Constructing Theories of Words

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References to be completed

1 Introduction

The goal of this chapter is not to present new research in morphology, South Asian Morphology, or morphological theory. Nor is it to sketch a perspective on issues in these domains. Our goal is pedagogical: to help students of linguistics see the need to develop the ability to construct theories, in this instance, theories in morphology; and to point to a way of working towards that goal.

This is not a scholarly piece of work: the reader will not find a large body of learned references in it. While we do have a few references by way of examples, a majority of the references are to our own work. The reason for this will become clear in Section 9 of the chapter.

Given what this volume is about, it would have been appropriate to begin with the question, "What is Morphology?" But beyond the cliched answer that morphology is the study of words, we will not try to address this question, because our answer is bound to be biased, shaped by our own graduate education and research in linguistics and in morphology in particular.

To see why we must be cautious about any answer to this question, consider raising the question, "Who is an academic?" with a random sample of those who regard themselves as academics. The answer is likely to be so varied that given X's answer, a Y would disqualify as an academic, and vice versa. If we were to ask a random sample of linguists, including the contributors to this volume, "What is morphology?" we are likely to find ourselves in a similar situation. Chances are that we would disagree with one another, or provide answers that are inconsistent with one another. So, given that our purpose is pedagogical, we will leave that question to the other chapters in the volume.

It would be safe to say that just as the study of physics can be broadly divided into experimental physics and theoretical physics, the study of morphology can be broadly divided into descriptive morphology and theoretical morphology. If we were to do an Internet search for 'morphology of X' where X is the name of a language ('Morphology of Malay,' 'Morphology of Tagalog,'…), it is not unlikely that most of the results would be examples of the descriptions of the morphology of a particular language, or a comparison of the descriptive morphologies of different languages. As for theoretical morphology, it can be subdivided into theoretically grounded morphological components of the grammars of particular languages, or the morphological component of universal grammar.

Our own project is neither: it is that of helping students develop the capacity to construct theories of the morphology of a particular language, as a component of universal grammar, with the possibility of making a contribution to the theory of universal grammar.

Why this particular project? The answer is: to empower students of morphology to become producers (rather than consumers) of theories that are grounded in the grammars of the languages they are interested in.

2 Theories of Words

2.1 Grammar, Representations, Laws, and Explanation

We will use the term ***grammar of a language*** to denote a ***theory*** of the ***structure*** of linguistic expressions (sentences, phrases, words, and so on) of that language, reserving the term ***linguistic theory*** to theories of grammars. Constructing a theory of linguistic expressions requires us to postulate:

- ***representations*** of linguistic expressions, and
- statements on the ***regularities in the representations*** (***rules, constraints, principles***, or ***conventions,*** the counterpart of which in the physical sciences are called ***laws)***.

In subsequent sections, we will see how the combination of representations and laws yields ***predictions*** and provides ***explanations***.

To turn to regularities in the representations of linguistic expressions, we will highlight two types: those of ***distribution*** and ***alternation***.

A regularity in distribution involves variations in the representations of a given linguistic expression in the same level of representation,. To illustrate, in English, two adjacent obstruents within the same syllable must agree in voicing. Thus, while /spit/, /lips/ and /lisp/ are well formed representations, */sbit/, */zpit/, */lipz/, */libs/, and */lizb/ are illformed. This is a distributional regularity, referred to in textbooks as phonotactic constraints.

A regularity in alternation holds between the representations of two related expressions, or between two levels of the representation of a single linguistic expression. Thus, the regularity in the phonological representations of *twelve* /twelv/ and *twelfth* /twelfθ/ is an example of an alternation between /v/ and /f/.

Predicting the regularities of distribution and alternation in terms of a unified explanation with a single set of laws is a preoccupation in linuistic theory, and one of the issues that we will be concerned with.

2.2 Dimensions and Levels of Representation

Linguistic expressions have three kinds of properties:

- pronunciation, expressed in terms of ***phonological*** representations;
- meaning, expressed in terms of ***semantic*** representations; and
- what mediates between the two, captured as ***syntactic*** representations.

To illustrate, consider the words *phenomena* and *phenomenology*, which are related in their meaning: *phenomena* refers to what appears to us through our senses rather than by thought or analysis; and *phenomenology* is the study of phenomena. They also have related pronunciations: /fəˈnɒ.mɪ.nə/ and /fəˌnɒ.mɪˈnɒ.lə.dʒi/). As for their syntax, they are both nouns; but while *phenomena* is plural, *phenomenology* is singular. In sum, the two words have three ***dimensions*** of representation, illustrated in the table below:

(1)

Dimensions	*phenomena*	*phenomenology*
Semantic	what appears to us through our senses	the study of what appears to us
Phonological	/fəˈnɒ.mɪ.nə/	/fəˌnɒ.mɪˈnɒ.lə.dʒi/
Syntactic	NOUN, PLURAL	NOUN, SINGULAR

In the previous section, we talked of *twelve* and *twelfth* as related words. *Phenomena, phenomenology, phenomenological,* and *phenomenologically* are also related words.

