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LINGUISTICS AND THE SCIENTIFIC METHOD*

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ABSTRACT. In the present paper, I contrast empirical and non-empirical approaches to linguistics by examining the extent to which they practice the scientific method. I provide examples of linguistic analyses that follow and depart from the scientific method and argue that valid explanations about actual language processing rely on adherence to scientific methodology. However, this is not a requirement for philosophical arguments about abstract language structure. Charges of pseudoscience arise when empirical significance is attached to analyses that fail to follow the scientific method. Progress in linguistics is only made to the extent that researchers adopt the method that is standard in scientific endeavors.

1. INTRODUCTION. If you were to randomly select an introductory science textbook the chances are very high that you would find a section dedicated to the scientific method. The steps of the scientific method are usually enumerated in this way:

- (1) Observe a phenomenon.
- (2) Formulate a hypothesis to explain it.
- (3) Carry out an experiment or collect other observations to test the hypothesis.
- (4) Analyze the results to determine whether they confirm or refute the hypothesis.

Studies which follow these steps are considered empirical or scientific. Of course, not every field of study is scientific. Literature, philosophy, pure mathematics, formal logic, and art are examples of these. All of them are worthy areas of inquiry even though they are not scientific, and in general they do not purport to be.

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In contrast, some fields have all the trappings of a scientific enterprise, but unlike philosophy or literature, for instance, they appear to make scientific assertions. Such enterprises are considered pseudosciences because they make scientific sounding claims but arrive at their conclusions without follow the scientific method. Astrology, extra-sensory perception, UFOlogy, and studies that tout magic diet pills fall into this category. Besides their failure to follow scientific method, pseudosciences demonstrate a number of other characteristics as well (Ruscio 2002):¹

- (1) They ignore contradictory evidence.
- (2) Their proponents often react in a hostile manner when their orthodoxy is challenged.
- (3) They use an inordinate amount of technical jargon.
- (4) The correctness of their ideas is supported by argumentation, reasoning, intuition, introspection, and reference to authority figures rather than tangible evidence.
- (5) Very little new real-world knowledge is produced.
- (6) It is impossible to subject their theories to scrutiny.
- (6) Explanations are vague and often involve scientific terms used out of context.

My contention in this paper is not to argue that the whole of linguistics is either scientific or pseudoscientific. It is patently unfair to subsume entire fields under one rubric or another since there is a great deal of diversity regarding how individual studies are carried out. I will, in fact, review some instances of pseudoscientific physics. However, the principal focus of this paper is to evaluate specific linguistic analyses and hypotheses in terms of their adherence to the scientific method. It is my hope that a discussion of scientific methodology will highlight the importance of well-designed experimental and quantitative analyses, and how these lead to progress in understanding linguistic processes.

2. **OBSERVATION.** The first step in the scientific method is to observe some phenomenon. Linguists are masters of observation and hardly an observable generalization is left untouched in some framework. Slips-of-the-tongue, bizarre syntax, and unusual pronunciations rarely go unnoticed either, and partners of linguists often lament that what they say is not heard, but rather, how they say it.

3. **HYPOTHESIS FORMATION.** The second step in the scientific method is to turn the observation into a testable statement. Observation of a linguistic phenomenon should naturally lead to speculations about why it occurs, how it is formed, and how it may be explained. Such speculation constitutes a scientific hypothesis if it

¹Also taken from: skeptical.com/pseudosc.html; www.chem1.com/acad/sci/pseudosci.html; www.csj.org/infoserv_articles/astop_science_vs_pseudoscience.htm

is formulated in such a way that it makes some sort of prediction. Statements in many areas of inquiry such as formal logic and philosophy do not purport to make any kind of prediction about the real world. Pedagogical grammars are written as precise descriptions of a language, but are not designed to predict anything. As a result, such studies exclude themselves from empirical test even though they are valid realms of inquiry. Pseudoscience never predicts what may happen under certain circumstances, but explains what happened after the fact. For example, Freudian psychoanalysis and the ‘predictions’ of Nostradamus always involve post hoc analyses of events and are not helpful in predicting future behavior or events.

3.1. FALSIFIABILITY. A crucial aspect of a scientific hypothesis is that it must make clear what predicted outcomes would prove the hypothesis wrong. Allow me to borrow an example from Stanovich (1996:21-22). In 1793, there was an outbreak of yellow fever in Philadelphia. A local physician, Benjamin Rush, had the hypothesis that blood letting would cure the fever as long as the disease had not progressed too far. When a patient lived, he counted it as evidence for the efficacy of his practice. However, when a patient died in spite of a bloodletting, he assumed that it was because the malady was too far advanced to yield to bloodletting. It should be clear that Rush’s hypothesis was unfalsifiable. No evidence whatsoever could prove it wrong. Both his patients that lived and his patients that died confirmed his hypothesis.

