

1 Introduction

Once they have reached a certain maturational stage, every member of the human species is able to produce and comprehend the language to which s/he is exposed, barring any serious impairment. Underlying this ability of ours to relate linguistic sounds/signs (henceforth just “sounds” to make the exposition simpler) and meaning is the *language faculty*: this is one of the most fundamental working hypotheses adopted in the research program initiated by Noam Chomsky over half a century ago. The aim of Chomsky’s research program is to discover the properties of the *language faculty*, in its initial state and in its steady state. It is hypothesized that, in its initial state, the *language faculty*, as the genetic endowment that underlies our ability to relate sounds and meaning, is uniform across the members of the species and that, in its steady state where its non-trivial “growth” has stopped, it varies in accordance with one’s linguistic experience, within the limit imposed by the genetic endowment. The research program is also concerned with how the universal properties in question might be related to laws that govern nature, beyond the language faculty per se, and how the language-particular properties are acquired. This book’s main concern is how hypotheses about the language faculty can be put to rigorous empirical test. I will propose how we can *deduce definite/categorical* and *testable predictions*, and illustrate how we test our predictions and how we can obtain experimental results that are very close to our *definite* and *categorical* predictions. In short, the goal of the book is to show that it is possible to pursue a study of the language faculty as an exact science in the sense just noted. I will refer to a study of the language faculty as an exact science in this sense simply as *language faculty science*.¹

The main purpose of the book is to provide a conceptual articulation of a methodology for language faculty science and its empirical demonstration on the basis of concrete hypotheses and experiments. The deduction of the predictions, based on specific (universal and language-particular) hypotheses, the designs of the experiments, and the

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interpretation of the experimental results will be in accordance with the methodological proposal to be made. How the proposed methodology is related to Chomsky's research program is not among the primary concerns of this book, and I feel that its inclusion in the main body of the book would considerably undermine the readability of the book. I have therefore decided to include in this introductory chapter general remarks on the background of the proposed methodology and its relation to Chomsky's research program.

What will be proposed in this book is a consequence of adopting the *internalist* approach and a rigorous version of the *methodological naturalist* approach to the study of language. Adopting the *internalist* approach, I take as our object of inquiry the language faculty, including its steady state (*I-language* in the terms of Chomsky 1986), rather than language as an external or externalized object (*E-language* in the terms of Chomsky 1986). Taking the *methodological naturalist* approach, I adopt the position that we should investigate our subject matter just as researchers in a natural science approach their subject matters (Chomsky 1986, 1995, among many other places including the papers in Chomsky 2000).

It is clear that Chomsky intended his research program to be a science of the language faculty (see Chomsky 1965: Ch. 1, for example). Conspicuously missing in Chomsky's writing, especially since the mid-1980s, however, is serious concern about testability and about the need to provide a conceptual and methodological articulation of how rigorous testability can be pursued in a study that aims at discovering the properties of the language faculty. One may find this rather peculiar in light of the fact that Chomsky claims to adopt and pursue the *methodological naturalist* approach and the *internalist* approach to "language" and the language faculty.² The most significant consequences of adopting these approaches *should* include recognizing the importance of *testability*, which is very closely related to the significance of *deducibility* of predictions in light of the inseparability of facts and hypotheses in language faculty science, as will be addressed shortly.

While what is presented here owes a great deal to Chomsky's pioneering work for articulating the goal of the generative enterprise and various related issues, it differs significantly from the so-called Chomskyan research program with regard to how rigorously one pursues testability as one of the most fundamental aspects of the research program.³ It is to emphasize this point that I am calling the research program being pursued in this book *language faculty science* instead of a version of generative grammar (or bio-linguistics).

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The research program that will be illustrated in the subsequent chapters tries to discover properties of the language faculty by adopting the method summarized by Richard Feynman as follows:

In general, we look for a new law by the following process. First we guess it. Then we compute the consequences of the guess to see what would be implied if this law that we guessed is right. Then we compare the result of the computation to nature, with experiment or experience, compare it directly with observation, to see if it works. If it disagrees with experiment, it is wrong. In that simple statement is the key to science. It does not make any difference how beautiful your guess is. It does not make any difference how smart you are, who made the guess, or what his name is – if it disagrees with the experiment, it is wrong. That's all there is to it. (Feynman 1965/94: 150)

Feynman emphasizes this point in many other places, as in: “The principle of science, the definition, almost, is the following: *The test of all knowledge is experiment.* Experiment is the *sole judge* of scientific ‘truth’” (*The Feynman Lectures on Physics*: 1-1, reproduced in Feynman 1963: 2). I would like to propose that it is possible to rigorously follow this basic method of science – let us call it the *Guess-Compute-Compare* method⁴ – in investigating the language faculty. Being a *methodological naturalist* does not necessarily mean being committed to *deduction* of *definite* predictions and pursuit of *rigorous testability*, whereas adopting the Guess-Compute-Compare method, as Feynman puts it, does.