Notice that some parts of the representations of related words exhibit alternation or variation, while others remain constant. For instance, the meaning of what appears to us through our senses remains constant in both the words, *phenomena* and *phenomenology*. So does the phonological string /fəˈnɒ.mɪn/, while the stress varies. The syntactic property of being a noun is the same in both, but the words exhibit a difference in number: singular vs. plural. The pair *phenomenology* and *phenomenological* exhibits an alternation in primary stress (on the 4th syllable in *phenome**no**logy*, and on the 5th syllable in *phenomeno**lo**gical*), and a corresponding vowel alternation between /ɒ/ and /ə/ in the fourth syllable.

A theoretical strategy for capturing such alternations is to postulate two ***levels*** of representations. Here is an illustration of the strategy, with the pair *twelve* and *twelfth*:

(2)

twelve	{TWELVE}	*twelfth*	{TWELVE TH}
	|		| |
	/twelv/		/twelf θ/

Even though we have used English spelling for the representation in curly brackets, those are not representations of either spelling or pronunciation. Lexeme-based theories use the term ***lexeme*** to refer to such representations. We have extended this concept to affixes as well: the notation of upper case letters views both {TWELVE} and {TH} as lexemes.

Should we extend this strategy to related pairs like *fight~fought, buy~bought, think~thought, teach~taught,* and *seek~sought*? For instance, to express the relatedness of *buy* and *bought*, should we represent *bought* as being composed of /b-t/ and /ɔ/?

To answer that question, we need to take a step back and engage with the concept of structure. We proceed to that task in what follows.

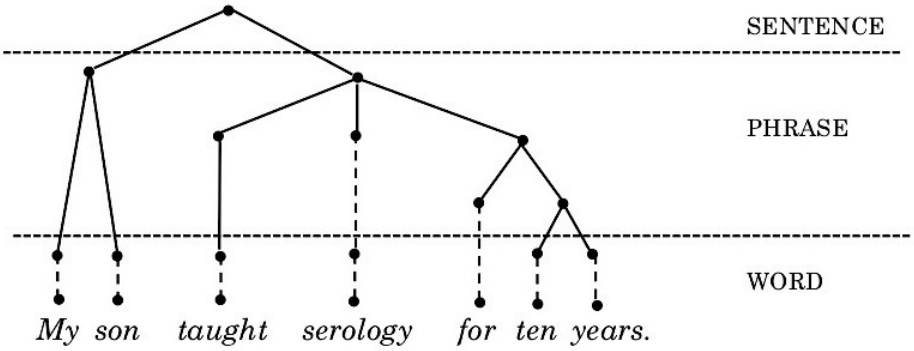
2.3. Compositionality: Sentences and Phrases

As mentioned earlier, we use the term ***grammar of a language*** to denote a ***theory*** of the ***structure*** of linguistic expressions in a given language. Now, central to the concept of structure is the relation of compositionality: X is composed of Y, where X is a single unit, and Y is one or more units. For the purposes of this chapter, we will assume that:,

- ~ sentences, phrases, and words are ***units*** of language structure; and
- ~ sentences are composed of phrases; phrases are composed of words.

The standard diagrammatic notation used for stating compositionality relations among sentences, phrases, and words is that of ‘tree diagrams’. Here is an example:

(3)



In (3), dots represent ***units*** of structure; solid lines represent the relation of ***compositionality***; dotted vertical lines from X to Y represent the relation 'Y is a X'; and dotted horizontal lines separate the different levels.

The information in (3), when expressed in words, would be as follows:

(4) The sentence, *My son taught serology for ten years*, is composed of the phrases *my son* and *taught serology for ten years*.
The phrase *my son* is composed of the words *my* and *son*.
The phrase *taught serology for ten years* is composed of the words *taught* and *serology*, and the phrase *for ten years.*
The phrase *for ten years* is composed of the word *for* and the phrase *ten years.*
The phrase *ten years* is composed of the words *ten* and *years.*