This anecdote exemplifies the requirement that a scientific hypothesis must be subject to possible falsification (Popper 1968). A hypothesis that is not formulated in this way does not lead to scientific progress. While it is easy to dismiss Rush’s flawed theory in hindsight, the same sort of irrefutable hypotheses are not hard to find in linguistics. For example, Kahn (1976) formulated a rule of /t/ flapping in American English that, among other criteria such as stress, states that flapping can only occur if the preceding segment is [-consonantal]. This accounts for the fact that the flap may follow either a vowel (e.g. *city* [sɪɾi]) or [ɹ] (e.g. *sorted* [sɔ:ɾɪd]). However, flapping is variable after [l] (e.g. *altar* [altʰə] or [alɾə]). To account for this he suggests that [l] must be [+cons] when flapping is not found and [-cons] when it does occur. This sleight-of-hand parallels Rush’s in that it effectively shields the hypothesis from possible refutation. It is scientifically useless because it rules nothing out.

Lest one think that such manipulations are something that fell out of vogue along with SPE phonology, I cite the following example from optimality theory which is more contemporary. Van Oostendorp (1997) provides an analysis of Dutch stress placement. Among other constraints, he posits two that are relevant for the present discussion:

- (1) HEAD-R: Primary stress falls on the right edge of a word.
NON-FIN: Primary stress may not fall on the final syllable of a word.

For most Dutch words NON-FIN outranks HEAD-R which in part accounts for the lack of final stress. However, what about Dutch words such as *chocola* ‘chocolate’ in which the stress does fall on the final syllable? The solution is to assume that for these words the rank order is reversed and that HEAD-R outranks NON-FIN. I could go on to cite other linguistic tweaks in the generative literature (e.g. rule order reversal, diacritic marking, etc.), as well as in non-generative schools such as cognitive linguistics (see Gibbs 2007), but the point is not to demonstrate how widespread they are, but to illustrate that these hypotheses are constructed in such a way that they avoid possible falsification. As Stanovich notes, ‘a theory can be so protected from falsifiability that it is simply no longer considered scientific at all’ (1996:23).

It is unfortunate that linguistics has its fair share of such hypotheses, although this fact does not reflect the whole of linguistics. Falsifiable hypotheses are not unusual. For example, one hypothesis in government and binding syntax (Chomsky 1981) is that reflexives and pronouns cannot have the same referent. Since this is stated in falsifiable terms, Runner et al (2006) were able to test it, although their experiment yielded negative results. In phonology, Bybee (2000) hypothesized that deletion of word-final /t/ and /d/ occurs more often in high frequency words, and further observations confirmed her hunch. Sociolinguistic studies hypothesize that factors such as age and socioeconomic status influence lexical use or pronunciation, and tests of these hypotheses have been both verified and disproved.

3.2. SPATIOTEMPORALITY. Another characteristic of nonempirical theories is that they either do not deal with data that exists in real space and real time or do deal with spatiotemporal entities, but they are formulated in a way that they do not lend themselves to possible refutation based on spatiotemporal data. Scientific theories, on the other hand, must crucially deal with entities, activities, or processes that take place in time and space and whose existence is subject to possible falsification based on spatiotemporal data (Itkonen 1978, Popper 1968). A theory that may be proved or disproved on the basis of spatiotemporal data possesses a sense of concreteness and tangibility. This is so because entities and events that are considered real exist in time and space. The same sense of tangibility is lacking in a theory that does not deal with real entities or that has no manifestations in the observable world.

Two concepts that are central to a number of linguistic analyses are problematic in this regard. For example, some linguists hold that their analyses reflect the language of an ideal speaker/hearer and not actual speakers. In like manner, many linguistic analyses claim to reflect a speaker’s competence—that is, the system of abstract mechanisms that are thought to underlie the speaker’s ability to produce and understand language—and not the speaker’s performance, which consists of actual utterances and other behaviors (Chomsky 1980: 205). Accordingly, hypotheses about ideal speaker/hearers or competence are irrefutable; they do not relate to observable, real-world entities. No tangible evidence of any sort could contradict them because they are hypotheses about fictional entities. The grammar of an

abstract speaker/hearer may be an interesting topic of study just as a study of the psychology of the character Jean Valjean in the novel *Les misérables*, or a philosophical treatise on the inherent goodness of man; however, they are not scientific. If all observable manifestations of language relate to performance, they can never be directly relevant to the study of abstract competence that many linguistic studies purport to deal with. Derwing (1983:66) demonstrates how the competence/performance distinction serves to insulate a theory from possible falsification:

Suppose we find some child who is quite adept at basic arithmetic. One possible hypothesis about the 'competence' thought to underlie this skill might be to attribute the child, not with something so mundane as a learned, laborious, step-by-step procedure for carrying out simple arithmetic operations, but rather with knowledge of number theory. And what if experimental results are found that seem to fly in the face of this hypothesis? Just chalk them up as 'performance errors' and the well-formed theory remains inviolate.

