

## Chapter 2

### Preliminaries

**Abstract** Chomsky's distinction between descriptive and explanatory theoretical adequacy is discussed, and his emphasis on "Universal Grammar" as *the* criterion for assessing linguistic explanatory adequacy is criticized (Sect. 2.1). Communication is deemed a primary principle for assessing proto-tonal explanatory adequacy (Sect. 2.2). Additional principles are termed "economical," "categorical," and "maximalist" (Sect. 2.3). Finally, in Sect. 2.4 formalities are established for handling "event sequences" and relationships between different types thereof, for example note sequences and pitch sequences.

The 130-odd pages of Part I of this book, *Proto-tonality*, require explanation. Is there really a need for such a complicated theory, the purpose of which is merely to set the stage for Part II, *The Languages of Western Tonality*, also the title of the book as a whole?

The answer depends on one's expectations from theories in general, and from theories that one might term "proto-tonal," in particular. If one only demands that theories be adequate *descriptively* then the answer to the question above is possibly negative. However, if theories are expected to be adequate *explanatorily* as well then the answer is positive: the theory of proto-tonal systems is a complicated theory, to be sure; and yet, it is no more complicated than necessary to attain explanatory adequacy.

We begin, therefore, with an essential methodological distinction.

## 2.1 Descriptive and Explanatory Proto-tonal Adequacy: A Lesson from Linguistics

According to Chomsky,

... there are two respects in which one can speak of “justifying a generative grammar.” On one level (that of descriptive adequacy), the grammar is justified to the extent that it correctly describes its objects, namely the linguistic intuition—the tacit competence—of the native speaker. In this sense, the grammar is justified on *external* grounds, on grounds of correspondence to linguistic fact. (1965, pp. 26–27)

To attain descriptive adequacy, Chomsky explains,

the structural descriptions assigned to sentences by the grammar, the distinctions that it makes between well-formed and deviant, and so on, must... correspond to the linguistic intuition of the native speaker (whether or not he may be immediately aware of this) in a substantial and significant class of crucial cases. (1965, p. 24)

It would seem that descriptive adequacy represents a rather minimal standard of scientific acceptability, but in fact, as Chomsky points out (*ibid.*), “... even descriptive adequacy on a large scale is by no means easy to approach.” This is true of music no less than it is of language.

Consider a hypothetical proto-tonal theory that equates the perfect octave with the pitch interval 1,200 cents (equivalently, the frequency ratio 2). The theory, I submit, is descriptively *inadequate*. Although every musical octave maps psychoacoustically into a pitch interval of ca. 1,200 cents, the reverse relation, as Fig. 2.1 demonstrates, does not hold. Note the asterisked E<sub>b</sub> and D<sub>#</sub> of the cello and second violin, a simultaneity representing the by-product of two note-against-note neighbor-note configurations D-E<sub>b</sub>-D and E-D<sub>#</sub>-E (the neighbor-note motive is of course central to the movement’s design). In performance, the corresponding pitch interval is an approximate whole multiple of 1,200 cents; and yet, the interval from E<sub>b</sub> to D<sub>#</sub> is *not* a compound perfect octave. Indeed, the interval, a compound augmented seventh, is *dissonant* by conventional music theory.

But let us assume that a descriptively adequate proto-tonal theory exists, and indeed, that there are *two* such theories; is there a way to decide in favor of one theory or the other?

According to Chomsky,

On a much deeper and hence much more rarely attainable level (that of explanatory adequacy), a grammar is justified to the extent that it is a *principled* descriptively adequate system, in that the linguistic theory with which it is associated selects this grammar over others, given primary linguistic data with which all are compatible. In this sense, the grammar is justified on *internal* grounds, on grounds of its relation to a linguistic theory that constitutes an explanatory hypothesis about the form of language as such. The problem of internal justification—of explanatory adequacy—is essentially the problem of constructing a theory of language acquisition, an account of the specific innate abilities that make this achievement possible. (1965, p. 27)

**Fig. 2.1** A (compound) augmented seventh in the first movement (m. 116) of J. S. Bach's Brandenburg Concerto No. 3

The musical score for J. S. Bach's Brandenburg Concerto No. 3, first movement, measure 116, is displayed. The score is written for a full Baroque orchestra, including Violino I, Violino II, Violino III, Viola I, Viola II, Viola III, Violoncello I, Violoncello II, Violoncello III, and Violone e Cembalo. The key signature is one sharp (F#) and the time signature is common time (C). The measure contains a complex harmonic structure, including a compound augmented seventh chord, which is marked with an asterisk (\*) above the Violino II staff.

