Generic Generalizations in Science: A Bridge to Everyday Language

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Abstract

This article maintains that an important class of scientific generalizations should be reinterpreted: they have typically been understood as ceteris paribus laws, but are, in fact, generics. Four arguments are presented to support this thesis. One argument is that the interpretation in terms of ceteris paribus laws is a historical accident. The other three arguments draw on similarities between these generalizations and archetypal generics: they come with similar inferential commitments, they share a syntactic form, and the existing theories to make sense of them are alike. Once these generalizations are properly understood as generics, the recent cognitive approach to generics can be extended to the study of the relevant sciences. The last section indicates ways in which this extension is fruitful for the two strands of research that we combine: the philosophy of science literature on generalizations and the semantics literature on generics.

1 Introduction

Generalizations make a good part of our knowledge. Yet, their status in the special sciences has always been a source of puzzlement if not of scorn. In this article, we argue that an important class of these generalizations, although they are typically interpreted as ceteris paribus laws, are what natural language semanticists call ‘generics.’ Building on this point, we argue that following the cognitive approach to generics for these scientific generalizations promises to help us dissolve old problems and shift the discussion toward promising directions.

Since much confusion in philosophical discussions can result from overlooking the heterogeneity of claims used in the sciences, we first propose a classification of generalizations (§2). This classification allows us to restrict our argument to world-referring, unquantified generalizations.

This is the final, post-refereeing version (November 2017) of an article forthcoming in *Erkenntnis*.
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The dominant interpretation of this class of generalizations maintains that it contains an implicit clause to the effect that the stated relationship holds ‘ceteris paribus’ or ‘all other things equal’. The literature on ceteris paribus laws (henceforth, cp laws) is vast. The general challenge that it tries to solve is known as Lange’s dilemma (Lange 1993). On the one hand, we can read the claim ‘Ks are F’ as meaning that a clear set relationship exists such that all members of category K that meet a further known condition C have property F. If this is our interpretation, the problem is that the claim is false. If an explicit condition C is given which does not trivialize the claim, the history of special sciences has shown us that it seems always possible to find members of K that meet condition C but fail to have property F. On the other hand, we can refrain from specifying a condition C, simply accepting that there is no feasible way to specify in advance all exceptions. In this case, the problem is that the claim borders on a tautology: anytime a member of K does not have the property F, it can be dismissed as not meeting the unspecified ceteris paribus condition.

A great number of accounts have been offered to meet this challenge (for a detailed survey, see Reutlinger, Schurz, and Hüttemann 2015). Our purpose is not to add one more account to the lot, but rather to shift the discussion. In parallel to the literature on generalizations in science, a literature on generic generalizations in everyday language has developed. Only recently did some scholars try to bridge these two literatures. Bernhard Nickel (2010; 2014; 2016) identifies similarities between generics and cp laws to argue that his semantics for the former is a good fit for the latter. Matthias Unterhuber (2014) argues that we can use a logic developed for generics to account for the logic of cp laws. These endeavors can be said to rest on a methodological point: cp laws *are similar enough to generics* or *can be expressed with them*.

Our claim is bolder. We argue that generalizations interpreted by many as cp laws *are* generic generalizations. In a way, establishing this claim makes Nickel’s and Unterhuber’s projects even more relevant than they already appeared. Nonetheless, we part ways with Nickel and Unterhuber by relying on an interpretation of generics unlike theirs. According to us, extending the *cognitive* *approach* to generics to the study of the sciences promises to be particularly fruitful, both for our understanding of scientific generalizations and for our understanding of all generics.

Our classification of generalizations in section 2 and a presentation of generics in section 3 pave the way for sections 4 and 5. Section 4 contains four arguments in favor of our claim that the world-referring unquantified generalizations in the sciences are generics. Although one can find at least indications of each argument in the literature, it is the combined force of them that makes our thesis compelling. The first argument notes that our class of generalizations and archetypal generics come with similar inferential commitments (§4.1). The second argument is that the now dominant *ceteris paribus* interpretation is no more than a historical accident (§4.2). The third argument considers the syntactic form of alleged cp statements and generics to question the very possibility of them being two different types of generalizations (§4.3). The fourth and last argument presents the major types of account in the *ceteris paribus* literature and pairs them with major types of account in the generics literature, thereby showing that 'both kinds' of generalizations can be accounted for in the same way (§4.4). Section 5 discusses how adopting the cognitive approach to generics opens promising research avenues and questions. The first of these is the study of how the cognitive traits of language users influence the acceptance of generics in the sciences. The second asks how scientists' endorsement of generics relate to their commitment to generalizations of other types. Finally, the third acknowledges the need to investigate how laypersons acquire generics through testimony from experts.

We focus throughout the article on economics as an instance of the sciences where the debate on the status of generalizations has been rife. To ensure some degree of continuity in our examples, we draw mostly on the recent literature on the effects of inequalities on economic growth for illustrations. We do not see compelling reasons to believe that our argument, if sound, applies only to economics. However, our confidence that generics are present to the same extent in other sciences decreases as we move further away from economics. For instance, we are highly confident about the exportability of our conclusion to sociology, but less so to molecular biology and even less so to fundamental physics (where the universal quantifier can often be pragmatically omitted because context provides a sufficient cue). Further research by specialists of other disciplines is required to assess how far generics ramify in science.

2 A Classification of generalizations in the sciences

In this section, we develop a classification of scientific generalizations. By “generalization”, we do not mean the process of generalizing, but its linguistic outcome: a proposition that covers more than one instance of a class. Our classification makes explicit three dimensions: quantification, hedge (expressed epistemic uncertainty), and target system. One function of the first two dimensions (quantification and hedge) is to explicitly proportion one’s claim to the evidence. To achieve this function, the syntactic form of the claim is adapted. In contrast, the last dimension (target system) is usually left implicit in the sentence itself. Yet, it shares a function with the first dimension (quantification): delimiting what the claim is about.