Once again I would like to emphasize the fact that the whole of linguistics does not fall victim to these difficulties. Many valid hypotheses have been posited and a great deal of empirical research is carried out in linguistics. The requirement that a hypothesis must be subject to test with real-world data simply serves as a criterion to distinguish hypotheses about ideas and strictly theory-internal entities from those that deal with the real-world.

3.3. STRING THEORY. Nonempirical studies not only appear in linguistics, but in other fields as well. Most people would classify physics as most representative of a hard empirical science. For scholars outside of physics, this gives rise to what has been called physics envy (Gould 1996). However, even some areas of physics are arguably pseudoscientific. String theory is one of them. According to string theory, one dimensional objects, called strings, exist which are much smaller than electrons (Smolen 2006). Strings resonate at different frequencies, and the particular frequency of their resonance is what makes them appear as different atomic particles such as protons and electrons. String theory entails the existence of from between ten and 26 dimensions, depending on the particular version of string theory consulted.

The difficulty with string theory is that it is impossible to test for the existence of strings or the other dimensions they predict. In other words, hypotheses about string theory are unfalsifiable (Glashow 2003, Smolen 2006). Sheldon Glashow, a Noble prize winning physicist, discusses string theory in these terms (2003):

And it turns out that the best and the brightest young theorists, instead of being concerned about the experimental enterprise, are going off among themselves and doing their thing with the doors closed. Because no one else is interested in coming, they're all making these secret signs to one another and putting incomprehensible formulas together that to them are, of course, central and simple and predictive and whatnot but to us are a little bit irrelevant.

They're answering a bunch of questions, but their questions lie completely within string theory, which has nothing to do with experiment.

What the string theorists do is arguably physics. It deals with the physical world. They're attempting to make a consistent theory that explains the interactions we see among particles and gravity as well. That's certainly physics, but it's a kind of physics that is not yet testable. It does not make predictions that have anything to do with experiments that can be done in the laboratory or with observations that could be made in space or from telescopes.

That is to say, there ain't no experiment that could be done nor is there any observation that could be made that would say, "You guys are wrong." The theory is safe, permanently safe. I ask you, is that a theory of physics or a philosophy?

What is striking about this characterization of string theory is that one could replace the references to physics with ones to certain types of linguistics and linguistic entities and the quotes would faithfully characterize many aspects of pseudoscientific linguistics. The statements about incomprehensible formulas, answering purely theory internal questions, and lack of testability, ring especially true.

4. WHAT DOES LINGUISTICS STUDY? Upon inspecting my arguments thus far there are sure to be those who feel that my criticism is based on a misunderstanding about what the focus of linguistics actually is. Some would argue that according to their conception of linguistics there is no need for experimental verification. These researchers would probably agree with Itkonen (1976:15-16) that the nonempirical linguist's goal is

to generate all and only intuitively valid formulae: insofar as they fail to do this, their systems are (non-empirically) falsified ... not by reference to some specific spatiotemporal occurrences, but showing that it does not capture the concept which it tries to capture. (See also Carr 1990:66, Kac 1992:39, Linell 1976:84-85)

Linguistic analyses in this sense belong to a metaphysical or philosophical realm of inquiry that deals with axiomatizations about linguistic structure which 'make it possible to deduce all true statements about the system from a small set of prior assumptions about its nature' (Kac 1974:44), much in the same way arguments in philosophy or logic do.

However, a serious concern in linguistics is determining whether the claims in an analysis are philosophical or scientific. Of course there are those who do clearly define their position. For example, Marantz (2005:440) believes that 'the categories and operations of generative grammar are hypotheses about the representations and computations in the minds and brains of speakers.' Bromberg and Halle also adopt a realist stance to phonology: 'Do speakers *really* retrieve morphemes

from their memory, invoke rules, go through all these labours when speaking? We think they do' (2000:35). According to Marantz and Bromberg and Halle, linguistics belongs in the realm of scientific empiricism. At the opposite end of the spectrum, Bradley claims that 'grammars do not (and moreover, are not intended to) dictate the ways in which the computation of speaking and listening proceed ...' (1980:38). Her definition of linguistics is clearly nonempirical.

It is unfortunate that many linguists carry out their analyses without specifically addressing what side of the spectrum their analysis falls on. It is not difficult to find examples of waffling between the two positions as well. For example, Kager states that 'explaining the actual processing of linguistic knowledge by the human mind is not the goal of the formal theory of grammar ... a grammatical model should not be equated with its computational implementation' (1999:26). This quote seems to demonstrate that he embraces a descriptive or philosophical stance to optimality theory. However, a few pages after denying that formal models have a relationship to psychological processing, Kager discusses how optimality theory relates to language acquisition. This is problematic because acquisition is not a process that takes place in a universe consisting of manipulation of abstract entities that relate only to the grammar of ideal speaker/hearers. Acquisition involves concrete psychological processing by actual speaker/hearers.