As Chomsky notes (*ibid.*, p. 26), even though "... it would be utopian to expect to achieve explanatory adequacy on a large scale in the present state of linguistics. . . , considerations of explanatory adequacy are often critical for advancing linguistic theory." He continues:

Gross coverage of a large mass of data can often be attained by conflicting theories; for precisely this reason it is not, in itself, an achievement of any particular theoretical interest or importance. As in any other field, the important problem in linguistics is to discover a complex of data that differentiates between conflicting conceptions of linguistic structure in that one of these conflicting theories can describe these data only by *ad hoc* means whereas the other can explain it on the basis of some empirical assumption about the form of language. . . . Thus whether we are comparing radically different theories of grammar or trying to determine the correctness of some particular aspect of one such theory, it is questions of explanatory adequacy that must, quite often, bear the burden of justification. This remark is in no way inconsistent with the fact that explanatory adequacy on a large scale is out of reach, for the present. It simply brings out the highly tentative character of any attempt to justify an empirical claim about linguistic structure.

For Chomsky, then, explanatory adequacy is the question of attaining descriptive adequacy *by principled means*. This, for Chomsky, is primarily a matter of construing the grammar of a particular language as a special case of “Universal Grammar” (UG)—a theory of “. . . the form of language as such.”

Chomsky emphasizes UG, as *the principle* in terms of which linguistic explanatory adequacy is to be assessed, even at the expense of what seems to be an equally important principle, namely, the communicative function of language. This imbalance is evident, for example, in the following interview.

*As I understand, language has an innate biological basis. Its use, however, is social. What do you think of the social functions of language? Is it primarily an instrument of communication?*

I think a very important aspect of language has to do with the establishment of social relations and interactions. Often, this is described as communication. But that is very misleading, I think. There is a narrow class of uses of language where you intend to communicate. Communication refers to an effort to get people to understand what one means. And that, certainly, is one use of language and a social use of it. But I don't think it is the only social use of language. Nor are social uses the only uses of language. For example, language can be used to express or clarify one's thoughts with little regard for the social context, if any.

I think the use of language is a very important means by which this species, because of its biological nature, creates a kind of social space, to place itself in interactions with other people. It doesn't have much to do with communication in a narrow sense; that is, it doesn't involve transmission of information. There is much information transmitted but it is not the content of what is said that is transmitted. There is undoubtedly much to learn about the social uses of language, for communication or for other purposes. But at present there is not much in the way of a theory of sociolinguistics, of social uses of languages, as far as I am aware.

*What, then, in the field of linguistics, are the greatest achievements?*

I think the most important work that is going on has to do with the search for very general and abstract features of what is sometimes called universal grammar: general properties of language that reflect a kind of biological necessity rather than logical necessity; that is, properties of language that are not logically necessary for such a system but which are essential invariant properties of human language and are known without learning. We know these properties but we don't learn them. We simply use our knowledge of these properties as the basis for learning. (Chomsky 2004, pp. 368–369)

Indeed, Chomsky's “overall approach to language” has been roundly criticized by Searle (1972) as “peculiar and eccentric” precisely because “. . . so much of the theory runs counter to quite ordinary, plausible, and common-sense assumptions about language,” namely, that “the purpose of language is communication in much the same sense that the purpose of the heart is to pump blood.” Searle continues:

In both cases it is possible to study the structure independently of function but pointless and perverse to do so, since structure and function so obviously interact. We communicate primarily with other people, but also with ourselves, as when we talk or think in words to ourselves. Human languages are among several systems of human communication (some others are gestures, symbol systems, and representational art) but language has immeasurably greater communicative power than the others.

