Министерство науки и высшего образования РФ
Национальный исследовательский Нижегородский государственный университет им. Н.И. Лобачевского

The Digital Scholar:
Philosopher's lab

Vol. 3. • no 1.

Цифровой ученый:
лаборатория философа

Т. 3. • №1.

Нижний Новгород
Издательство Нижегородского государственного университета
2020

ISSN 2618-9267

The Digital Scholar: Philosopher's lab

2020. Vol. 3. No 1.

Quarterly peer-reviewed journal

Abstracting and indexing: Philosophy Documentation Center (PDC),
Ulrichs Periodicals Directory, Russian Index of Science Citation (RISC).
DOI assignment by PDC.

Publisher: Nizhni Novgorod State University Press.
The Mass Media Registration Certificate: No. FS77-72454 on 05.03.2018
Frequency: 4 times per year. First issue: 2018.
Place of publication: 23 Prospekt Gagarina (Gagarin Avenue), Nizhny Novgorod, 603950, Russia
Official website: http://www.digital-scholar.unn.ru
Subscription index in the integrated catalogue «The Press of Russia» is 39461.

TABLE OF CONTENTS

SPECIAL ISSUE ON COMMUNICATIONS ON SCIENCE AND TECHNOLOGY

УНИВЕРСИТЕТ

УДК 001.4
DOI: 10.5840/dspl2020316

ОГРАНИЧЕНИЯ НА ОБЩЕЕ: К (НЕПРАВИЛЬНОМУ) ИСПОЛЬЗОВАНИЮ ОБЩИХ ВЫСКАЗЫВАНИЙ В НАУЧНОЙ ПРОЗЕ

Джозеф Уилсон – соискатель степени PhD, лингвистическая и семиотическая антропология, департамент антропологии. Университет Торонто, 19 Russell St, Торонто, ON, M5S 2S2, Канада;
e-mail: joseph.wilson@utoronto.ca

Общие утверждения – это высказывания, содержащие утверждения общего характера, которые встречаются в самых разных письменных и устных жанрах. Общие утверждения по определению не содержат в своей структуре никаких указаний на предпосылки, при которых они могут считаться верными. При этом их неправильное использование в научно-популярной литературе может подорвать доверие общественности к самому научному процессу, когда обнаруживается, что выводы в значительной степени зависят от определенных условий истинности. Язык, используемый в научных работах, часто включает в себя различные оговорки и хедж-обороты[1], эпистемологические последствия которых изучались Бруно Латуром, Томасом Куном, Яном Хакингом и др. Некоторые исследования, однако, показывают, что аннотации и рефераты научных текстов часто содержат общие утверждения, которые не подтверждаются научными данными, приведенными в полном тексте работы. Аналогичным образом, когда сообщения о научных открытиях появляются в популярных СМИ, журналисты также часто удаляют из своих текстов оговорки, хедж-обороты и маркеры контекстов, содержащиеся в оригинальных текстах. Исследования в области антропологии, проведенные Джозефом Думитом, Аннемари Мол, Харрисом Соломоном и др., посвящены изучению реакции человека на подобные утверждения. Одним из возможных решений проблемы чрезмерного использования высказываний общего характера в аннотациях и рефератах научных текстов, особенно в исследованиях с участием человека в качестве субъекта, является включение обязательного раздела «Ограничения на общее», предложенное Гутьерресом и Рогоффом

[1] Хедж-обороты (от англ. hedge) – средства различных уровней языка со значением вероятности и возможности. Явление лингвистического хеджирования связано с установлением границ ответственности автора высказывания и смягчением категоричности (примеч. переводч.).

(2003). Кроме того, предлагается использовать меньше субстантивированных глаголов и больше описаний в форме прошедшего времени о том, что на самом деле имело место в конкретном исследовании.

Ключевые слова: высказывания общего характера, журналистика; лингвистика; научные публикации

Цитирование: Wilson J. Constraints on generality: The (mis-)use of generic propositions in scientific prose // Цифровой ученый: лаборатория философа. 2020. Т. 3. №1. С. 51-66. DOI: 10.5840/dspl2020316

CONSTRAINTS ON GENERALITY: THE (MIS-)USE OF GENERIC PROPOSITIONS IN SCIENTIFIC PROSE

Joseph Wilson – PhD Student, Linguistic & Semiotic Anthropology, Department of Anthropology. University of Toronto, 19 Russell St., Toronto, ON, Canada, M5S 2S2;
e-mail: joseph.wilson@utoronto.ca

Generic propositions are statements that make general claims about 'kinds' that are found in a wide variety of written genres and speech. By definition, generics do not include in their structure any reference to the conditions under which they hold true. Their mis-use in popular scientific writing, however, can erode the public's confidence in the process of science itself when they discover that conclusions are highly contingent on certain truth conditions. The language used in scholarly scientific papers often includes qualifiers and hedges, the epistemological consequences of which have been explored by Bruno Latour, Thomas Kuhn, Ian Hacking and others. Some research shows that abstracts, however, often include generic statements that are not warranted by the scientific evidence described in the full text. Similarly, when accounts of scientific discoveries appear in popular media, journalists often remove qualifiers, hedges and context markers that existed in the original study. Studies in anthropology by Joseph Dumit, Annemarie Mol, Harris Solomon and others explore the human reactions to such pronouncements. One possible solution to the over-use of generics in scientific abstracts, especially for studies that rely on human subjects, is the inclusion of a mandatory section entitled "Constraints on Generality," as suggested by Gutiérrez and Rogoff (2003). Other suggestions include using less nominalized verbs and more past-tense descriptions of what actually occurred in the particular study.