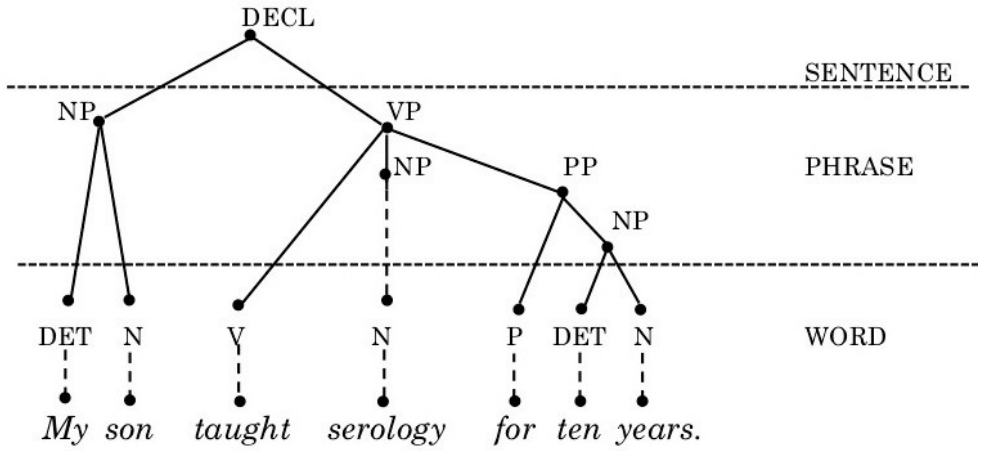
Tree diagrams representing the structure of units also employ the concept of ***categories***. For instance:

(5)

UNIT	LEVEL	CATEGORY
My son taught serology for ten years.	Sentence	Declarative
my son	Phrase	Noun Phrase
son	Word	Noun

The category information is expressed in tree diagrams by labelling the units with appropriate category labels:

(6)



The diagram in (6) serves as good illustration to unpack the kinds of information expressed in syntactic trees.[1]

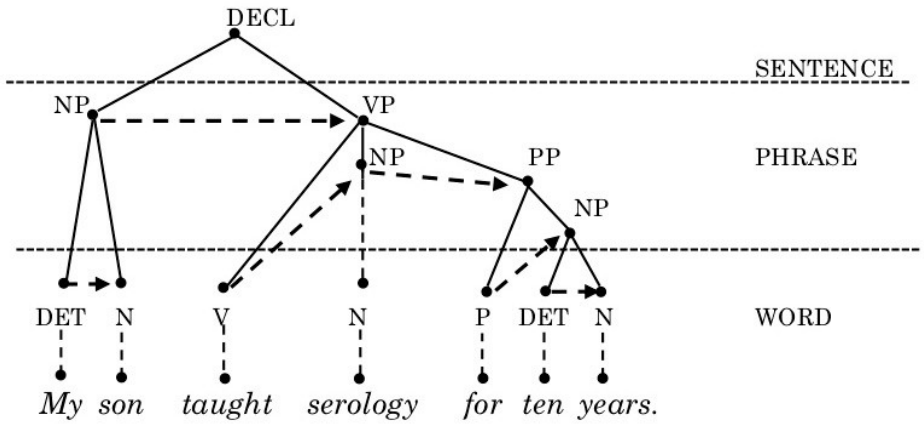
1 This is not the kind of tree diagram that the reader is likely to find in the literature. For instance, the top node might be labeled S, S-bar, or CP; *my son* might be labeled DP instead of NP, and a binary branching structure might be imposed on *taught phenomenology for two decades*. Such differences do not

Syntactic trees also encode another piece of information, that of ***precedence*** (UNIT X precedes UNIT Y) :

(7) *My son* precedes *taught serology for twenty years;*
my precedes *son*;
taught precedes *serology*; and
serology precedes *for twenty years*.

One way to express the precedence relation in a tree diagram is to use the notation of dotted arrows:

(8)



Another notation commonly used to express the precedence relation is that of the left-to-right order of units, instead of the dotted arrow notation.

In sum, compositionality lies at the core representation of the structure of units. In addition to compositionality, structural representations may also express concepts like categories and precedence.

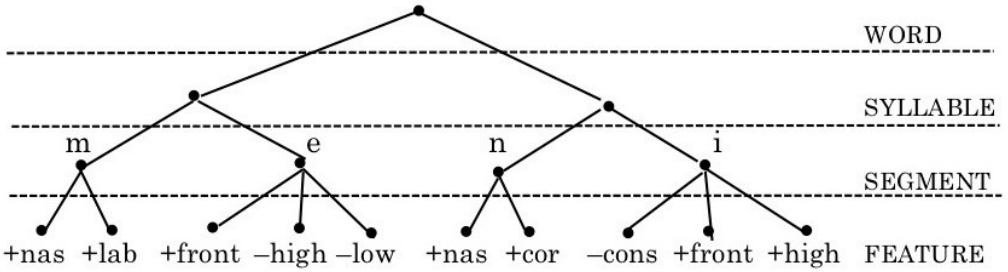
2.4. Compositionality: Syllables and Segments

There is sufficient evidence in the literature on phonological representations to show that:

(9) Words are composed of syllables, and
Segments are composed of distinctive features.

