are used, they are very rarely unrestricted, but range over some contextually determined domain. The mechanisms by which this is achieved are the subject of much research, to be discussed in this and the following chapter.

In the following sentences, we will not usually be quantifying over all people or bottles:

(4.1) *Everyone* had a good time.

(4.2) *Someone* knocked over *the* bottle.

We mean that every one of some group of people had a good time, and probably again that someone in some group knocked over some salient bottle. These restrictions will be given by context, whether by specific reference to the group involved, or by interpolation using world knowledge, or some other method.

On a similar note, it has often been pointed out with respect to definite descriptions that there need not be only one F for 'the F' to denote successfully. In asserting (4.2) above, one is neither asserting nor presupposing that there is only one bottle in existence, the one knocked over.

In speaking of quantifier *restrictions*, we bring out the intuition behind most analyses of what is going on in the examples above. In (4.1) we are not quantifying over all people, but over a restricted set of people. In any analysis of this sentence, the domain of the quantifier is restricted to those in the group under discussion.

Two questions now arise, concerning how such restrictions are determined. First, how are such sentences analysed? For example, is there one restricted domain per conversation, per utterance, or per quantifier occurrence? Second, where do the restrictions come from? Are they given by semantic information from preceding discourse, by interpolation of world knowledge, or by some combination of these? I will examine each of these questions in the following two sections.

4.1.1 Domains and context sets

An initial thought about the examples above may lead one to think that as long as we include the right objects in the domain of our model for a discourse (the domain of discourse) we will have the right objects over which to quantify. The domain of discourse is the technical name for the domain of the model we use to model a discourse. It contains all the objects referred to, quantified over, and so on, during the discourse. Thus in (4.1) and (4.2) above, we should include the relevant people and the relevant bottle. Westerståhl (1985) calls this the "flexible universe strategy".

The flexible universe strategy can be glossed as follows: if we have the right domain of discourse, and allow each quantifier to range over that domain, rather than over everything in the universe, we will get the right results. Presumably this will work for simple examples such as those above. But as Westerståhl points out, this will not work for more complex examples. Here is such an example:

(4.3) Despite being so close to other European countries, the British can be decidedly xenophobic. Some dislike all foreigners, and most cannot speak a foreign language.

On the flexible universe strategy, the domain of discourse for these sentences will contain all people (British and 'foreign'=non-British). But with this domain, the second sentence will be true if there is a non-British person who dislikes everyone from outside his or her country, and if most *people* cannot speak a language other than their native tongue. Yet 'some' and 'most' here are clearly restricted to British people: the second sentence above means the same as 'Some British people dislike all foreigners, while most British people cannot speak a foreign language'. But if we restrict our domain of discourse to contain only British people, we cannot refer to or quantify over foreigners.

McCawley (1979) gives examples of a similar phenomenon with definite descriptions. Consider:

(4.4) The dog had a fight with another dog yesterday.

If correct use of the definite description requires a unique dog in the domain of discourse, this kind of sentence must be incorrect. 'Another' requires there to be two distinct dogs in the domain, so neither can be picked out with 'the dog'.

The conclusions drawn by Westerståhl and McCawley are similar: it is not enough to evaluate the quantifiers in a discourse with respect to a single domain of discourse. We must be able to use different domains for different quantifiers in the same discourse or even the same sentence. These quantifier domains will be subsets of the domain of discourse, but may not contain everything in it. I will talk about quantifier *restrictions*, meaning the restricted subset of the domain of discourse over which a particular use of a quantifier ranges. Restrictions, then, are not relative to a discourse or even a sentence, but occur on a quantifier-by-quantifier basis.

Westerståhl proposes the existence of a *context set* of entities over which a quantifier ranges. Each use of a quantifier has its own context set which is a subset (or restriction) of the domain of discourse, and which is identified somehow by the context.

This works as follows: a simple quantified sentence such as 'every girl had fun' consists of a quantifier, 'every', a restrictor, 'girl', and a nuclear scope 'had fun'. The context set attaches to the quantifier phrase 'every girl' (the set containing every girl) and intersects with the restrictor, and the nuclear scope applies to the result. So, basically, instead of the quantifier ranging over the extension of the predicate 'girl' in the domain of discourse (all the girls in the domain of discourse), it ranges over the intersection of the extension of the predicate 'girl' in the domain of discourse and the context set (that is only those girls in the domain who are in the context set).

McCawley's proposal is similar to Westerståhl's, but he terms the set of contextually identified objects the *contextual domain*, which also includes the objects assumed to exist given the common or world knowledge of the discourse participants. The contextual domain is incremented as the discourse proceeds, sometimes only temporarily, for example, with the antecedent of a conditional in order to determine the truth-value of its consequent. This kind of temporary extension will be discussed in greater detail in section 4.3.1.

So, to sum up, it seems clear that we need to analyse quantifier restrictions on a quantifier-by-quantifier basis; each quantifier needs its own domain, or context set, which is a subset of the domain of discourse.

4.1.2 Accommodation and other contextual mechanisms

David Lewis's famous paper, "Score-keeping in a language game" (1979), presents his theory of accommodation which describes how we "accommodate" presuppositions which arise during discourse. Lewis's *rule of accommodation for presupposition* states that

> If at time t something is said that requires presupposition P to be acceptable and if P is not presupposed just before t, then — *ceteris paribus* and within certain limits — presupposition P comes into existence at t. (p. 340)

For example, the sentence below requires the presuppositions that there is a unique dog:

(4.5) Every child likes the dog.

If someone utters this sentence without this presupposition having arisen previously, then according to the rule above, it will come into existence at the time of the utterance. This rule governs which objects in a discourse are *salient*. Lewis suggests that

> 'the F' denotes x if and only if x is the most salient F in the domain of discourse, according to some contextually determined salience ranking. (p. 348)

Salience is determined by many factors, to do with the local environment of the speaker and hearer (for example, whether there is a single dog in the vicinity), what is said previously in the discourse (perhaps a particular dog was identified) as well as other factors. Lewis formulates a *rule of accommodation for comparative salience* as follows:

> If at time t something is said that requires, if it is to be acceptable, that x be more salient than y; and if, just before t, x is no more salient than y; then — *ceteris paribus* and within certain limits — at t, x becomes more salient than y. (p. 349)

Lewis gives an example with two cats, whose comparative salience changes as conversation about them proceeds. We are to imagine we are sitting in Lewis's front room with his cat Bruce "who has been making himself very salient by dashing madly about". There are no other cats about. Lewis says:

> The cat is in the carton. The cat will never meet our other cat, because our other cat lives in New Zealand. Our New Zealand cat lives with the Cresswells. And there he'll stay, because Miriam would be sad if the cat went away.

First, 'the cat' denotes Bruce, since he is the most salient cat, but as the New Zealand cat becomes more salient, he is picked out by 'the cat'. If Lewis were to continue with 'Look out, the cat is going to pounce on you!', in order for this to be acceptable (the cat cannot pounce from New Zealand) Bruce must become salient again, so that 'the cat' then denotes him.

It has been argued that accommodation of salience can give us a way of determining context sets, since quantifiers will range over sets of salient objects. So, in (4.5) above, the universal quantification would be over the salient children in the domain of discourse.

Some of the ways quantifiers get their restrictions are anaphoric, in that they are selecting from previously introduced or accommodated objects in a discourse. Many theories of quantifier restrictions discuss anaphoric quantified phrases which somehow derive their restrictions from their antecedents. Recently the notion of anaphoric reference has been broadened to include non-identity anaphora. Van Deemter (1992) discusses examples such as the following where the relation between the anaphor (in italics) and its antecedent is not one of identity but of "bridging", where there is a clear relation between 'book' and 'author':

(4.6) Bill read a book about Schubert. He wrote a letter to *the author*.

(4.7) Bill read several books about Schubert. *All the authors* had done their research in Salzburg.

Bridging relations are given by world knowledge and include association, such as between books and authors, inference, such as between a dead person and a murderer, and set-element relations, where we pick out a member or members of a set, such as the oldest man from the men in the room.

4.1.3 Summary

I have discussed quantifier restrictions, how they should be analysed and where they come from. We clearly need to restrict the domain of each occurrence of a quantifier, and this will be achieved by some combination of accommodation and semantic and pragmatic information. I will now discuss whether these mechanisms can be used to accurately describe the semantics of generic sentences.

4.2 Generics as restricted universal generalisations

The idea of many realisations of the indefinites theory is that what is going on in a generic 'Fs are Gs' is that in order to see if it is true or not, we look for the normal Fs and see if they are Gs. We saw in chapter three that there are some constraints on how exceptions can be characterised.

As mentioned before, most approaches to the problem of how to analyse the generic operator interpret it as a restricted universal quantifier, where the restrictions are determined by pragmatic and contextual factors, including Lewis's idea of "accommodation" discussed above. Here I will argue against the claim that this problem can be best solved using this kind of pragmatic mechanism. This claim is just not adequate to explain what is going on. Then I will present my account which I believe gives a better explanation of the phenomenon.

Applying Lewis's notion to generics, the basic idea is that in

(4.8) Peacocks have brightly coloured tails.

(4.9) Chickens lay eggs.

as well as any generic "quantifier" being restricted to "normal" or "typical" individuals, it is also contextually restricted to male peacocks and female chickens in the examples above.

I will now give further data, arguing that these kinds of restrictions are not adequate.

The generic operator does not quantify over salient individuals

For example, consider the following discourse:

A: I've never seen so many peacocks mating at once.
B: How do you know they're peacocks?
A: Peacocks have brightly coloured tails.
B: How many of them do you think there are?
A: There must be at least 50 pairs.

Here, 'peacocks' in the third utterance refers only to normal male peacocks. But many other peacocks, *i.e.*, the females mating with the males, are also salient. This can be seen in the rest of the discourse, when the females are counted along with the males.

While comparative salience can change rapidly, as we saw in the previous section, with Lewis's example of the cats, this requires some effort:[1] the sudden change has to be accommodated, since this is the only way the discourse can be "rescued" and remain coherent. I am

[1]Mechanisms which signal this kind of accommodation include changes in intonation, tone or speed of speech, cues from the world, in this case, perhaps, the cat rushing past, and so on.

not denying that changes in which peacocks are salient could be accommodated in the above discourse. However, if this is what is going on in this case, it is a different kind of accommodation to what occurs in Lewis's cats example.

It does not seem difficult to move between the second and third and between the third and fourth sentences above; the discourse flows naturally. However, if accommodation of the kind in Lewis's example were involved, we would expect some discontinuity, and an active effort to comprehend on the part of the hearer. Since this does not occur, I conclude that Lewis's accommodation is not the mechanism by which the shift in quantifier domain occurs.

Generic restrictions do not vary across contexts

While ordinary quantifier restrictions are often determined wholly by the context, generic restrictions seem to be independent of it.[2] Compare the discourse above with the following:

A: Look at this pen of peacock chicks.
B: But peacocks have brightly coloured tails.
A: These ones are too young.

Despite the context favouring various peacocks in the first discourse above, and only baby peacocks in the second, the generic 'Peacocks have brightly coloured tails' has the same semantic value in each case.

Generic restrictions are not available using ordinary quantifiers

We cannot get the same kinds of restrictions that we do with generics with ordinary quantifiers. Compare:

(4.8) Peacocks have brightly coloured tails.

(4.10) Every peacock has a brightly coloured tail.

In the same context, these sentences will often have different truth-values. But the point is stronger: these sentences have the same truth-value if and only if only and all the non-exceptional male peacocks are salient. There is no way *in general* of using 'every peacock' to pick out just the males.

I have argued that the question of which individuals are salient in discourse does not affect the restrictions on a generic operator, and neither does the context in general. This would imply that the restrictions on the generic quantifier are not contextual, and what is going on

[2] In one sense, described here, they are independent of context. In another sense, to be discussed in chapter five, they are not.

is not accommodation, given that, in the examples, there is no evidence of this; the discourses flow naturally without any need to fill in extra information.

Clearly, different things are going on when we use a regular quantifier which is contextually restricted, and when we use a generic. There is no one set of normal birds or peacocks or chickens which we can contextually restrict in an appropriate way to stand as the referent of 'birds', 'peacocks' or 'chickens' in a generic sentence. This sort of approach would also make the set of normal chickens the union of all sets of chickens normal with respect to some property, which suggests it is probably inconsistent. This is a problem for any account (for example, that of Asher and Morreau, 1995) which analyses generics as contextually restricted universally quantified sentences

However, there are other, possibly more subtle mechanisms for restricting quantifiers. I will now discuss some of these, examining whether they might account for the generic quantifier restrictions.

4.3 Other approaches to restricting quantifiers

In this section I will look at some other approaches to restricting quantifiers. These depart from the basic theories of accommodation outlined above, and have been developed to analyse other phenomena in natural language. I will examine whether we might be able to use these, or insights from these, in our attempt to analyse the semantics of generics.

First I will look at the theory of local accommodation, first developed by Irene Heim, to restrict quantifiers locally as a way of rescuing sentences which cannot be interpreted any other way. Then I will outline McCarthy's technique of circumscription, not developed to analyse natural language, but to represent information about situations and allow non-monotonic reasoning about them.

4.3.1 Local accommodation

McCawley (1979) discusses how the domain of discourse may be temporarily incremented with some discourse referent, for example, when evaluating a conditional. This is based on Lauri Karttunen's work on solving the "projection problem for presuppositions" (see, for example, Karttunen, 1974). The problem is how the presuppositions of complex sentences are derived compositionally from the presuppositions of their parts. For example (from Heim, 1983):

(4.11) The king has a son.

(4.12) The king's son is bald.

(4.13) If the king has a son, the king's son is bald.

(4.11) presupposes that there is a (unique) king and asserts that the king's son exists. (4.12) similarly presupposes that there is a (unique) king and also presupposes that he has a (unique) son. However, when these two sentences are combined into the conditional sentence (4.13), not all the presuppositions are inherited. The presupposition that there is a king, which both components carry, is inherited, but that the king has a son, which is asserted by (4.11) and presupposed by (4.12), is not inherited as a presupposition.

Informally, in evaluating the conditional, the antecedent is evaluated with respect to the context, and so the context must contain the presupposition that there is a king (and if it does not, this presupposition must be accommodated), but only the consequent is evaluated with respect to the context of the antecedent, so its assertion that the king has a son forms part of the context only for the consequent and not for the whole discourse.

Karttunen allows the context to be temporarily extended in these cases: McCawley adds that the context set (McCawley's contextual domain) may be temporarily extended as well. So in the example above, the contextual domain would be temporarily incremented when the antecedent is evaluated with the king's son, in order that the consequent can be evaluated with respect to the enlarged domain.

Karttunen and McCawley discuss when and with what the context of a discourse is updated. Heim (1983) discusses how this interacts with accommodation. In (4.13) above, the presupposition of the antecedent, that there is a king, must be accommodated into the context if it is not already present. But can presuppositions be temporarily accommodated?

Heim presents us with the following example:

(4.14) The king of France didn't come.

If uttered in a context which did not already entail that there was a king of France, this presupposition is accommodated in order to evaluate the definite description. But there are two different ways this accommodation may occur. We may "globally" accommodate the presupposition, that is, add it to the context *before* evaluating the sentence above, so that it is permanently part of the context, or we may "locally" accommodate it. This requires us to add the presupposition to the context purely for the purposes of evaluating the sentence (rather like the assertion of the antecedent in (4.13) above) and then discarding it. Different continuations of (4.14) illustrate when each approach is useful.

(4.15) The king of France didn't come, because he was too busy.

(4.16) The king of France didn't come, because France doesn't have a king.

The first continuation requires the presupposition that there is a king of France to be globally accommodated so that the pronoun 'he' has a referent. The second, a more unusual case, required local accommodation. The presupposition is accommodated purely to evaluate the first part of the sentence; the second part is then not inconsistent, because the presupposition it would contradict was only local to the first part. For more technical details, see Heim (1983).

Why is this relevant to generics? I have argued for a quantificational analysis of generics, and that Lewis's accommodation — Heim's global accommodation — is not sufficient to explain the data. But perhaps local accommodation might be.

While, to my knowledge, no-one has attempted to account for generic quantifier restrictions by using the principles of local accommodation, some work has been done on adverbial quantification. Berman (1991) makes a claim that

> in the logical representation of a quantified sentence (as analysed in terms of restricted quantification), the presuppositions of the nuclear scope become part of the restrictive term. (p. 88)

This is achieved by the presuppositions of the nuclear scope being accommodated into the restrictive term, and it is local accommodation at work here, rather than global accommodation. For example, in the following examples from Schubert and Pelletier (1987):

(1.79) Cats always land on their feet.

(4.17) Robin Hood never misses.

the presuppositions of the nuclear scope: that cats are falling in (1.79) and that Robin Hood is shooting at something in (4.17) are locally accommodated into the restrictor of the quantifier in each case. Thus the cases over which we are quantifying are determined by the presuppositions of the nuclear scope. So (1.79) is restricted to quantify over events of cats falling, and says of all of them that they are events of cats landing on their feet. Similarly, (4.17) is restricted to quantify over events of Robin Hood shooting at something and says of them that they are not events of him missing.

I do not want to go into specific criticisms of Berman's account of accommodation, since it ranges over many areas which are not discussed in this thesis. Von Fintel (1994) argues that while Berman's account deals nicely with Schubert and Pelletier's examples, it is not as general as he claims and cannot account for various differences of ease of accommodation of different kinds of presupposition. Von Fintel claims that the principles which determine how quantifier domains are restricted are pragmatic, grounded in principles which maintain discourse coherence, rather than "mechanisms of sentence grammar". In particular, with respect to the Schubert and Pelletier examples, he suggests that various factors, including pragmatic features such as discourse topics, yield the quantifier restrictions.

While I cannot comment here on the debate between Berman and von Fintel, since it would take us well beyond the scope of this thesis, I present this as a suggestion of how local accommodation might apply to generics, which to my knowledge has not previously been suggested.