Keywords: generics, journalism, linguistics, publishing

Might be cited as: Wilson, Joseph. 2020. Constraints on generality: The (mis-)use of generic propositions in scientific prose, *The Digital Scholar: Philosopher's Lab*, 3 (1): 51-66. DOI: 10.5840/dspl2020316

A Generic Molecule

The definition of a molecule is one of the first things students learn in grade school science. "A molecule is a neutral group of two or more atoms held together by chemical bonds," says one popular education website, a definition with which most grade school teachers would agree [Helmenstine, 2019, web]. The definition above is written as a *generic statement*, one that applies to all molecules, not just a particular molecule, or even a specific group of molecules. It is assumed to be universal truth, one that transcends time and space, valid everywhere and anywhere [Latour, 1987]. The sentence defines "molecules" as a "kind," a concept that needs to be accepted and understood for anyone interested in progressing in science. The same syntactic form is used to deepen the definition on the same website:

(1) Molecules may be simple or complex.
(2) Molecules made up of two or more elements are called compounds.
(3) All compounds are molecules.
(4) Single atoms of elements are not molecules.

The short, generic sentences are comforting in their assuredness. They are exemplary in their representation of science, projecting objectivity and clarity.

As is the case with many scientific concepts, however, the clarity of the definition conceals a complex core that is contingent on assumed truth conditions. For example, when two scientists were asked whether a "single atom of helium was or was not a molecule, both answered without hesitation, but their answers were not the same," writes Thomas Kuhn in *The Structure of Scientific Revolution* [1996, p. 49]. "For the chemist the atom of helium was a molecule because it behaved like one with respect to the kinetic theory of gases," Kuhn writes, "for the physicist, on the other hand, the helium atom was not a molecule because it displayed no molecular spectrum" [ibid.]. Their disagreement suggests that the generalization created by the generic sentence #4 above, is not warranted. Similar exercises can be performed with the other sentences above to show that previous knowledge, including context, truth conditions and competency in the English language are required in order to accept the conclusion[1]. The two scientists were defining molecules under different truth conditions as determined by their laboratory equipment and the goals of their work. In short, the *context* in which a molecule exists as a 'kind' is erased and remains uninterrogated in such ge-

[1] For example: water is a 'simple' molecule composed of only three atoms yet has a remarkably 'complex' polar structure leading to complex chemical and physical properties, problematizing statement #1 above. To raise a purely linguistic objection, sentence #3 is certainly not true—compound words, compound fractures and prison compounds are certainly not molecules.

neric statements. "Referents of scientific words are often conveniently vague," writes Whorf, "markedly under the sway of the patterns in which they occur" [1940, p. 260].

This paper will examine the use of generic sentences in scientific discourse. In particular, attention will be paid to the process of turning highly contingent discoveries into generic statements, a process Bruno Latour refers to as the "construction of a scientific fact" [Latour, Woolgar, 1986].

There are consequences to relying too heavily on generic statements in science, especially when we are faced with difficult choices regarding health care or are presented with scientific claims in the media. Although generics might be good to think with and can allow for glimpses of deeply embedded beliefs and semantic relationships between terms, they can also be dangerous, papering over nuance in favour of an ersatz certainty.

Lions, Mosquitos and Donkeys

In 1977, John Lyons made a famous comparison between two generic propositions in his book *Semantics* (1977):

(5) The lion is a friendly beast

(6) A lion is a friendly beast[1]

Sentence #5 contains a definite noun phrase ("the lion"), whereas sentence #6 contains an indefinite noun phrase ("a lion"), however the two sentences could both refer to the generic category of "lion," instead of what would be expected from a traditional grammatical interpretation [Lyons, 1977, 196].

In the same year, Greg Carlson analysed the different ways in which generic propositions appeared in the English language with his Master's thesis on English bare plurals. With classic understatement, he says that, "the relationship between *a*, *the*, and φ is a most interesting (and difficult) one" [Carlson, 1977, p. 455]. Generic propositions can take many different forms in the English language, and native speakers use them often [Mari et al., 2014, p. 32]. They are not used to refer to specific objects (or lions), nor necessarily all the individuals that make up a group, but to the group itself, a sort of Platonic ideal of what members of a group should be. In short, generics define 'kinds.' According to philosopher Ian Hacking, the goal of scientific inquiry is to determine the "natural kinds" that make up the world, such as "water, sulphur,

[1] Lyons' eponymous example seems to have sparked an interest in lions amongst linguists. In the Mari volume [Mari et al., 2014] alone we find: "the lion is a predatory cat" (p. 27); "les lions ont une crinière" (p. 69); "there is a lion in the courtyard" (p. 333); "un lion a couru très vite" (p. 368); "lions give birth to live young" (p. 392). This reminds me of Barthe's comment (taken from poet Paul Valéry) on the sentence *quia ego nominor leo* from his childhood Latin textbook. The sentence does not mean "for my name is leo" (who is a lion, naturally), as a literal translation would suggest, but more accurately translates as "I am a grammatical example meant to illustrate the rule about the agreement of the predicate" [Barthes, 1972, p. 116)].

horse, tiger, lemon, multiple sclerosis, heat and the color yellow" [Hacking, 1999, p. 107].