The representation of the English word *many* illustrates these statements:

(10)



It must be noted that while /m/ precedes /e/, /e/ precededs /n/, and /n/ precedes /i/, there is no precedence relation among the distinctive features of a segment: [+lab, +nas] is not distinct from [+nas, +lab].

affect the point we are making.

2.5 Compositionality: Words

In the table in (1), we specified the semantics, syntax, and phonology of the words *phenomena* and *phenomenology*, and looked at what is constant in the two words, and how they vary. How do we represent the compositionality in *phenomenology*, and similar words, for instance, *serology*, *phonology*, *biology*, *mythology*, and son?

Let us assume that *phenomenology* is composed of *phenomena* and *ology*, and *serology* is composed of *serum* and *ology*. Given this assumption, we might explore the possibility of representing the word *serology* as in (11):

(11)

serology serum ology	*serum*	*ology*	
Meaning	the fluid component of blood	the study of something	
Pronunciation	/siə.rəm/	/ɒ.lə.dʒi/	
Syntax	Noun	Preceding sister: Mother:	Noun Noun

Given the 'atomic' representations of *serum* and *ology*, the independently needed phonological rules for the assignment of word stress, and a morpho-phonological rule that deletes [əm] in *serum* to yield *ser-ology*, we can derive the composite representation of *serology* from those of *serum* and *ology*.

If we accept the above representations, we also need to accept that:

(12) a. There exist composite words which are composed of word parts.
b. Some of the word parts need not be words by themselves.

Speakers of English who are familiar with names of academic fields denoted by terms of the form X*ology* (e.g., *phonology*, *biology*, *zoology*, sociology, ...) know that:

'X-*ology* means 'the study of Y'
where Y is a word of the form X*z*
where z is string of zero, one, or more phonological segments.

Let us take the word *Soteriology*, which many may not have across. Yet, they would be able to infer that it is the study of *soteri*..., probably *soteria*, with the final vowel deleted when *-ology* is attached, as in the case of *serology*, where the [əm] of *serum* is deleted. Dictionaries tell us that *soteriology* is the study of religious doctrines of salvation. According to Wikipedia, the word originates from the ancient Greek word *sōtēria* "salvation", from *sōtēr* 'savior, preserver' and *logos* 'study' or 'word'. (https://en.wikipedia.org/wiki/Soteriology) Any theory of morphology must provide an explanation for this phenomenon of speakers of the language being able to infer the meaning of a new word on the basis of what they perceive it as being composed of.[2]

2.6 Distinctiveness

To settle the issue of whether or not words have word parts that are not themselves words, we need the concept of distinctiveness. To unpack this concept, we begin with the core

2 The form *-ology*, an affix in textbook terminology, is an instance of a word part that is not a word. There are morphological theories that reject the idea that there exist word parts that are not words. This issue needs to be settled through a rational debate.

insight that led to the so called ***minimal pair*** test in classical phonemics, and in the distinctive feature framework in phonological theory. Both the IPA framework and the distinctive feature framework agree that the presence and absence of vocal chord vibration in the first segment of the minimal pair *bin*/*pin* in English is ***distinctive*** in the sense that:

> The ***difference*** in the vocal chord vibration in a phonological segment corresponds to a difference in meaning.

It is this insight that led classical phonemics to postulate the distinction between ***contrastive distribution*** and non-contrastive distribution as the first step in their discovery procedure.

The minimal pair test is founded on the procedure of ***substitution***. While *pin* and *bin* form a minimal pair, *spin* and *pin* are not treated as so, even though the only difference between them is that of the presence of /s/ in *spin*, absent in *pin*. In procedural terms, we could either the difference either as the addition of /s/ in *spin*, or as the deletion of /s/ in *pin*.

Suppose we expand the notion of minimal pair to include not only substitution but also addition/deletion in its definition:

> A pair of words form a ***minimal pair*** if they exhibit a difference in pronunciation (viewed as substitution, addition, or deletion) corresponding to a difference in meaning and/or syntax.

If we accept this generalised concept of minimal pair, the presence vs. absence of /θ/ in *tenth~ten* make them a phonological as well as morphological minimal pair. What makes them a phonological minimal pair is their distinctiveness in a single segment, /θ/, which is both a segment and a word part. The presence and absence of -ology in *climatology* and *climate*, makes them a morphological minimal pair.