We don't know how language evolved in human prehistory, but it is quite reasonable to suppose that the needs of communication influenced the structure. For example, transformational rules facilitate economy and so have survival value: we don't have to say, “I like it that she cooks in a certain way,” we can say, simply, “I like her cooking.” We pay a small

price for such economies in having ambiguities, but it does not hamper *communication* much to have ambiguous sentences because when people actually talk the context usually sorts out the ambiguities.

Transformations also facilitate communication by enabling us to emphasize certain things at the expense of others: we can say not only “Bill loves Sally” but also “It is Bill that loves Sally” and “It is Sally that Bill loves.” In general an understanding of syntactical facts requires an understanding of their function in communication since communication is what language is all about.

“The defect of the Chomskyan theory” Searle concludes towards the end of the review “arises from the same weakness we noted earlier, the failure to see the essential connection between language and communication, between meaning and speech acts.”

Chomsky (1975, p. 55 ff.) responds to these serious charges at length, while acknowledging (*ibid.*, p. 235), that “the bulk” of Searle’s account is “. . . accurate and compelling, including many of the critical comments”; he even refers (*ibid.*) to Armstrong (1971) as suggesting “. . . that the theory that communication provides ‘the clue to an analysis of the notion of linguistic meaning’ can be traced to Locke.”

In his response, Chomsky (1975, p. 59 ff.) isolates the explanatory role of communication *with regard to the theory of meaning* as “. . . the sole serious point of disagreement.”<sup>1</sup> As he notes,

Under innumerable quite normal circumstances—research, casual conversation, and so on—language is used properly, sentences have their strict meaning, people mean what they say or write, but there is no intent to bring the audience (not assumed to exist, or assumed not to exist, in some cases) to have certain beliefs or to undertake certain actions. Such commonplace examples pose a difficulty for an analysis of meaning in terms of speaker’s intention with regard to an audience, even if it were possible, for the case where there is intent to communicate, to account for what a sentence means in these terms—and this too I doubt, for reasons to which I will return. (1975, p. 62)

The difficulties that Chomsky notes with regard to a communication-motivated theory of meaning are instructive in the present context because the analogy between language *and music* seems to break precisely at this point: semantics. Though it seems eminently reasonable to speak of “musical syntax,” to speak of “musical semantics” is, at best, controversial. Indeed, musical “utterances,” even less so than linguistic ones, do not ordinarily carry an “intention with regard to an audience,” for example “to have certain beliefs or to undertake certain actions.” Moreover, a musical audience is normally not even expected to perform the linguistically commonplace action of *responding* to an utterance in the manner of a conversation, where *semantically related* utterances are tossed back and forth such that the roles of “speaker” and “audience” are constantly interchanged. (A musical audience, in fact,

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<sup>1</sup> Chomsky (*ibid.*, p. 57) is rather uncomfortable with “. . . Searle’s concept of ‘communication’ as including communication with oneself, that is, thinking in words.” “. . . I agree with Searle that there is an essential connection between language and communication once we take ‘communication’ in his broader sense—an unfortunate move, I believe, since the notion ‘communication’ is now deprived of its essential and interesting character.” However, as we shall see in Sect. 6.4, musical self-communication can be a highly interesting form of communication, with far-reaching structural ramifications.

does not seem to object and often even seems to enjoy attending to essentially the same utterance, passively as it were, time and time again.)

In short, if music is a language, and in particular, one that (for all practical purposes) *lacks* a semantic component, then one can hardly object to a Searle-like position that places the idea of communication center-stage. Before proceeding any further, therefore, it is only natural that we state as precisely as possible what such a position entails.