According to the proposed methodology, we check predictions made by our hypotheses against experiment. I do not claim this to be the only productive and viable method for language faculty science. But I will try to show how promising this method is for the study of the language faculty, despite the widely held belief that the method in question cannot be effectively applied outside physics and its closely related fields.

Experiments are meant to test predictions. Once we adopt the *internalist* approach to “language” and the language faculty, and take the *universal* properties of the language faculty of an *individual* speaker as the object of inquiry, it follows that our experiments in language faculty science must be testing predictions about an *individual* speaker.⁵ In line with the Guess-Compute-Compare method, it also follows that our predictions must be as definite as possible so that we can rigorously compare our predictions with experimental (or observational) results. One should then naturally wonder what our predictions are about and what counts as data in a research program that aims at discovering universal aspects of the language faculty.

There are no restrictions, determined prior to our empirical investigation, as to what can be regarded as evidence for or against our hypotheses about any subject matter. This applies to the study of the

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language faculty. But, no matter what kind of evidence we might consider, it should be revealing about the subject matter – in our case about universal properties of the language faculty. Since the language faculty is, by hypothesis, what underlies our ability to relate linguistic sounds and meaning, it seems reasonable to consider the informant judgment on the relation between linguistic sounds and meaning as something that we can use to test the validity of our hypotheses about the properties of the language faculty. We leave open, of course, the possibility that other types of evidence may serve the same purpose and provide converging evidence for our hypotheses.

The informant's introspective judgments, including the researcher's own, have in fact been a primary source of data in the generative research tradition. Chomsky (1986: 37) states:

To be sure, the judgments of native speakers will always provide relevant evidence for the study of language,⁶ just as perceptual judgments will always provide relevant evidence for the study of human vision, although one would hope that such evidence will eventually lose its uniquely privileged status.⁷ If a theory of language failed to account for these judgments, it would plainly be a failure; we might, in fact, conclude that it is not a theory of language, but rather of something else.

I shall therefore consider that the informant's introspective judgment on the relation between sounds and meaning is something that we can make predictions about in language faculty science, leaving open the possibility of the effective and meaningful use of other possible types of data. Considering the judgments of an *individual* speaker of a *particular* language as relevant evidence for or against hypotheses about *universal* properties of the language faculty is thus a consequence of pursuing the *internalist* approach.

We cannot directly observe the language faculty. It can be “observed” only indirectly by hypothesizing its properties and their relation to “what can be observed.” Hypotheses about properties of the language faculty are thus necessarily abstract. They are about some abstract objects hypothesized to be part of the language faculty. One might thus suggest that, without hypotheses, there are no facts that can be revealing about the properties of the universal aspects of the language faculty.

The realization that a set of judgments of an *individual* speaker of a *particular* language qualifies as a fact in language faculty science because it is predicted by our hypotheses, i.e., because it is given a theoretical account, leads us to recognize the inseparability of facts and hypotheses in language faculty science. Facts and hypotheses are inseparable in language faculty science in the sense that, according to the preceding considerations, something is a fact only if it is predicted by hypotheses

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and only if the prediction has been confirmed by experiments. In other words, the inseparability of facts and hypotheses in this sense makes language faculty science an extreme case of a theory-laden research program even at its very early stage of development.

One may wonder how we can make *definite* and *categorical* predictions about the judgment of an *individual speaker* of a *particular language* as a reflection of *universal* properties of the language faculty and how we can attain experimental results in accordance with such predictions. The subsequent chapters provide answers to these and related questions and illustrate them by making reference to actual experiments. They are an attempt to show how we can make language faculty science a rigorous empirical research program despite its inherently theory-laden nature. According to the proposed methodology, we check *hard predictions* with *hard facts* and state the *hard facts* in a theory-neutral way, although they are identified as such by being predicted by hypotheses. “*Hard*” in “*hard predictions*” and “*hard facts*” here is borrowed from Feynman (1999: 198–199):

In the strong nuclear interaction, we have this theory of colored quarks and gluons, very precise and completely stated, but with very few hard predictions. It’s technically very difficult to get a sharp test of the theory, and that’s a challenge. I feel passionately that that’s a loose thread; while there’s no evidence in conflict with the theory, we’re not likely to make much progress until we can check hard predictions with hard numbers.