Distinctiveness is not restricted to phonology or morphology. Consider the following sentences:

(13) a. (i) Zeno read the book.
(ii) Zeno read the book again.
(iii) Zeno re-read the book.

b. (i) Ana arranged the furniture.
(ii) Ana arranged the furniture again.
(iii) Athena rearranged the furniture.

Consider what is distinctive when *again* is added to a sentence. The distinctiveness illustrated by minimal pairs of sentences ((i) and (ii)) in (13a, b) is located in the word *again*. When we include the sentences in (iii), the distinctiveness is now located in *re-*. Thus, while *again* is a word and *re-* is an 'affix', they both involve broadly the same meaning, even though their meanings are not identical.

At this point, we must stop and ask: What is an affix?

If we accept the claims that *climatology* is composed of *climate* and *-ology*, and *rearrange* is composed of *re-* and *arrange*, we may define an affix as:

> An affix is a morphological segment that is not itself a word.

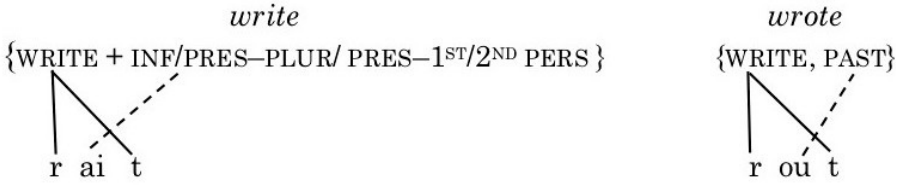
Now, if we accept this definition, we are forced to conclude that *bio* in *biology* is an affix. If so, it follows that *biology* is composed of two affixes, *bio-* and *-ology*. We would then

be forced to conclude that a composite word can be composed of two words, two or more affixes, or a combination of words and affixes.[3]

What is distinctive about the pair *write* and *writing*, then, is the additional affix *-ing* in one member of the pair. What is distinctive about the pair *write* and *wrote* is the presence of *ai* in the first member, and instead, *ou* in the secondmember. While the first type of distinctiveness is analogous to *pit* and *spit* in that it is one of presence/absence, the second is similar to *pit* and *bit* in that it is one of substitution.

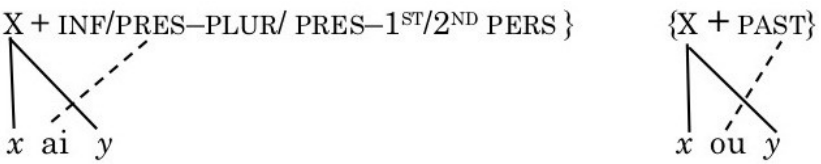
In the minimal pair *pit* and *bit*, all that we need to specify is that there is a phonological difference and a meaning difference. This is not sufficient in the minimal pair *write* and *wrote*, where their representations need to specify something along the following lines:

(14)



We can abstract away from *write~wrote* the general pattern of the pairing of morpho-syntax and morpho-phonology as in (15):

(15)



A slightly more complex pattern is that of *five~fifth*, where the vowel alternation (ai ~ i) is accompanied by the presence of the affix /θ/. This affix appears on every ordinal number, except *first*, *second*, and *third*: *fourth*, *fifth*, *sixth*, *seventh*, *eighth*, *nineth*, *tenth*, *eleventh*, *twelfth*… It also appears as a nominalising affix in pairs like *grow~growth*, *heal~health, long~length*, and *steal~stealth*.

We must note that the pattern of expressing morpho-syntactic properties in terms of pairing phonological segments are ubiquitous across languages. An example from English is the pattern of vowel pairing, as in (15). Other such pairings are ai~i (*divine~divinity*), ei~æ (*sane~sanity*), ii~e (*meter~metric*), and ou~ɒ (*cone ~conic*). A language like Malayalam uses gemination (pairing of geminate and non-geminate segments) and denasalisation (pairing of a nasal and a corresponding non-nasal) as a staple mode to express morpho-syntactic meanings. (KPM 1976) This is like saying that English likes to use the affix *en* repeatedly, as the prefix *en-* in *en-rich* and *en-circle*; the suffix -en in *broad-en*, *ox-en*, and *brok-en*; and the combination in *en-light-en*.

To develop a clearer understanding of the concepts of compositionality, ordering, categories, distinctiveness/contrastiveness, and minimal pair, as well as the idea of phonological vs. morphological segments, we need to move from the discipline-specific study of linguistic expressions to a trans-disciplinary space provided by scientific inquiry in general.