"The presence or absence of number morphology seems to play a critical role in kind formation and in the way a kind is related to its instances," writes Alda Mari et al. [2014, p. 32]. But beyond this, there is much debate about how generics should be classified and what they actually represent in the minds of speakers. Pelletier and Asher (1997) summarize some properties of generic kinds that are useful to our purposes in analysing their use in scientific discourse. First, generics always have "unstated truth conditions," [Mari et al., 2014, p. 85] as we saw with the definition of a molecule above. For example, for Lyons, if one particular lion displayed a distinctly un-friendly character, it would not be enough to disqualify the generic from being "true". As such, generics are not "rules" to be followed, nor do they define objects in the world categorically – generic propositions always exhibit a "tolerance to exceptions" [ibid.].

In explaining where generics come from, some scholars subscribe to the 'one-drop' model which is to say that if one member of a kind can be demonstrated to have a particular characteristic, a generic statement is justified. "Mosquitos carry the West Nile Virus," is a classic example of a generic that is generally considered to be true even though a vanishingly small proportion of mosquitos actually carry the virus. The full quote including this above clause is instructive in determining why the 'one-drop' model does not work: "You be careful about mosquitos and deer ticks. Mosquitos carry the WNV and deer ticks too" [Asher, Pelletier, 2014, p. 330]. Asher and Pelletier argue that "weak existential-like truth conditions" cannot be the basic truth conditions for all generics [ibid., p. 332]. The aforementioned generic about mosquitos is appropriate in the context of someone is going out into the woods who has perhaps asked for suggestions on how to stay safe. The validity of the generic is created by the introductory sentence, suggesting that even though not very many mosquitos carry the virus, there are enough of them to worry about. If one in 10 billion carries it, on the other hand, the generic wouldn't be considered as true and the one single virus-carrier would be considered an anomaly [ibid.].

Moving from mosquitos to donkeys, Manfred Krifka argues that the sentence "a donkey has 62 chromosomes" [2014, p. 382], creates a kind as being defined by the number of chromosomes they have. This is a common goal of science, to continually tweak the limits of categories with the hopes of refining the system of taxonomy to better represent nature. A donkey with a chromosomal abnormality would not render this statement false, yet if by some strange fluke the scientists had sequenced the only donkey to have 62 chromosomes, the generic certainly would be considered false. In the past, donkeys and mosquitos were classified by their physical features or their behaviour, suggesting that the kinds created by generic propositions change over time [Krifka, 2014, p. 383]. The fact that "donkey" is recognized as a kind is the only way this sentence can work. If one were to say, "an animal in this cage has 62 chromosomes," even though it might be true, it doesn't work on a linguistic level because "an animal in this cage" is not a natural kind [ibid., p. 385].

Dubious Generics

Human beings certainly qualify as natural kinds. It doesn't take much to find generic statements of the form "people are_____" or "humans are________". Such generalizations often contain a glimmer of truth, but the use of such phrases as stereotypes or in drawing erroneous conclusions about human nature is of great concern to many scholars. In scientific publications, "generic language (e.g., "Introverts and extraverts require different learning environments") may mislead by implying general, timeless conclusions while glossing over exceptions and variability," writes psychologist Jasmine DeJesus et al. [2019, p. 18370]. In 2015 and 2016, DeJesus and three collaborators analysed the text of the abstracts of 1,149 psychology articles across 11 journals. They found that "generics were ubiquitously used to convey results (89% of articles included at least 1 generic)" [ibid.]. Furthermore, "readers judged results expressed with generic language to be more important and generalizable than findings expressed with non-generic language" [ibid.]. Although other studies have shown that the language in the full bodies of scientific articles tends to include more qualifiers and hedges than everyday speech [Ransohoff, Ransohoff, 2001, p. 186], this was not found to be true for the abstracts in DeJesus et al.'s study. Considering most scholars only read the abstracts of published papers [Pain, 2016], this has the potential of propagating false generalizations about human behaviour. Even more problematic was the finding that "generic use was unrelated to the evidentiary basis of the claim (as measured by the features of the sample coded from the articles): Articles that recruited a larger sample were not more likely to include generics than articles that reported smaller samples," the authors write [DeJesus et al., 2019, p. 18373]. To combat this, Gutiérrez and Rogoff (2003) recommend replacing such broad generic claims with past-tense statements that convey what was observed in a given situation ("the children did such and such") [DeJesus et al. 2019, p. 18371].

Statements about the human genome in the biological sciences can be similarly generic. In biology textbooks one often finds reference to "the human genome" in definite form suggesting there is only one, or that humans have genomes that can all be classified as part of the same kind.