2.1 Quantified and unquantified generalizations

Quantifiers are words or expressions marking generality (Uzquiano 2016). More specifically, they express generalizations extensionally by posing a relation between two sets corresponding to properties (Keenan 2012). To use a philosophically well-worn example, “All Ravens are black” says that the set of ravens is contained in the set of black things, while “Some ravens are black” says that the intersection between the set of ravens and the set of black things is not empty.

In *Redistribution, Inequality, and Growth*, for instance, the authors claim that “when redistribution is already high (above the 75th percentile), there is evidence that further redistribution is indeed harmful to growth” (Ostry, Berg, and Tsangarides 2014, 23). Without quantifiers, the claim would have been that “there is evidence that redistribution is indeed harmful to growth”.[1] Not only is this picture different from what the authors have expressed, it is also at odds with one of

1 “There is evidence that” is a hedge, see below.

their main findings, namely that further redistribution when below the 75th percentile seems to have no effect on growth (Ostry, Berg, and Tsangarides 2014, 23). In the actual sentence found in the report, “when redistribution is already high (above the 75th percentile)” and “further” work together to pick a subset of redistribution levels (corresponding to the 25 highest percentiles), thus defining the scope where the predicate “is harmful to growth” applies to redistribution.

This simple example shows why we find quantifiers in the sciences: they are a great tool to make our ideas more precise, thereby rendering a more faithful picture of our evidence (Keenan 2012, p.1). They also indicate how to challenge the generalizations: by showing empirically that the alleged set relationship does not hold in the world.

However, some generalizations in the sciences are not quantified. Familiar examples in economics abound, e.g., “Agents are rational” and “Low interest rates cause inflation”. There are also more complex cases such as “*More unequal societies tend to redistribute more*” (Ostry, Berg, and Tsangarides 2014). In this case, the two “more” are quantifiers that together express a functional relation between unequalness and redistribution. However, we are not told the extent to which this functional relation holds across societies. Is it always, most of the time, often, or sometimes?

In sum, while it is easy to understand why quantified generalizations are prevalent in the sciences, we must recognize that there are instances of unquantified generalizations. This article focuses on these instances.

2.2 Hedged and unhedged generalizations

Hedging, as we define it here, is the practice of expressing epistemic uncertainty.[2] Suppose your guests hear a sound in your house. If you know for sure what caused it, you might say: “it’s a pipe”.

2 When George Lakoff coined the term ‘hedges’, it referred to those “words whose job is to make things fuzzier or less fuzzy” (Lakoff 1973, 471), where ‘fuzzy’ is to be taken in the logical sense. We are not directly concerned with this reading.

If you are not sure, you might say "*I think* it's a pipe" or, more pompously (but quite commonly in science), "*There is evidence that* it is a pipe". Expressions of the sort are key in all sorts of intellectual exchanges, for they signal the speaker's uncertainty to the hearer. In *Hedging in Scientific Research Articles*, Ken Hyland (1998, 1) thus defines hedging as *"Any linguistic means used to indicate either a) a lack of complete commitment to the truth value of an accompanying proposition, or b) a desire not to express that commitment categorically."*

The distinction between quantification and hedging is important, although there are borderline cases. One such case is 'tend to', a common expression in economics (already in one of the two examples above). We are not aware of a systematic semantic analysis of this expression, but it is amenable both to an ontic reading – e.g., members of a kind have the potential to possess the property, but a given member may fail to actualize the potential – as well as to an epistemic reading – e.g., the utterer is not fully confident that members of the kind have the property. We will not discuss these borderline cases in what follows.

As we already mentioned, our analysis in this article focuses on unquantified generalizations. As regards the hedged/unhedged dimension, our analysis covers both.

2.3 Target system

Many sciences extensively use and talk about models. In our use of the term, a model is a system that is easier to study than the system we are primarily interested in. Scientists thus study a model in the hope that they can extrapolate what they learn about it to their system of primary interest (Morgan and Morrison 1999; Claveau and Vergara Fernández 2015). Although models can be built out of diverse materials (think of animal models in medicine), they are mostly systems of equations in modern sciences, thus creating a sharp contrast between the model and the worldly system of interest.

When one parses the scientific literature looking for generalizations, it is crucial not to mistake claims that are about the model for claims that are about worldly systems.[3] In the economic literature on the effects of inequalities on economic growth for example, we find unquantified, unhedged generalizations such as “High inequality means that the poor can gain little from the public good” (Halter, Oechslin, and Zweimüller 2014, 88). This claim refers to a precise property of a system of equations, not directly (if at all) to a property of worldly systems. As a model-referring claim, it can be straightforwardly interpreted as an ‘all other things equal’ proposition: the modeler reports a deductive implication of the level of inequality on the benefits accruing to the poor from the public good, *provided* all the other assumptions of the model are kept.

We will not discuss generalizations about models any further in this article; we are concerned with worldly (or real-world) generalizations. More specifically, we are concerned with Worldly, Unquantified Generalizations in the Sciences, henceforth WUGS.

2.4 About WUGS

There is a preliminary hurdle to cross in our quest to study Worldly, Unquantified Generalizations in the Sciences (which can be either hedged or unhedged): Are WUGS oxymoronic in combining ‘science’ with what seems like loose talk?