We must warn the reader that the trans-disciplinary space can be challenging for someone who is not comfortable with scientific inquiry in general. However, we recommend not

3 Given the above ideas, do we need the concepts of stem and root as theoretical constructs in morphology? We leave that for the reader to pursue.

giving up, but each of us taking from the following discussion what is of relevance to our own study of the structure of language.

3 General Considerations in Theory Construction

3.1 Learning, Knowing, and Understanding

The institution of education is founded on three fundamental concepts: *learning, knowing,* and *understanding*. (Children go to school because parents expect them to *learn*, and continue their formal education because that is what is expected.)

What is 'learning'? We may say that it is *a process that results in a change internal to an organism, which in turn results in a change in its behavior.*

What is 'knowing'? A possible answer is: Knowing is *an internal state in an organism, resulting from the process of learning.* So we may say that knowledge is *a set of statements that we accept as true*.

Philosophy distinguishes between two kinds of knowing One is propositional knowing, which is of the form: *X knows that Y*. For instance, we know that bicycles have two wheels, while motorcars have four wheels. The other is procedural knowing, which is of the form, *X knows how to Y*. For instance, many of us know how to ride a bicycle, and some of us also know how to drive a car. As part of our education, we acquire both these forms of knowing. When we learn that a triangle is a three-sided polygon, we are acquiring a KNOW-THAT form of knowledge. And when we learn how to calculate the area of a triangle, we are acquiring a KNOW-HOW-TO form of knowledge — a skill or ability.

What is 'understanding'? Hard as it is to answer, we may begin by saying; Understanding is *a mental grasp of how different things are related, where they belong, and how they fit together as a whole.*

For instance, take the concepts of learning, inquiry, research, knowledge, belief, and truth. If we treat them as unrelated concepts, we are missing something. But if we explore how they are related to one another, and see them as a network of interrelated concepts that fit together as a whole, we have a sense of understanding them.

3.2 Academic Knowledge

Academic knowledge, like indigenous knowledge, traditional knowledge, folk knowledge, commonsense knowledge, and so on, is a subcategory of knowledge in general. Scientific knowledge in turn is a subcategory of academic knowledge. And a theory of words is a subcategory of scientific knowledge. Let us turn to some of the characteristics of academic knowledge, and of scientific knowledge, in order to place theories of words in perspective.

As we said above, we take knowledge to be a body *of propositions that we judge to be true.* We can say that a child of three 'knows' that we can walk on the surface of the earth, but not on the surface of a lake. That we can walk on land but not on water is something that we judge to be true.

Within that broad category, we take ***academic knowledge*** to be *a body of propositions that the academic community judges to be true, on the basis of rational justification.* This is the category of knowledge that:

- is disseminated through research publications;

- is documented as knowledge in encyclopedias; and
- students are exposed to in textbooks and classrooms;

For a knowledge claim to qualify as part of academic knowledge, it must be *rationally justified*, to the satisfaction of the members of the academic community. When the knowledge claims that two different individuals or groups in the community propose are logically contradictory, they need to engage in a *rational debate* to arrive at a resolution of the conflict and eliminate the contradiction.

Rational justification and debates to make a choice from among alternative theories is central to academic knowledge. This is because such knowledge is founded on the awareness of the fallibility of human knowledge in every domain, including mathematics and science. And as a consequence, regardless of the degree of certainty we assign to knowledge propositions, they are subject to doubting and questioning.

3.3 What Counts as a Theory

In the context of academic knowledge, a ***theory*** is a set of statements from which we can deduce a set of logical consequences, which we refer to as ***conclusions***. The statements from which the conclusions are derived, we refer to as ***premises***. And the steps of ***reasoning*** from the premises to the conclusions is a ***derivation***, much like the proof of a theorem in mathematics That structure, of **p**remise-**d**erivation- **c**onclusion (which we call the **PDC** structure), is central to all theories in mathematics and the sciences. A theory of geometry in mathematics, for example, has a set of statements called *definitions* (e.g., "A triangle is a three-sided polygon."), and a set of statements called *axioms* (e.g., "Through any two points, we can draw one and only one straight line."). These are the premises of the theory. The logical consequences of these definitions and axioms are theorems. (e.g., "The sum of angles in a triangle is two right angles.")

In scientific theories, what corresponds to mathematical ***axioms*** are ***laws***, and what corresponds to ***theorems*** are ***predictions***. A scientific theory ***explains*** what is *puzzling* in our observation. To meet this requirement, we need to ensure that the logical consequences, namely the predictions, of the laws and definitions of the theory are consistent with (match) our observations. When the logical consequences of the theory match the observations, we call them ***correct*** predictions.