"The human genome is the genome of Homo sapiens" says Science Daily [2019, web], even though most of the genome sequenced through the Human Genome Project was sequenced from a very few individuals from Buffalo, New York [Osoegawa, 2001]. Most scholars would defend the use of the generic as valid by claiming that only 0.1% of the human genome is different from individual to individual. That said, a lot can be hidden in that 0.1% as any scholar in the humanities or social sciences can attest to. Scholars working on the human genome project very consciously used the definite generic noun phrase to refer to their work, both for humanitarian reasons to emphasize the common structure of human biologics, but also, I suspect, to establish the sequence as a landmark accomplishment, amounting to nothing less than the creation of a new generic category.

Generic categories work, in part, because they are easy to imagine and are simple to remember, even when they are contradictory under certain conditions. From the anecdote in the introduction we could claim that "Helium is a molecule" and "Helium is an atom" and be correct both times. Kuhn explains why Copernicus' contemporaries generally did not accept his heliocentric model. "They were not either just wrong or quite wrong," he writes. "Part of what they meant by 'earth' was fixed position. Their Earth, at least, could not be moved", [Kuhn, 1996, p. 149] he writes, in an argument that could just as easily apply to the contextual assumptions of our two helium scientists.

Constructing Facts

Developing generic propositions that describe the widest possible variety of phenomena in the most parsimonious means possible is, in a sense, the entire purpose of positivist science. So how do generic propositions in science come to be? Scientists are generally cautious about generalizing too liberally because they know that there is a rival scientist in a neighbouring lab only too happy to point out the conditions under which their new law does not apply. As such, generic propositions are created, step by step, as scientists progress through layers of experiments, references, and as they secure support for their theories from colleagues. This process is explored in much of Bruno Latour's early work during a period of field work in the laboratories of endocrinologists working at the Salk Institute in the 1970s.

Latour and colleague Steve Woolgar track the process by which statements go from being highly contingent on the work of individual scientists and particular labs, to the generic state of being facts that 'everyone knows'. In this way, scientific facts are *constructed*, not *discovered*, a semantic distinction that annoys scientists who feel like this phrasing is an attack on their profession. However, the etymological root of the word "fact" implies such creation. It comes from the Latin root *facere* meaning "to do," a connection that is more obvious in Italian where fact is translated as *fatto* and do/make is translated as *fare*, or in Latour's mother tongue, French, which uses *fait* and *faire* respectively [OED, 2019, web].

Scientists' goal is to uncover the "objective facts of nature," yet "by noting that human agency was involved in its production, the inclusion of a reference diminishes the likelihood that the statement will be accepted," write Latour and Woolgar [1986, p. 80]. In analyzing both the talk (albeit without transcriptions from recordings) and the written work of their subjects, Latour and Woolgar claim that "activity in the laboratory had the effect of transforming statements from one type to another" [ibid., p. 81]. They lay out a five-level scale on which statements can be classified, from one (highly contingent, highly tentative) to five (with no trace of contingency). The below example uses statements that refer to the discovery, in 1974, that the hormone "somatostatin" inhibits the release of human growth hormone (GH), specifically the thyroid-stimulating hormone (TSH).

(7) *"[W]e might as well envisage them [the mechanisms] as involving* inhibition of secretion of endogenous substance B, *a hypothesis which is not incompatible with the data*" [ibid., p. 86].

Here, statement #7 is presented as a highly contingent hypothesis emerging from the observation of some unknown process. (Substance B is the mystery substance that will turn out to be somatostatin). I have added italics to show the hedges the writer includes to emphasize the tentative nature of the claim, that the (unknown) substance is employing (unknown) mechanisms that are "involving" inhibition. The clause at the end of the sentence admits, in the most timid language possible, that the hypothesis is not incompatible with the data. (He'll leave it to others to say that it might, in fact, be compatible with the data). Further experimentation reveals that:

(8) "*these experiments show that*… synthetic substance B inhibits GH *in rats*" [ibid., p. 86].

The statement is bolder, but still includes context such as reference to their particular experiments and the use of rats as subjects. The mystery substance has been given a name and is now easily isolated in the lab. After some time, other laboratories were able to replicate the study, which prompts the author to remind his colleagues, in print, that repeatability is the hallmark of scientific progress:

(9) "*Our original observations* of the effects of somatostatin in the secretion of TSH *have now been confirmed in other laboratories*" [ibid., p. 83].

Statement #9 is on its way to becoming a fact, corroborated as it is by other experiments at other labs. The word "blocks" is now used in a statement that contains no traces of context or authorship. The only hedge that remains is the reference to the specific apparatus used to measure the results:

(10) "Somatostatin blocks the release of growth hormones *as measured by radioimmunoassay*" [ibid., p. 184].

After some time, the reference to the apparatus is gone and the fact is repeated until it becomes a generic statement:

(11) "Somatostatin inhibits GH secretion" [Molitch, 2012, p. 1426].

It is instructive that the generic statement regarding somatostatin and growth hormone was not taken from Latour's book (originally published in 1979), as the book came out only a few years after the discovery of somatostatin in 1974. The fact took years to "settle" and to be comfortable being expressed in generic form.

For Latour and Woolgar, "a fact is nothing but a statement with no modality… and no trace of authorship" [Latour, Woolgar, 1986, p. 82].