In my analysis, presented in section 4.4, I will argue that the lexical meanings of predicates involved determine the quantifier restrictions on generics.

4.3.2 McCarthy's "circumscription"

McCarthy's "circumscription" is a way of representing knowledge in a way amenable to default reasoning about it (see McCarthy, 1980, 1986). While McCarthy's main interest is in solving problems of knowledge representation and reasoning, rather than formalising natural language, he uses an idea which could be applied to the semantics of generics. This is his method of relativising normality to each predicate: an individual may be normal in some respects but not in others. McCarthy's work formalises our commonsense assumptions that things are normal, or fall under certain regularities, unless we have evidence that they do not.

McCarthy starts with a knowledge base of sentences which state facts about the "world" or situation being represented. He then applies a technique called "circumscription", which minimises the extensions of predicates, with respect to various constraints, including that the knowledge base remains consistent. (For full details see McCarthy (1980).) For example:

Suppose our KB (knowledge base) consists of the following facts: we know Darren will be late, and we know that the linguists will be late. We can formalise this as follows:

$$\text{KB} = \text{late}(d)\ \&\ \forall x(\text{linguist}(x) \rightarrow \text{late}(x))$$

Circumscribing the predicate 'late', *i.e.*, finding facts which describe the minimal models in which it is true, involves the assumption that the KB says everything there is to know about the extension of 'late'. One way of achieving this is by predicate completion: if we know that $\forall x(\Phi(x) \rightarrow P(x))$ then the completion of P is the reverse implication: $\forall x(P(x) \rightarrow \Phi(x))$. So here, we can find the circumscription of late with respect to this KB by rewriting the facts above as

$$\forall x[(x = d \vee \text{linguist}(x)) \rightarrow \text{late}(x)]$$

and then the circumscription of the KB with respect to the predicate 'late' is

$$\forall x[(x = d \vee \text{linguist}(x)) \leftrightarrow \text{late}(x)]$$

Thus in the circumscribed knowledge base, *only* Darren and the linguists are late: this is the model in which fewest people are late.

McCarthy applies this to commonsense reasoning by formalising the assumption that things are normal unless we have evidence otherwise. A predicate *ab*, standing for 'abnormal', is introduced, to express that a certain individual is abnormal in a certain respect. This predicate is then circumscribed.

A regularity like 'birds fly' would be represented in the knowledge base as that normally things don't fly (4.18), but that birds are abnormal in this respect (4.19):

(4.18) $\forall x[\neg ab(\text{aspect1}(x)) \rightarrow \neg\text{flies}(x)]$

(4.19) $\forall x[\text{bird}(x) \rightarrow ab(\text{aspect1}(x))]$

We can then say that birds normally fly, unless they are abnormal in that respect (4.20), and that penguins are birds (4.21) but that they are abnormal in this respect (4.22):

(4.20) $\forall x[(\text{bird}(x) \& \neg ab(\text{aspect2}(x))) \rightarrow \text{flies}(x)]$

(4.21) $\forall x[\text{penguin}(x) \rightarrow \text{bird}(x)]$

(4.22) $\forall x[\text{penguin}(x) \rightarrow ab(\text{aspect2}(x))]$

Circumscribing the various *ab* predicates then gives the minimal models in which all the above are true, representing our commonsense intuitions that unless we know a bird is a penguin, we can derive that it flies.

Circumscription with abnormality predicates relativised to the property in question is a way of formalising relativisation of exceptions to the predicate, as discussed at the end of chapter three. However, as it stands it is insufficient to cover the complexities of the semantics of generics. The main reason is that it is a purely extensional formalisation, and therefore cannot distinguish between nomic and accidental regularities. McCarthy did not intend to formalise natural language sentences, and the theory sketched above works with a set of axioms which comprise a knowledge base, with respect to which the relevant predicates can be circumscribed. The extensional treatment of a finite set of axioms is computationally tractable, and thus can be implemented as an AI program, whereas an intensional treatment involving possibly infinitely many sentences of natural language would not be. However, taking some of McCarthy's ideas, I propose a modified analysis which I will describe in the following section.

4.4 A semantic analysis

I propose a possible worlds analysis to deal with the effect of the predicate in determining restrictions on a generic operator, taking an idea from default reasoning and McCarthy's work on circumscription, namely the idea that we may describe individuals as abnormal in some aspects without thereby making them abnormal in all aspects. We saw in chapter three that a generic 'Fs are Gs' should entail that all Fs which are non-exceptional with respect to being Gs are Gs. Thus 'Peacocks have brightly coloured tails' will entail 'All peacocks which are non-exceptional with respect to having brightly coloured tails, have brightly coloured tails'.

In chapter three we characterised the difference between exceptions and counterexamples to a nomic regularity; exceptions do not falsify a generalisation, whereas counterexamples do. How do we tell the difference between exceptions and counterexamples? Call the exceptional Fs with respect to being G the *exception class* for F and G. We can think of exception classes as determined by our world knowledge, in this case, that peacocks which are in the exception class for having brightly coloured tails are female, juvenile, have had accidents happening to their tails, and so on. With this rough characterisation, let us examine some features of the exception class.

4.4.1 What are exception classes?

The modal element

What does the generic 'Fs are Gs' mean? It entails that all non-exceptional Fs with respect to being G are G, but as we saw in chapter three, the entailment is not both ways.

First, there may be no Fs in the actual world, for example, recall example (1.32) from chapter one:

(1.32) Dyslexic students get an extra 30 minutes in the exam.

This can be true, or false, whether or not there are actually (or ever will be) any dyslexic candidates. Yet if there were no Fs in the actual world, the semantics of the material conditional would mean that both 'all non-exceptional Fs with respect to being G are G' and 'all non-exceptional Fs with respect to being not-G are not-G' would come out vacuously true, whatever F and G were.

Second, it could accidentally happen that all the non-exceptional Fs with respect to being G were G. For example, 'Left-handed people are taller than average' might happen to be true, and we might consider this to be a potential generic since obvious exceptions, such as if there were left-handed people with a growth disorder who were very short, would not count towards the falsity of this sentence. The universal generalisation 'all left-handed people non-exceptional with respect to being taller than average are taller than average' would come out true as all the relevant actual left-handed people would be taller than average, but the generic sentence would be false as it would not state a nomic regularity.

In chapters one and three, we noted that generics have some kind of modal force, and that an extensional treatment would be inadequate. Thus a generic 'Fs are Gs' cannot mean just that all the existing Fs not in the exception class for F and G are Gs.

A possible worlds semantics

I will propose a possible worlds semantics for generics, the full details of which are given in appendix A. (A strongly compositional version of the formalisation, which is also extended to cover other quantified sentences, is given in appendix B.) Crucially, to capture the modal element of the semantics of generics, we need to look in other possible worlds than the actual world, to see what would happen if things were slightly different.

The idea is that by looking at other possible worlds which differ only in small (and irrelevant) respects from the actual world, we see if the truth is affected by irrelevant factors. We want to ensure we look at worlds where Fs exist, and also where relevant things are the same, so that if in some world it accidentally happens that all the actual non-exceptional Fs with respect to G are Gs, we can see if this is just a feature of that world, or if it is true in all the worlds similar in the relevant respects.

The relevant respects are the same sorts of laws holding, and the same sorts of things being exceptional. Nomic regularities vary in their nomic force. For example, 'birds fly' expresses some kind of natural or physical necessity; 'women earn less than men' expresses some kind of social or conventional necessity, and 'a true friend never lets you down' expresses some kind of moral or normative necessity. So a generic 'Fs are Gs' will be true if and only if at every appropriate possible world, all Fs non-exceptional with respect to being G are G.

Before looking at what the appropriate possible worlds are, let us return to the question of what is in an exception class. Should exception classes just contain actual exceptions? It seems not: recall the example of the three-legged tigers from chapter one (page 13). All the tigers left in the world happen to have three legs. This is an accidental regularity, since if one of these tigers gave birth to a cub, it would be extremely likely to have four legs. But unlike the accidental regularity of the left-handed people just mentioned, we have nothing to go on in the actual world. There, we had exceptions in the actual world — left-handed people with a growth disorder. But here, there are no non-exceptional tigers in the actual world. It is not that all the non-exceptional tigers with respect to some property happen to have that property — such as being hungry — and if we checked in nearby possible worlds, we would find non-exceptional tigers which did not (showing that being hungry is an accidental regularity). Since there are no non-exceptional tigers in the actual world, what would we look at in other possible worlds?

This means that exception classes are not determined extensionally; we think of exceptions as themselves determined by what things might be like. So the non-exceptional tigers with respect to number of legs are those in nearby possible worlds where the unfortunate accidents did not occur, despite the fact that these tigers do not actually exist.

Providing a modal element in determining what makes an exception now gives us a way of determining which are the appropriate possible worlds to look at to see if a generic is true or false. Recall that I said that the appropriate possible worlds to look at are those where the same sorts of laws hold and the same sorts of things are exceptions. In order to do this, we must take an approach which allows non-actual individuals to be non-exceptional in a world. Then in similar possible worlds, individuals which may exist in one world but not in another may be in the same exception class in both worlds. For example, non-actual four-legged tigers will be non-exceptional tigers with respect to number of legs in the world described in the above example, and will also be non-exceptional tigers with respect to number of legs in a nearby possible world in which they exist. We may then define the appropriate possible worlds to look at as those in which the exception classes are the same. So, a generic 'Fs are Gs' means:

(4.23) in all possible worlds where the same Fs are non-exceptional with respect to being G, all non-exceptional Fs with respect to being G are G.

Formally defining exception classes

For any predicates F and G, we can define a predicate whose extension in any possible world is the set of Fs (including possibly non-actual Fs) which are non-exceptional with respect to G. Call this $N_{F,G}$. Then

(4.24) $N_{F,G}(x) \Leftrightarrow_{\mathrm{df}} x$ is a non-exceptional F with respect to being G.

This formalises the weakened universal generalisation which a generic entails, as described in chapter three, and so the generic 'Fs are Gs' will always entail:

(4.25) $\forall x[(F(x)\&N_{F,G}(x)) \rightarrow G(x)]$

We can define an equivalence relation $\sim_{F,G}$ such that for worlds w_1, w_2:

(4.26) $w_1 \sim_{F,G} w_2 \Leftrightarrow_{\mathrm{df}} V(N_{F,G}, w_1) = V(N_{F,G}, w_2)$

where V is a function mapping non-logical constants to their denotations. This partitions the set of possible worlds into equivalence classes where $N_{F,G}$ has the same extension.[3]

Let us define a generic modal operator $\boxast$ to represent the modal force of generics. Then a generic 'Fs are Gs' means

(4.27) $\boxast\forall x[(F(x)\&N_{F,G}(x)) \rightarrow G(x)]$

which is true at a world w iff

(4.28) $\forall x[(F(x)\&N_{F,G}(x)) \rightarrow G(x)]$

[3]This particularly neat way of formalising this constraint was suggested to me by Peter Milne.

is true at every world w' such that $w \sim_{F,G} w'$.

$\circledast$ is an intensional operator which ensures the truth of generics independently of their instances in the actual world. It is a kind of necessity operator, although obviously the necessity is generally much weaker than logical necessity. In our weak sense of nomic, we can read it as 'it's nomologically necessary that...' or 'it's a nomic regularity that...'. Since $\circledast$ depends on F and G, the different modal forces of different generics are captured.

The fact that (4.28) must be true at each of some set of possible worlds ensures that a generic will not come out vacuously true because there are no Fs at the actual world, and also that a generic will not come out true accidentally. Moreover, the way $N_{F,G}$ is defined allows us to meaningfully talk about exceptions when there are Fs at a world but they are all exceptions. The full technical details of the formalisation are given in appendix A.

4.4.2 How do we determine exception classes?

How is $N_{F,G}$ determined for each F and G?

$N_{F,G}$ is the set of non-exceptional Fs with respect to being G. We roughly characterised this as determined in some way by our world knowledge. Here are some examples:

(4.29) $N_{\text{peacock,has·a·brightly·coloured·tail}}$ = actual or possible peacocks without the exception class, *i.e.*, without the females, juveniles, those whose tails have been amputated, and so on.

(4.30) $N_{\text{bird,flies}}$ = actual or possible birds without penguins, ostriches, baby birds, birds whose wings have been clipped, and so on.

(4.31) $N_{\text{penguin,flies}}$ = actual or possible penguins without those who have been fitted with jet-packs, put in aeroplanes, and so on.

The fact that each of the above examples ends with "and so on" may cause some anxiety, since we are trying to give a non-vacuous analysis of the semantics of generics. Clearly if the specification of $N_{F,G}$ contained the clause 'is a G', then the specification would be vacuous: we would have an analysis of 'Fs are Gs' which entailed that all Fs which are Gs are Gs, which is not exactly informative. Such a specification must be ruled out. But since a complete specification cannot be given, how can we guarantee that the account is not vacuous?

This kind of vacuity is indeed ruled out by the account of *ceteris paribus* laws given in Pietroski and Rey (1995) discussed in chapter two. This account states that a sufficient condition for a putative *ceteris paribus* law to be non-vacuous is that every exception be explainable independently, that is, that there must be a fact which explains the exception which also explains something else (and moreover, the something else must not be a logical, analytic or causal consequence of the exception).

Could this kind of account apply to generics in general? Take the generic 'birds fly'. Are the various exceptions to this generic independently explainable? The fact that Fred the penguin does not fly is explained by the fact that Fred is a penguin. This fact also explains other things about Fred, such as the fact that he eats fish, and this fact is independent of his not flying in the required sense. The fact that Fluffy the three-day-old chick does not fly is explained by the fact that Fluffy is three days old, which also explains the fact that Fluffy has juvenile plumage, which is again independent. So 'birds fly' is non-vacuous in terms of this account.

However, we can also apply this account to false generics such as 'cats are black'. While we might think of albino cats as genuine exceptions to this generic, we want to count most non-black cats as counterexamples. But on this account we do have an independent explanation of why Kiki the ginger cat is not black: this is explained by the fact that he has a certain genetic makeup. The genetic makeup also explains the fact that he is shorthaired rather than longhaired, and so is an independent explanation in the required sense.

The problem is that Pietroski and Rey's account can only take us so far. While it successfully rules out vacuous *ceteris paribus* laws which are those which can only be saved by reference to *ad hoc* hypotheses, there are lots of non-vacuous (in their sense) generalisations which we do not want to count as genuine *ceteris paribus* laws. 'Cats are black' is one such example, and another is their coin tossing example, discussed in chapter two.

As shown in (4.29)–(4.31) above, we do seem to be able to list exception classes for pairs of predicates. Moreover, we do have an intuitive idea about the sorts of things that make an F which is not a G an *exception* to the generic 'Fs are Gs', and what sorts of things make an F which is not a G a *counterexample* to the same generic. For example, the exceptions to birds which fly are that they are too young, or are penguins, and so on. Penguins are thus exceptions to the true generic 'birds fly'. However, ginger cats are counterexamples, rather than exceptions, to the false generic 'cats are black'.

This general agreement about which things count as exceptions and counterexamples, or conversely, which generics are true and which are false, is reminiscent of Putnam's notion of a stereotype (Putnam, 1975a). Putnam's aim is to give an account of what natural kind terms mean, and he argues that the meanings of such terms are given in terms of stereotypes:

> ...that a normal member of the kind has certain characteristics...is...the stereotype associated with the word.[4]

The stereotype account itself cannot be sufficient to explain how exception classes are determined, because of Carlson's "chicken problem". A generic 'Fs are Gs' cannot entail "all

[4] p. 148.

stereotypical Fs are Gs". Given the truth of both the following generics

(4.8) Peacocks have brightly coloured tails.

(4.32) Peacocks lay eggs.

since no peacock both has a brightly coloured tail *and* lays eggs, at least one of

(4.33) All stereotypical peacocks have brightly coloured tails.

(4.34) All stereotypical peacocks lay eggs.

must be false. But suppose we do have a notion of a stereotypical F, along the lines Putnam suggests. If all stereotypical Fs were Gs, then this would be a reason for us to be committed to the generic 'Fs are Gs'. So while stereotypes cannot wholly give the meanings of generics, they can contribute to the way exception sets are determined. If all stereotypical Fs are Gs, then any Fs which are not Gs count as exceptions rather than counterexamples to the generic 'Fs are Gs', even if this seems an arbitrary matter of decision, rather than being because of some unusual feature of these Fs.

This may explain why some exception classes are constituted as they are, but does not adjudicate in cases where there is no stereotype, as in (1.32), or where it is not the case that every stereotypical member of a kind has some property, as, for example, in the case of the peacocks. In these cases we take generics to be true or false based on some more complex notion of a stereotype, relativised to the property in question.

In many of these cases, we are able to list most kinds of exception (as, for example, in (4.29)–(4.31) above). However, in some cases this is impossible because we do not know everything about the world, and often we cannot list all kinds of exception because there are too many. In everyday discourse, we do not think about all the ways something could be an exception, although we can recognise something that is.

What this means is that whether certain things or kinds of things count as exceptions rather than counterexamples is essentially relative to our interests. This might appear to undermine the notion of generalisation as applicable across all fields of enquiry, including science, where the facts are not supposed to be relative to our interests in this way.

The facts about which objects have which properties are not relative to our interests in this way. But as we have seen, just because every F is G, this does not make it a law that all Fs are Gs. This latter claim relies on how things would be if things were different, and to count as a law, this generalisation must be true in some other possible worlds. The trouble is in determining which other possible worlds, and this itself relies on our interests. Hence, the semantics of any lawlike claim are relative to our interests.

How do we deal with change of the truth-values of generics over time?

A feature of the N predicate is that it can change its extension over time, as circumstances change. For example, it may be that 200 years ago, the generic 'Cats are black or white' was true, since the fancier colourings had not been bred at that point in time. Any new colourings might well have been considered exceptions to this true generic, while now ginger cats, say, are not considered exceptional with respect to colour, and are counterexamples.