## 2.2 The Communication Principle

Figure 2.2 reproduces Shannon's (1948, p. 381) schematic diagram of a "general communication system." A "message" conceived at some "information source" is transformed into a "signal" transmitted over some "channel." "The *receiver*" states Shannon "ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal." Moreover,

The fundamental problem of communication is that of reproducing at one point exactly or approximately a message selected at another point. . . . The significant aspect is that the actual message is one *selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design. (p. 379)

I shall assume henceforth that tonal music is a communication system in the following sense (Fig. 2.3). The message is a sequence of *notes* and the signal is a corresponding sequence of *pitches*. Following Shannon, I shall assume that the received message is as faithful as possible an image of its transmitted counterpart, and shall refer to this assumption as the Communication Principle. Ideally, then, an *identity relationship* should hold between the transmitted message and the received one; however, we shall say that *the Communication Principle is satisfied* if the relationship between the transmitted and received message is one of *transposition*.

In a communicative context it is natural to assume that transmitters and receivers are more than just "neutral" agents for transmitting and receiving messages. Rather, transmitters and receivers are "communication seekers" in the sense of making a *purposeful effort* to engage in fruitful exchange. Transmitters, therefore, will take into account the difficulties that face receivers and will not only transmit messages via a signal deemed optimal, but will also construe their messages in the first place such that they are not cognitively opaque. Conversely, receivers will attempt to decode a less-than-optimal and even corrupted signal; and they will make some effort to cope with a cognitively demanding message.<sup>2</sup>

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<sup>2</sup> It is difficult to disagree with Molino (1975, p. 47, quoted in translation in Lidov 2005, p. 86), that "nothing guarantees a direct correspondence between the effect produced by a work of art and the intentions of its creator. Every symbolic object presumes an exchange in which producer and consumer, sender and receiver are not interchangeable and have different perspectives on this object which they hardly conceive in the same way." I believe, nonetheless, that despite the lack of guarantee of success, human beings are communication seekers.

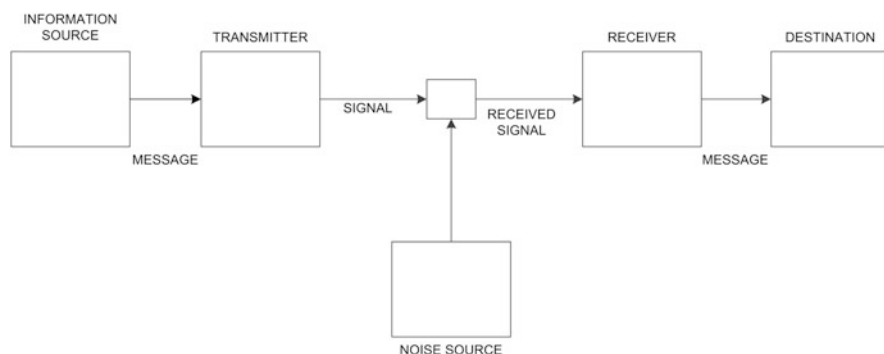


Fig. 2.2 Shannon's General Communication System



Fig. 2.3 The note-communication system

Though we shall usually think of communication as an act in which information passes through an external medium between two distinct persons, we shall also entertain the idea of *reflexive* communication, where information passes *internally* between the transmitting and receiving “faculties” of the same person. There is nothing abnormal or perverse about reflexive communication; indeed, successful “intrapersonal communication” (communication with oneself) is arguably a prerequisite for successful “interpersonal communication” (communication with others).<sup>3</sup> Intrapersonal musical communication, for example, hearing music “in one’s head,” seems pervasive.

Finally, it is important to note that the note-communication system depicted in Fig. 2.3 falls short of satisfying Shannon’s definition of a “communication system” since the “signal” (a sequence of pitches) is not “suitable for transmission over the channel” (Shannon 1948, p. 381). Therefore, in Sect. 3.3, a lower-level system is constructed, a system the message of which—a sequence of pitches—corresponds to the higher-level “signal.” A pitch-communication system is a genuine communication system. The message (a sequence of pitches) is transformed into an eminently transmittable signal, namely, a sequence of *sound waves*.

<sup>3</sup>The terms “interpersonal communication” and “intrapersonal communication” originate with Ruesch and Bateson (1951, pp. 15–16).