In fact, much of what passes as science uses worldly, unquantified generalizations. WUGS are used by scientists to communicate with laypersons (see §5.3), but they are also part of the internal life of disciplines.[4] In economics for instance, there is a tradition of running opinion surveys in which scholars are asked their opinion about a list of claims (e.g., Kearl et al. 1979; Fuller, Alston, and Vaughan 1995; Fuller, Geide-Stevenson, and Ahmad 2014). Many of these claims are WUGS – e.g., ‘A ceiling on rents reduces the quantity and quality of housing available.’ This practice indicates that economists find it legitimate to ask their colleagues and to state their beliefs about

3 Of course, this conflation is exactly what economists are sometimes accused of making (Morgan 2012, 405–9).

4 There are also reasons to reject the attribution of ‘loose talk’ to WUGS. For arguments in this direction about *generics*, see Nickel (2016, 26–30).

WUGS. More generally, these generalizations are used in a non anecdotal manner *in scientific publications* in all the sciences we looked at. One even finds WUGS directly in the title of highly-cited articles. For instance, the title of an article in psychology is “Serotonin modulates behavioral reactions to unfairness” (Crockett et al. 2008) and one from biology is “Dogs are definitive hosts of *Neospora caninum*” (McAllister et al. 1998). In short, WUGS exist and need explaining.

3 Generic generalizations

The previous section provided a classification of generalizations, which allowed us to circumscribe our inquiry to WUGS. The main claim of this article, defended in the next section, is that *WUGS are generic generalizations*. In this section, we thus introduce generic generalizations, a type of generalization studied by natural language semanticists. We also offer a summary of the *cognitive approach* to generics. This summary is most important for section 5, where we argue that the cognitive approach to generics opens up interesting research areas regarding WUGS.

Like other generalizations, generic generalizations (henceforth, generics) ascribe properties to members of a category. For example, “*Ravens are black”* ascribe the property *black* to members of the kind *raven*.[5] Although they are commonly used in everyday language (Gelman 2003), generics have proven very difficult to analyse semantically.[6] The sources of the difficulty are that generics tolerate exceptions and, as a result of being unquantified, do not explicitly supply information on the number of instances they cover (the resemblance with WUGS is striking, see §4.1).

The two most common approaches to solve this problem can be labelled as majority-based and normalcy-based. While the former approach claims that a generic is true if and only if the majority of its instances satisfy the ascribed predicate, the latter claims that a generic is true if and only if all normal instances satisfy it. Both approaches prove to be flawed, at least in their naive

5 We will not discuss in this article generics that are said to be habituals, e.g., *Mary smokes after lunch*, and kind predicating generics, e.g., *Dinosaurs are extinct.*

6 For a comprehensive presentation of the multiple attempts to analyse the semantics of generics, see Leslie and Lerner 2016.

forms. It might be true that the majority of sea turtles die within the first few minutes following their hatching, but “Sea turtles die in infancy” is nonetheless false (Nickel 2009). On the other hand, while it is not normal for ticks to carry the Lyme disease, “ticks carry the Lyme disease” still seems to be true (Leslie 2008).

Of course, the majority-based and the normalcy-based approaches can be refined to account for these simple counterexamples. We will not, however, draw on such “content-neutral” approaches (Lerner and Leslie 2016, 405). These approaches are content neutral because they presume that the truth conditions of generics depend solely on whether a specified set-theoretic relationship holds – e.g., the set of normal members of K being a subset of the bearers of F – and this irrespective of the properties and kinds at stake.[7]

In this article, we rather rely on what is called the *cognitive approach* to generics, which is a content-based approach. Although we will not argue for it here, we think this approach is the most promising comprehensive account of generics. For the purpose of the current article, the main virtue of the cognitive approach is that it has the resources to shift the study of WUGS in a fruitful direction, as we will argue in section 5.

What is specific to the cognitive approach to generics? There are two noteworthy aspects. The first aspect is that its semantics is content based: relying on empirical studies of acceptance patterns, it maintains that, because of specific cognitive traits of language users, the types of properties and kinds to which a generic refer affect systematically its truth conditions. To this day, there is only one content-based semantic theory of generics in the cognitive approach, the one developed by Sarah-Jane Leslie (2007, 2008, 2012).[8] As we will point out in section 5.1, there are reasons to believe that

7 Nickel (2009, 2016) acknowledges the need to take the properties and kinds at stake into account, but does so with set-theoretical tools. As a result, his truth-conditions for generics are not oriented towards the cognitive traits of the utterer.

8 Leslie’s project, like other empirically informed research in semantics, involves a transition from the study of patterns in the use of language to a theory about the truth conditions guiding the patterns. In her early work, Leslie used hesitantly the terminology of ‘truth conditions’ (see her distinction between “semantic truth conditions” and

other content-based semantics will be developed once it is recognized that generics also include WUGS. But to give an idea of what a content-based semantics of generics looks like, it makes sense to present in some detail Leslie's version.

According to Leslie (2008), the factors determining the truth conditions of generics constitute a sort of flowchart – i.e., a series of acceptance factors. For a generic to be true, a constraining factor must be met: the negative alternative constraint (NAC). Once this constraint is met, the presence of one of three eliciting factors is sufficient for the truth of a generic.[9] We describe briefly below the NAC and the three eliciting factors, noting that these conditions have to do with the cognitive traits of language users as well as with how they believe the world to be.

According to the constraining factor (NAC), a generic can be true only if its exceptions are construed as negative counterinstances, as opposed to positive ones. Often, this plays out as the absence of an alternative. Thus, "Lions have a mane" is true even if only mature males do, because the alternative to having a mane is the absence of one, which is construed as negative. In contrast, even if over ninety percent of books are paperbacks, "books are paperbacks" is false because the remaining part of books, hardcover ones, are construed as positive counterinstances. Here, one should note that the distinction is psychological rather than ontological. Sometimes, the alternative, although present, is not salient. "Cardinals are red" is true even if only males are, because cardinal females are brown. Ontologically, it makes no sense to say that brownness is a negative alternative to redness, but it does psychologically. Part of the negative alternative constraint (NAC) thus has to do with salience.