It is not obvious when exceptions start to become counterexamples; however, people do seem to have strong intuitions about whether something is an exception or not. This is probably due to semantic conventions about which generalisations are true. There may be no fact of the matter overall but a certain amount of vagueness in the extension of $N_{F,G}$ is no different to vagueness in the extension of other predicates.

Varying modal force

The following examples seem to be able to be interpreted with varying modal force:

(4.35) Countries with common borders share their resources.

(4.36) Humans have brown eyes.

(4.35) could be interpreted as deontically necessary or as a rule governing acceptable international behaviour. (4.36) is true in virtue of facts about the evolution of humankind, but in social or conventional terms does not seem to state a nomic regularity.

As we saw in the previous section, the semantic value of $N_{F,G}$ is not fixed but can be (in a sense) contextually determined: it can vary over time. In these cases we must also allow it to be determined by the kind of modality implied in the context.

Thus different modal forces, as well as different times of utterance, can determine the semantic value of $N_{F,G}$ which in turn determines which possible worlds we quantify over in ascertaining the truth value of a particular generic.

Generics with non-atomic predicates

So far we have considered generics of the form 'Fs are Gs'. But of course, generics may also occur with more complex predicates. I will first consider negation, and then conjunction and disjunction.

Generics can be negated in two ways: by denying that a generic is true — the wide scope negation (it is not the case that Fs are Gs) and by denying that a class has a certain property — the narrow scope negation (Fs are not Gs). These are not equivalent: consider the (false) generic 'Cats are black'. The wide scope negation is true, as one would expect: it is not the case that cats are (in general) black, they can be other colours too. But the narrow scope negation is false — the narrow scope reading of 'Cats are not black' does not hold because there are ordinary non-exceptional cats which are black.

The wide scope negation is just the negation of the whole generic. The narrow scope negation is equivalent to 'Fs are not-Gs'. These are represented as follows:

(4.37) $\neg\circledast\forall x[(F(x)\&N_{F,G}(x)) \rightarrow G(x)]$

(4.38) $\circledast\forall x[(F(x)\&N_{F,\neg G}(x)) \rightarrow \neg G(x)]$

(4.37) is true if there is a (relevant) world where a non-exceptional F with respect to G fails to be G. With the cats example above, this could be the actual world, where there are cats non-exceptional with respect to colour which are not black. In order to evaluate (4.38), we need to know the extension of the predicate $N_{F,\neg G}$. How is this determined? Some examples may help here. Consider the following examples and their translations:

(4.39) Penguins fly. $\circledast\forall x[(\text{penguin}(x)\&N_{\text{penguin,flies}}(x)) \rightarrow \text{flies}(x)]$

(4.40) Penguins don't fly. $\circledast\forall x[(\text{penguin}(x)\&N_{\text{penguin,}\neg\text{flies}}(x)) \rightarrow \neg\text{flies}(x)]$

The first is false, the second is true. From above we have:

(4.31) $N_{\text{penguin,flies}}$ = actual or possible penguins without those who have been fitted with jet-packs, put in aeroplanes, and so on.

To find out whether (4.39) is true, we look at the above set described in (4.31) and see if everything in it has the property of flying. There are plenty of things in this set which do not fly (in fact, nothing in this set flies). So since at one world (the actual world) there are counterexamples to (4.39), (4.39) is false.

To evaluate (4.40) we must look at the set $N_{\text{penguin,}\neg\text{flies}}$ of penguins which are non-exceptional with respect to not flying. In fact, these are the same ones as those which are non-exceptional with respect to flying, that is, those described in (4.31) above. The exception class for penguins and flying is those which are exceptional with respect to flying and not flying: these come down to the same thing. So here $N_{F,G} = N_{F,\neg G}$. Hence if we look at the set described in (4.31) and see if everything in it has the property of not flying, we find that this is the case, and will be in any world which has the same exception class for penguins and flying. Thus (4.40) is true.

Does it generally hold that $N_{F,G} = N_{F,\neg G}$? Looking at a wide range of examples shows that it does. For example, the birds which are exceptional with respect to not flying are just those which are exceptional with respect to flying; for example, penguins are exceptional birds with respect to not flying, just as they are exceptional birds with respect to flying. Similarly the peacocks which are exceptional with respect to not having brightly coloured tails are just those which are exceptional with respect to having brightly coloured tails: the females, juveniles and so on. We will then adopt the constraint on our formal representation that $N_{F,G} = N_{F,\neg G}$ for all predicates F and G.

Conjoined and disjoined subjects pose some problems for a simple analysis. I will briefly outline some cases where $N_{F,G}$ is not determined in the obvious way.

Generics often appear with modifiers: adjectival or with relative clauses. For example:

(4.41) Furry dogs bark.

(4.42) Hispanic Americans speak Spanish.

(4.43) Men over 50 like cats.

These are all of the form:

(4.44) $\circledast \forall x[((F(x) \& G(x)) \& N_{F\&G,H}(x)) \rightarrow H(x)]$

It is not always the case that $N_{F\&G,H} = F \cap N_{G,H}$ where F is the modifier. For example, consider the following pairs of sentences where the a. sentences are true, whereas the b. sentences are false:

(4.45) a. Americans do not speak Spanish.

b. Hispanic Americans do not speak Spanish.

(4.46) a. Birds fly.

b. Birds which are penguins fly.

Hispanic Americans are exceptions to (4.45 a.) since they do speak Spanish. Thus $[\![\text{hispanic}]\!] \cap [\![N_{\text{american,speaks-spanish}}]\!] = \emptyset$. Similarly the intersection of penguins with $N_{\text{bird,flies}}$ is empty. Since this will happen in every relevant possible world, (4.45 b.) and (4.46 b.) will come out vacuously true.

Instead we must have a separate predicate $N_{F\&G,H}$ for each of these examples. $N_{\text{hispanic\&american,speaks-spanish}}$ will be the set of Hispanic Americans who are non-exceptional with respect to speaking Spanish, presumably all of them except those who have grown up in an artificially English-speaking environment. In the next chapter I will show why this cannot be done using an extra conjunction with the modifier, since the modifier will interact with the subject and change the things which will count as exceptions.

Generics with conjoined subjects include examples such as

(4.47) Cats and dogs are furry.

which in English are synonymous with the distributed conjunction as in:

(4.48) Cats are furry and dogs are furry.

While the surface form of (4.47) looks as if it should be representable as follows:

(4.49) $\circledast \forall x[((F(x) \vee G(x))\&N_{F\vee G,H}(x)) \rightarrow H(x)]$

this will not work. Consider the examples:

(4.50) a. Birds fly.

b. Penguins and birds fly.

(4.51) a. Birds fly.

b. Penguins and other birds fly. (Penguins and non-penguins fly.)

(4.52) a. Birds fly.

b. Birds which fly and birds which do not fly, fly.

In each of these, our intuitive judgements, due to the equivalence of the distributed conjunction as in (4.48), make the a. sentences true, but the b. sentences arguably false. For example, (4.50 b.) is equivalent to 'penguins fly and birds fly' which is false because the first conjunct is. But since $[\![\text{bird}]\!] = [\![\text{penguin} \vee \text{bird}]\!]$ since $[\![\text{penguin}]\!] \subset [\![\text{bird}]\!]$, on the analysis given in (4.49), (4.50 a. and b.) would come out equivalent. The other examples are similar.

So we must represent sentences of this form as

(4.53) $\circledast \forall x[((F(x)\&N_{F,H}(x)) \rightarrow H(x))\&((G(x)\&N_{G,H}(x)) \rightarrow H(x))]$

Surface form is not always a guide to logical representation. A similar thing happens with logics of counterfactuals. For example, in Ellis's logic of counterfactuals, he is forced to treat an 'or' in the antecedent of a counterfactual as a "wide-scope conjunction", that is 'If A or B were the case then C would be the case' has to be treated as 'If A were the case then C would be the case and if B were the case then C would be the case' (see Ellis, 1979, pp. 68 ff.). Exactly the same problem also arises in Asher and Morreau's Commonsense Entailment (see, for example, Asher and Morreau, 1995), although they only discuss cases (like, for example (4.47)) where in fact the apparent logical form (4.49) and the more general logical form (4.53) are equivalent.

4.5 Conclusions

In this chapter I have presented an account of how to formalise generic sentences as necessarily true universally quantified sentences. Having looked at various mechanisms by which the restrictions on both the worlds and individuals quantified over could be generated, I proposed my own account. This gives a way of generating the restrictions from the subject and predicate of the generic sentence. My account formalises the criteria for generics laid down at the end of chapter one as follows:

- Generics are generalisations over individuals since they are represented as generalisations over non-exceptional individuals.
- Generics may have exceptions since the universal quantifier only ranges over non-exceptional individuals.
- Generics are counterfactual-supporting since in any world where the exceptions are the same, a generic 'Fs are Gs' will entail the extensional generalisation that all non-exceptional Fs with respect to being G are G.

My account is based on the insight from chapter three that while generics express nomic regularities, they may have exceptions, and that we can make sense of the idea of a law with exceptions by differentiating between an exception and a counterexample to a nomic regularity. Treating exceptions intensionally, that is, allowing our criterion of what makes an exception to a generic to include reference to non-actual individuals, gives us a way of restricting the universal quantifier which determines the universal generalisations true in the actual world, which generics entail. It also gives us a way of determining which worlds to look at to see if a generic is true or not.

I then showed how this account could deal with various examples of generics discussed earlier in the thesis, and how it formalises the criterion for genericity laid down at the end of chapter one.

Chapter Five

Context

In the thesis so far I have characterised the linguistic phenomenon of genericity and compared it with the notion of lawlikeness from the philosophy of science. From this I have given an account of the semantics of generics based on the distinction between exceptions and counterexamples. This account is based on restricting the universal force of generics, but not by the more usual kinds of contextual restrictions on quantifiers proposed by Lewis, Westerståhl and others. Generics have their own special kind of local restriction, given by the subject and predicate involved. I gave a formalisation of this in a possible worlds semantics, and demonstrated some of its properties.

However, having given this formalisation, I now wish to consider the question whether it is possible to contextually restrict generics in the usual sense, as mentioned above. We can make generalisations in a local context using 'every': for example, 'every student who wishes to graduate in December must register by November 24th'. Here the quantifier is restricted by context to students at Edinburgh University. While I argued previously that this sort of restriction was not responsible for the distinction between exceptions and counterexamples, could it still apply to generics? In other words, can we use generics in restricted contexts?

In this chapter, I will start by examining the restrictions that can apply to ordinary English universal quantifiers, such as 'all' and 'every', comparing features of these quantifiers with features of generics. I will then apply these observations to generics, arguing that generics may, *in certain circumstances*, be contextually restricted, and moreover that these contextual restrictions have an effect on the other features of generics and universal quantifiers, such as presuppositions of existence. Finally, I will apply these observations to some recent work by Cleo Condoravdi (1994), who suggests a third reading for the English bare plural (in addition to the existential and generic readings) based on certain data. I will suggest that her examples may be analysed as restricted generics, so that a third reading is not necessary.

5.1 Forms of universal quantifiers

I will now examine in detail a specific case of what kinds of restrictions certain quantifiers will accept, by comparing two forms of the universal quantifier in English, namely 'all' and 'all (of) the'. Logicians, and most philosophers, think of 'every', 'all' and 'all the' as interchangeable forms of the universal quantifier. When translating from logical notation into English, they are used as equally reasonable translations of the symbol $\forall$, and English sentences in which they occur as quantifiers are again almost invariably translated using this symbol.

For example, Quine says:

> ... we may switch over to plural forms without change of meaning — using 'all' or 'all the' instead of 'every'. (1964, p. 86)

and

> Quantification cuts across the vernacular use of 'all', 'every', 'any', ... *etc.*, ... in such fashion as to clear away a baffling tangle of ambiguities and obscurities. ... The device of quantification subjects this level of discourse, for the first time, to a clear and general algorithm. (1940, pp. 70–71)

In this section I will argue that these English forms of the universal quantifier do not always mean the same, and in particular that 'all' and 'all the' are not both representable solely by the universal quantifier. Moreover, sentences of the form 'all Fs are Gs', as opposed to 'every F is G' or 'all (of) the Fs are Gs', have important parallels with generic sentences, which we may use in extending our analysis of generics to make restricted generalisations. The sentences I will consider in this section will be of the following forms:

(5.1) All Fs are Gs [All Fs G]

(5.2) All (of) the Fs are Gs [All (of) the Fs G]

(5.3) Every F is G [Every F Gs][1]

I take these to be the forms of non-technical English sentences. I will compare these with the formal language sentence

(5.4) $\forall x(Fx \rightarrow Gx)$

The truth-value of this sentence is determined with respect to some model. Whatever formal mechanism is used to calculate this, it is true precisely when all the objects in the relevant domain which are in the extension of F are in the extension of G. In theories formalising

[1] As in the rest of the thesis, I am not distinguishing between predicates of the form 'are G' and 'G'.

natural language, typically the universal quantifier ranges over some context set (as discussed in the previous chapter) and it is the intersection of this set with the extension of F which is the restriction of the quantifier. I will argue that (5.4) is not always an appropriate translation for each of the above three forms of English sentences, which do not mean exactly the same.

5.1.1 Empirical and lawlike generalisations

Accidental generalisations and laws

As observed previously in chapters two and three, 'all Fs are Gs' is often considered to state something different to $\forall x(Fx \rightarrow Gx)$. This is the whole thrust of arguments against a regularity theory of laws discussed in section 2.1.1. If "mere regularities" are stated by sentences of the form $\forall x(Fx \rightarrow Gx)$, and laws of the form 'all Fs are Gs' are not "mere regularities" then clearly 'all Fs are Gs' does not express the same as $\forall x(Fx \rightarrow Gx)$.

The fact that universally quantified sentences can either express accidental generalisations or lawlike sentences has, of course, been noticed before, perhaps most notably by Strawson (1952) who writes about this in connection with the presuppositions associated with each kind of utterance, which I discussed in chapter one.

More recently, Horn (1997) and Moravcsik (1991) have taken up this issue, and discussed whether the different forms of universal quantifiers in (5.1)–(5.3) can be associated with lawlike or non-lawlike sentences, a point not considered by Strawson. Horn summarises in the following table:

EMPIRICAL UNIVERSALS [+ existential import]	**LAWLIKE UNIVERSALS** [− existential import]
Aristotelian/Strawsonian:[2] entail or presuppose existence of subject set; *All F are G* is about the Fs	P.C.:[3] neutral with respect to existence of subject set; *Any F are G* is about the F-G connection
every, each, all (of the)	*all (?of the), any* (if universal at all)
subject-predicate in nature (and in logical form?)	conditional in nature, typically with counterfactual force
determiner mandatory *(*All) seats are taken)*	determiner usually optional *((All) ravens are black)*
no exceptions tolerated	admit exceptions, *ceteris paribus*
range over present entities	range over present/past/future entities
range over actual entities	range over possible as well as actual entities

[2]Aristotelian/Strawsonian analysis: treated as sentences of subject predicate form.

[3]P.C.: predicate calculus analysis, *i.e.*, $\forall x(Fx \rightarrow Gx)$.

Some of the issues about existential import were discussed back in chapter one. While I agreed with Horn and Moravcsik that accidental generalisations carry presuppositions of existence, I pointed out that lawlike generalisations are actually ambiguous between what I called an idealised reading, which does not carry a presupposition of existence, and an individualised reading, which does. However, my analysis given in chapter four agrees with Horn that lawlike universal generalisations (treating generics as a species of universal generalisation) are conditional in nature, have counterfactual force, have an optional determiner, *i.e.*, may occur with bare plural subject, admit exceptions, and do not range merely over actual or present entities.

I will now look at the second line of the table: whether these differences attach to particular English forms of the universal quantifier.

English usage

When is it that an English expression is really a translation of $\forall x(Fx \rightarrow Gx)$ (or conversely, when does $\forall x(Fx \rightarrow Gx)$ express the same as some English expression)? In the previous section we noted that universally quantified English sentences can have two different kinds of meaning: they can express accidental regularities or lawlike regularities. But are certain forms of the universal quantifier preferred for each kind of meaning? In the following examples, (5.5) attempts to state a lawlike regularity, whereas (5.6) attempts to state an accidental regularity, and each is given with the various forms of the universal quantifier:

(5.5) a. All kittens are born blind.

b. ?Every kitten is born blind.

c. ??All the kittens are born blind.

(5.6) a. ??All kittens have white paws.

b. Every kitten has white paws.

c. All the kittens have white paws.

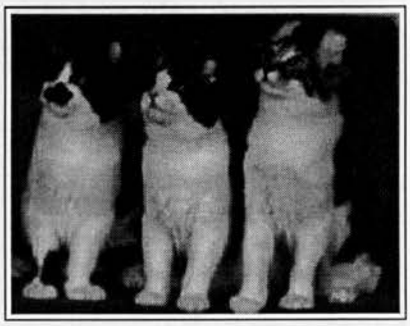


Figure 5.1: Every kitten has white paws

The question marks before some of the examples indicate that some sound stranger than others on the intended reading. The lawlike regularity sounds much better expressed using 'all' on its own, whereas the accidental regularity sounds much better expressed using 'every' or 'all of the'.

These are not isolated examples. The clearest difference is that between 'all' and 'all (of) the', which is striking. Philosophers have tended not to notice this difference, and to lump all occurrences of 'all', whether with or without an article, together. Moravcsik himself does not seem to notice the clear differences between these two forms, and as Hofmann (1992) observes, often moves between them in a misleading way. Moreover, the contrast is even more marked with direct objects: compare 'John ate every cake' or 'John ate all of the cakes' with 'John ate all cakes'. The latter just sounds ridiculous.[4]

As we noted before, there are two basically different kinds of things that universally quantified sentences can express. One is a restricted quantification over certain salient immediate objects which have a certain property, *e.g.*, that all the kittens in the picture have white paws. This might be glossed as an empirical or accidental generalisation. The other is an unrestricted claim which expresses some kind of lawlike relationship, which may indeed be a law of nature such as 'all metals conduct electricity'. It appears that 'all' on its own (pure 'all') prefers a lawlike reading, whereas 'all (of) the' prefers the empirical reading.