This inconsistency is found elsewhere as well. Chomsky boldly pronounced that linguistics is a 'branch of cognitive psychology' (1972:1), and specifically asserted that linguistic rules and principles are psychologically real (1980:48). However, at the same time he paradoxically denied the psychological relevance of his rules saying: 'Although we may describe the grammar *G* as a system of processes and rules that apply in a certain order to relate sound and meaning, we are not entitled to take this as a description of the successive acts of a performance model' (1972:117). On the one hand, he asserts that linguistics is the study of abstract linguistic entities; on the other, he proposes that it is the empirical study of human cognitive abilities (Katz and Postal 1991:541-547, Olszewsky 1985).

In a similar fashion, studies in the field of cognitive linguistics are generally carried out with the stated goal of making claims that are psychologically plausible (Lakoff 1990); however, such studies are largely based on contrived utterances and linguists' personal intuitions about how speakers must process them. Only recently have some empirical methods been applied to test the psychological assertions of cognitive linguistics (e.g. Boroditsky 2000, Gibbs and Perlman 2006).

Perhaps the most perplexing stance is that taken by proponents of 'substance-free' phonology. They assert that phonology is a completely autonomous field that should be carried out in total isolation from phonetic data and behavioral studies such as psycholinguistic experiments (Hale and Reiss 2000). According to them, the goal of phonology is 'to categorize what is a computationally possible phonology' (Hale and Reiss 2000:168-169) in contrast to what computations speak-

ers actually perform. Although they divorce themselves from all references to human behavior and place their theories squarely in the realm of the radically abstract, they paradoxically claim that this kind of phonology is cognitive science (168). Given this state-of-affairs, is it any wonder that there is often confusion about the scientific status of linguistic analyses?

It is not my contention that all studies of language must be empirically-based to be good studies. Detailed descriptions of linguistic phenomena may lead to empirically testable hypotheses about those phenomena, and are in fact a prerequisite to empirical research (Baker 1979:141, Black and Chiat 1981:51-54, Carr 2000, Derwing 1979:125, Kac 1980:243, Pierrehumbert et al 2000, Sampson 2001). The problem, however, consists in confounding empirical and non-empirical approaches. Katz (1985:193) notes:

No one confuses psychological theories of how people make inferences with the logical theories of implication, or psychological theories of how people perform arithmetical calculations with mathematical theories of numbers. Yet, in the exact parallel case of linguistics, conceptualists do not make the distinction, conflating a psychological theory of how people speak and understand speech with a theory of the language itself.

The results of an experiment on how speakers process a certain linguistic phenomenon should not have any bearing on what would be the most rigorous, concise, or elegant way to account for that pattern in a particular framework; conversely, the most intuitively satisfying way of describing a phenomenon in a framework is to be ascribed only to an ideal speaker/hearer, not necessarily to actual speakers of the language (Bradley 1980, Stemberger 1996). Charges that a linguistic analysis is pseudoscientific surface when an analysis makes scientific claims without following scientific methodology; therefore it is necessary to clearly demarcate the boundary between the claims and conclusions of empirical approaches and the claims and conclusions of nonempirical approaches (Carr 1990:34-38, Itkonen 1976:219, Stemberger 1996).

5. EXPERIMENTATION. The third step in the scientific method is to make further observations or conduct experiments in order to test the hypothesis. I have already discussed the requirement that the observations or experimental data must be based on spatiotemporal events. It is unfortunate that many linguistic analyses do not submit their hypotheses to experimental test. Instead, they make the critical error of elevating a hypothesis about a phenomenon to the status of an explanation of the phenomenon (Black and Chiat 1981:48, Higginbotham 1991:555, Itkonen 1978:220-221, Ohala 1990:159, Sampson 2001:124, Yngve 1996). Chomsky provides an example of this common fallacy. He claimed that 'perform' may only be followed by a count noun, never by a mass noun, which would rendering 'perform labor' incorrect in English (Hill 1962:29). When pressed for evidence that his hypothesis was correct, Chomsky merely responded that he was a native speaker

of English. Chomsky's intuition about the possible predicates of 'perform' resulted in a hypothesis. Hypotheses are indeed borne of intuition. However, his intuition at the same time provided him with the supporting evidence for the hypothesis; he saw no need to consult a corpus to confirm it.²

Cases in which a hypothesis becomes its own explanation are found outside of Chomsky's view of syntax as well. Harris (1983), for example, notes that with the exception of a handful of borrowings, no Spanish word has antepenultimate stress if the penultimate syllable is closed. As a result, he postulates that a restriction or constraint exists in Spanish which bars words such as **te.lé.fos.no* from occurring. No proof to support the hypothesis is presented beyond the observations that constitute the hypothesis in the first place. Alvord (2003), on the other hand, tested the hypothesis by having Spanish speakers judge how word-like a series of nonce words was. In contrast to what Harris' stress constraint predicts, such words were generally rated as highly plausible Spanish words. This illustrates that finding a generalization in linguistic data does not constitute proof that the generalization plays a role in actual linguistic cognition. It was only in the course of writing the present article that I realized that I have also fallen prey to this error in my own work (see Eddington 2001).