The first eliciting factor is the characteristic dimension factor (CDF). It allows a generic to be true if the property predicated is seen as lying along a characteristic dimension for the category. Consider an example given by Leslie: "Dogs have oddly shaped lumps on their backs". Since there

"worldly truth makers" in Leslie 2008, 43), but has been more outspoken recently (e.g., Lerner and Leslie 2016, 406).

9 In formal terms, we can write: "Ks are F" is true if and only if (NAC ∧ (CDF ∨ SF ∨ EPF)).

are some dogs with oddly shaped lumps on their back, and given that the counterinstances are construed as negative, a theory with NAC alone predicts the truth of this generic (contra intuition). However, CDF is not met here, because the background knowledge of most people is such that this predicate cannot be construed as lying along a characteristic dimension of the dog category. Note that what is considered ‘characteristic’ varies across cultures and also across individuals in the same culture, but with different experiences.

The second eliciting factor has to do with how striking (SF) the property predicated is. The more striking the property, the easier it is to generalise. Some very dangerous or appalling properties can thus be attributed to a category at a very low prevalence level. For example, “mosquitoes carry the West Nile virus” and “sharks attack bathers” are true despite a very small percentage of mosquitoes and sharks actually having the predicated property (Prasada et al. 2013, p.416) Note that the extent to which something is striking depends on the cognitive traits of the individual.

The third eliciting factor is the estimated prevalence of the property among members of the category (EPF). In fact, prevalence rarely plays more than a minor role when it comes to the acceptance of a generic (Leslie 2008; Khemlani, Leslie, and Glucksberg 2009; Cimpian, Brandone, and Gelman 2010; Prasada et al. 2013). More precisely, it only plays a decisive role when NAC is met and the other eliciting factors are not present (Leslie 2008). For example, given that *having a radio* in a car does not have a positive alternative and is not characteristic or striking, the acceptance of “cars have radios” depends solely on prevalence. Such generics can be dubbed as *statistical*, taking into account the type of connection they express (Prasada and Dillingham 2006).

These content-based truth conditions have been validated by a number of empirical studies using *everyday* generics. If they are found wanting in the future, this result should not directly lead us to discard the cognitive approach to generics. Indeed, the first specificity of the cognitive approach is not Leslie’s specific truth conditions, but rather the more general claim that the truth conditions of a generic depend on how language users process the types of properties and kinds to which the generic refers.

The second specificity of the cognitive approach is the focus on learning and on how generics are used in cognition. Two empirically supported claims of this approach about the cognition of generics can be subsumed under the notion of *defaultness*.[10] First, there is *inferential* defaultness, i.e., “the hypothesis that generics reflect a cognitively default, fundamental mode of generalizing in humans.” (Lerner and Leslie 2016, 405) The capacity to learn through generalizing predates language: infant behavior strongly indicates that, prior to mastering language, they can form expectations about members of a kind by encountering only a few (sometimes only one) instances of it. Being able to generalize obviously has great survival value. We thus have a pre-linguistic mode of generalizing. The cognitive approach claims that the non-linguistic expectations so formed are expressed in language by generics, while explicitly quantified generalizations express the outcome of “cognitively more sophisticated” modes of generalizing (Leslie and Lerner 2016, sec. 4.1; see the same section for a review of empirical evidence supporting this hypothesis). This hypothesis can thus explain the peculiar truth conditions of generics: they reflect how our cognitive system is adapted to make us form action-guiding expectations based on limited informational inputs.

Second, there is *interpretive* defaultness: according to the cognitive approach, the unmarked character of generics – i.e., the typical absence of a pronounced quantifier – is due to the fact that generalizations are, by default, interpreted as generics. Explicit marks (e g. ‘some’, ‘many’, ‘the majority of’, ‘all’) are necessary only when the utterer needs to signal that a type of statement should not be interpreted in the default manner. To illustrate, Leslie asks us to consider the sentence ‘John climbed the mountain’, an example taken from Chomsky (2000, 125):

10 We thank an anonymous referee for helping us articulate this important distinction, which is not made in Leslie’s work.

> This [sentence] is understood as meaning that John climbed up the mountain; to obtain the interpretation that John climbed down the mountain, we must explicitly use the preposition ‘down’. The unmarked case ‘climbed the mountain’ is never interpreted as climbed down the mountain. [...] To deviate from this default interpretation, we must use the more marked form ‘climbed down the mountain’, which makes use of an explicit preposition. (Leslie 2008, 24)

According to her, letting interpretive defaults being unmarked makes language efficient (Leslie 2012).

Inferential and interpretive defaultness should not be conflated, although there might be evolutionary reasons for why they come together with respect to generics.

4 Ceteris Paribus or generic generalizations?

We now come back to world-referring, unquantified generalizations in the sciences (WUGS). As mentioned in the introduction, these generalizations are frequently interpreted as cp laws. In this section, we argue that this interpretation is forced: WUGS are generics.

4.1 Inferential commitments

This thesis is prima facie plausible because the literature on alleged cp laws recognize that WUGS have two important and closely tied features that archetypal generics also have.

First, WUGS and archetypal generics allow for exceptions. In other words, if someone endorses a WUGS or an archetypal generic of the form *Ks are F*, she is not committed to the claim that *Each and every K is F*. She can thus simultaneously endorse, without contradiction, *Ks are F* and *This specific K is non-F*.