The differences between pure 'all' and 'every' are harder to pin down. In the examples above, pure 'all' sounds much better making lawlike generalisations, whereas 'every' sounds better making accidental generalisations. 'All' is more consistent here: it is generally very hard to make empirical generalisations with pure 'all', whereas 'every' can lend itself to making lawlike generalisations, particularly in circumstances where we are generalising over some well-defined and easily enumerated class. For example, compare the following:

(5.7) Every metal conducts electricity.

(5.8) Every raven is black.

As lawlike rather than empirical generalisations, (5.7) sounds very much better than (5.8). This seems to be the case because while the metals are a well individuated class with a relatively small number of members which we can list given a periodic table, there are many more ravens, and we do not distinguish individual ravens in the same way as we distinguish individual metals. This might explain why in cases like (5.7), 'every' seems to be possible for lawlike generalisations.

To summarise, while the jury may still be out on which class 'every' belongs to, it seems clear that 'all' on its own, pure 'all', yields a lawlike, counterfactual-supporting generalisation, and 'all (of) the' yields a non-lawlike, enumerative generalisation.

Accounting for the different uses of 'all'

The question which naturally arises from this is how we can account for this variability in the use of the quantifier 'all'. If it were a modal operator of some kind, then we should expect it

[4]It is not ridiculous if interpreted as the less obvious past tense habitual reading, meaning John ate all kinds of cakes.

to give rise to counterfactual-supporting generalisations in all cases. But here we have clear evidence that in some cases universally quantified sentences using 'all' express counterfactual-supporting generalisations, and in other cases they do not.

A phenomenon known in linguistics as that of "floated quantifiers" can help shed some light on this. Certain quantifiers in some languages need not occur with the rest of the phrase to which they belong, in English, 'each', 'both', and 'all'. For example, we may have:

(5.9) The philosophers *all/both* went to the pub.

(5.10) The children bought an ice cream *each*.

(5.11) Kittens are *all* born blind.

One approach to floating quantifiers treats them as adverbial phrases,[5] and while there is no consensus in linguistic theory about whether this approach is correct, it seems clear from the above examples that in such cases, the floating quantifiers need not be acting as variable-binding. This role can be played by the other quantificational elements in the sentence, for example, 'the' in (5.9) and (5.10), and the generic operator in (5.11). What this means for 'all' is that in these sorts cases at least, 'all' is not necessarily functioning as the variable-binding universal quantifier $\forall$.

Returning to our comparison of universally quantified sentences, in (5.5) and (5.6), we can see that the effect of deleting 'all' is to make remarkably little difference:

(5.12)	a.	All kittens are born blind.	Kittens are born blind.
	b.		
	c.	??All the kittens are born blind.	??The kittens are born blind.
(5.13)	a.	??All kittens have white paws.	??Kittens have white paws.
	b.		
	c.	All of the kittens have white paws.	The kittens have white paws.

The grammaticality judgements remain the same whether or not 'all' is present, and moreover, whether or not the sentence is counterfactual-supporting also remains constant.

There are two possible approaches one might take to this. The first is what one might call a "null" analysis of the quantifier 'all'. It has no contribution as a quantifier: the rest of the sentence determines the logical subject of the sentence, and, in the case of generics, the modal force. This accounts for the fact that sentences using 'all' on its own, without the definite article, have a modal force, namely, the modal force associated with the equivalent generic.

[5] See, for example, Dowty and Brodie (1984).

On the other hand, sentences with 'all' plus the definite article carry no modal force, since plural definite descriptions do not. Of course, there is one change in meaning which occurs by deleting 'all'. As noted previously, generics famously have exceptions. However, adding 'all' to a generic results in a generalisation that cannot have exceptions. Generics are not the only kind of generalisation which may have exceptions. David Dowty (1986) discusses examples such as:

(5.14) After the lecture, the students asked questions.

which does not entail that every single student referred to by 'the students' asked a question. Dowty suggests that the semantic contribution of 'all' is to indicate entailments of involvement in the property predicated. In other words, adding 'all' to (5.14) yields a sentence which means that every single student did ask a question.

While there is something very attractive about this kind of approach, it fails to account for a similar phenomenon with other quantifiers. If the contrast between the a. and c. sentences above is accounted for by the fact that 'all' is not a quantifier, then how are we to account for similar contrasts with other quantifiers, most notably 'most'?

(5.15) a. Most kittens are blind until the age of three weeks.

b. ??Most of the kittens are blind until the age of three weeks.

(5.16) a. ??Most kittens have white tails.

b. Most of the kittens have white tails.

In a suitably restricted situation, (5.16b.) is true, but (5.16a.) is far too strong. Conversely, (5.15a.) is true, whereas (5.15b.) does not convey the lawlike regularity. Similar contrasts can be observed with 'few', and possibly with other quantifiers. However, there are some quantifiers which cannot participate in these contrasts, notably 'the', 'these' and so on, which do not occur in partitive constructions at all, and 'several' which always has to pick out an existing salient set.

However we account for the contrasts observed in (5.5) and (5.6), and in (5.15) and (5.16), it is clear that sometimes quantified sentences do have a modal force which does not derive from an explicit modal operator. In appendix B, I formalise an approach to quantifiers which allows them to be intensional, that is, instead of treating quantifiers as relations between sets, as in traditional generalised quantifier theory, we treat them as relations between properties. As just mentioned, some quantifiers, for example, 'the' and 'several', are degenerative, in that they only take account of the extension of the property at the world of evaluation, and thus reduce to relations between sets. The contrast observed in (5.5) and (5.6) is thus accounted for by the fact that in partitive constructions, a definite description or a demonstrative occurs.

These quantifiers are extensional. The inclusion of the definite description in a quantifier phrase unsurprisingly brings with it its own semantics.

It is clear, however, that there is a lot more work to be done on exactly what is going on here, and to what extent the approach outlined in appendix B can be extended to cover the full range of phenomena.

What do universally quantified English sentences mean?

In the previous section, I suggested that some universally quantified sentences express lawlike propositions, namely pure 'all' sentences of the form of (5.1), and some do not, namely 'all the' sentences, of the form of (5.2).

If this is correct, then it is part of the semantics of 'all' (as opposed to 'all the' or 'every') that it makes a lawlike claim. The necessitation is already there as part of the meaning of the English expression. This is (tacitly) supported by the literature: the Goodman examples (in Goodman, 1954) of accidental, or non-lawlike, generalisations have the 'all the' rather than the pure 'all' form, for example, 'all the coins in my pocket are silver'. Moreover, all the examples of non-lawlike universally quantified sentences which Strawson (1952) gives are of the form 'all (of) the Fs are Gs', whereas his lawlike universally quantified sentences are of the form 'all Fs are Gs'.

We noted above the enumerative properties of 'every' and 'all (of) the'. These English quantifiers do behave just like the formal universal quantifier seen in (5.4):

(5.4) $\forall x(Fx \rightarrow Gx)$

Hence I am quite happy to say, for now, that (5.2) and (5.3) are (roughly) equivalent to (5.4).

However, pure 'all' sentences express lawlike regularities. They will support appropriate counterfactuals, which will not be true of the corresponding 'all the' and 'every' sentences. An ability to support counterfactuals is not a property of the formal sentence (5.4), and as we noticed previously (in chapter two), most philosophers of science tend to take laws of nature as not being expressed by a sentence of this form.

So, (5.1) cannot be equivalent to (5.4). 'All' asserts something more than just enumeration; there is a modal element. We can characterise this just by saying that 'all Fs are Gs' means 'it is a counterfactual-supporting generalisation that $\forall x(Fx \rightarrow Gx)$'. It may not come as a surprise that I will later argue that we can characterise 'all Fs are Gs' as expressing something with the same modal force as a nomic regularity.

We should note that this distinction is not just at the level of surface structure, but at the level of logical form. Not all sentences which *look like* pure 'all' sentences actually *are*. For example, 'all my students turned up late this morning' is really 'all the students in my class (or whatever) turned up late this morning', and so on. Hence this is not a pure 'all' sentence, and is not lawlike.

The distinction made by Horn between the two kinds of universally quantified sentences, with their properties summarised in the table on page 102, does not, of course, rely on the arguments I have presented about whether particular English quantifiers always fall in one class or the other. There may be examples where the distinctions are less clear-cut than those I have presented here, partciularly in colloquial uses of English, such as the following example, where it looks as if 'all' is elliptical for 'all the':

(5.17) All systems are go.

Moreover, occasionally an enumerative generalisation may be used where the stronger lawlike generalisation is also true, for example in:

(5.18) All the metals conduct electricity.

Of course, in any such case, the corresponding lawlike generalisation entails the weaker claim: here, 'all metals conduct eletricity' entails (5.18) above. However, these examples notwithstanding, it seems clear that the paradigm cases of lawlike generalisations are expressed using 'all', and the paradigm cases of accidental or empirical generalisations are expressed using 'all the'.

5.1.2 Restrictions on 'all', 'all the' and 'every'

Universally quantified sentences, and indeed all quantified sentences, can usually be explicitly restricted by the inclusion of extra modifiers, or implicitly restricted by contextual information. For example, in (5.6), the picture provides an implicit restriction to kittens in the picture; we might explicitly give this restriction by changing (5.6c.) to:

(5.19) All of the kittens in the picture have white paws.

Both kinds of restrictions raise issues for the distinction between the different English forms of the universal quantifier.

Explicit restrictions

If a sentence of the form 'all Fs are Gs' contains a very specific restriction to a certain time or place, the modal force of such a sentence is greatly reduced. In the following example

(5.20) Currently, all Americans support the President.

because of the adverbial quantifier which restricts consideration to the current time, (5.20) is rather restricted in its modal force. It makes a statement about actual and possible Americans *now*, rather than Americans who lived one hundred years ago, or Americans one hundred years in the future. However, despite the restriction, (5.20) is still not purely extensional; it supports counterfactuals of the form "if Fred were an American, he would support the President".

A related issue arises with the past tense. The following is an example of a past-tense counterfactual-supporting generalisation:

(5.21) Due to works on the line, all northbound trains were delayed.

Although any future northbound trains may not be delayed, this is irrelevant to the determination of the modal force of (5.21) since it only makes a generalisation about the part of the past picked out by the context (the time when the works on the line were taking place, presumably). However, this generalisation is still counterfactual-supporting, exactly in the same way as (5.22) is:

(5.22) Dodos were flightless birds.

However, there are examples where it it looks as if a specific kind of explicit restriction causes 'all' to behave extensionally:

(5.23) All examined ravens were black.

Here we might say that the logical form of this sentence is not really that of a pure 'all' sentence: perhaps it is really 'all the ravens that were examined were black'. (Note that 'all ravens that were examined were black' sounds much less good.) In this case, 'all' seems to abbreviate 'all the', as with (5.17) in the previous section.

Implicit restrictions

How does the distinction between lawlike and accidental generalisations relate to the issue of how quantifier domains are determined which I discussed in chapter four? We saw there that 'every' can be restricted. However, Vendler (1967) notes that pure 'all' sentences must be non-enumerative (or perhaps, unrestricted?):

> ... the non-referential *all*-proposition ... cannot be found true as a result of enumerative induction. Such propositions always remain open, whereas statements of evidence, statements of fact, are necessarily closed. Laws are not statements of fact and statements of fact are not laws.

While we will modify the claim that 'all' sentences must be unrestricted in the next section, it is true that we generally cannot use 'all' on its own to state a fact which we have verified by examining instances. 'All' cannot be restricted in the same way as 'every'. So, consider the following pairs of sentences:

(5.24) a. ?All ravens were black.

b. Every raven was black.

(5.6) a. ??All kittens have white paws.

b. Every kitten has white paws.

I can say 'all ravens *are* black' but not 'all ravens *were* black' (unless I mean something like, 'it used to be the case that all ravens were black but now a new variant has emerged with white plumage'. See Strawson (1952), p. 198 for a similar example). (5.24 b.) is fine; this is because 'every' is quantifying over some set of ravens salient in the context.[6] Similarly, the enumerative generalisation made in (5.6) sounds very odd with 'all', but fine with every. So, 'every' can be contextually restricted in the examples above, but it is very hard to restrict 'all' in the same way.

So, to sum up, lawlike sentences, and hence pure 'all' sentences, will not pick up the same contextual restrictions as non-lawlike 'every' and 'all (of) the' sentences.

In this section, I have looked at the properties of 'all' and 'every' with respect to the kinds of propositions they express, and how contextual restrictions affect them. I have argued that pure 'all' can only be used to express nomic regularities, and moreover, cannot be restricted by context in the same way as 'every' can be. I will now show that the connection between lawlikeness and an inability to be restricted carries over to generics.

5.2 Generics and restrictions

In chapter four I argued that generics were best analysed as restricted universally quantified sentences, where the quantifier is restricted to only quantify over non-exceptional cases. Let us call the restrictions on generics which restrict the quantifier to non-exceptional cases *generic restrictions*. I argued previously (in section 4.2) that these restrictions are semantically determined by the rest of the sentence rather than given by the previous context. Moreover, they are independent of which individuals are salient, and seem to be given *independently of context* by semantic information from the rest of the sentence. I also argued previously (in the same section) that other (non-generic) quantifiers cannot in general be subject to this kind of restriction. We cannot say 'Every peacock has a brightly coloured tail' meaning just the males.

[6]For example, those examined by someone attempting to confirm a hypothesis of Hempel's.

In this section, I will consider the status of generic restrictions and whether there could be circumstances where they do occur with other quantifiers. I will compare the data presented on 'all' and 'every' in the previous section with what happens with generics, in particular whether and how generics can be contextually restricted.

5.2.1 When do generics accept restrictions?

I argued in the previous section that certain kinds of universally quantified sentences, namely 'all' sentences, could not be restricted in the same way as 'every' sentences. Generics seem to behave in a similar way. Recall that in chapter four I argued that generic restrictions were not determined by salience. Generics do not quantify over the salient individuals in the context. Therefore, we cannot use normal restrictions on quantifiers to salient individuals to pick out the context set or domain for a generic quantifier. Compare the following minimal pairs:

(5.25) a. Every dog is a collie.

b. Dogs are collies.

(5.26) a. All the students are likely to do well in their exams.

b. Students are likely to do well in their exams.

(5.27) a. Most of the books have between 100 and 150 pages.

b. Books have between 100 and 150 pages.

In each case, imagine a suitable context set in which the a. sentence is true. For example, for (5.25) assume we are visiting a champion sheepdog breeder. In a context where the a. sentences are true, because the quantifier is restricted by an appropriately derived context set, the b. sentences are simply false. The context set on the generic quantifier cannot be the same as that on the quantifiers in the a. sentences.

As we saw in the previous section, we can use 'every' to quantify over contextually salient individuals. In fact, most uses of 'every' are restricted in this way. For example, if I say:

(5.28) Every philosopher came to the talk.

I mean every philosopher in the department, not in the world. As we saw before, the same holds for 'all of', but this kind of restriction will not apply to 'all'.

However, it does seem that we can have (non-explicitly) restricted lawlike sentences. For example:

(5.29) (All) cars drive on the left.

(5.30) (All) Honours students have taken a first-year Logic course.

(5.31) (All) swans are white.

We can use (5.29) to mean not that all cars in the world drive on the left, but just those in Britain do. (5.30) is true for Edinburgh University's Philosophy undergraduates, but may well not be true elsewhere, and (5.31) is true if restricted to Europe (say, 500 years ago), while there are black swans native to Australia. These sentences are equally acceptable whether as universally quantified 'all' sentences, or as generics (although, of course, the generic sentences are tolerant of exceptions whereas the 'all' sentences are not). Of course, all of these sentences require the right context in order to be true, but given that context, they are perfectly felicitous. So what is the difference between these examples and the previous ones?

Let us consider a specific example. Consider the following sentences:

(5.32) a. All lecturers are male.

b. Lecturers are male.

Suppose we are discussing whether or not the women's toilet should be upgraded in Edinburgh University's philosophy department. "Why should we?" a cost-conscious administrator asks, "All the lecturers are male." Could the administrator equally well have said either of the sentences in (5.32)? It seems not.

Now consider the same situation, but in a future where a fundamentalist government has decreed that no woman may go into academia. The same discourse including either of (5.32) now seems fine. My claim is that this is because in this situation it is possible to interpret (5.32) as expressing a nomic regularity.

To support this, compare (5.32) with (5.33) below:

(5.33) a. All lecturers go to departmental meetings.

b. Lecturers go to departmental meetings.

The new junior lecturer in the department asks if he is expected to attend the departmental meeting on Wednesday. The reply comes: "Of course, (all) lecturers go to departmental meetings." Here '(all) lecturers' is restricted to exactly the same domain as in the first situation with (5.32): the philosophers at the University of Edinburgh. However, in this situation (5.32) cannot be restricted in this way, whereas (5.33) can be. Thus the same restricted domain can sometimes be fine, and sometimes not. My suggestion is again, that the reason is that it is possible to interpret (5.33) as lawlike: it is a rule that lecturers attend departmental meetings.

To summarise, the critical factor seems to be whether the sentence itself can be interpreted as expressing a nomic regularity or not. If it can, the restriction is fine. If it cannot, then the sentence sounds odd and fails to pick up the restriction. Hence in the first situation, (5.32) comes out false, because we cannot construe it as a law restricted to Edinburgh philosophers, and because both pure 'all' and the generic have a modal element, and this modal element is not satisfied. To "rescue" the sentence, we may try instead to restrict it to the nearest available domain, perhaps lecturers in Britain, or philosophers in Britain. But since not all of these lecturers are male, it still comes out false. In (5.33), however, we can construe it as a law restricted to Edinburgh philosophers, and so the modal element is satisfied, since they do all attend departmental meetings. (5.33) thus comes out true.