One requirement of the scientific method is that the evidence be publicly available. This means that details about the experiment, how the data were collected, their source, method of elicitation, and means of analysis must be specified in such a way that the study may be replicated by other researchers. A person's own introspections of his or her language are poor data for a number of reasons (Gibbs 2006, 2007; Labov 1975; Schütze 1996), but their inability to be replicated is especially troubling. A particularly illustrative example of problems in this regard is provided by Lozanov's work in second language acquisition (1978). His method, called suggestopedia, involves seating students in soft chairs in a room with pleasant background music while the teacher reads texts in the target language. Songs and games also play a part. The idea is that this instruction causes spontaneous acquisition, much of which is assumed to take place on the subconscious level. Lozanov claimed his method dramatically improved both the speed of acquisition and the amount of material retained. However, closer inspection of his work (Scovel 1979) reveals tables summarizing the results of unexplained experiments, vague descriptions of methodology, lack of control groups, etc. In sum, because he failed to make many details of his method publicly available no one has been able to closely replicate it, nor observe the extraordinary findings he reported, although tests using some aspects of his method have resulted in much more conservative outcomes than what he reported.

²A quick search on Google yields thousands of cases of 'perform labor'. Sampson (2001) discusses a similar case in which personal introspection led to the idea that central embedding was impossible, when many cases are found in actual language data.

By citing Lozanov's work on language acquisition, I do not mean to imply that language acquisition as a whole suffers from the same lack of scientific rigor. Inspection of the acquisition literature reveals many experiments carried out in accordance with the scientific method. The same is true of many other areas of linguistic inquiry such as sociolinguistics and phonetics. However, what makes a study empirical is not the subfield of linguistics it belongs to, but the methodology it follows.

What of a hypothesis that, due to the nature of the subject studied, cannot be subjected to experimental verification or further observation? This occurs with many hypotheses in historical linguistics where obtaining further data is often impossible.³ Evidence such as observation of a similar process occurring in another language may be relevant, but constitutes only indirect evidence. Of course, exceptional circumstances occasionally present further evidence that allow a hypothesis to be tested, as was the case for Saussure who asserted that Indo-European must have contained laryngeal consonants in certain words. Many years passed before the discovery and analysis of Hittite documents proved his hypothesis. In short, linguistic analyses of this sort follow the scientific method to the extent that they are able, but because they deal with entities that no longer exist they cannot be experimented on. However, the lack of experimental verification cannot be extended to theories that make claims about how living speakers process their language in the present.

6. ANALYZE THE DATA. The final step in the scientific method is to analyze the results in order to determine whether the hypothesis has been supported or discounted. To this end, science has adopted statistical analysis in which significance is defined as the outcome of the experiment having a smaller than one in twenty chance of occurring randomly. Statistical procedures exist that work with a wide range of data types (nominal, numeric, rank order, etc.), and may be applied to both experimental outcomes as well as corpus-based analyses. In fact, a rough way to gauge whether a field generally follows scientific methodology is to determine if undergraduate students are required to study statistics and experimental methods. Students of philosophy, history, and literature are not trained in statistics while those in sociology, chemistry, and physics are.

Of course, every researcher hopes that the results of a study will be statistically significant and thus allow him or her to claim positive support for the hypothesis. However, negative results are just as important to the scientific enterprise. An example of this comes from the excitement in 1989 over cold fusion (Park 2000). The initial positive indicators that nuclear fusion had been carried out at room temperature were soon contradicted by negative results from numerous other

³I credit Joan Bybee for pointing me to this topic.

laboratories. In the end, the inability of the scientific community to replicate the cold fusion study led to an advance in physical science; the purported method has subsequently been abandoned by most physicists who now spend time and effort testing other methods, and tax dollars have been spared on further research into an ineffectual method.

Of course, negative results are often hard for a researcher to accept given the considerable time and effort expended on a particular project. Medawar (1979:39) explains how this may interfere with the scientific process:

Scientists who fall deeply in love with their hypotheses are proportionately unwilling to take no as an experimental answer. Sometimes instead of exposing a hypothesis to a cruelly critical test, they caper around it, testing only subsidiary implications, or follow up sidelines that have an indirect bearing on the hypothesis without exposing it to possible refutation. ... I cannot give any scientist of any age better advice than this: *the intensity of the conviction that a hypothesis is true has no bearing on whether it is true or not*. The importance of the strength of our conviction is only to provide a proportionately strong incentive to find out if the hypothesis will stand up to critical evaluation.

When a hypothesis has been disproved, it may either be abandoned or it may be modified based on the outcome of the experiment, and then submitted to further testing. However, under these circumstances the temptation is great to ignore or discount counterevidence, which is a common pitfall in pseudoscientific studies.