Second, WUGS and archetypal generics serve as premises in non-monotonic inferences. An inference is said to be non-monotonic if its conclusion can be revised in light of further information. For instance, *Tweety is a bird* and *Birds can fly* warrants *Tweety can fly*, unless you add *Tweety is a penguin* in the set of premises. When someone endorses one of these generalizations, she is thus committed to infer claims about specific instances of the kind K, but also to withdraw these conclusions if defeaters are provided.

We are not the first ones to point out that these inferential commitments are shared by alleged cp statements and archetypal generics. This recognition seems to be what led other philosophers such as Nickel (2010) and Unterhuber (2014) to analyse alleged cp laws with a semantics developed for generics.[11] They simply did not go far enough: a semantics for generics should be used to analyze WUGS because WUGS are generics. The next three arguments establish this thesis.

4.2 History of the ceteris paribus literature

The second argument for the generic interpretation of WUGS is that, from a historical perspective, the cp interpretation results from misplaced concerns regarding the scientific character of economics (where the cp interpretation originated). From the 19th century and up to recently, methodological discussions of economics typically turned to more secured sciences such as the physical sciences for conceptual resources. In so doing, the proximity of much economics research to everyday cognition was occulted.

John Stuart Mill can be taken as the initiator of the methodological literature on *ceteris paribus*, although he did not use the clause explicitly in his methodological discussion of political economy.[12] The goal of establishing economics as a genuine science is central to his methodological writing. At one point in his *System of Logic*, he refers to “all the truths of common experience,

11 Nickel (2010, sec. 3.1) discusses such similarities, except he dubs as “open-ended” what we construe as being non-monotonic. Unterhuber (2014) acknowledges the non-monoticity of inferences from generics (insofar as he accepts Delgrande’s logic for generic sentences) as well as their tolerance towards exceptions.

12 It is neither in *On the Definition of Political Economy* (Mill 1844) nor in Book VI of *A System of Logic* (Mill 1886), but he used the phrase 16 times in a non-philosophical context in his *Principles of Political Economy* (Mill 1848) and his well-known methodological characterization of economics as a deductive, inexact science is a primary influence on Cairnes (1888, see especially endnote 21), who seems to be the first to use *ceteris paribus* in methodological work. For examples of explicit use of the *ceteris paribus* clause prior to this period, see Persky (1990, 87–89) and Reutlinger, Schurz, and Hüttemann (2015, sec. 2).

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constituting a practical knowledge of mankind" (Mill 1886, para. VI.V.1). He thus attributes some merit to the output of everyday cognition, but only to elevate the bar for the human and social sciences well above what this cognition can claim to achieve:

> [T]he science of Human Nature may be said to exist, in proportion as the approximate truths, which compose a practical knowledge of mankind, can be exhibited as corollaries from the universal laws of human nature on which they rest; whereby the proper limits of those approximate truths would be shown, and we should be enabled to deduce others for any new state of circumstances, in anticipation of specific experience. (Mill 1886, para. VI.III.2)

Mill maintains that economics meets this demand as a deductive, inexact science: it is lucky enough to study, like physics, a phenomenon that obeys the Law of the Composition of Causes (Mill 1886, para. VI.VII.1), it is also fortunate to be able to build on a relatively secure knowledge of psychological laws, but it falls short of astronomy in not being able to identify all the initial conditions and perform the required computation that are needed for accurate predictions (i.e., an inexact science; Mill 1886, chap. VI.IV).

The main point to draw from Mill's example is that his methodological views of economics (and the "moral" sciences more generally) were profoundly shaped by what he saw as the successful methods used in the physical sciences. The introduction to Book VI of his *System of Logic* is categorical: "The backward state of the Moral Sciences can only be remedied by applying to them the methods of Physical Science, duly extended and generalized" (Mill 1886, para. VI.I.1). Since the physical sciences were said to be in the business of discovering "universal laws", economics needed to be doing something similar. The spotlight was thus turned away from the type of claims that laypersons rely on in trying to navigate the social world.

We can clearly not survey the rich history of the cp interpretation here. We will draw below on Alfred Marshall's interpretation, which is far more generous to everyday cognition than Mill's. Marshall indeed establishes a correspondence between the method of economics and how "sensible men have dealt from time immemorial with every difficult problem of ordinary life" (Marshall

1920, para. P.20). Yet, although Marshall is often credited with popularizing the ceteris paribus terminology (Persky 1990, 189–91; Reutlinger, Schurz, and Hüttemann 2015, 12–13), his relax attitude toward the scientific credentials of economic generalizations did not prevail.

Indeed, an attitude more akin to Mill's is found in Lionel Robbins, who supplied the next important methodological work on economics:

> Economic laws describe inevitable implications. If the data they postulate are given, then the consequences they predict necessarily follow. In this sense they are on the same footing as other scientific laws, and as little capable of "suspension". (Robbins 1935, 121)

We are back to a rigid view of generalizations in economics, i.e., statements that hold strictly if only the "data" do not change. This interpretation arguably fits current model-based generalizations. But it allows no space for a separate semantics of WUGS, one that is closer to the "approximate truths" of the layperson.

4.3 Syntactic form

In this section, we argue that the syntactic form of generics and WUGS points towards them being the same kind of generalization. An authoritative survey of the philosophical literature on cp laws states:

> [A] major, controversial question concerns the determination of the precise meaning of "ceteris paribus". Philosophers have attempted to explicate the meaning of ceteris paribus *clauses* in different ways. (Reutlinger, Schurz, and Hüttemann 2015, 1, our emphasis)

These attempts presuppose that there is a clause to explicate, but some scholars have already noted that *there is usually no stated clause* (e.g., Woodward 2002). For instance, the same survey lists seven generalizations in its introduction to motivate the analysis, none of which has an explicit 'ceteris paribus' or 'other things being equal'. In the literature on inequality and growth, these phrases are also extremely rare.[13] The syntactic form of most generalizations that are interpreted as

13 The general pattern that we found is that such phrases are used in the context of discussing theoretical models or results of statistical estimation. In this context, the phrase 'ceteris paribus' refers in a straightforward fashion to

cp laws is, in fact, the one of generics (Nickel 2010, sec. 3.1). This identity of form is the first step in our argument. Now, we want to establish that this fact is evidence that WUGS and generics are the same type of generalization.