The above suggests a reason why some restrictions on 'all' sentences are acceptable whereas others are not. Importantly, bare plural generics seem to behave exactly analogously to 'all' sentences in this respect: if they can be interpreted as expressing a nomic regularity, they can be restricted to a context set; if not, they cannot. This important insight has many consequences; I will now apply it, starting with when generic restrictions are possible.

5.2.2 Generic restrictions are not intersective

We have seen in chapter four that restrictions on ordinary quantifiers, as seen in examples (5.25)–(5.27) above, are intersective. By this I mean that the restriction intersects with the restrictor of the quantifier as with Westerståhl's context sets; the quantifier is restricted to the context set, so only ranges over those items which are salient. So, for example, in (5.25), instead of ranging over all dogs, it ranges over just those dogs which are salient, or in the context set. Hence the domain of the quantifier is the intersection of the set of dogs and the context set.

Generic restrictions do not function like this. Consider the following examples:

(5.34) Students take exams.

(5.35) Students do not take exams.

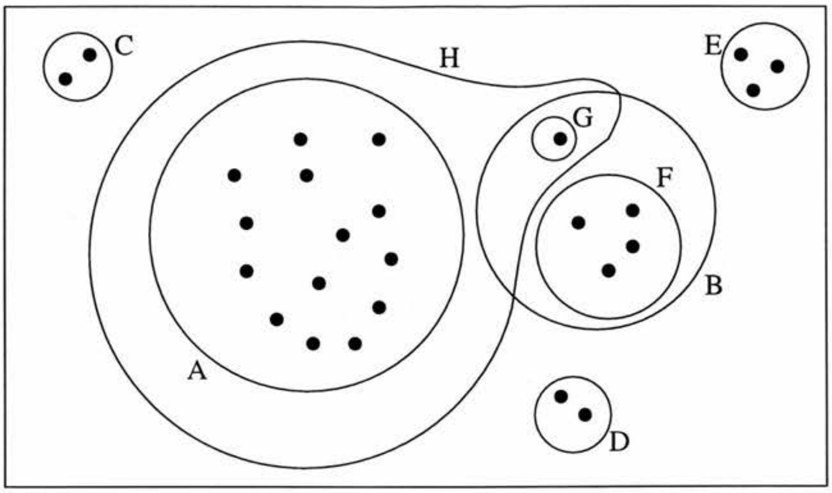
The first is a true generic. The second, its narrow scope negation, is false. (5.34) is true despite the existence of some institutions where exams are frowned upon and all grades are given by a continuous assessment system, so students in fact generally do not sit exams, except in unusual circumstances, perhaps as a last appeal against expulsion.

Suppose the University of Carlops is such an institution. Clearly (5.36) below is then false, and in fact its narrow scope negation (5.37) is true:

(5.36) Students at the University of Carlops take exams.

(5.37) Students at the University of Carlops do not take exams.

So from chapter four, since in general $N_{F\&G,H} \neq F \cap N_{G,H}$, $N_{\text{carlops·student,take·exams}} \neq N_{\text{student,take·exams}}$. In fact students at Carlops will be exceptions to (5.34), so there will not be any of them in $N_{\text{student,take·exams}}$.



The square box represents the set of students. ● a student
A students non-exceptional wrt taking exams
B students at the University of Carlops
C students who do not take exams because of illness
D students who do not take exams because they have special needs
E students who are on wholly practical courses
F Carlops students non-exceptional wrt taking exams
G Carlops students who take exams to avoid expulsion
H the set of exam-takers

Figure 5.2: Students take exams (but not at the University of Carlops)

The diagram shows how this works. In the set of all students (the square box), a large number are contained within the set A of students non-exceptional with respect to taking exams, *i.e.*, $N_{\text{student,take}\cdot\text{exams}}$. Those which are not within A are exceptions, for various reasons (sets B, C, D and E) including being a student at the University of Carlops. But since the set A of students non-exceptional with respect to taking exams is a subset of the set H of exam-takers, we have $\forall x[(\text{student}(x)\&N_{\text{student,take}\cdot\text{exams}}(x)) \rightarrow \text{take}\cdot\text{exams}(x)]$, and so (5.34) is true. From chapter four recall that $N_{\text{student,take}\cdot\text{exams}} = N_{\text{student},\neg\text{take}\cdot\text{exams}}$ and so since this set is not a subset of non-exam-takers, *i.e.*, it does not lie wholly outside the set H of exam-takers, (5.35) is false.

To evaluate (5.36) and (5.37), we need to look at the set B of students at the University of Carlops. They are mostly contained within the set F of students at Carlops non-exceptional with respect to taking exams, *i.e.*, $N_{\text{carlops}\cdot\text{student,take}\cdot\text{exams}}$. Since this set is not a subset of the set H of exam-takers, we have counterexamples to $\forall x[(\text{carlops}\cdot\text{student}(x)\&N_{\text{carlops}\cdot\text{student,take}\cdot\text{exams}}(x)) \rightarrow \text{take}\cdot\text{exams}(x)]$ and so (5.36) is false. However, since $N_{\text{carlops}\cdot\text{student,take}\cdot\text{exams}} = N_{\text{carlops}\cdot\text{student},\neg\text{take}\cdot\text{exams}}$, and this set is a subset of the non-exam-takers, we have $\forall x[(\text{carlops}\cdot\text{student}(x)\&N_{\text{carlops}\cdot\text{student},\neg\text{take}\cdot\text{exams}}(x)) \rightarrow$

$\neg$take $\cdot$ exams(x)] and so (5.37) is true.

But what if (5.35) is uttered in a context where it is thereby restricted to the students at Carlops? Suppose I am visiting the Carlops campus, and remark to my guide that there does not seem to be a room big enough to use as an exam hall. The guide replies that this is because they do not need one, and in explaining why says 'students do not take exams'. If generics could be restricted in the same way as ordinary quantifiers, we would have our universal quantifier restricted to the intersection of the restriction on (5.35), *i.e.*, $N_{\text{student},\neg\text{take}\cdot\text{exams}}$ and the context set, *i.e.*, things in Carlops. But the intersection of these sets, *i.e.*, A and B is empty. Thus in this and similar worlds, the conditional will be vacuously true, and this will result in the truth of both (5.35) and unfortunately (5.34).

The fact that A and B are disjoint, *i.e.*, that there are no Carlops students who are non-exceptional *students* with respect to taking exams, means that intersective restrictions will give us the wrong results. This problem will apply to any account of restricted generics which attempts to analyse restrictions as intersective, for example, any account which uses global accommodation to determine quantifier restrictions to account for exceptions, such as that of Asher and Morreau (1995).

Thus these kinds of restrictions on generic cannot be intersective; in fact, I will make the stronger claim, defended previously (in chapter four), that generics cannot accept intersective restrictions at all. So how can they be restricted?

Previously, when discussing how generics and 'all' sentences could be restricted, I concluded that this could only happen when the sentence could be interpreted as expressing a (true) nomic regularity. But what does it mean to "interpret a sentence as expressing a nomic regularity"? If a sentence expresses a nomic regularity, then it quantifies over non-exceptional entities. If we take a sentence to express a law, we take it that such an exception-set exists, and that it is possible to distinguish exceptions from counterexamples. This means that we must be prepared to give some kind of justification of what sort of things are members of the exception-set. Failure to do this would consist in an inability to defend taking it as a law. Of course, we generally will not know *exactly* what is in the exception-set, as in many cases this is not epistemologically accessible. We do, though, need to be able to give some kind of defence that it is well-defined.

This presents a view of generics from the opposite direction. Previously I discussed how we might determine which generics were true or false given the extension of the relevant exception-set. Here we are taking certain sentences to be laws, and thereby determining their exception-sets, or at least determining that we have some kind of grasp of what the exception-sets are.

In conclusion here, I will note that this conception of nomic regularity has some similarities with the traditional notion of a law as spatiotemporally unrestricted. Once we have determined the exception-set for some nomic regularity, we cannot then apply this nomic regularity to a restricted subset of the world. If we wish to do so, we must determine a new exception-set. This is the sense in which generics cannot be contextually restricted. In order to contextually (or spatiotemporally) restrict them, we must reinterpret what they mean.

5.3 Condoravdi's bare plurals

Having argued for an account of how generics behave when restricted, I will now look at some data presented by Cleo Condoravdi in her recent thesis (1994). She gives some sentences involving bare plurals which do not seem to be straight existential readings (*i.e.*, still mean the same if the bare plural is prefixed with 'some'), but which she argues are not generic. She therefore suggests there is a third reading of the bare plural.

Several of Condoravdi's arguments turn on issues raised already in this chapter, and I will apply my analysis of generics to her data. I will argue that in fact Condoravdi's examples are restricted generics, as discussed in section 5.2.1. I will also give evidence for this from my discussion of existential presuppositions, adverbial quantification and syntactic forms of generics from chapter one.

5.3.1 Condoravdi's data

Condoravdi discusses bare plurals, and as well as the generic and existential readings of the bare plural, discussed back in chapter one, she claims that there is another reading, which she calls the "functional reading". This is introduced with the following example; Condoravdi asks us to consider (5.38 a.) and three possible continuations, (5.38 b.)–(5.38 d.):

(5.38) a. In 1985 there was a ghost haunting the campus.

b. Students were aware of this fact/the danger.

c. The students were aware of this fact/the danger.

d. There were students who were aware of this fact/the danger.[7]

Condoravdi suggests that intuitively (5.38 b.) is synonymous with (5.38 c.), rather than (5.38 d.). (5.38 d.) is synonymous with the (less obvious) existential reading of (5.38 b.) — the intuitive reading of (5.38 b.) is not existential, *i.e.*, synonymous with (5.38 d.). But then she goes on to argue that it is not generic either. She claims:

> Although the bare plural receives a universal reading, (5.38 b.) is not generic in any obvious way; it does not express a non-accidental generalisation about students in general, nor a regularity about the occurrences of awareness in other situations in which a ghost was haunting the campus. (p. 69)

[7] Condoravdi (1994), p. 69.

She thus rejects the possibility that (5.38 b.) is generic because it is not lawlike. But if the intuitive reading of (5.38 b.) is not existential either, what is the intuitive reading?

Condoravdi suggests two possibilities: that (5.38 b.) is some kind of generic, despite the arguments above, or that it is not, and there is a third reading of the bare plural. She then presents detailed arguments that this cannot be a generic reading, which mainly concern contextual restrictions and presuppositions of existence, and therefore concludes that the second possibility is the correct one.

I will argue that, in fact, these readings *are* generic. I will draw on the claims I have already made about the existence of restricted generics, and the consequences for presuppositions of existence. These account for the "unusual" properties which Condoravdi notes and which lead her to suggest that (5.38 b.) is not generic.

5.3.2 Positive and negative contextual sensitivity

Two of the arguments which Condoravdi presents that (5.38 b.) is not generic concern contextual restrictions. She shows that her examples can be contextually restricted and moreover can be *implicitly* contextually restricted, by the same kind of restrictions that normal quantifiers accept. (5.38 b.) just means that students on the campus at the time were aware of the danger. Generics do not, on the whole, have this property, as I discussed in section 5.2.1. This is one of Condoravdi's reasons for concluding that (5.38 b.) is not generic.

Condoravdi makes two points about these restrictions. First, not any contextual restriction is possible. She calls this "negative contextual sensitivity". Second, if a contextual restriction is present (and in all the examples given by Condoravdi, one is) then it cannot be cancelled, like contextual restrictions on other indefinites.[8] She calls this "positive contextual sensitivity". Since she claims that contextual restrictions in general are not possible for generics, these form part of her description of the properties of her new reading.

Negative contextual sensitivity

Consider (5.39 a. and b.) and three possible continuations, (5.39 c.), (5.39 d.) and (5.39 e.):

[8]For example, I can say: 'The party was good. Some new students got drunk. They missed the party, which was a shame.' After the second sentence, the hearer assumes that 'some new students' is restricted to those at the party, but after the third, realises that this is not the case, as the restriction is cancelled.

(5.39) a. There is a ghost haunting the campus.

b. There are 500 students in this dormitory.

c. Students are aware of the danger.

d. The students are aware of the danger.

e. Every student is aware of the danger.[9]

Condoravdi argues that while (5.39 d.) and (5.39 e.) are able to pick up the narrower contextual restriction to students in the dormitory, (5.39 c.) still means the same as (5.38 b.); it is only restricted to students on the campus. This is "negative contextual sensitivity": the bare plural cannot pick up just any contextual restriction.

In order to defend the argument that (5.39 c.) is generic, we need to explain why it can pick up the restriction from (5.39 a.) but not from (5.39 b.). Earlier in the chapter, I gave a criterion for acceptability of contextual restrictions on generics based on whether or not the generic in question could be interpreted as a law of some description.

I want to argue, following on from my claims in section 5.2.1, that (5.39 c.) can pick up the restriction from a. but not b. as follows: while (5.39 c.) is not an obvious candidate for a lawlike sentence, it seems clear that it is more likely to be lawlike if we assume it is talking about the whole group of students in the dangerous situation, *i.e.*, those on the campus, rather than those in some particular group within this. If students in the dormitory were threatened further by the ghost in some way, then this might give us a reason to construe (5.39 c.) as particularly applicable to them. But in the absence of such information, (5.39 c.) makes more sense if it applies to the whole body of students on the campus. Thus, we explain why (5.39 c.) picks up the restriction from (5.39 a.) but not from (5.39 b.).

However, trying to give an example to demonstrate this is difficult. We might try:

(5.40) a. There is a ghost haunting the campus.

b. There are 500 students in this dormitory, which is highly liable to paranormal activity.

c. Students are aware of the danger.

This seems to make it very much easier to get 'students' in the last sentence to pick up the restriction to students in the dormitory, and hence supports my argument above. But it does not sound very natural.

The main problem that I have with (5.39) above is that the whole discourse is extremely unnatural. If we wanted to refer to students in the dormitory, we would not repeat 'students' in (5.39 c.), but would use the pronoun 'they'. Because 'students' is repeated, it makes us assume

[9]Condoravdi (1994), pp. 86–87.

that a wider class, students in general, is intended. This is again why (5.40) sounds odd; in (5.40 c.) it would be much more natural to say 'they are aware of the danger'.[10]

Condoravdi gives a second example to illustrate her point:

Context: We know that there is a ghost haunting the campus. We are standing in front of the library and we can both see several students.

(5.41) Students are afraid to enter the library.[11]

She notes that here again the bare plural 'students' cannot pick up the contextual restriction to the perceptually salient students, but is instead relativised to students on the campus. Again, my explanation is that it is more likely, without any extra information about these particular students, to be a counterfactual-supporting regularity that students on the campus are afraid to enter the library, than that these ones are. The campus is the smallest domain in which (5.41) is likely to be lawlike.

If this analysis of the examples is correct, then we should see the same patterns with 'all', as discussed in section 5.1.2. Pure 'all', like the bare plural, should not be able to pick up the restrictions, while 'all the' should be able to pick them up. Consider (5.39 a. and b.) again, with three possible continuations, (5.39 c.) again, and now (5.39 f.) and (5.39 g.):

(5.39)
a. There is a ghost haunting the campus.
b. There are 500 students in this dormitory.
c. Students are aware of the danger.
f. All students are aware of the danger.
g. All the students are aware of the danger.

As predicted, while (5.39 g.), like (5.39 e.), can pick up the restriction from (5.39 b.), (5.39 f.) does not. Like the bare plural it retains only the restriction to students on the campus. Again, consider (5.41) with two new alternatives:

Context: We know that there is a ghost haunting the campus. We are standing in front of the library and we can both see several students.

(5.41) Students are afraid to enter the library.

(5.42) All students are afraid to enter the library.

(5.43) All the students are afraid to enter the library.

[10] Thanks to Sheila Glasbey for pointing this out.

[11] Ibid., p. 87.

As predicted, while (5.43) can pick out just those students we can see in front of us (although it does not have to), (5.42) cannot.

Condoravdi claimed previously that examples such as (5.39 c.) are "not generic in any obvious way" and do not "express a non-accidental generalisation about students in general". I have shown earlier in the chapter that we can in certain circumstances see a generic reading for examples like this, and so Condoravdi's claim is just false. Moreover, I have already given an outline of a theory of why generics will accept certain restrictions and not others; Condoravdi's negative contextual sensitivity seems to exemplify it. If we have reason to construe a restricted generic as lawlike, we will. Otherwise, the restriction will fail, and the nearest available domain will be selected instead. This predicts why both (5.39 c.) and (5.41) fail to pick up the smaller restrictions, but why this is easier for (5.40 c.). This pattern is repeated with pure 'all' instead of the bare plural, while 'all the' picks up the restrictions. Hence my theory predicts Condoravdi's data and does not suggest that either (5.39 c.) or (5.41) fail to be generic.

Positive contextual sensitivity

Condoravdi argues that functional readings must be contextually restricted, that unlike other indefinites, cancelling the (implied) contextual restriction results in incoherence. This is positive contextual sensitivity. For example, she claims that the following discourse, where the last sentence cancels the contextual restriction, is contradictory:

(5.44)
a. In 1985 a ghost was haunting the campus.
b. Students were aware of the danger.
c. However, none of the students associated with the campus was aware of the danger.[12]

She compares this with the following example with a generic instead, which is felicitous:

(5.45)
a. A ghost is haunting the campus.
b. In general, students are aware of this kind of danger.
c. However, none of the students associated with the campus is aware of this kind of danger.[13]

In (5.45 b.) above, 'students' is generic, and since generics are (Condoravdi claims) never contextually restricted, 'students' is not restricted to students on the campus, so there is no problem when this is explicitly made clear in (5.45 c.). However, since there are supposedly problems with (5.44 c.), 'students' in (5.44 b.) must be contextually restricted to students on

[12]Condoravdi (1994), p. 84.
[13]Ibid., p. 84.

the campus, and so since generics will not accept contextual restrictions, 'students' in (5.44 b.) cannot be generic.