## 2.3 Three Additional Guiding Ideas

As a guiding idea, the Communication Principle is by far the most important in this book. Indeed, the book may fruitfully be read as a narrative by which the ability to communicate notes successfully is analyzed step by step. However, additional principles do exist.

### 2.3.1 *The Economical Principle*

The Economical Principle states that the mental resources available to the listener for decoding a tonal message are not unlimited. In particular, “... the span of absolute judgment and the span of immediate memory impose severe limitations on the amount of information that we are able to receive, process, and remember” (Miller 1956, p. 95). The Economical Principle is not dependent on some specific theory of (short-term) memory. Rather, it states quite generally that the “universal grammar” of tonality is constrained to reduce cognitive load as much as possible.

The Economical Principle is implemented primarily in Sect. 5.2. See also Sects. 14.2 and 15.1.

### 2.3.2 *The Categorical Principle*

Consider the phenomenon known as “categorical perception” (CP). According to Harnad (1987, p. 3), an example of CP is

... the color spectrum as it is subdivided into color categories, or an acoustic continuum called the “second-formant transition” as it is subdivided into the (synthesized) stop-consonant categories /ba/, /da/, and /ga/. In both cases, equal-sized physical differences between stimuli are perceived as larger or smaller depending on whether the stimuli are in the same category or different ones.

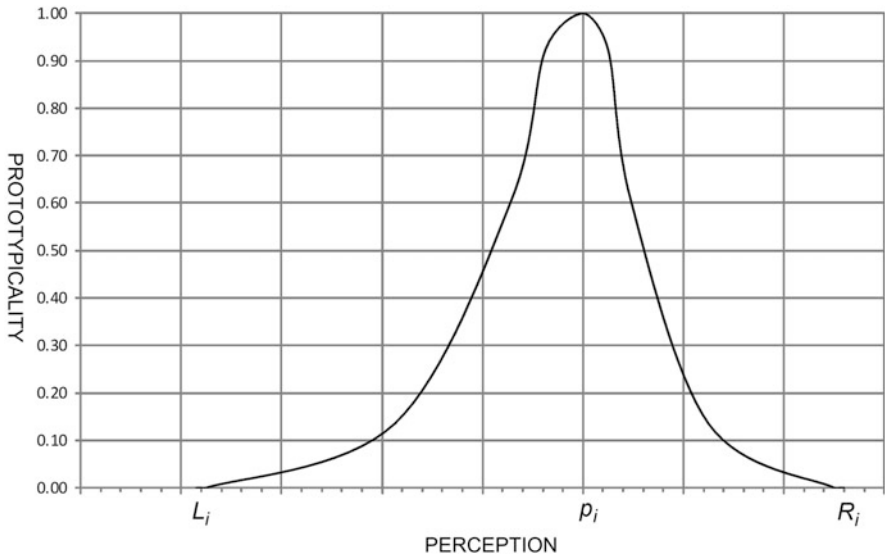
Suppose that perceptions of a certain type (for example, color) are representable as a continuum  $P$  analogous to the line of real numbers (Fig. 2.4). Suppose further that there exist points  $p_0 < p_1 < \dots$  on the line that, for some reason or another, are perceptually privileged. Then, if the Categorical Principle applies, for any three privileged points  $p_{i-1}$ ,  $p_i$ , and  $p_{i+1}$  the central  $p_i$  is the *prototype* of the category  $C_i$ , a category defined as the continuum of perceptions (real numbers)  $p_i$  extending from a “left boundary”  $L_i = \frac{p_{i-1}+p_i}{2}$  to a “right boundary”  $R_i = \frac{p_i+p_{i+1}}{2}$ , exclusive of the boundaries themselves (the category  $C_i$  is thus the open interval  $(L_i, R_i)$ ).