In the case of generics, the absence of a pronounced quantifier – i.e., their unmarked character – has been taken as prime evidence that they are interpretive default in the context of everyday linguistic exchanges (see the previous section). If being unmarked is a sign that a statement will be appropriately interpreted by default (e.g., *climbing a mountain* will not be interpreted as *climbing it down*), WUGS are also the interpretive default in their context of utterance (since they are unmarked). So what is the context of utterance of WUGS? In fact, this context is plural. As we have already seen, WUGS are used among specialists. The same WUGS is also often uttered by an expert when communicating with laypersons (we will discuss this context in §5.3).

So WUGS and generics typically share a syntactic form and also elicit default interpretations. Furthermore, one context of utterance of WUGS – the expert-to-layperson communication – is not radically unlike the context of everyday linguistic exchanges in which archetypal generics are uttered. Is it still plausible that WUGS nevertheless express different types of generalization? Although possible, it is implausible: if a default form is meant to carry meaning efficiently across individuals, expressing two types of generalization with the same default form in a similar context would be selected against.[14] We thus conclude that it is far more plausible that WUGS and generics are of the same type.

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what would happen if the value of one variable in an equation was changed while keeping intact the other variables (for examples, see Cingano 2014, 28; Halter, Oechslin, and Zweimüller 2014, 84). We also note that some scholars have an unusual fondness for the phrase (e.g., Piketty 2014 who uses it nine times in his admitedly lengthy best seller).

14 The context condition is important: if interpretive defaultness was not a function of the context, we could not explain why unquantified generalizations about mathematical models (see §2.3) are *not* generics although they share their syntactic form. We submit that, in this case, the generalization can be unmarked because, in the context of specialist-to-specialist conversations over mathematical systems, there is no great risk of misinterpretation when the quantifier is omitted.

One might object that scientists do occasionally feel the need to say ‘ceteris paribus’. What can we say about these cases? We see two possibilities here that do not threaten our thesis. First, it is possible that at least some of these world-referring generalizations are thereby *quantified* – i.e., they would be equivalent to saying *All Ks are F if other things are equal*. But these claims must lie outside our analysis (since they are not WUGS). Second, adding ‘ceteris paribus’ to what is otherwise a WUGS might be similar to what happens when a ‘typically’ or ‘generally’ is affixed to a everyday generics: “the resulting sentence exhibits at most a slight change of meaning” (Krifka et al. 1995, 9). We leave the study of these rare world-referring sentences with an explicit *ceteris paribus* for future work.

4.4 Parallel semantic theorizing

Up until recently, WUGS and everyday generics have been studied in parallel literatures. It is thus striking that the same types of semantic theories have been developed in the two literatures. This similarity constitutes the fourth argument for our thesis that WUGS are generics. We have already discussed three of the four types of theories when introducing generics.

According to majority-based theories, the generalization can be taken as a probabilistic claim with the probability left implicit. In the cp literature, such views rest on the idea that probabilistic claims “capture the familiar non-universal character of special science laws” (Reutlinger and Unterhuber 2014, 1708), namely that they allow for exceptions.[15] In the generics literature, Cohen (1999) similarly maintains that a generic is true given that the probability of an arbitrary instance of the category satisfying the corresponding predicate rather than one of its alternatives is greater than 0.5.[16] We note that there are more accounts appealing to statistics or probabilities in the cp literature than there are in the literature on generics, but this is easily explained by comparing the size of both

15 A recent version of a statistical interpretation of cp laws is provided by Roberts (2014). For a detailed survey of the cp literature with references to numerous accounts of each type, see Reutlinger et al. (2015).

16 These are what he calls *absolute generics*, but there are also *relative* generics. For detailed presentation, discussion, and refutation of Cohen’s view, see Nickel (2009, sec. 5, 2016, chap. 4.2), Leslie (2008, 7–13), and Leslie & Lerner (2016, sec. 2.5).

literatures as well as acknowledging that theorists might be more inclined to use mathematical tools for science-related generalizations than for everyday generics. In any case, the parallel still holds as the central idea in both literature remains that the relevant generalizations represent what is true most of the time.

In both literatures, we also find scholars endorsing normalcy-based theories, i.e., theories according to which *Ks are F* is true if and only if *all normal Ks are F* (e.g., Spohn 2002 for the cp literature and Asher and Morreau 1995 for generics). In both literatures, appeal to normality thus allows exceptions to simply be labeled as abnormal. Of course, the precise meaning of "normal" changes from account to account in the two literatures.

The third type of theories – the only one we have not discussed yet – is what we call *essentialist readings* of the generalizations. They maintain that a generalization refers to something that lies behind the appearances and that they variously call a mechanism, disposition, or capacity. For instance, Nancy Cartwright is known in the cp literature for defending a semantics of generalizations in terms of capacities. She maintains that these "capacities are real" (Cartwright 1994, 1). Given the *realness* of capacities, a sentence like "CP, smoking causes lung cancer" is simply taken to express that *Smoking has the capacity to cause lung cancer* (Cartwright 2002). In the literature on generics, Nickel is known for a semantic theory relying on normality, but supplemented with the metaphysical notion of an underlying causal mechanism (Nickel 2009, 2016). He also recently exported his theory of generics in the cp literature (Nickel 2010, 2014), which is further evidence that generics and WUGS can be accounted for with almost identical theories.