First of all, I will query Condoravdi's claim that the discourse in (5.44) is actually *contradictory*. This seems a rather strong claim. It certainly does not sound very natural, and one assumes after b. that 'students' is restricted to, or at least includes, the students on the campus. (However, it seems a lot more natural if one thinks of a multi-campus university — 'students' in (5.44 b.) refers to students at the university.) But it is, I claim, possible to reinterpret this in a similar way to (5.45), although, I concede, it is harder.

Second, Condoravdi is assuming that generics cannot be contextually restricted, and if this were true, then since the bare plural 'students' in (5.44) is clearly restricted, then this itself would establish that 'students' there was not generic. But I have argued previously that generics *can* be contextually restricted.

Third, it is not at all clear that the comparisons made between (5.44) and (5.45) above are comparing like with like. It is not just the bare plural which participates in genericity. Note the change in tense between the two examples, and also the change from 'the danger' to 'this kind of danger'. Instead compare (5.44) with the following:

(5.46) a. In 1985 a ghost was haunting the campus.

b. Most students were aware of the danger.

c. However, none of the students associated with the campus was aware of the danger.

(5.47) a. In 1985 a ghost was haunting the campus.

b. Students were typically aware of the danger.

c. However, none of the students associated with the campus was aware of the danger.

It seems almost as hard in the two examples above as in (5.44) to make the last sentence coherent. But perhaps this is because in the b. sentences we have already pinned down the context by talking about 'the danger', which is assumed to be the danger posed by the ghost on the campus.

Let us test this by replacing 'the danger' with the less specific 'the danger posed by ghosts', that is, by ghosts in general. Consider the following:

(5.48) a. In 1985 a ghost was haunting the campus.

b. Students were aware of the danger posed by ghosts.

c. However, none of the students associated with the campus was aware of the danger posed by ghosts.

Here, although one still initially assumes 'students' in (5.48 b.) refers to students on the campus, it is very much easier to reinterpret it after hearing (5.48 c.) to mean students in general.

So, to conclude, it seems that the positive contextual sensitivity is not a result of this kind of reading, but of tense and other contextually important features of the sentence, such as the restriction to a particular situation suggested by the definite article in the direct object 'the danger'. Thus positive contextual sensitivity is not an argument for these examples being other than generic.

5.3.3 Assertions and presuppositions of existence

As we saw in chapter one, generics and lawlike sentences in general are ambiguous between a reading in which they lack presuppositions of existence, and a reading in which they do carry such presuppositions.

However, Condoravdi, in common with many others in the literature, claims that generics in general do not presuppose existence, and so since her readings do seem to presuppose existence, she takes this as evidence they are not generic. She says:

> Unlike (5.38 d.), (5.38 b.) does not make an existential assertion but, like (5.38 c.), it is an assertion about the totality of the contextually relevant students, whose existence in the actual world seems to be presupposed by both (5.38 c.) and (5.38 b.). (p. 69)

Here Condoravdi says (5.38 b.) is behaving like a definite, or, in Strawson's terminology, like an empirical universally quantified sentence, in presupposing that there are students on the campus.

(5.49) a. In 1985 there was a ghost haunting the campus.

b. Students were aware of the danger.

c. Students with police connections were aware of the danger.

d. (But) there were no students (with police connections) on the campus in 1985.[14]

Condoravdi says about this example:

> Although the existence of individuals satisfying the description of the bare plural in (5.49 c.) cannot be taken for granted, (5.49 c.) certainly implies that there were actually students with police connections on the campus in 1985. Continuing the discourse ... with (5.49 d.) leads to a contradiction. If the generic interpretation were the only interpretation for (5.49 b.) and (5.49 c.), no implication of existence

[14] Condoravdi (1994), pp. 75–76.

> would be guaranteed since (5.49 b.) and (5.49 c.) could be true, and even entail the equivalent actual generalisation, even if no students with police connections actually existed on campus in 1985. (p. 76)

These examples are cases which we described in chapter one as individualised readings of lawlike universal sentences, which do carry presuppositions of existence. This is marked by their being in the past tense: as I noted in chapter one, this generally signifies an individualised reading, and so a presupposition of existence of members of the subject class *in the past*.

To summarise, the main properties that this reading has which are at odds with the properties of generics are the following: on this reading, bare plurals are synonymous with definites (as (5.38 b.) is synonymous with (5.38 c.) above) and therefore presuppose existence of members of the subject class.

5.3.4 Other arguments

Adverbial quantification

Another argument given by Condoravdi that these readings are not generic is that as I observed in chapter one, adverbial quantifiers such as 'usually', 'typically' and 'generally' may be added to generics without a radical change of meaning. Condoravdi gives some examples where this does not seem to be possible. For example:

(5.50) a. Rescue teams have rescued 28,950 victims.

b. ??Normally/??Typically rescue teams have rescued 28,950 victims.

(5.51) a. Details will be presented tomorrow.

b. ??Normally/??Typically details will be presented tomorrow.

(5.52) a. Prices went up today.

b. ??Normally/(?)Typically prices went up today.

Here, I have replaced Condoravdi's grammaticality judgements with my own. She thinks all of the above b. sentences are ungrammatical, whereas I suggest there are contexts where each of these might be possible, although they are not particularly easy-to-parse sentences. (5.50) is what I call a *collective generic*, because it refers to the collective action of rescue teams, rather than actions of individual rescue terms. The behaviour of collective generics is unusual in this and in other respects, and I will return to examples like this shortly. Let us consider (5.51) and (5.52) first.

Condoravdi points out that both these examples have existential readings: that some details will be presented, or some prices went up. They also have another reading, which is universal.

What does this reading mean? For (5.51), it means something like: the relevant details will be presented tomorrow. For (5.52), it means that prices generally went up today.

In section 1.4.4, where I discussed adding explicit adverbial quantifiers to generics, I noted that we should be clear about what it is that the adverbial quantifier ranges over; if it ranges over the individuals then it replaces the generic quantifier, but it may also range over something else: events or times, say, in which case, the sentence is still generic, with the same form, but the property predicated is one which contains an adverbial quantifier.

In the b. sentences above, the reason 'normally' and 'typically' sound bad is that it is much easier to interpret them as quantifying over events, and in conjunction with 'tomorrow' or 'today', this sounds bad. Both are interpreted as 'in normal/typical situations' or 'in the normal/typical run of things'. If 'tomorrow' is replaced by 'the next day' and 'today' by 'the same day', these sentences read much better:

(5.51) c. Normally/Typically details will be presented the next day.

(5.52) c. Normally/Typically prices went up the same day.

But this of course does not answer Condoravdi's point, that (5.51) and (5.52) cannot accept adverbial quantifiers over details and prices, and that therefore they are not generic.

Why do we not get readings where 'normally' and 'typically' range over the individuals? With (5.51), it is because 'details' is in this context essentially plural. A detail being presented tomorrow does not make very much sense. So a typical or normal detail does not make much sense either. We have not discussed how to handle examples like this within the framework I have presented, although it seems likely that a simple modification will suffice. However, rephrasing (5.51), we can approximate to what the generic reading would be: non-exceptional details with respect to being presented tomorrow will be presented tomorrow, which is something like: 'relevant details will be presented tomorrow'. This is a case where what the details are typical or normal with respect to is really important: there is no one set of typical or normal details.

With (5.52), things are easier. It is actually just about possible to get a reading of (5.52 b.) where the adverbial quantifier quantifies over 'prices'. This is possible if you think of a typical price and what happened to it. Again, it is hard to imagine what normal prices would be without the restriction to the predicate, but this example works much better with 'generally': 'a general price went up today' or 'generally prices went up today' is basically fine.

Hence Condoravdi's argument that these examples are not generic because of their refusal to accept adverbial quantifiers is inadequate.

Returning to the issue of collective generics, here are some examples (the first two are from Condoravdi):

(5.50) Rescue teams have rescued 28,950 victims.

(5.53) Although the odds still seem to favour Senate approval of Thomas, *opponents* redoubled their effort and tried to delay a floor vote on confirmation... *Proponents*, in contrast, demanded a vote next week. (*San Francisco Chronicle*, Sept. 28, 1991)

(5.54) Students owe £50 million to the big four banks.

(5.55) Students buy 50 million books every year.

(In (5.53), the italicised bare plurals are the ones in question.) In all of these examples, a collective action is reported. There is no sense in which we can reduce these examples to conjunctions (even infinitely long ones) about individuals. Since these examples cannot be reduced to statements about individuals, they are not of the same form as the kinds of examples we have been considering previously. We cannot analyse them as quantified conditionals, from chapter four:

(4.27) $\circledast\forall x[(F(x)\&N_{F,G}(x)) \rightarrow G(x)]$

since individual Fs do not have the property G. Note that this is different from (5.51) where 'details' is in this context essentially plural. Particular details will be presented, but it doesn't make much sense to say of a particular detail that it will be presented. The distinction in this example is that it is not that the individual details do not *have* the property, but that it is semantically awkward to say that they do.

As far as I know, there has been no work on collective generics. Work on an analysis of them will have to draw on the huge literature on plurality and the distributive/collective distinction, which I do not have the space to go into here. However, I will point out a few of the properties which collective generics seem to have.

First, the exception-tolerating property of generics manifests itself in collective generics in that not every individual referred to by the bare plural need be involved in the collective action. For example, in (5.55) there may be students who buy no books, but it is still true that students between them buy 50 million books every year.[15]

Second, the intensional aspect of the generic does not manifest itself in the truth-value of the generic, but in the inferences we can make from it about individual students. We cannot necessarily predict the truth-value of (5.55) from the book-buying behaviour of individual

[15] In fact, this would be consistent with most students buying no books. Sheila Glasbey suggested the following example:

> Students typically do not buy books but borrow them from libraries. However, the few that do buy books buy lots of them. In fact, students buy 50 million books every year.

In this case, we only have exceptional students with respect to buying books participating in the collective action. This suggests that collective generics are really not generic, but some kind of collective or summing sentence.

students. All we know is that if a student is non-exceptional with respect to buying books, the implication is that he or she will take part in the buying of the 50 million books (but see footnote 15). But this generic could be true whether there were 50 million students who bought one book each, or 50 students who bought a million books each. This makes collective generics look much less like ordinary generics; in fact, perhaps they are not actually generics at all.

Third, because of the fact that the collective property does not hold of the individuals, we cannot replace the generic quantifier with an adverbial quantifier over individuals, since the generic quantifier, if here at all, does not quantify over individuals. This is why we cannot add 'normally', 'typically', 'usually' or 'generally' to collective generics and preserve meaning: the original meaning is not that non-exceptional Fs have the property G, so we cannot add 'typically' and get 'typical Fs have the property G'.

Whether collective generics are actually generic, or whether they represent a new reading of the bare plural, is not wholly clear. They seem to share some properties of generics, but any current analysis of generics will have to be modified to deal with them. If they are not generic, then perhaps they are a new reading of the bare plural. However, this would be a rather weaker claim than the one Condoravdi is proposing, since collective generics are a much smaller class than the kinds of examples she gives, and do not include examples such as (5.38). They certainly do not have the universal force she claims for (5.38): none except perhaps (5.53) of the examples above are synonymous with a sentence where a definite description replaces the bare plural. It is not clear whether this is really a new reading, or whether it results from the interaction of features of the bare plural with the collective/distributive distinction, which is not yet completely understood.

Kinds of indefinites

Condoravdi claims that her readings can only arise with the bare plural and not with other indefinites ('a', 'some'). Since the generic reading can occur with either the bare plural or the indefinite article, she takes this to be an argument that her readings are not generic. For example, we cannot get anything except an existential reading for 'a student' below:

(5.56) a. In 1985 there was a ghost haunting the campus.

b. A student was aware of the danger.[16]

We saw in chapter one that generics do vary in the acceptability of their various forms. Some generics which are fine with the bare plural are bad with the indefinite article. In particular, we looked at some arguments from Lawler (1973) which suggested that indefinite article generics were only acceptable when the property predicated of the generic subject was

[16] Condoravdi (1994), p. 92.

an identifying or defining property. While I did not completely agree with Lawler's claims, I concluded that indefinite article generics were harder to get with such properties.

In particular, we should note that Lawler points out that generics with modifiers, or explicitly restricted generics, and also past tense generics, are much less common with the indefinite article. Since Condoravdi's readings are generally contextually restricted, and often in the past tense, this ties in with Lawler's observation.

Condoravdi's claim here that her readings are unlikely to be generic, because they cannot arise with the indefinite article, cannot be taken as good evidence for this, given the little-understood constraints on when indefinite article generics are acceptable.

5.3.5 Degenerate genericity

A suggestion made, but later rejected by Condoravdi, to explain the readings given in this section, is that they arise from what she calls "degenerate genericity", defined as follows:

> Degenerate genericity is the case when a generic generalisation reduces to an actual generalisation. It will arise from an extensionalised generic operator, that is a generic operator with a trivial modal dimension. In that case, quantification is vacuous with respect to worlds and the generic operator ends up quantifying only over individuals. Once we have a degenerate generic generalisation, the corresponding actual generalisation is not just entailed by the generic generalisation but it coincides with it. Degenerate genericity should thus be an option allowed by the semantics, with the pragmatics determining when it arises. (p. 136)

While it would be possible to analyse this on my account by taking $N_{F,G}$ to be the subset of actual Fs which are non-exceptional with respect to being G, is this desirable? Of course, it might be the case that for some generic the worlds quantified over by $\boxast$ would just coincide with (and only with) the actual world, but this is not the same as contextually (or pragmatically) restricting $\boxast$ to quantify over only the actual world.

As Condoravdi acknowledges, degenerate genericity would be a puzzling phenomenon. It is not always available: as we have observed, accidental generalisations such as 'students in my class are right-handed' cannot be interpreted as generics. But if degenerate genericity were an option, there would appear to be a reading on which this sentence is true.

That the modal or counterfactual-supporting property of generics is essential is something which I have argued for from the start of this thesis. The putative phenomenon of degenerate genericity rejects this, suggesting that there may be cases where it does not occur. As we have seen, Condoravdi's examples *are* modal in some sense and are not equivalent to extensional generalisations.

Hence we should also reject degenerate genericity as a contradiction in terms. Generics are never read simply as extensional generalisations.

5.3.6 Summary

To summarise, Condoravdi has presented four main arguments that her so-called "functional reading" of the bare plural is a new third reading, and not a form of the generic reading. These were the arguments from context sensitivity, the argument about presuppositions of existence, the arguments about adverbial quantification and the argument about syntactic forms.

I have shown that each of these arguments fails, and that we may interpret her examples as restricted generics. This subsumes her examples under a much more general and widely-studied phenomenon, and removes the need for a new analysis of bare plurals. My theory can account for her data much more simply.

5.4 Conclusions

I began this chapter by pointing out the differences between 'all' and 'all (of) the' which have previously not been explored in the philosophical literature. Pure 'all' has an intensional element and sentences in which it occurs express lawlike propositions. I noted that such sentences share many properties with generics.

As we saw in chapter four, generic restrictions are determined independently of context. But generics may be restricted in a sense — by creating a new generic which expresses a new nomic regularity. I have shown that when sentences which express nomic regularities are restricted, they become non-lawlike unless we can reconstruct them as expressing a new law about the restricted situation. Basically, then, I conclude that what is going on when generics are "restricted" is that either they cease to be generic, or they are reinterpreted as expressing a new and different nomic regularity. Thus, in a sense, generics cannot be restricted, since restriction creates a new generic. These "restrictions" are again, unlike restrictions which apply to other quantifiers.

This is an important discovery, since it clears up the confusion surrounding restricted generics, which has led to complex analyses, such as Condoravdi's, being proposed to solve a non-existent problem — that of the features of a certain kind of restricted generic, which since it is restricted "could not be generic". My theory can account for Condoravdi's data much more simply and intuitively. Moreover, it has implications for the philosophy of science, since it shows exactly when the concept of a restricted law is comprehensible, and what needs to happen in order for one to exist.

Chapter Six

Conclusions

In this thesis I have attempted to show the wide applicability within philosophy of the phenomenon of genericity. Not only are there exciting implications for philosophy of language in developing a semantics for these kinds of sentences, but also the concept of a nomic regularity illuminates some long-standing problems in the philosophy of science.

Generics have been neglected by philosophers, and treated as a special case of some other phenomenon (such as universally quantified sentences), as if their properties were nothing special to worry about. The regularities they express have also been subsumed under other phenomena — sometimes as sub-standard laws of nature, sometimes as rules or conventions, whose semantics is not well understood. This piecemeal approach misses important insights into a fundamental phenomenon of language — our ability to generalise and idealise at the same time, which involves considering how the world might be, as well as how it is.

I have argued that this kind of piecemeal approach gets things the wrong way around, and that in order to fully appreciate the properties of generics and of nomic regularities, we need to take them as unified classes in their own right and in some cases, to analyse other concepts in terms of them.

Generics express the basic class of nomic regularity. I have shown that this is an important class, both for philosophy of science, and for philosophy of logic and language. In the philosophy of science, nomic regularities occur in physics, biology, the social sciences, and in what one might call the science of everyday life. I have shown that laws of nature are best analysed as a special case of nomic regularity, rather than the other way around.