This book is an attempt to show how we can deduce *hard predictions* and how we can identify *hard facts* in language faculty science.⁸

Chapters 2–4 provide a conceptual basis for language faculty science. Chapter 2 addresses what *definite* and *categorical* predictions we can make about judgments by an *individual* informant that are revealing about *universal* properties of the language faculty and how we can expect to obtain experimental results in accordance with our predictions. The discussion leads us to recognize the need to consider informant judgments in terms of schemata. It furthermore leads us to recognize two types of schemata, which will be called a *Schema and an ^{ok}Schema. They differ from each other as follows: *Every* example sentence instantiating the former is predicted to be completely unacceptable with the specified interpretation pertaining to two expressions while *some* example sentences instantiating the latter are predicted to be acceptable *at least to some extent* with the specified interpretation pertaining to the two expressions. The difference between the two types of predictions is one of the keys to language faculty science. The combination of the two types of predictions will be referred to as a *predicted schematic asymmetry*. When our experimental result is in line with the predicted schematic asymmetry, we say that we have obtained a *confirmed predicted schematic asymmetry*.

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I would like to suggest that confirmed predicted schematic asymmetries are the smallest units of fact in language faculty science.

Chapter 3 addresses how we can deduce *definite* and *categorical* predictions about the informant judgment on the relation between sounds and meaning. The considerations in Chapter 2 lead us to accept that the deduction of such a prediction requires, minimally, a *universal* hypothesis (i.e., a hypothesis about universal properties of the language faculty) and a *language-particular* hypothesis (i.e., a hypothesis about language-particular properties). In addition, we must have a hypothesis about what formal property underlies a particular interpretation that is detectable by the informant, which will be called a *bridging hypothesis*. Finally, we must have a minimal articulation of how informant judgments can be understood as revealing about properties of the language faculty.

In order to deduce *definite* predictions about the informant judgment on the relation between sounds and meaning, as a reflection of properties of the language faculty, we must have a theory of the language faculty, in the terms of which we formulate our universal and language-particular hypotheses and bridging hypotheses. We adopt Chomsky's (1993) model of the Computational System (= CS) of the language faculty because it allows us to formulate our hypotheses and deduce *definite* and *categorical* predictions from them. According to this model of the CS, what underlies the meaning is the mental representation called an *LF* (Logical Form) *representation*.⁹ The only structure-building operation assumed in this model of the CS takes two syntactic objects and forms one. We can thus define a basic and *universal* structural relation in terms of this structure-building operation. This allows us to formulate hypotheses about what surface phonetic sequence corresponds to what LF representation(s), and, more specifically, about the structural relation between two syntactic objects at the level of LF representation (henceforth simply "at LF") that correspond to two expressions in the surface phonetic sequence. As an articulation of how informant judgments can be revealing about properties of the language faculty, we will adopt Ueyama's (2010) model of judgment-making by the informant.

We can make *testable* predictions about an *individual* informant's judgment on the relation between sounds and meaning by specifying (i) a *universal* hypothesis about a formal object/relation at LF, (ii) a language-particular hypothesis about the structural relation between two LF syntactic objects corresponding to two expressions in the surface phonetic sequence, and (iii) a bridging hypothesis about what interpretation pertaining to two expressions *must* be based on the formal object/relation at LF alluded to in (i). It will be hypothesized that there is a

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formal object at LF, called $FD(a, b)$, whose structural condition is that a must *c-command* b .¹⁰ For the interpretation alluded to in (iii), it will be suggested that we consider a particular dependency interpretation pertaining to two expressions α and β . A bridging hypothesis states that such a dependency interpretation must be based on $FD(LF(\alpha), LF(\beta))$ with particular choices of α and β . $LF(\alpha)$ and $LF(\beta)$ stand for LF syntactic objects that correspond to expressions α and β , respectively.

Chapter 4 is concerned with how we can obtain *definite* and *categorical* experimental results in accordance with our predictions. One of the keys to doing so is to understand our experiments in terms of concepts such as Main-Hypotheses and Sub-Hypotheses, and Main-Experiment and its Sub-Experiments. These concepts will serve as a basis for informant classification, which will be used crucially in Chapters 6 and 7 in interpreting the result of our Main-Experiment with regard to the validity of its Main-Hypotheses. It is by recognizing the fundamental asymmetry between the two types of predictions and by analyzing our experiments in terms of concepts such as Main-Hypotheses and Sub-Hypotheses, and Main-Experiment and Sub-Experiments that we can expect to obtain *definite* and *categorical* experimental results in language faculty science.