Examples of such behavior are not difficult to find in linguistic literature. When confronted with counter evidence some dismiss it with a wave of the hand as simply uninteresting or peripheral to the core of theory (see Schütze 1996 for a discussion of these tactics). For example, when confronted with evidence that does not support the proposed projection principle, Burzio (1986:48) sidesteps it by claiming that the evidence ‘violates more the letter than the spirit of the projection principle.’ Chomsky provides another example of how counterevidence may be brushed aside. In 1964, he formulated what he called the A-over-A principle. Three years later, Chomsky directed a dissertation in which Ross (1967) demonstrated that the A-over-A principle did not work for English. Rather than recognize that the principle was invalid, Chomsky continued to refer to it as an important part of his theory of universal grammar as late as 1994 (Haley and Lunsford 1994:135).

7. OCCAM’S RAZOR. Some may ask at this point how Occam’s razor fits into the scientific method. In reality, Occam’s razor is not part of the scientific method. It is often misconstrued to mean that the simplest explanation is necessarily the correct one. The linguistic literature is littered with claims that one analysis is simpler or more elegant than another, and is therefore correct due to Occam’s razor (e.g. the phonological analysis that uses the least amount of ink to write is the correct analysis). Perhaps the most extreme misinterpretation of Occam’s razor is

that of Hale and Reiss (2000:176-177). They assume that Occam's razor basically is the scientific method (Carr 2000:69).

However, Occam's razor is neither a part of scientific methodology nor a kind of evidence. The fact that one model is simpler than another is not evidence that the simpler model is correct. Instead, Occam's razor is a heuristic people use for comparing competing theories or models. When two models account for the same data equally well, a person who assumes that the simpler model is preferred has used Occam's razor to justify that preference. One reason for preferring the simpler explanation may be that it is easier to test than a more complex one.

Now, suppose there are two models of speech production. One includes low-level phonetic detail, individual variation, as well as variation due to social context. This model would surely be extremely complex, while a model that abstracts away from such performance factors would be much simpler. However, since the models do not account for the same data, simplicity or Occam's razor have nothing to say about which model should be preferred. Occam's razor essentially says that when all things are equal, it is probably best to go with the simplest model.

8. CONCLUSIONS. Classifying a theory into one domain or the other is not done to draw a proverbial line in the sand so that one may thumb his or her nose at the people on the other side. Linguistic analyses that follow the methods of formal logic and philosophical argumentation align themselves with those important schools of thought that span several thousand years, and which are represented in most colleges and universities around the globe. However, when a researcher makes empirical claims without following scientific methodology he or she must realize that this is precisely what is done by enthusiasts of disreputable 'sciences' such as extra-sensory perception, perpetual motion machines, and astrology (Park 2000, Shermer 2002), all of which are surely unsavory bedfellows for the field of linguistics.

The second motive for following the scientific method is that failure to do so results in lack of progress and stagnation in the field (Popper 1963). Stanovich (1996:26) explains how the theories of Freudian psychoanalysis led to lack of progress in understanding psychological disorders:

The explanations they provided created only the illusion of understanding. By attempting to explain everything after the fact, they barred the door to any advance. Progress occurs only when a theory does not predict *everything* but instead makes specific predictions that tell us—in advance—something specific about the world.

The inability to test a hypothesis is another obstacle to scientific progress as well. Once again, consider string theory. It is actually not a single monolithic theory but a set of them that differ in their particulars. Some entail a total of 10 different spatiotemporal dimensions and others 26. Because they are unable to make hy-

potheses that make observable predictions, it is impossible to provide empirical evidence to support or refute one version of string theory in favor of another. It is currently mired in the bog of intellectual stagnation and will be until it is able to move past the hypothesis formation step and into the hypothesis testing mode.

Collins summarizes the importance of following scientific method in this way (2006:2280):

The scientific method is the only reliable way to seek out the truth of natural events. Yes, experiments can fail spectacularly, interpretation of experiments can be misguided, and science can make mistakes. The nature of science is self-correcting. No major fallacy can long persist in the face of a progressive increase in knowledge.

In linguistics, purely descriptive analyses are obviously a required prerequisite from which testable hypotheses may be drawn. However, pure description, theories of abstract entities that do not move beyond the conceptual domain, and hypotheses that do not make predictions about observable phenomena, lead one to suspect that a great deal of progress in linguistics has been made in learning how linguistic data fit into particular theoretical frameworks, but much less in how people actually process language as a psychological and social entity. Therefore, progress in linguistics is only made to the extent that linguists adopt the scientific method that is standard in scientific endeavors.