There is a large recent literature in the philosophy of science on *ceteris paribus* "laws", since the connections between the Special Sciences and more "basic" sciences have great conceptual importance.[1] I consider it to be of vital importance to establish that *ceteris paribus* "laws" are non-vacuous, because, as Nancy Cartwright puts it, we don't have much else. Strict laws are not generally available to us. Yet categorisation and ability to subsume phenomena under a general principle are the backbone of our reasoning abilities. This is summed up nicely in a quotation from Whitehead (1933):

[1]This is particularly true in the currently popular area of the philosophy of mind.

> The notion of Law, that is to say, of some measure of regularity or of persistence or of recurrence, is an essential element in the urge towards technology, methodology, scholarship and speculation. Apart from a certain smoothness in the nature of things, there can be no knowledge, no useful method, no intelligent purpose. Lacking an element of Law, there remains a mere welter of details with no foothold for comparison with any other such welter, in the past, in the future, or circumambient in the present. (p. 139)

Moreover, empirical enquiry is not restricted to the sciences; we need principles in order to be able to function in the world at all.

My analysis of the semantics of generics shows that we can understand *ceteris paribus* "laws" by distinguishing between exceptions and counterexamples to generics. There is a semantic mechanism which generates the exception-set we need to consider, and which restricts the domain of quantification accordingly. I have presented a formalisation of my analysis and shown how it applies to a variety of generic sentences.

Moreover, further applications of my analysis to "restricted" generics shows that if we try to restrict a nomic regularity, we are forced to re-calculate the exception-set, and reinterpret the regularity as it applies in the new situation. This is a particularly important insight. While it is commonly acknowledged that generics do have an intensional or modal aspect, any analysis which fails to fully realise how this modal aspect functions in our life, scientific or otherwise, cannot fully account for the semantics of generics. Thus accounts of generics in terms of contextual restrictions cannot capture what is essential about them, which is that we are interpreting the world around us in terms of regularities. We do not do this by pragmatic or contextual features of discourse, but by expressing ourselves intensionally, using language to talk about how the world might be.

I hope that this thesis will contribute to linguistics in clarifying some important issues by clearly and accurately characterising some linguistic phenomena which were greatly in need of this. I hope it will contribute to philosophy not only by presenting a new defence of *ceteris paribus* "laws", but also for reinterpreting the traditional old philosophical concept of a law of nature, rehabilitating it from its verificationist past and metaphysically dubious more recent past, and putting it where it belongs at the centre of our investigations of and reasoning about the world around us.

Appendix A

A Formalisation of the Semantics of Generics

A.1 Syntax

Let $\mathcal{L}_{\boxast}$ be the extension of the language $\mathcal{L}$ of first order logic defined as follows:

(A.1) If F and G are predicates of $\mathcal{L}$ then $N_{F,G}$ is a predicate of $\mathcal{L}_{\boxast}$.

(A.2) If ϕ is a formula of $\mathcal{L}_{\boxast}$ of the form $\forall x[(F(x)\&N_{F,G}(x)) \rightarrow G(x)]$ then $\boxast\phi$ is a formula of $\mathcal{L}_{\boxast}$.

A.2 Semantics

A model M for the language $\mathcal{L}_{\boxast}$ is a triple $\langle W, D, V\rangle$ where

(A.3) W is a nonempty set of worlds

(A.4) D is a function which maps each world $w \in W$ to its domain D_w

(A.5) V is a function which maps non-logical constants to their denotations.

V and D satisfy the usual constraints concerning names, predicates of $\mathcal{L}$ and logical connectives and quantifiers, with the addition of:

(A.6) $V(N_{F,G}, w) = V(N_{F,\neg G}, w)$ for any predicates F and G and world w

(A.7) If $V(F, w) \neq \emptyset$ then $V(N_{F,G}, w) \neq \emptyset$, for all predicates F and worlds w

(A.8) If $V(F_1, w) = V(F_2, w)$ for every world w, then $V(N_{F_1,G}, w) = V(N_{F_2,G}, w)$ for every world w and every predicate G. Similarly, if $V(G_1, w) = V(G_2, w)$ for every world w, then $V(N_{F,G_1}, w) = V(N_{F,G_2}, w)$ for every world w and every predicate F.

Define equivalence relations $\sim_{F,G}$ such that for worlds $w_1, w_2 \in W$:

(A.9) $w_1 \sim_{F,G} w_2 \Leftrightarrow_{\text{df}} V(N_{F,G}, w_1) = V(N_{F,G}, w_2)$.

The truth value of a formula ϕ, with respect to a model $M = \langle W, D, V \rangle$ and a world $w \in W$, written $[\![\phi]\!]^{M,w}$, is defined as follows:

(A.10) $[\![P^n(a_1, a_2, \ldots, a_n)]\!]^{M,w} = T$ iff $\langle V(a_1, w), V(a_2, w), \ldots, V(a_n, w) \rangle \in V(P^n, w)$

(A.11) truth functional connectives and quantifiers are standard

(A.12) $[\![\circledast \forall x[(F(x) \& N_{F,G}(x)) \rightarrow G(x)]]\!]^{M,w} = \text{T}$ iff for every $w' \in W$, if $w \sim_{F,G} w'$ then $[\![\forall x[(F(x) \& N_{F,G}(x)) \rightarrow G(x)]]\!]^{M,w'} = \text{T}$.

Appendix B

A Compositional Formalisation

We may also formalise the semantics of generics in a strongly compositional semantics. While the approach given in the previous appendix is, of course, compositional, in the sense that the meaning of the whole is given by, and only by, the meanings of the parts and their manner of combination, there is no correspondence between distinct constituents of the formalisation and the constituents of the sentence analysed.

This means that there is a great difference between the way a simple subject-predicate sentence such as 'John walks' and a quantified sentence such as 'Every man walks' are represented. While the former is represented as of subject-predicate form, the latter has no constituent corresponding to the subject.

A formalisation such as Montague Grammar (see, for example, Dowty *et al.*, 1981) allows quantified noun phrases to be represented as of subject-predicate form, by using lambda abstraction to create a representation of each constituent, so that as in the sentence 'Every man walks' the constituent for 'every', the constituent for 'man' and the constituent for 'walks' are concatenated to give the representation for the whole sentence.

Below I give a formalisation of the semantics of generics, and of the universal quantifier 'all' in the style of Larson and Segal (1995), a recent compositional formalisation which has the advantage of closely connecting semantics to syntax.

B.1 A strongly compositional semantics

B.1.1 Larson and Segal's theory GQ

Larson and Segal (1995) provide a strongly compositional semantics for a fragment of English. They analyse a simple quantified sentence, such as 'Every man ponders' as having the syntactic structure

$$[_S[_{NP_1}[_{Det}\text{Every}][_{N'}[_N\text{man}]]][_S[_{NP_1}e][_{VP}[_V\text{ponders}]]]]$$

which can be represented by the following tree diagram (p. 277):

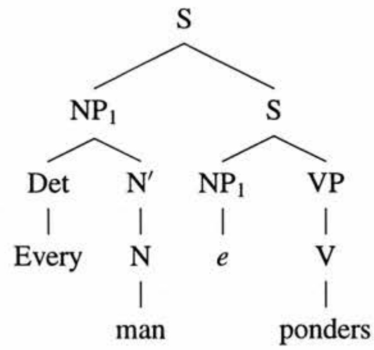


Figure B.1: The LF syntax of 'Every man ponders'

They formulate various rules which allow the derivation of the truth-conditions of sentences represented in this way. Below is their theory GQ, which uses the framework of generalised quantifier theory (taken from pp. 310–312):

Lexical Axioms

(B.1) a. Val $(x, \textit{Kate}, \sigma)$ iff x = Kate

b. Val $(x, \textit{Chris}, \sigma)$ iff x = Chris

c. Val $(x, \textit{Phil}, \sigma)$ iff x = Phil

d. Val $(x, \textit{Jill}, \sigma)$ iff x = Jill

(B.2) a. Val$(x, \textit{man}, \sigma)$ iff x is a man

b. Val$(x, \textit{woman}, \sigma)$ iff x is a woman

c. Val$(x, \textit{fish}, \sigma)$ iff x is a fish

(B.3) a. Val$(x, \textit{ponders}, \sigma)$ iff x ponders

b. Val$(x, \textit{agrees}, \sigma)$ iff x agrees

c. Val$(x, \textit{protests}, \sigma)$ iff x protests

(B.4) a. Val$(\langle x, y\rangle, \textit{knows}, \sigma)$ iff x knows y

b. Val$(\langle x, y\rangle, \textit{admires}, \sigma)$ iff x admires y

c. Val$(\langle x, y\rangle, \textit{instructs}, \sigma)$ iff x instructs y

(B.5) a. $\text{Val}(\langle X, Y\rangle, \textit{every}, \sigma)$ iff $|Y - X| = 0$

b. $\text{Val}(\langle X, Y\rangle, \textit{some}, \sigma)$ iff $|Y \cap X| > 0$

c. $\text{Val}(\langle X, Y\rangle, \textit{no}, \sigma)$ iff $|Y \cap X| = 0$

d. $\text{Val}(\langle X, Y\rangle, \textit{most}, \sigma)$ iff $|Y \cap X| > |Y - X|$

e. $\text{Val}(\langle X, Y\rangle, \textit{two}, \sigma)$ iff $|Y \cap X| = 2$
(And similarly for the other numeral determiners.)

f. $\text{Val}(\langle X, Y\rangle, \textit{the two}, \sigma)$ iff $|Y - X| = 0$ and $|Y| = 2$

g. $\text{Val}(\langle X, Y\rangle, \textit{both}, \sigma)$ iff $\text{Val}(\langle X, Y\rangle, \textit{the two}, \sigma)$

h. $\text{Val}(\langle X, Y\rangle, \textit{neither}, \sigma)$ iff $|Y \cap X| = 0$ and $|Y| = 2$

i. $\text{Val}(\langle X, Y\rangle, \textit{the}, \sigma)$ iff $\text{Val}(\langle X, Y\rangle, \textit{the one}, \sigma)$

Phrasal Axioms

(B.6) a. Val(t, [$_S$ S$_1$ *and* S$_2$], σ) iff both Val(t, S$_1$, σ) and Val(t, S$_2$, σ)

b. Val(t, [$_S$ S$_1$ *or* S$_2$], σ) iff either Val(t, S$_1$, σ) or Val(t, S$_2$, σ)

c. Val(t, [$_S$ *It is not the case that* S], σ) iff it is not the case that Val(t, S, σ)

(B.7) a. Val(t, [$_S$ NP VP], σ) iff for some x, Val(x, NP, σ) and Val(x, VP, σ)

b. Val(x, [$_{VP}$ V NP], σ) iff for some y, Val($\langle x, y\rangle$, V, σ) and Val(y, NP, σ)

c. Val(x, [$_X Y$], σ) iff Val(x, Y, σ) (where X, Y are any nodes)

(B.8) a. Val(X, [$_{NP}$ Det N′], σ) iff for some Y, Val($\langle X, Y\rangle$, Det, σ) and
$Y = \{y : \text{Val}(y, \text{N}', \sigma)\}$

b. Val(x, [$_{NP_i}$ e], σ) iff $x = \sigma(i)$ for $i \geq 1$

c. Val (t, [$_S$ NP$_i$ S], σ) iff for some X, Val(X, NP, σ) and
$X = \{\sigma'(i) : \text{Val(t, S}, \sigma'), \text{for some } \sigma' \approx_i \sigma\}$

Production Rules

(UI) Universal Instantiation

$$\frac{\text{For any } x,\ F(x)}{F(\alpha)}$$

(SE) Substitution of equivalents

$$\frac{F(\alpha) \qquad \alpha \text{ iff } \beta}{F(\beta)}$$

(SI) Substitution of identicals

$$\frac{\phi \text{ iff } F(\alpha) \text{ and } \alpha = \beta}{\phi \text{ iff } F(\beta)}$$

Definition For any positive integer i, $\sigma(i)$ is the ith element of σ.

Definition For any sequences σ, σ', $\sigma \approx_i \sigma'$ iff σ' differs from σ at most at $\sigma'(i)$.

A sample derivation

A sample derivation of the truth-conditions of the sentence 'every man ponders' can be found on pp. 277-278 of Larson and Segal (1995).

B.1.2 Generics in GQ

Assume that there is an (unpronounced) generic operator, Gen, functioning syntactically as a determiner or quantifier. (We will come back shortly to its syntactic category.)

Generalised quantifiers are relations between sets. "Intensional" quantifiers, like the generic operator, are series of relations between sets, in that they hold when a GQ relation holds at each of a series of possible worlds.

To formalise this, let us associate with each predicate a set of pairs of a world and the extension of the predicate at that world. So with a prediate F, we associate $\{\langle F_w, w\rangle : w \in W\}$, where F_w is the extension of F at w, and W is the set of possible worlds. For short, we refer to the series $\{F_w\}$.

Larson and Segal suggest a modification to the theory GQ which allows reference to possible worlds, to deal with the modal operators 'necessarily' and 'possibly' (p. 429). This approach is adopted, and the rules are modified accordingly.

The lexical axioms for names remain the same, but we must modify the rules for nominals and verbs to denote pairs (triples, *etc.*) of objects (or pairs, *etc.* of objects) and worlds. The rules for the quantifiers are modified to make all quantifiers relations between properties rather than sets, although with "extensional" quantifiers, only the extension at the world of evaluation is taken into account in calculating the semantic value.

The phrasal axioms for connectives ('and', 'or', and 'not') remain the same, but the other phrasal axioms must be modified to take account of the new denotations.

The production rules and definitions remain the same, with the addition of a definition of the equivalence relation $\sim_{F,G}$ from appendix A, (A.9).

Lexical Axioms

(B.1) a. proper names as before

(B.2′) a. Val($\langle x, v\rangle$, *man*, σ, w) iff x is a man at v, some $v \in W$

b. Val($\langle x, v\rangle$, *woman*, σ, w) iff x is a woman at v, some $v \in W$

c. Val($\langle x, v\rangle$, *fish*, σ, w) iff x is a fish at v, some $v \in W$

(B.3′) a. Val($\langle x, v\rangle$, *ponders*, σ, w) iff x ponders at v, some $v \in W$

b. *etc.* for other intransitive verbs

(B.4′) a. Val($\langle x, y, v\rangle$, *knows*, σ, w) iff x knows y at v, some $v \in W$

b. *etc.* for other transitive verbs[1]

(B.5′) a. Val($\langle\{X_j\}, \{Y_j\}\rangle$, *every*, σ, w) iff $|Y_w - X_w| = 0$

b. *etc.* for the other (extensional) quantifiers

j. Val($\langle\{X_j\}, \{Y_j\}\rangle$, *Gen*, σ, w) iff
$|\{y \in Y_v : y \text{ is a non-exceptional } Y_j \text{ wrt } X_j\} - X_v| = 0$ for all v such that $w \sim_{Y_j, X_j} v$

Phrasal Axioms

(B.6) a. and, or, not as before

(B.7′) a. Val(t, $[_S$ NP VP$]$, σ, w) iff for some x, Val(x, NP, σ, w) and Val($\langle x, w\rangle$, VP, σ, w)

b. Val($\langle x, v\rangle$, $[_{VP}$ V NP$]$, σ, w) iff for some y, Val($\langle x, y, v\rangle$, V, σ, w) and Val(y, NP, σ, w)

c. Val(x, $[_X Y]$, σ, w) iff Val(x, Y, σ, w) (where X, Y are any nodes)

(B.8′) a. Val($\{X_j\}$, $[_{NP}$ Det N′$]$, σ, w) iff Val($\langle\{X_j\}, \{Y_j\}\rangle$, Det, σ, w) and $\{Y_j\} = \{Y_v : y \in Y_v \text{ iff Val}(\langle y, v\rangle, \text{N}', \sigma, w)\}$

b. Val(x, $[_{NP_i} e]$, σ, w) iff $x = \sigma(i)$ for $i \geq 1$

c. Val (t, $[_S$ NP$_i$ S$]$, σ, w) iff for some $\{X_j\}$, Val($\{X_j\}$, NP, σ, w) and $\{X_j\} = \{\{\sigma'(i) : \text{Val(t, S}, \sigma', j)\text{, some } \sigma' \approx_i \sigma\}\}$

[1]The above three sets of rules for nominals, transitive and intransitive verbs presuppose a univeral accessibility relation, but we may, of course, restrict the accessibility relation by the choice of v allowed here.

Definition For any $w_1, w_2 \in W$, $w_1 \sim_{F,G} w_2$ iff
$\{y \in F_{w_1} : y \text{ is a non-exceptional } F \text{ wrt } G\} = \{y \in F_{w_2} : y \text{ is a non-exceptional } F \text{ wrt } G\}$

A sample derivation

We may use this modified framework to derive the truth-conditions of the sentence 'men ponder'.