Moreover, if the Categorical Principle applies, then for every category  $C_i$  there exists a *categorical-perception function*  $CP_i$  from  $P$  into some closed interval, say  $[0, 1]$ , a function with the following properties (see Fig. 2.5). For every  $p \in P$  the value  $CP_i(p)$ , to which we shall refer as *the prototypicality of  $p$  relative to  $C_i$* ,





**Fig. 2.4** The prototype  $p_i$  and the category  $C_i$  on the perceptual continuum  $P$ .  $L_i$  and  $R_i$  are the category's left and right boundaries, respectively



**Fig. 2.5** Prototypicality as a function of perception relative to an arbitrary category  $C_i = (L_i, R_i)$  with prototype  $p_i$

decreases smoothly, monotonically, and symmetrically with the distance of  $p$  from  $p_i$  such that  $CP_i(p) = 1$  implies that  $p = p_i$  and  $CP_i(p) = 0$  implies that either  $p \leq L_i$  or  $p \geq R_i$ . Note that the symmetry is relative to the ratio  $\frac{p_i - L_i}{R_i - p_i}$ . That is, for a perception  $p$  lying to the left of  $p_i$  there exists a perception  $p'$  of equal prototypicality lying to the right of  $p_i$  such that  $\frac{p_i - p}{p' - p_i} = \frac{p_i - L_i}{R_i - p_i}$  (and vice versa, for a perception  $p'$  lying to the right of  $p_i$ ).

The Categorical Principle is applied in Sect. 5.3.

### 2.3.3 The Maximalist Principle

The Maximalist Principle is rather abstract. It states that in positing the existence of a (non-empty) set  $S$  of objects  $s$  of a certain type, in the absence of a compelling reason to assume otherwise it is natural to assume that  $S$  contains the *maximal* possible number of objects  $s$ . The Maximalist Principle is implemented primarily in Sects. 5.1 and 6.4; see also Sect. 10.1.

The Maximalist Principle may conflict with other principles (for example the Economical Principle). Such conflicts and their resolution are discussed as relevant.

## 2.4 Event Sequences

In various contexts in the course of this study we posit the existence of “event sequences,” for example, pitch sequences in Sect. 3.3; note sequences in Sect. 3.5; and chord sequences in Sect. 7.4. The following definitions, therefore, are essential.

**Definition 2.1.** Sequence; Length (of a sequence); Empty Sequence; Position (of an element in a sequence); Sequence Membership

Let  $R$  be a non-empty set (the “event repository”).

- A. A *sequence*  $s$  over  $R$  is a finite sequence of elements from  $R$ . For example, “successfully” is a sequence over the Roman alphabet.
- B. The *length* of a sequence  $s$  is denoted  $\text{lsl}$ .
- C. The length of the *empty sequence*, denoted  $\epsilon$ , is 0.
- D. Given a non-empty sequence  $s$ , the element that occurs at the  $j$ th *position* of  $s$ ,  $1 \leq j \leq \text{lsl}$ , is denoted  $s(j)$ . Thus  $s = s(1), s(2), \dots, s(\text{lsl})$ .
- E. If  $s(j) = a \in R$  we write  $a \in s$  and say that  $a$  is a *member* of  $s$ .

**Definition 2.2.** Sequence Exchange

Let  $Q$  and  $R$  be two event repositories and let  $s$  and  $t$  be two non-empty sequences over  $Q$  and  $R$ , respectively,  $\text{lsl} = \text{ltl} = L$ .

The *exchange of  $s$  with  $t$* , written  $X : s \rightarrow t$ , is the sequence over  $Q \times R$  of pairs  $(s(j), t(j)), j = 1, 2, \dots, L$ .<sup>4</sup>

For every pair  $(s(j), t(j)) \in X$  we write  $X(s(j)) = t(j)$ . Thus, in the context of an exchange  $X : s \rightarrow t$  the notation  $X(a) = b$  (often simplified to  $Xa = b$ ),  $a \in s$ ,  $b \in t$ , is understood to imply that elements  $a$  and  $b$  occupy the same position relative to their corresponding sequences.

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<sup>4</sup>Thus  $X$  is the order-preserving bijection from the ordered multiset  $s$  onto the ordered multiset  $t$ .

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