REFERENCES

- ALVORD, SCOTT M. 2003. The psychological unreality of quantity sensitivity in Spanish: Experimental evidence. *Southwest Journal of Linguistics* 22.1-12.
- BAKER, WILLIAM J. 1979. On draining the conceptual swamp. *Perspectives in experimental linguistics*, ed. by Gary D. Prideaux, 41-149. Amsterdam: John Benjamins.
- BLACK, MARIA and SHULAMITH CHIAT. 1981. Psycholinguistics without "psychological reality." *Linguistics* 19.37-61.
- BORODITSKY, LAURA. 2000. Metaphoric structuring: Understanding time through spatial metaphors. *Cognition* 75.1-28.
- BRADLEY, DIANE. 1980. Lexical representation of derivational relation. *Juncture*, ed. by Mark Aronoff and Mary Louise Kean, 37-55. Saratoga, CA.: Anma Libri.
- BROMBERG, SYLVAIN and MORRIS HALLE. 2000. The ontology of phonology revised. *Phonological knowledge: Conceptual and empirical issues*, ed. by Noel Burton-Roberts, Philip Carr, and Gerald Docherty, 19-37. Oxford: Oxford University Press.
- BURTON-ROBERTS, NOEL, PHILIP CARR and GERALD DOCHERTY. 2000. *Phonological knowledge: Conceptual and empirical issues*. Oxford: Oxford University Press

- BURZIO, LUIGI. 1986. *Italian syntax: A government-binding approach*. Dordrecht: D. Reidel Publishing.
- BYBEE, JOAN L. 2000. The phonology of the lexicon: Evidence from lexical diffusion. *Usage-based models of language*, ed. by Michael Barlow and Suzanne Kemmer, 65-85. Stanford: Center for the Study of Language and Information.
- CARR, PHILIP. 1990. *Linguistic realities: An autonomist metatheory for the generative enterprise*. Cambridge: Cambridge University Press.
- CARR, PHILIP. 2000. Scientific realism, sociophonetic variation, and innate endowments in phonology. *Phonological knowledge: Conceptual and empirical issues*, ed. by Noel Burton-Roberts, Philip Carr, and Gerard Docherty, 67-104. Oxford: Oxford University Press.
- CHOMSKY, NOAM. 1964. *Current issues in linguistic theory*. The Hague: Mouton.
- CHOMSKY, NOAM. 1972. *Language and mind*. New York: Harcourt Brace Jovanovich.
- CHOMSKY, NOAM. 1980. *Rules and representations*. New York: Columbia University Press.
- CHOMSKY, NOAM. 1981. *Lectures on government and binding*. Dordrecht: Foris.
- COLLINS, FRANCIS S. 2006. *The language of God*. New York: Free Press.
- DERWING, BRUCE L. 1979. Psycholinguistic evidence and linguistic theory. *Perspectives in experimental linguistics*, ed. by Gary D. Prideaux, 113-138. Amsterdam: John Benjamins.
- DERWING, BRUCE L. 1983. On drawing the right conclusions in psycholinguistics: Some critical areas of control in experimental and analytical practice. *Proceedings of the Ninth Annual Meeting of the Berkeley Linguistics Society*, ed. by Amy Dahlstrom, Claudia Brugman, Monica Macaulay, Inese Civkulis, Michele Emanatian, Donna Sakima, and Raquel Teixeira, 64-73. Berkeley: Berkeley Linguistics Society.
- EDDINGTON, DAVID. 2001. Spanish epenthesis: Formal and performance perspectives. *Studies in the Linguistics Sciences* 31.33-53.
- GIBBS, RAYMOND W. JR. 2006. Introspection and cognitive linguistics: Should we trust our own intuitions? *Annual Review of Cognitive Linguistics* 4.135-151.
- GIBBS, RAYMOND W. JR. 2007. Why cognitive linguists should care more about empirical methods. *Methods in cognitive linguistics*, ed. by Monica Gonzalez-Marquez, Irene Mittelberg, Seana Coulson, and Michael J. Spivey, 2-18. Amsterdam: John Benjamins.
- GIBBS, RAYMOND W. JR., and MARCUS PERLMAN. 2006. The contested impact of cognitive linguistic research on the psycholinguistics of metaphor understanding. *Cognitive linguistics: Current applications and future perspectives*, ed. by Gitte Kristiansen, Michel Achard, René Dirven, and Francisco José Ruiz de Mendoza Ibáñez, 211-227. Berlin: Mouton de Gruyter.
- GLASHOW, SHELDON. 2003, July 11, 18, 25. Interview for PBS's *The elegant universe*. <http://www.pbs.org/wgbh/na/elegant/view-glashow.html>
- GOULD, STEPHEN JAY. 1996. *Mismeasure of man*. New York: Norton.