This sentence has the LF syntax

$$[_S[_{NP_1}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$$

shown in the following tree diagram:

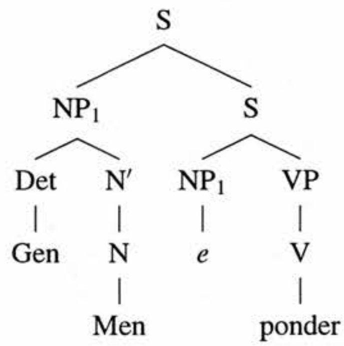


Figure B.2: The LF syntax of 'Men ponder'

- Val (t, $[_S[_{NP_1}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff for some $\{X_j\}$, Val($\{X_j\}$, $[_{NP}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]]$, σ, w) and $\{X_j\} = \{\{\sigma'(1) : \text{Val(t, } [_S[_{NP_1}e][_{VP}[_V\text{ponder}]]], \sigma', j), \text{ some } \sigma' \approx_1 \sigma\}\}$, by (B.8′c.), (UI).
  - Val($\{X_j\}$, $[_{NP}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]]$, σ, w) iff Val($\langle\{X_j\}, \{Y_j\}\rangle$, $[_{Det}\text{Gen}]$, σ, w) and $\{Y_j\} = \{Y_v : y \in Y_v \text{ iff Val}(\langle y, v\rangle, [_{N'}[_N\text{Men}]], \sigma, w)\}$, by (B.8′a.), (UI).
    - Val($\langle\{X_j\}, \{Y_j\}\rangle$, $[_{Det}\text{Gen}]$, σ, w) iff Val($\langle\{X_j\}, \{Y_j\}\rangle$, *Gen*, σ, w) by (B.7′c.), (UI).
    - Val($\langle\{X_j\}, \{Y_j\}\rangle$, *Gen*, σ, w) iff $|\{y \in Y_u : y \text{ is a non-exceptional } Y_j \text{ wrt } X_j\} - X_u| = 0$ for all u such that $w \sim_{Y_j, X_j} u$, by (B.5j.).
    - Val($\langle\{X_j\}, \{Y_j\}\rangle$, $[_{Det}\text{Gen}]$, σ, w) iff $|\{y \in Y_u : y \text{ is a non-exceptional } Y_j \text{ wrt } X_j\} - X_u| = 0$ for all u such that $w \sim_{Y_j, X_j} u$, by above two lines, (SE).
    - Val($\langle y, v\rangle$, $[_{N'}[_N\text{Men}]]$, σ, w) iff Val($\langle y, v\rangle$, *man*, σ, w) by (B.7′c.), (UI).
    - Val($\langle y, v\rangle$, *man*, σ, w) iff y is a man at v, some $v \in W$, by (B.2′a.).

  - * Val($\langle y, v\rangle$, $[_{N'}[_N\text{Men}]]$, σ, w) iff y is a man at v, some $v \in W$, by above two lines, (SE).
    * Val($\{X_j\}$, $[_{NP}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]]$, σ, w) iff $|\{y \in Y_u : y$ is a non-exceptional Y_j wrt $X_j\} - X_u| = 0$ for all u such that $w \sim_{Y_j, X_j} u$, and $\{Y_j\} = \{Y_v : y \in Y_v$ iff y is a man at v, some $v \in W\}$, by previous lines, (SE).
    * Val($\{X_j\}$, $[_{NP}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]]$, σ, w) iff $|\{y : y$ is a man at u and y is a non-exceptional man wrt $X_j\} - X_u| = 0$ for all u such that $w \sim_{\text{man}, X_j} u$, by the previous line, (SI).[2]
  - Val(t, $[_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]$, σ', v) iff for some x, Val(x, $[_{NP_1}e]$, σ', v) and Val($\langle x, v\rangle$, $[_{VP}[_V\text{ponder}]]$, σ', v), by (B.7′a.), (UI).
    * Val(x, $[_{NP_1}e]$, σ', v) iff $x = \sigma'(1)$, by (B.8b.), (UI).
    * Val($\langle x, v\rangle$, $[_{VP}[_V\text{ponder}]]$, σ', v) iff Val($\langle x, v\rangle$, *ponders*, σ', v), by (B.7′c.), (UI).
    * Val($\langle x, v\rangle$, *ponders*, σ', v) iff x ponders at v, by (B.3′a.).
    * Val($\langle x, v\rangle$, $[_{VP}[_V\text{ponder}]]$, σ', v) iff x ponders at v, by above two lines, (SE).
    * Val(t, $[_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]$, σ', v) iff for some x, $x = \sigma'(1)$ and x ponders at v, by previous lines, (SE).
    * Val(t, $[_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]$, σ', v) iff $\sigma'(1)$ ponders at v, by previous line, (SI).
  - Val (t, $[_S[_{NP_1}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff for some $\{X_j\}$, $|\{y : y$ is a man at u and y is a non-exceptional man wrt $X_j\} - X_u| = 0$ for all u such that $w \sim_{\text{man}, X_j} u$, and $\{X_j\} = \{\{\sigma'(1) : \sigma'(1)$ ponders at v, some $\sigma' \approx_1 \sigma\}\}$, by previous lines, (SE).
  - Val (t, $[_S[_{NP_1}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff $|\{y : y$ is a man at u and y is a non-exceptional man wrt pondering $\} - \{y : y$ ponders at $u\}| = 0$ for all u such that $w \sim_{\text{man,ponders}} u$, by previous line, (SI).[3]

- This is equivalent to the truth-conditions given in appendix A, since Val (t, $[_S[_{NP_1}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff the set of men non-exceptional wrt pondering is a subset of the set of ponderers at every world u such that $w \sim_{\text{man,ponders}} u$, or in other words, iff at each such world, every man non-exceptional wrt pondering ponders.

[2]The fact that $\{Y_j\} = \{Y_v : y \in Y_v$ iff y is a man at v, some $v \in W\}$ tells us that $\{Y_j\}$ is the property of being a man, and $Y_u = \{y : y$ is a man at $u\}$.

[3]$\{\sigma'(1) : \sigma'(1)$ ponders at v, some $\sigma' \approx_1 \sigma\}$ is the set $\{x : x$ ponders at $v\}$, so $\{\{\sigma'(1) : \sigma'(1)$ ponders at v, some $\sigma' \approx_1 \sigma\}\}$ is the property of pondering.

B.1.3 Intensional quantifiers

How should we incorporate intensional quantifiers like 'all' into the above framework? Recall that 'all' behaves intensionally with a nominal expression, but extensionally with a partitive. In fact, intensional quantifiers like 'all' will function on whatever their arguments are. If their arguments are intensional (for example, a nominal expression), they will behave intensionally. If their arguments are extensional, in that they only take the values of extensions into account (for example, as in the NP involved in a partitive construction), they will behave extensionally.

To incorporate these constructions, we need to add a rule for 'all' and a rule for the partitive construction. We also need to add a rule for 'the' in the plural, since the rule given in GQ was for the singular definite descriptions. Since this would require a formalisation of a logic of plurality, which is beyond the scope of this thesis, I will assume for now that 'the' is always elliptical for 'the n', where n is some numeral.

We then add the following lexical axioms for 'all' and 'the':

(B.5″) i. Val($\langle\{X_j\}, \{Y_j\}\rangle$, *the (n)*, σ, w) iff $|Y_w - X_w| = 0$ and $|Y| = n$

k. Val($\langle\{X_j\}, \{Y_j\}\rangle$, *all*, σ, w) iff $|Y_v - X_v| = 0$ for all v such that $w \sim_{Y_j, X_j} v$

The phrasal axioms must be modified to include a new rule for partitives, and to modify the [Det N′] rule. There are now two clauses in the [Det N′] rule: one for when N′ denotes a set (as with the partitive construction), and one for where N′ denotes a property (as with a nominal). Which clause is satisfied depends on the kinds of semantic values the N′ involved can take, that is, whether its semantic values are properties or sets.

(B.8″) a. Val($\{X_j\}$, [$_{\text{NP}}$ Det N′], σ, w) iff Val($\langle\{X_j\}, \{Y_j\}\rangle$, Det, σ, w) and **either** $\{Y_j\} = \{Y_v : y \in Y_v$ iff Val($\langle y, v\rangle$, N′, σ, w)$\}$ **or** Val(Y_w, N′, σ, w)

d. Val(Z, [$_{N'}$ of NP], σ, w) iff $Z = \bigcap\{X_w$: Val($\{X_j\}$, NP, σ, w)$\}$ where NP is a proper principal filter[4]

Sample derivations

I will now provide a sample derivation for both 'All men ponder' and 'All of the men ponder', to demonstrate the modified rules.

'All men ponder' has the LF syntax

$$[_{\text{S}}[_{\text{NP}_1}[_{\text{Det}}\text{All}][_{\text{N}'}[_{\text{N}}\text{men}]]][_{\text{S}}[_{\text{NP}_1}e][_{\text{VP}}[_{\text{V}}\text{ponder}]]]]$$

[4]See Larson and Segal (1995), pp. 294–298.

- Val (t, $[_S[_{NP_1}[_{Det}\text{All}][_{N'}[_N\text{men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff for some $\{X_j\}$, Val($\{X_j\}$, $[_{NP}[_{Det}\text{All}][_{N'}[_N\text{men}]]]$, σ, w) and $\{X_j\} = \{\{\sigma'(1) : \text{Val(t}, [_S[_{NP_1}e][_{VP}[_V\text{ponder}]]], \sigma', j), \text{some } \sigma' \approx_1 \sigma\}\}$, by (B.8′c.), (UI).
  - Val($\{X_j\}$, $[_{NP}[_{Det}\text{All}][_{N'}[_N\text{men}]]]$, σ, w) iff Val($\langle\{X_j\}, \{Y_j\}\rangle$, $[_{Det}\text{All}]$, σ, w) and **either** $\{Y_j\} = \{Y_v : y \in Y_v \text{ iff Val}(\langle y, v\rangle, [_{N'}[_N\text{men}]], \sigma, w)\}$ **or** Val(Y_w, $[_{N'}[_N\text{men}]]$, σ, w), by (B.8″a.), (UI).
    * Val($\langle\{X_j\}, \{Y_j\}\rangle$, $[_{Det}\text{All}]$, σ, w) iff $|Y_u - X_u| = 0$ for all u such that $u \sim_{Y_j, X_j} v$, by (B.5″k.) and reasoning as previously.
    * Val($\langle y, v\rangle$, $[_{N'}[_N\text{men}]]$, σ, w) iff y is a man at v, some $v \in W$, by reasoning as previously.
    * Val($\{X_j\}$, $[_{NP}[_{Det}\text{All}][_{N'}[_N\text{men}]]]$, σ, w) iff $|Y_u - X_u| = 0$ for all u such that $u \sim_{Y_j, X_j} v$, and $\{Y_j\} = \{Y_v : y \in Y_v$ iff y is a man at v, some $v \in W\}$, by above two lines, (SE).[5]
    * Val($\{X_j\}$, $[_{NP}[_{Det}\text{All}][_{N'}[_N\text{men}]]]$, σ, w) iff $|\{y : y \text{ is a man at } u\} - X_u| = 0$ for all u such that $u \sim_{\text{man}, X_j} v$, by the previous line, (SI).
  - Val(t, $[_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]$, σ', v) iff $\sigma'(1)$ ponders at v, by reasoning as previously.
  - Val (t, $[_S[_{NP_1}[_{Det}\text{All}][_{N'}[_N\text{men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff for some $\{X_j\}$, $|\{y : y \text{ is a man at } u\} - X_u| = 0$ for all u such that $u \sim_{\text{man}, X_j} v$, and $\{X_j\} = \{\{\sigma'(1) : \sigma'(1) \text{ ponders at } v, \text{some } \sigma' \approx_1 \sigma\}\}$, by previous lines, (SE).
  - Val (t, $[_S[_{NP_1}[_{Det}\text{All}][_{N'}[_N\text{men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff $|\{y : y \text{ is a man at } u\} - \{y : y \text{ ponders at } u\}| = 0$ for all u such that $u \sim_{\text{man,ponders}} v$, by previous line, and reasoning as previously.

- Val (t, $[_S[_{NP_1}[_{Det}\text{Gen}][_{N'}[_N\text{Men}]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff the set of men is a subset of the set of ponderers at every world u such that $w \sim_{\text{man,ponders}} u$, or in other words, iff at each such world, every man ponders.

'All (of) the men ponder' has the LF syntax

$$[_S[_{NP_1}[_{Det}\text{All}][_{N'}(\text{of})[_{NP}[_{Det}\text{the}][_{N'}[_N\text{men}]]]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$$

- Val (t, $[_S[_{NP_1}[_{Det}\text{All}][_{N'}(\text{of})[_{NP}[_{Det}\text{the}][_{N'}[_N\text{men}]]]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]$, σ, w) iff for some $\{X_j\}$, Val($\{X_j\}$, $[_{NP}[_{Det}\text{All}][_{N'}(\text{of})[_{NP}[_{Det}\text{the}][_{N'}[_N\text{men}]]]]]$, σ, w) and $\{X_j\} = \{\{\sigma'(1) : \text{Val(t}, [_S[_{NP_1}e][_{VP}[_V\text{ponder}]]], \sigma', j), \text{some } \sigma' \approx_1 \sigma\}\}$, by (B.8′c.), (UI).

[5] Note that because the semantic values of $[_{N'}[_N\text{men}]]$ are ordered pairs of an object and a world, the second clause of (B.8″a.) cannot be applied, since for that clause to apply the semantic values of $[_{N'}[_N\text{men}]]$ would have to be sets.

- Val($\{X_j\}$, $[_{NP}[_{Det}$All$][_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]]$, σ, w) iff
  Val($\langle\{X_j\}, \{Y_j\}\rangle$, $[_{Det}$All$]$, σ, w) and
  either $\{Y_j\} = \{Y_v : y \in Y_v$ iff Val($\langle y, v\rangle$, $[_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]$, σ, w)$\}$
  or Val(Y_w, $[_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]$, σ, w), by (B.8″a.), (UI).
  * Val($\langle\{X_j\}, \{Y_j\}\rangle$, $[_{Det}$All$]$, σ, w) iff $|Y_u - X_u| = 0$ for all u such that $u \sim_{Y_j, X_j} v$, by (B.5″k.) and reasoning as previously.
  * Val(Z, $[_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]$, σ, w) iff
    $Z = \bigcap\{V_w$: Val($\{V_j\}$, $[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]$, σ, w)$\}$ where NP is a proper principal filter, by (B.8″d.), (UI).
    · Val($\{V_j\}$, $[_{NP}[_{Det}$the(n)$][_{N'}[_{N}$men$]]]$, σ, w) iff $|\{y : y$ is a man at $w\} - V_w| = 0$, and $|\{y : y$ is a man at $w\}| = n$, by (B.5″i.) and reasoning in a similar way as previously.
    · Val(Z, $[_{N'}$(of)$[_{NP}[_{Det}$the(n)$][_{N'}[_{N}$men$]]]]$, σ, w) iff
      $Z = \bigcap\{V_w : |\{y : y$ is a man at $w\} - V_w| = 0$, and $|\{y : y$ is a man at $w\}| = n\}$
    · Val(Z, $[_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]$, σ, w) iff
      $Z = \{y : y$ is a man at $w\}$, by the previous line, (SI).[6]
  * Val($\{X_j\}$, $[_{NP}[_{Det}$All$][_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]]$, σ, w) iff
    $|Y_u - X_u| = 0$ for all u such that $u \sim_{Y_j, X_j} v$, and
    Val(Y_w, $[_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]$, σ, w), by previous lines, (SE).[7]
  * Val($\{X_j\}$, $[_{NP}[_{Det}$All$][_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]]$, σ, w) iff $|\{y : y$ is a man at $w\} - X_w| = 0$, by the previous line, (SI).[8]
- Val(t, $[_{S}[_{NP_1}e][_{VP}[_{V}$ponder$]]]$, σ', v) iff $\sigma'(1)$ ponders at v, by reasoning as previously.
- Val (t, $[_{S}[_{NP_1}[_{Det}$All$][_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]][_{S}[_{NP_1}e][_{VP}[_{V}$ponder$]]]]$, σ, w) iff for some $\{X_j\}$, $|\{y : y$ is a man at $w\} - X_w| = 0$, and $\{X_j\} = \{\{\sigma'(1) : \sigma'(1)$ ponders at v, some $\sigma' \approx_1 \sigma\}\}$, by previous lines, (SE).
- Val (t, $[_{S}[_{NP_1}[_{Det}$All$][_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]][_{S}[_{NP_1}e][_{VP}[_{V}$ponder$]]]]$, σ, w) iff $|\{y : y$ is a man at $w\} - \{y : y$ ponders at $w\}| = 0$, by the previous line, and reasoning as previously.

[6]Here we drop the assumption that 'the' is 'the n', *i.e.*, the assumption that there are n men, and also note that the set $\bigcap\{X : |Y - X| = 0\}$ is equal to the set Y.

[7]Note that because the semantic values of $[_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]$ are sets, the first clause of (B.8″a.) cannot be applied, since for that clause to apply the semantic values of $[_{N'}$(of)$[_{NP}[_{Det}$the$][_{N'}[_{N}$men$]]]]$ would have to be ordered pairs, as in the previous sample derivation.

[8]Note that here, reference to other possible worlds than w drops out, since we only have a value for Y_w, and so there is no constraint on $\{X_j\}$ where $j \neq w$.

- Val (t, $[_S[_{NP_1}[_{Det}\text{All}][_{N'}(\text{of})[_{NP}[_{Det}\text{the}][_{N'}[_N\text{men}]]]]][_S[_{NP_1}e][_{VP}[_V\text{ponder}]]]]\sigma$, w) iff the set of men is a subset of the set of ponderers at w, or in other words, iff every man at w ponders at w.

B.1.4 The syntactic category of "Gen"

In the above treatment I have assumed that Gen falls into the syntactic category of determiner. Natural language determiners appear to be characterised by the property of conservativity which has been formalised in various ways by various authors. However, this property must be reformulated to apply to intensional determiner quantifiers.

Intuitively, a determiner Det is conservative iff it satisfies the following:

(B.9) Det Fs are Gs iff Det Fs are Fs which are Gs.

For example, all men ponder iff all men are men who ponder, some men ponder iff some men are men who ponder, and so on. The quantifier 'only' does not satisfy this: 'Only men ponder' does not have the same truth-conditions as 'Only men are men who ponder'.

Gen does seem to satisfy this intuitive defintion of conservativity. 'Birds fly' is true iff 'Birds are birds which fly' is true. We can thus modify Larson and Segal's definition of conservativity to include intensional quantifiers:

(B.10) A determiner Det is conservative if for any $\{X_j\}$, $\{Y_j\}$, Val($\langle\{X_j\}, \{Y_j\}\rangle$, Det, σ, w) iff Val($\langle\{X_j\} \cap \{Y_j\}, \{Y_j\}\rangle$, Det, σ, w) where $\{X_j\} \cap \{Y_j\} =_{df} \{\{X_j \cap Y_j\}\}$

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