At the core of ***explanation***, ***prediction,*** and ***calculation/computing*** and also of ***proof*** (which involves rational justification) lies ***reasoning***, studied under the discipline called ***logic***. A strong foundation in reasoning is therefore central to developing the ability to construct and evaluate theories.

These remarks point to four important considerations to pay attention to in theory construction and theory evaluation:

(16) A. Articulating what needs to be explained (the ***explananda***) in a shared vocabulary is the starting point for a scientific theory of words;

B. Articulating what yields the explanation (the ***explanantia***) as the premises (definitions and axioms; rules/constraints/laws/principles) of the theory that we seek to defend;

C. Deducing the logical consequences (predictions) of (B) to show that they match the statements of A;

D. Comparing the theory we seek to defend with alternative theories in terms of A-C, and choosing the best combination of the premises of the explananda.

3.4 Understanding via Explanation

The theories relevant to this volume are part of scientific inquiry. In scientific inquiry, understanding comes from *a process of looking for an explanation, triggered by a sense of puzzlement,* and results in *the perception of how different things are related, where they belong, and how they fit together as a whole.*

Suppose we see an object that looks like very small piece of dried food on the table. As we watch, it begins to move. It moves from point A to point B, and then to point C, and on to point D, and so on. We would be puzzled by what we see. But when we look closer, we see that it is not an inanimate piece of dried food, but a tiny insect, an animate entity. With that change in the interpretation of what we see, we have a feeling of understanding. We believe that only animate entities are capable of motion on their own, so we are puzzled when we see something that we think is inanimate, moving on its own. That puzzlement evaporates when we have an explanation for the motion: it is an animate entity.

We get such a sense of understanding from ***theories*** of what we seek to understand. So we might say that *a theory is a set of statements that yields a sense of understanding.*

In the context of scientific knowledge, we use the term ***theory*** to refer to ***something that yields an explanation for what is puzzling***. A scientific theory, then, *is a set of statements that yield a sense of understanding by providing an explanation for what is puzzling.*

Through our years of education, we come across names of theories such as theory of motion, theory of gravity, atomic theory, theory of electricity, big bang theory, germ theory, evolutionary theory, theory of geometry, number theory, literary theory, and so on. But this gives us only the knowledge and level of understanding that allows us to apply those theories in various contexts; it does not help us develop the capacity to construct and evaluate those theories. In such a system, producing theories is viewed as the job of researchers, while teachers and textbooks deliver the theories, and learners blindly accept, without critical thought, whatever is delivered to them.

We believe that this approach to theories indoctrinates learners, without educating them. The effect on learners is the mindset of blind faith, rather than one of doubting, questioning, and challenging what the 'authorities' (researchers, textbooks, and teachers) assert as true.

To get a stronger grasp of both theories and what they seek to explain, it is important that learners have an experience of constructing and evaluating theories themselves. An approach that would allow for this would be one that helps students develop the capacity to construct theories and to critically evaluate them, such that they can decide for themselves what to accept, what to reject, and what to reserve for further scrutiny in the future. Given this capacity, interested learners might go on to become researchers and innovate novel theories.

In a series of booklets and articles, we have talked about and exemplified the approach to education that initiates learners to the art and craft of theory construction and theory evaluation.[4] In what follows, we will look at some examples in domains outside linguistics, and then extend that approach to the theory of words.

4 See, for instance, …

A word of caution. What we outline below is perhaps best viewed as an extended description of a course on theory construction. Its purpose is to point to what a student needs to learn in order to be able to engage in theory construction. Clearly, a single chapter cannot ensure the capacity to construct theories; for that, learners need guided practice. The best we can do in that direction is point the learner to a set of learning materials from which they can learn on their own.[5]

3.5 Scientific Theory

As stated earlier, theories of words as part of the theories of language structure are scientific theories. To construct and evaluate scientific theories of words, we need an understanding of the structure of scientific explanations. To be specific, we need to understand how scientific theories explain what needs to be explained, and how the explanations are tested by checking their predictions. Explanation and prediction, in other words, are at the heart of theory construction in scientific inquiry.

For convenient reference, we will use the term ***explanandum*** (plural: *explananda*) for "what needs to be explained", and ***explanans*** (plural *explanantia*) for "what yields the explanation." By way of illustration, consider part of the explananda for a theory of the solar system.

EXPLANANDA: From the vantage point of an observer on Earth:

A. **CELESTIAL PHENOMENA** (as seen from earth's northern hemisphere, with the earth's horizon as the frame of reference)

The STARS

i. **Polaris**: its position does not change (i.e., it is stationary).
ii. **Other stars**: observed positions change, in an orbit around Polaris.