- HALE, MARK, and CHARLES REISS. 2000. Phonology as cognition. Phonological knowledge: Conceptual and empirical issues, ed. by Noel Burton-Roberts, Philip Carr, and Gerald Docherty, 161-184. Oxford: Oxford University Press.
- HALEY, MICHAEL C. and RONALD F. LUNSFORD. 1994. Noam Chomsky. New York: Twayne Publishers.
- HARRIS, JAMES W. 1983. Syllable structure and stress in Spanish. Cambridge, MA: MIT Press.
- HIGGINBOTHAM, JAMES. 1991. Remarks on the metaphysics of linguistics. *Linguistics and Philosophy* 14.555-566.
- HILL, ARCHIBALD A. 1962. The third Texas conference on problems of linguistic analysis in English. Austin: University of Texas Press.
- ITKONEN, ESA. 1976. Linguistics and empiricalness: Answers to criticisms. Helsinki: University of Helsinki.
- ITKONEN, ESA. 1978. Grammatical theory and metascience. Amsterdam: John Benjamins.
- KAC, MICHAEL. 1974. Autonomous linguistics and psycholinguistics. *Minnesota Working Papers in Linguistics and Philosophy of Language* 2.42-7.
- KAC, MICHAEL. 1980. In defense of autonomous linguistics. *Linguistics* 50.243-248.
- KAC, MICHAEL. 1992. Grammars and grammaticality. Amsterdam: John Benjamins.
- KAGER, RENE. 1999. Optimality theory. Cambridge: Cambridge University Press.
- KAHN, DANIEL. 1976. Syllable-based generalizations in English phonology. Bloomington, IN: Indiana University Linguistics Club.
- KATZ, JERROLD J. 1985. An outline of platonist grammar. The philosophy of linguistics, ed. by Jerrold J. Katz, 172-203. Oxford: Oxford University Press.
- KATZ, JERROLD J. AND PAUL M. POSTAL. 1991. Realism vs. conceptualism in linguistics. *Linguistics and Philosophy* 14.515-554.
- LABOV, WILLIAM. 1975. What is a linguistic fact? Lisse: Peter de Ridder Press.
- LAKOFF, GEORGE. 1990. The invariance hypothesis: Is abstract reason based on image-schemas? *Cognitive Linguistics* 1.39-74.
- LINELL, PER. 1976. Is linguistics an empirical science? *Studia Linguistica* 30.77-94.
- LOZANOV, GEORGI. 1978. Suggestology and outline of suggestopedy. New York: Gordon and Breach.
- MARANTZ, ALEC. 2005. Generative linguistics within the cognitive neuroscience of language. *The Linguistic Review*, 22, 429-445.
- MEDAWAR, PETER BRIAN. 1979. Advice to a young scientist. New York: Harper and Row.
- OHALA, JOHN J. 1990. There is no interface between phonology and phonetics: A personal view. *Journal of Phonetics* 18.153-171.
- OLSHESKY, THOMAS. 1985. Chomsky's realism. *Proteus* 2.19-25.
- VAN OOSTENDORP, MARC. 1997. Lexicale variatie in optimaliteitstheorie. *Nederlandse Taalkunde* 2.133-154.

- PARK, ROBERT L. 2000. *Voodoo science*. Oxford: Oxford University Press.
- PIERREHUMBERT, JANET, MARY E. BECKMAN, and D. R. LADD. 2000. Conceptual foundations of phonology as a laboratory science. *Phonological knowledge: Conceptual and empirical issues*, ed. by Noel Burton-Roberts, Philip Carr, and Gerald Docherty, 273-303. Oxford: Oxford University Press.
- POPPER, KARL R. 1963. *Conjectures and refutations: The growth of scientific knowledge*. London: Routledge.
- POPPER, KARL R. 1968. *The logic of scientific discovery*, 2nd ed. New York: Harper and Row; original English edition 1959, London: Hutchinson.
- ROSS, JOHN R. 1967. *Constraints on variables in syntax*. Cambridge, MA: MIT dissertation.
- RUSCIO, JOHN. 2002. *Clear thinking with psychology: Separating sense from nonsense*. Pacific Cove, CA: Wadsworth.
- RUNNER, JEFFREY T., RACHEL S. SUSSMAN, and MICHAEL K. TANENHAUS. 2006. Processing reflexives and pronouns in picture noun phrases. *Cognitive Science* 30.193-241.
- SAMPSON, GEOFFREY. 2001. *Empirical linguistics*. London: Continuum.
- SCHÜTZE, CARSON T. 1996. *The empirical base of linguistics: Grammaticality judgments and linguistic methodology*. Chicago: University of Chicago Press.
- SCOVEL, THOMAS. 1979. Review of suggestology and outlines of suggestopedy, by Georgi Lozanov, *TESOL Quarterly* 13.255-266.
- SHERMER, MICHAEL. 2002. *Why people believe weird things: Pseudoscience, superstition, and other confusions of our time*. New York: A. W. H. Freeman.
- SMOLEN, LEE. 2006. *The trouble with physics*. Boston: Houghton Mifflin.
- STANOVICH, KEITH E. 1996. *How to think straight about psychology*, 4th ed. New York: Harper Collins.
- STEMBERGER, JOSEPH P. 1996. The scope of the theory: Where does "beyond" lie? *Proceedings of the parasession of the Chicago Linguistics Society's 32nd meeting*, ed. by Lisa McNair, Kora Singer, Lise M. Dobrin, and Michelle M. Aucoin, 139-164. Chicago: Chicago Linguistic Society.
- YNGVE, VICTOR H. 1996. *From grammar to science*. Philadelphia: John Benjamins.