"Grammatical modalities ('maybe', 'definitely established', 'unlikely', 'not confirmed') often acted like… an expression of the *weight* of a statement," they write [ibid.]. As cautious as the endocrinologists were in their writing, over time the qualifiers disappear from their statements until a fact is born. As in the DeJesus et al. study, scientists are eager to make the 'weightiest' statements possible and they use generic propositions to do so.

Latour and Woolgar are not linguists, nor anthropologists, and as such entreat such researchers to engage with the language of scientists. "For semioticians, science is a form of fiction or discourse like any other… one effect of which is the 'truth effect,' which (like all other literary effects) arises from textual characteristics, such as the tense of verbs, the structure of enunciation, modalities, and so on," they write [1986, p. 184]. Sociologists G. Nigel Gilbert and Michael Mulkay took seriously this call-to-action and spent years recording and analysing the speech of scientists in the lab. They identify two "registers" of speech employed by the scientists, one that is used in formal scientific literature that tends to remove all traces of the scientist from the action, and another that was used in their casual, semi-structured interviews [Gilbert, Mulkay, 1984, p. 39]. The scientists were fully aware that science did not proceed in an objective, disinterested fashion and that politics and rhetoric were part of the game. But they seemed to think that it was worth striving for nonetheless. This reliance in the formal literature on language that removed the scientist from the process had some strange consequences, however. They identify generic propositions such as "everybody accepts that the fundamental particles of oxidative phosphorylation are the electron and the proton" in the literature [ibid., p. 135], or "everybody accepts chemiosmosis" in everyday interviews, but what the individual scientists meant by those noun phrases, much like the helium problem from the Introduction, differed significantly. Each scientist had his (there were only men involved in the study) own version of what was meant by "chemiosmosis," yet they all claimed that the theory was universally accepted. "The apparent facticity of chemiosmosis and its apparently widespread endorsement are illusory in the specific sense that they exist, not as objective entities in an external social world, but only as attributes of participants' contingent consensus accounts," write Gilbert and Mulkay [1984, p. 137]. This incongruity was only evident during the oral interviews, however. "The relative absence of obvious contradictions among the claims advanced in particular written texts is probably due to the care with which such texts are prepared, to the use of a restricted interpretative repertoire and to the absence of that direct interaction with other actors which elicits variable responses in so many subtle ways," they write [ibid., p. 125]. That is to say, any generics used by the scientists are carefully constructed so as to leave "tolerance for exceptions" in the words of Pelletier and Asher (1997). Gilbert and Mulkay also found that, at certain times, instead of taking years for facts to emerge as generics, "the factual status of one substance, for instance, varied dramatically over a period of a few days"

(Gilbert, Mulkay, 1984, p. 179]. The process of transformation, however, is very subtle, even if scientists remove hedges that should probably not be removed [DeJesus et al., 2019]. "The process of construction involves the use of certain devices whereby all traces of production are made extremely difficult to detect," writes Latour. "Both participant and observer are soon left with a version of the event which has been eroded of all contingent circumstances," he writes [Latour, Woolgar, 1986, p. 174].

Coffee Causes Cancer

One of the realms of science where generics are particularly problematic is in health care.

Consumers of news media are familiar with the kinds of generics that have in them a grain of scientific accuracy but are stripped of all contingencies without qualification, such as:

(12) "High cholesterol causes heart disease"

(13) "Salt is bad for you"

(14) "Coffee causes cancer"

In a study of "women's magazines" such as *Redbook, Good Housekeeping* and *Cosmopolitan*, Amanda Hinnant read 148 articles on the topic of women's health. The articles were full of generics such as the examples above, deployed according to a specific formula. First, the writers would remove the qualifiers and hedges and context markers that existed in an original scientific study and use generic propositions to instil anxiety in the reader. Then, using the language of feminism and personal empowerment the authors would advocate for any number of self-help cures. Most of the articles did include a hedge, usually near the end, that reminded readers that health issues are complicated and to always "check with your doctor", before making any decisions. Doctors were almost always quoted in the articles as voices of authority but were usually not the medical scientists responsible for the original study.

"News reports of scientific research are rarely hedged," argues Jakob Jensen after analyzing mass media reports of cancer studies. "In other words, the reports do not contain caveats, limitations, or other indicators of scientific uncertainty," he writes [2008, p. 347]. He also found that scientists and the journalists who were writing about them were viewed as more trustworthy when hedges were included in the reporting and even more so when the hedging was attributed to the scientists responsible for the research [ibid.]. However, if the data collected by DeJesus et al. by perusing psychology journals is any guide, this means that scientists are presented with a difficult choice: do they want to make statements that are "more important and generalizable" [2019, p. 18370] or do they want to be viewed as trustworthy? "Hedging might enhance scientists' trustworthiness while decreasing the believability of the research being reported," writes Jensen [2008, p. 365].