The last type of theories maintains that these generalizations express in language the outcomes of expectation forming mechanisms. We have already presented a version of this type of theories in the literature on generics: it is the cognitive approach. According to this account, "the capacity to generalize—the capacity for inductive learning—is innately given" (Leslie 2008, 21) and it is of fundamental practical value:

> Inductive learning is what allows the child to avoid a hot stove after a single burn, the adult to avoid repeating errors indefinitely, and perhaps even the conditioned rat to flee a shock box after hearing a warning tone. Without the ability to make generalizations that go beyond particular, experienced instances and so respond accordingly to novel events and items, an animal would probably not last very long. (Leslie 2008, 21)

In other words, generics depend for their meaning on our capacity to draw "inferences from particular instances of a category to novel and unobserved ones" (Leslie 2008, 29) and to adapt our behavior accordingly.

Is there a similar account in the literature on cp laws? We are not aware of a *contemporary* account around these lines. But something highly similar has been put forward in the past by no one else than Alfred Marshall. For him, a cp law boils down to "a statement that a certain course of action may be expected under certain conditions from the members of a social group" (Marshall 1920, para. I.III.12). Unusually relax about the scientific credentials of such a statement, he likens it to what a layperson does:

> Life is human conduct, and the thoughts and emotions that grow up around it. By the fundamental impulses of our nature we all—high and low, learned and unlearned—are in our several degrees constantly striving to understand the courses of human action, and to shape them for our purposes, whether selfish or unselfish, whether noble or ignoble. (Marshall 1920, para. I.III.10)

The accounts of Marshall and Leslie thus share the idea that generics and WUGS are expressions of fundamental, action-guiding, cognitive processes. Some of the resulting generalizations will identify what is most likely, what is normal or what is supported by a stable mechanism, but these identities are accidental. The principal function of these processes is to efficiently form expectations.

In sum, we have argued in this section that each major type of theories for WUGS finds its equivalent in the literature on generics. This fact is only weak evidence for our thesis that WUGS are generics, but the combined force of our four arguments makes this thesis compelling.

5 Genericity in Science: questions for further research

WUGS are generics. We will refer to them as scientific generics for now on. We contend that recognizing the identity of WUGS does more than unify two literatures: it entices us to extend the cognitive approach to generics to the study of scientific generics. In other words, it supplies a strong impetus to take the road indicated by Marshall in the remarks above, but that has been barely explored in the cp literature. In this section, we indicate some of the ways by which taking this road will be fruitful both for the study of scientific generics – for which it will shift attention to major questions – and for the cognitive approach to generics – for which it represents a significant extension of the set of statements to account for. We start by the first specificity of the cognitive approach – i.e., a content-based semantics. We then turn to its second specificity – its focus on how generics are used in cognition. For this second characteristic, we distinguish between learning a generic *in* science and learning a generic *from* science. The general point of this section is that the two characteristics of the cognitive approach are useful guides for future work on scientific generics although Leslie's specific accounts of truth conditions and of inferential defaultness are likely to be amended.

5.1 Toward a content-based semantics of scientific generics

The common semantic approaches to scientific generics are content neutral. As we indicated already in the introduction, they attempt to flesh out what general set theoretic relationship must hold between kinds and properties for a scientific generics to be true. This strategy leads to problems such as Lange's dilemma: if the set relationship is strict, actual scientific generics are most certainly false; if the set relationship is permissive, scientific generics become almost uninformative.

The cognitive approach has already shifted the literature on *everyday generics* away from seemingly endless refinements of content-neutral semantic theories toward the study of how generics are integral parts of our cognitive life. We propose to operate the same shift for the study of scientific generics.

Remember from section 3 that Leslie proposes that four factors determine the truth conditions of generics: a constraint (NAC) and three enabling factors (CDF, SF, EPF). Only pronouncements based on the last and allegedly less decisive factor – the estimated prevalence factor – can be assessed almost independently of the cognitive traits of the agent[17] – that is, we can evaluate the agent's estimated prevalence of F in K by comparing it to the actual prevalence of F in K. The pronouncements based on the other factors depend not only on how the world is: they depend on *what properties the agent finds salient, characteristic and striking*. More generally, they depend on *cognitive traits* of the agent.

The question now for the scientific generics is: *What are their content-based truth conditions?* This question presupposes that Leslie's truth conditions might have to be amended. They however serve as a starting point to empirically study the cognitive aspects of the truth conditions of scientific generics. Let us exemplify this point by focussing on Leslie's notion of 'characteristic dimension'.

It is uncontroversial that the cognitive traits of scientists are partly determined by socialization in a discipline and, more narrowly, by the adherence to a theoretical approach inside a discipline.[18] Take the contrast between economics and sociology: these disciplines carve up the world differently. A brief perusal of textbooks should be sufficient to convince anyone: a student of economics will be introduced to concepts such as markets, demand & supply, marginal utility and

17 Cognitive traits always play a role insofar as they determine what counts as negative.

18 If we were to focus on Leslie's notion of 'strikingness', political and moral commitments would seem a more promising place to start the empirical enquiry since what is deemed 'dangerous' depends on what we value. Due to space constraints, we do not further explore this hypothesis here.

prices (e.g., Krugman and Wells 2015); a student of sociology will rather learn about social structures, social classes, culture, socialization (Giddens and Sutton 2009). To a lesser extent, theoretical approaches inside disciplines also carve up the world in their own way. Our hypothesis is that these specificities are responsible for patterns of acceptance and rejection of scientific generics across disciplines and theoretical approaches: the socialization and prior commitments of scientists should determine what they judge to be characteristic.