Chapter 5 introduces the general design of on-line Experiments and how we can view experimental results, in accordance with the proposed methodology outlined in Chapters 2–4. Chapters 6 and 7 are an attempt to argue for the viability of language faculty science by making reference to actual Experiments in English (Chapter 6) and in Japanese (Chapter 7). Chapter 8 provides a summary of the book and concluding remarks.

There is an accompanying website, where the experimental designs and experimental results discussed in subsequent chapters are made available in more detail than in the book. The website is intended to make it possible for others to examine the validity of the book's empirical claims more thoroughly than is made possible in what follows, and hence, indirectly, the viability of its methodological proposal. The website provides, among other materials, the “raw data” of the experimental results so that interested people can analyze them by the statistical techniques of their choice. The book and its accompanying website are meant to show, *for the first time* in my view, how it is possible to investigate the language faculty as an exact science in the sense noted above. Language faculty science thus turns out to be much closer to physics than to social and behavioral sciences, and this should have far-reaching implications for research that deals with other aspects of the mind. No other work in the literature claims that we can *deduce* definite and testable predictions about the judgments of an *individual* informant on the acceptability of

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sentences *and* expect them to be supported by experimental results. Nor is there any work in the literature, as far as I am aware, that proposes how to design experiments and interpret the experimental results so as to obtain robust experimental results in accordance with our *definite* and *categorical* predictions about the judgments of the *individual* informant as a reflection of *universal* properties of the language faculty.

It is generally agreed that it is not possible outside physics and its closely related fields to deduce *definite* predictions and expect them to be borne out experimentally. I am going to argue that it is indeed possible. The book's slogan is: language faculty science as an exact science is possible; yes, it is. Some may say that I am a dreamer. But I am not the only one. I hope upon reading the rest of the book some of the readers will join us.

2 The fundamental schematic asymmetry

2.1 Introduction

The present work attempts to pursue and defend the thesis that it is possible to investigate the language faculty by applying the *hypothetico-deductive* method, which Feynman describes as the Guess-Compute-Compare method. The passage from Feynman 1965/94 quoted in Chapter 1 is repeated here.

In general, we look for a new law by the following process. First we guess it. Then we compute the consequences of the guess to see what would be implied if this law that we guessed is right. Then we compare the result of the computation to nature, with experiment or experience, compare it directly with observation, to see if it works. If it disagrees with experiment, it is wrong. In that simple statement is the key to science. It does not make any difference how beautiful your guess is. It does not make any difference how smart you are, who made the guess, or what his name is – if it disagrees with the experiment, it is wrong. That's all there is to it. (Feynman 1965/94: 150)

More specifically, I argue that the language faculty can be studied as an exact science. By an “exact science” I mean a research program in which *definite* and *categorical predictions* are *deduced* from hypotheses and are tested against experimental results (or observations). Such a research program will be called *language faculty science*, as noted in Chapter 1. Insofar as we can carry this out successfully with compelling empirical demonstration, that will constitute support for the existence of the language faculty.

Given the assumption that the language faculty underlies our ability to relate sounds and meaning, it seems reasonable to ask informants about the relation between sounds and meaning and consider the informants' reported judgments as evidence for or against our hypotheses about the language faculty. One should, however, naturally wonder how we can justify the use of informants' introspective judgments as crucial evidence, in light of the observation that the informant judgment can be unstable, especially when we consider “meaning.” The present work proposes how

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informant judgments can constitute *hard evidence* in language faculty science, providing conceptual articulation of the claim and its empirical demonstration. This and the subsequent two chapters provide an overview of the proposed methodology for language faculty science.

2.2 Types of judgments and types of predictions

Since the language faculty, by hypothesis, relates sounds and meaning, it seems that the most elementary form of an experiment in language faculty science is such that the informant is asked whether a given sentence is acceptable under a specified interpretation. The *individual* informant’s response can be one of the three types, as indicated in (1).

(1)

Judgment	*	??	ok
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“*” and “ok” in (1) represent “completely unacceptable” and “fully acceptable,” respectively, with “??” covering a range of responses between “*” and “ok.” One should therefore naturally ask whether and how each type of informant judgment in (1) can be considered significant with regard to the validity of our hypotheses.

In order to ensure significance of the *individual* informant’s judgment, it is necessary to clarify what types of predictions we can make about the *individual* informant’s judgments, presumably as a reflection of the hypothesized *universal* properties of the language faculty, and how we can test the predictions against the actual judgments reported by the *individual* informant. One may suggest that there are three types of predictions, just as there are three types of judgments. If there were indeed three types of predictions, as indicated in (2), the experimental results in accordance with the predictions would be as indicated by the shaded cells in (3).

(2)

Prediction
*
??
Ok

(3)

Judgment Prediction	*	??	ok
*			
??			
ok			