The Error Bar

Science itself shares one core feature with that of a generic proposition: that of falsifiability. According to philosopher Karl Popper, claims in science can never be known to be fully true; claims can never be 'proven' [Popper, 1959]. Instead, only the inverse of the claim can be shown empirically. A famous example refers to the generic claim that (with Lyonesque wording), "the swan is a white animal" or "a swan is a white animal." It only takes one black swan to disprove this claim, and we will never be able to see all the swans in the world, so we will never know for sure. Because of this epistemological approach, many people are suspicious of the claims made by scientists. 'It's always changing,' people say. 'They can't decide what's true.' Or, to quote Wittgenstein, "if I don't trust this evidence why should I trust any evidence?" [1975, #672]. This is a feature (not a bug) of science, and it ensures that the generic facts found in science textbooks continually change, something that fuels people's skepticism. You can hear the frustration in this quote from an Australian physician who published an early study about the relationship between coffee and cancer (glossed in generic proposition (14) above which appeared in headlines all over the world), only to have the theory refuted by further data. "People said the researchers in Australia have changed their minds," he said. "They don't understand what science is," he continues. "We didn't change our minds. We just produced more data" [Levinovitz, 2015, p. 41]. (For the record, coffee does not cause cancer [Loomis et al., 2016]. For now.).

Harris Solomon, in his ethnography of the Indian health care system, says that "facts are supposed to clear up confusion and calm the mind, but all too often they do the opposite and are mistakenly taken to be alarming" [2016, p. 116]. Solomon mentions that the guidelines on what constitute 'high cholesterol' have changed four times in the past twenty years in India. At the same time, the Body Mass Index (BMI) threshold for obesity was lowered, meaning millions of Indians were suddenly rendered 'obese' overnight. As such, patients are always in doubt about their health because the threshold that constitutes 'health' is continually changing. The generic, pronounced as a definitive conclusion, is prone to slippage and to modification.

Scientists see this as a reason to celebrate. "Science, you see, is the optimum belief system: because we have the error bar, the greatest invention of mankind, a pictorial representation of the glorious, undogmatic uncertainty in our results, which science is happy to confront and work with. Show me a politician's speech, or a religious text, or a news article, with an error bar next to it," writes physician and medical writer for *The Guardian*, Ben Goldacre [2015, p. 481]. This (only partly-ironic) paean to the "error bar" is naïve because it ignores how the error bar feels from the perspective of a patient, that is, as a source of anxiety.

In *Drugs for Life* (2012), anthropologist Joseph Dumit frames the biomedical "fact" as a tool of persuasion in much the same way Latour and Woolgar describe the rhetorical tools scientists use to get people to support their conclusions. The risk factors of high cholesterol are not illnesses in themselves but are indexical of certain illnesses [Dumit, 2012, p. 123]. The patient is left with a glaring paradox between the certainty of generic pronouncements such as "high cholesterol is dangerous" or "high cholesterol leads to heart disease" against the reality of a statistical model which indicates a slightly higher risk than they had before their diagnosis.

"For a long time, and in many places, science held (or continues to hold) the promise of closure through fact-finding," writes Annemarie Mol in *The Body Multiple* [2002, p. 177]. But this closure never comes because of the ever-present 'tolerance for exceptions' in generic propositions. The error bar is always present, spoiling our desire to be anxiety-free through the grace of undisputable facts. The solution suggested by Mol is to accept the uncertainty of facts as a truth in itself and to constantly interrogate generics as being incomplete statements [ibid., p. 184].

Conceptual Blending

To avoid the allure of objectivity suggested by generics, one rhetorical technique often used by scientists is to employ metaphors such as the familiar comparison 'atoms are like solar systems.' Novel metaphors, once they are used for the first time in science, are accepted by scientists as an appropriate way to explore the limitations of a certain model [Hesse, 1966]. "[I]n order to be viable for propagation, novel metaphors and metonymies must fulfill structural *iconicity,* and pragmatic *relevance* requirements," writes Alicia Urquidi [2015, p. 219]. There is an iconic relationship between the orbiting of planets around a star and the orbiting of electrons around a proton. There are relational similarities between the components (lighter object/heavier object; closer orbits/further orbits etc.) that allowed scientists to create new hypotheses about the behaviour of atoms. This process, known as "conceptual blending" is a more modern understanding of how metaphors work than what was suggested by Aristotle's comparison approach 2,000 years ago [Fauconnier, Turner, 2002, p. 222].

The paradox is that, once novel metaphors become conventional in use, they lose much of their metaphorical power. This means that they can become generic propositions like any other, prone to oversimplification and supporting outdated kinds that many scholars feel we should move past. The most successful strategies, argues Urquidi (at least in the realm of Economics textbooks), is to blend novel metaphors with conventional metaphors in a process known as *generic interference,* a tool that "transforms pre-existing conventional figurative meaning into a part of the generic space of a blend" [Urquidi, 2015, p. 225]. Much of the language analyzed by Urquidi and her colleagues employed linguistic metaphors that pointed to a few core conceptual metaphors [Lakoff, Johnson, 1980] such as A COMPLEX SYSTEM IS A SHIP, or in a more general form, ECONOMIC ACTIVITY IS A JOURNEY [Urquidi, 2015, p. 227]. Using this conventional metaphor as a base, effective writers would use 'generic interference' to create novel metaphors for new ideas. "In order to compare a British bank with a British pirate ship and, metonymically, with the infamous Pirate Drake, the following utterances are used" (original in Spanish):

(15) LCH.Clearnet hizo de Drake

(16) LCH.Clearnet did of Drake

(17) LCH.Clearnet acted as Drake

This metonym is not a generic proposition in the sense proposed by Lyons or Carlson, but the reference to Drake points, in an indexical manner, to the generic kind 'pirate'.