Of course, similar hypotheses have been around for a while. Even Milton Friedman, who is so often erroneously depicted as a single-minded positivist, attempted to explain, in his famous 1953 methodological essay, why a given "hypothesis is far more likely to appeal to an economist than to a sociologist." (Friedman 2001, 29) His answer relied on one discipline's greater acquaintance with a category – in his example, it is the centrality of the category of "competitive industries" in economics. Our contention is thus not that a cognitive approach to scientific generics will produce fully novel hypotheses. What we contend is that this approach gives a conceptual framework to more systematically study the factors that influence the acceptance or rejection of scientific generics.

5.2 Learning a generic in science

This second research direction does not stem from the content-based truth conditions proposed by the cognitive approach, but rather from its other specificity: its focus on how generics are used in cognition and especially on how they are learned.

The cognitive approach has so far emphasized *one way* to learn a generic – what we called inferential defaultness above (§3). The cognitive approach is however not committed to the claim that this is the only way to learn a generics. For instance, Leslie (2017, 416–17) recognizes that generics are transmitted verbally from parents to children (i.e., testimonial learning; see the next subsection). 'Default inference' is also at odds with how generics are inferred by scientists. Indeed, the evidential base for a scientific generic is typically not constituted by a few observations collected in a haphazard way, but by a systematic protocol. Furthermore, scientific generics are ostensibly inferred from (often hedged) quantified generalizations – especially outcomes of statistical tests – about the real world or from generalizations about models (see section 2 for these distinctions).

The second research direction that we propose is thus oriented toward answering the following question: *How does the scientist's commitment to a given scientific generic relate, temporally and functionally, to commitments to other generalizations such as model-based generalizations or statistical generalizations?* To illustrate why we think this research direction will be fruitful, we put forward two competing hypotheses about the relations among types of generalizations.

The first hypothesis is that generics appear only at the end of the inferential process in science. At the point of communicating to colleagues (in print or in oral exchanges) or when reporting to laypersons, the scientist might find it more convenient to state the gist of her results in the form of a generic. This late transition to generic would be primarily motivated by mundane considerations such as time and cognitive constraints in the communication process.[19]

The second hypothesis is that generics (or at least their correlates in terms of non-linguistic, unquantified expectations) affect the whole inferential process – i.e., other forms of generalizations are only credible on the background of accepted generics. For instance, in statistical work, what is used to select background assumptions about, say, statistical independence among a set of variables might be based on generics. Similarly, models might be built by turning some generics into universal truths in the model, becoming “credible worlds” (Sugden 2000) only by reflecting generics accepted by the relevant community of specialists.

19 There is indeed increasing psycholinguistic evidence that generics are easier to process than quantifiers, even for adults (Meyer, Gelman, and Stilwell 2011; Leslie, Khemlani, and Glucksberg 2011).

Regardless of which hypothesis is correct, this research direction is likely to enrich our understanding of scientific cognition and, at the same time, the cognitive approach to generics.

5.3 Learning a generic through expert testimony

As we already remarked, the cognitive approach is aware that learning a generic does not happen in a social vacuum. For example, children learn some of their generics through testimony. Testimonial learning of generics happens among adults too, which leads us to formulate our third research question: *How do adult laypersons acquire generics through testimonies from experts?* Two processes come spontaneously to mind. In the first process, the expert does not put forward a generic, but it is translated as such by laypersons.[20] In the second process, the expert expresses herself directly with generics.

Our study of the literature on the effects of inequalities on growth shows that the real processes are more complicated. For instance, Federico Cingano (2014, 28) from the OECD carefully states his main conclusion in statistical terminology: “income inequality has a sizeable and statistically significant negative impact on growth”. But the conclusion reaching the broader public is a blunt generic thanks to the OECD’s Newsroom: “Inequality hurts economic growth” (OECD 2014). In an even more influential research paper, Jonathan D. Ostry and colleagues (2014, 5) opt for generics, but hedge them: “equality seems to drive higher and more sustainable growth”. Yet, the general press relays their conclusion as an unhedged generic – e.g., “IMF study finds *inequality is damaging to economic growth*” (Inman 2014, our emphasis). The same Ostry (2014) also picks a different communicative strategy when writing an opinion piece in the *Financial Times*: “inequality […] makes an important difference to the level of economic growth.” The hedge is gone.

A better understanding of how the testimonies of experts participate to the acquisition of generics by laypersons promises to be especially relevant to contemporary discussions over the

20 This phenomenon of “defaulting to generic” has already been documented in children and in adults (Leslie 2012, 36–41)

legitimate roles of experts in our societies. For instance, it should make us reconsider the argument for inductive risk, which is still premised on a set-theoretical reading of expert's claims, where the core issue would be to balance the risks of false positive and false negative (e.g., John 2015). More generally, it should make us reconsider the informational content transfered from experts to laypersons.

6 Conclusion

This article argued that the worldly unquantified generalizations of the sciences (WUGS) are generics. We have then indicated how the cognitive approach to generics duly extended to scientific generics promises to shift research away from problems such as Lange's dilemma and toward more fruitful questions about the content-based elements in their truth conditions, about the relationships of scientific generics with other types of scientific generalizations and about the testimonial relationship of experts and laypersons with respect to learning generics.

Of course, these promising research areas need to be explored extensively before we can draw definitive conclusions about them. We can also expect new questions to arise along the way, for instance questions relative to how genericity manifests itself in specific scientific fields (especially the ones furthest from economics). Finally, all these developments should also be beneficial to natural-language semanticists who have been focussing on everyday generics. We invite them to study genericity in and outside science.

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