Zombie Nouns

In his book *The Language of Science* [2006], M.A.K. Halliday argued that one of the tools scientists should use for "organizing and packaging information" is that of grammatical metaphor [ibid., p. 2]. Halliday calls for writers to turn their verbs into nouns, a process called nominalization, a way of "shifting the whole set of mappings 'downwards'; a sequence is downgraded to a figure, a figure to an element, an element to a thing, and so on," he writes [ibid., p. 4]. So "stem cells fail" becomes "stem cell failure" and "to dissect a rat" becomes "dissection". This process replaces the scientist as an actor in the prose with nouns such as "dissection" or, from Latour and Woolger, "involving inhibition of secretion of endogenous substance B," which uses noun forms instead of verbs such as "inhibit" or "secrete." "There is a general tendency towards thingness," writes Bahram Kazemian [2013, p. 156]. It is certainly easier to create a simple generic proposition out of a noun phrase than it is a clause with a number of transitive verbs. Clauses that include actors are necessarily non-generic; they are marked as occurring at a particular time and place with a particular actor. "I call them 'zombie nouns'," writes Helen Sword at the *New York Times*, "because they cannibalize active verbs, suck the lifeblood from adjectives and substitute abstract entities for human beings" [Sword, 2012].

This process is what gives written scientific discourse its turgid, inflexible tone. "In scientific writing, the lexical density may go much higher and the language appears intricate because it contains a significant number of interrelated technical taxonomies and each of which has been defined and includes information the reader is expected to already make sense of", writes Kazemian [2013, p. 154]. This density can be alienating and is prone to misunderstanding. If readers do not have the requisite network of definitions at hand they often treat nominalized sentences as generic propositions without qualification.

Remarkably, this strategy is recommended by a large number of writing coaches for budding scientists. The benefit is that "in nominalized expressions, the voice of the writing seems more abstract, objective and more formal," writes Kazemian [2013, p. 161]. A paper by Chinwe Ezeifeka (2015) claims that nominalization and the use of grammatical metaphor are "a systemic resource for achieving proficiency in research abstract writing" [ibid., p. 1]. Scientific writing "requires a specialized pattern of information packaging and texture in ways which not only make for word economy but also retain the sophistication and erudite touch which mark it out as proficient academic discourse," he argues [ibid.]. "Sophistication and erudite touch" are probably not the words most readers would use to describe scientific prose, yet his argument largely supports the claims of Gilbert and Mulkay, Latour, Bourdieu and others who argue that the impenetrability of academic prose is a deliberate rhetorical strategy to appear authoritative and objective. It is all the more telling that Ezeifeka's suggestions are specifically designed for writing academic abstracts with "word economy and information density," precisely the sections that are most read by other scholars [Pain, 2016], and the sections in which DeJesus et al. found the most generic propositions were used to gloss over experimental contingencies.

Conclusion

Contingencies, complexities, and context, although often boring, or complicated, or long-winded, are what give writing its life. This includes scientific prose. "Scientific research begins with a set of sentences which point the way to certain observations and experiments," writes Benjamin Lee Whorf, "the results of which do not become fully scientific until they are turned back into language, yielding again a set of sentences which then become the basis of further exploration into the unknown" [1940, p. 221]. Pierre Bourdieu puts it less charitably, saying "the ruse of scientific reason consists in making necessity out of contingency and chance, and in making a scientific virtue of social necessity" [2004, p. 77].

One of the flaws of relying on the 'self-correcting' nature of the peer-review process in scientific journals is that incorrect claims that are strongly worded as generic propositions become anchored in the minds of the readers (ex. "coffee causes cancer"), even though later research reveals inconsistencies [Simons et al., 2017, p. 1125]. "Both participant and observer are soon left with a version of the event which has been eroded of all contingent circumstances," writes Latour [1986, p. 174] of the fact-making process. This can have the effect of establishing facts as part of the scientific canon, yet often erode the trustworthiness of the individual scientists [Jensen, 2008]. As such, I wholeheartedly endorse Simon et al.'s suggestion of a 'Constraints on Generality' section for scientific papers, especially when those papers rely on human subjects such as the were in DeJesus et al.'s study. They suggest that "the discussion section of all articles describing empirical research should include a statement of the *Constraints on Generality* … that explicitly identifies and justifies the target populations for the reported findings" [Simon et al., 2017, p. 1124]. For the authors, the reason for this addition is not aesthetic, it is pragmatic. "The gears of science will turn more effectively," they argue [ibid.]. If scientists truly believe in Popper's vision of science as a series of falsifiable hypotheses, the means for falsification should be included in the declarative sentences featured in scientific prose. It might just mean we can enjoy our morning coffee once again.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Список литературы / References

Asher, Pelletier, 2014 – Asher, N., Pelletier, F.J. "More Truths about Generic Truth," in: A. Mari, C. Beyssade, F. Del Prete (eds.), *Genericity*. Oxford: Oxford University Press, 2014, pp. 312–333.

Barthes, 1972 – Barthes, R. *Mythologies*. New York: Hill and Wang, 1972.

Bourdieu, 2004 – Bourdieu, Pierre. *Science of Science and Reflexivity*. Chicago: University of Chicago Press, 2004.

Carlson, 1977 – Carlson, G.N. "A unified analysis of the English bare plural," *Linguistics and Philosophy*, 1977, vol. 1, no. 3, pp. 413–457.

DeJesus et al., 2019 – DeJesus, J.M., Callanan, M.A., Solis, G., Gelman, S.A. "Generic language in scientific communication," *PNAS*, 2019, vol. 16, no. 37, pp 18370–18377.

Dumit, 2012 – Dumit, J. *Drugs for Life: How Pharmaceutical Companies Define Our Health*. Duke University Press, 2012.

Ezeifeka, 2015 – Ezeifeka, Ch. R. Grammatical Metaphor: In Search of Proficiency in Research Abstract Writing," *SAGE Open*, 2015 January-March, pp. 1–14.

Fauconnier, Turner, 2002 – Fauconnier, G., Turner, M. *The Way We Think: Conceptual Blending and the Mind's Hidden Complexities*. New York: Basic Books, 2002.

Goldacre, 2015 – Goldacre, B. *I Think You'll Find It's a Bit More Complicated than That.* London: Fourth Estate, 2015.

Gilbert, Mulkay, 1984 – Gilbert, G. N., Mulkay, M. *Opening Pandora's Box: A Sociological Analysis of Scientists' Discourse*. Cambridge: Cambridge University Press, 1984.

Gutiérrez, Rogoff, 2003 – Gutiérrez, K. D. Rogoff, B. "Cultural ways of learning: Individual traits or repertoires of practice," *Educational Researcher*, 2003, vol. 32, no. 5, pp. 19–25.

Hacking, 1999 – Hacking, I. *The Social Construction of What?* Cambridge: Harvard University Press, 1999.

Halliday, 2006 – Halliday, M.A.K. *The Language of Science. Volume 5: The Collected Works of M.A.K. Halliday*. New York: Continuum, 2006.

Helmenstine, 2019, web – Helmenstine, A. M. "What is a Molecule?" *ThoughtCo.com*, July 09, 2019. Available at: https://www.thoughtco.com/what-is-a-molecule-definition-examples-608506 (accessed on December 19, 2019).

Hesse, 1966 – Hesse, M. *Models and Analogies in Science*. Notre Dame: University of Notre Dame Press, 1966.

Hinnant, 2009 – Hinnant, A. "The Cancer on Your Coffee Table," *Feminist Media Studies*, 2009, vol. 9, no. 3, pp. 317–333.

Jensen, 2008 – Jensen, J. D. "Scientific Uncertainty in News Coverage of Cancer Research: Effects of Hedging on Scientists' and Journalists' Credibility," *Human Communication Research*, 2008, vol. 34, no. 3, pp. 347–369.

Kazemian, 2013 – Kazemian, Bahram. "Ideational Grammatical Metaphor in Scientific Texts: A Hallidayan Perspective," *International Journal of Linguistics*, 2013, vol. 5, no. 4, pp. 146–168.

Krifka, 2014 – Krifka, M. "Definitional Generics," in: A. Mari, C. Beyssade, F. Del Prete (eds.), *Genericity*. Oxford: Oxford University Press, 2014, pp. 372–390.

Kuhn, 1996 – Kuhn, T. S. *The Structure of Scientific Revolution, 3rd Edition*. Chicago: University of Chicago Press, 1996 (1962).

Lakoff, Johnson, 1980 – Lakoff, G., Johnson, M. *Metaphors We Live by*. Chicago: University of Chicago Press, 1980.

Latour, 1987 – Latour, B. *Science in Action*. Cambridge: Harvard University Press, 1987.

Latour, Woolgar, 1986 – Latour, B., Woolgar, S. *Laboratory Life: The Construction of Scientific Facts.* Princeton University Press, 1986 (1979).

Levinovitz, 2015 – Levinovitz, A. *The Gluten Lie: And Other Myths About What You Eat*. New York: Regan Arts, 2015.

Loomis et al., 2016 – Loomis, D, Guyton, KZ, Grosse et al. "Carcinogenicity of drinking coffee, maté, and very hot beverages," *The Lancet Oncology*, Published online, 2016, 15 June. Available at: http://dx.doi.org/10.1016/S1470- 2045(16)30239-X (accessed on December 19, 2019).

Lyons, 1977 – Lyons, J. *Semantics*. Cambridge: Cambridge University Press, 1977.

Mari et al., 2014 – Mari, A., Beyssade, C., Del Prete, F. (eds), *Genericity*. Oxford: Oxford University Press, 2014.

Mol, 2002 – Mol, A. *The Body Multiple: Ontology in Medical Practice*. Durham: Duke University Press, 2002.

Molitch, 2012 – Molitch, M. E. *Goldman's Cecil Medicine (Twenty Fourth Edition)*. Philadelphia: Saunders (Elsevier), 2012.

OED, 2019, web – OED. 2019. Online Etymology Dictionary. Available at: https://www.etymonline.com/search?q=fact (accessed on December 19, 2019).

Поступила в редакцию 23.01.2020