The SUN

iii. **East-West daily cycle** (sunrise and sunset)
The sun's position:
   a. is close to the eastern horizon in the morning;
   b. appears to move up, and then move down towards the West; and
   c. is close to the western horizon in the evening.

5 See …

iv. **North-South yearly cycle**
The position of sunrise and sunset: moves towards
a. the North, reaching an extreme point around summer solstice;
b. the South, reaching an extreme point around winter solstice;
c. the North again.

B. **TERRESTRIAL PHENOMENA** (as experienced on the earth)

i. **TEMPERATURE**
a. **Daily cycle**: The temperature keeps increasing, reaches the maximum after midday, then starts decreasing, reaches the minimum after midnight, and begins to increase again.
b. **Yearly cycle** (seasons): The mean temperature of the day keeps increasing, reaches the maximum around June/July, then keeps decreasing, reaches the minimum around December/January, then begins to increase again.

ii. **LIGHT** (Periods of brightness (daytime) and darkness (nighttime))
a. **Daily cycle**: In a day, brightness keeps increasing, reaches the maximum after midday, then gradually decreases, reaching the minimum after midnight, then begins increasing again.
b. **Yearly cycle** (seasons): The length of daytime keeps increasing, reaches the maximum around June/July, then begins decreasing, reaches the minimum around December/January, and then begins to increase again.

iii. **CORRELATIONS: TEMPERATURE, LIGHT, AND LOCATION**
a. **Temperature and Length of Daytime**:
As the mean temperature of the day increases, so does the length of daytime (the length of nighttime decreases); and
as the mean temperature decreases, so does the duration of daytime (and the length of nighttime increases).
b. **Northern and Southern Hemispheres**:
When the mean temperature and length of the day is highest in the northern hemisphere, it is the lowest in the southern hemisphere, and vice versa.

iv. **SHADOWS**
a. **Length**: Daily cycle
Shadows are longest in the early morning and early evening, when the sun appears lowest in the sky, and shortest around midday, when the sun appears highest in the sky.
b. **Orientation**:
Daily cycle: As the sun appears to move across the sky from East to West, the shadows of objects on Earth change not only in length but also in orientation (direction).
Yearly cycle: Coinciding with the Sun's movement described in (A-iv), the shadows of objects on Earth change orientation along the North-South trajectory.

EXPLANANTIA (concepts and statements that yield the explanation):

A. Geocentric Theory (Core of the explanantia):
a. The Earth is the stationary center of the universe.
b. The Sun revolves around the Earth.

B. Heliocentric Theory (Core of the explanantia):
   a. The Sun is the center of the solar system.
   b. The Earth spins on a tilted axis, taking one day to complete a rotation; and revolves around the Sun, completing a revolution in approximately 365 days.[6]

We may view explanantia as a set of premises, composed of definitions and axioms, from which we derive a set of the logical consequences – called predictions – as the conclusions. When the predictions match the observational generalizations arrived at from a sample of observations (data), we take the predictions to be correct. And when what is correctly predicted are the puzzling asymmetries in the observational generalizations, we say that the theory explains what needs to be explained.

During the initial stages when the theory is only emerging, the statements of explananda are about experienced reality, *what appears to us.* And the statements of explanantia are what we *postulate* as what we believe to be true of the reality. As theories grow, and what is postulated is widely accepted as true, they tend to be taken as (and called) 'facts'. For the novice, however, it is important to bear in mind that there are no facts, only those statements that we *currently take to be 'facts*'.

4 Explanations in a Theory of Language Structure

4.1 Explananda in a Theory of Language Structure

In astronomy, the data on the basis of which we construct, evaluate, and justify theories are largely the information we receive through light, gathered through our naked eyes and various instruments. In the scientific study of ants, researchers study ant societies by observing their behavior in their natural habitat, with or without experimental intervention. (https://en.wikipedia.org/wiki/Myrmecology)

Experimental intervention uses the methodology of stimulus and response. The stimulus–response pairing is used in animal psychology as well, as in the case of behavioral psychology. The data for a great deal of the study of the structure of words, phrases, and sentences in theoretical linguistics is based on the ***judgments*** of speakers (responses) on the linguistic forms they are given (stimuli).

Within the category of speaker judgments, the most common are ***acceptability*** judgments. To illustrate, consider the following pairs of sentences, phrases, and words:

(17) a. Sentences
   i. *Zeno will write the letter tomorrow.*
   ii. * *Zeno wrote the letter tomorrow.*

   b. Phrases
   i. *From my school*
   ii. * *My from school*

   c. Words
   i. *happily*, *joyful*
   ii. * *joyly*, * *happiful*

6 This is not the place to elucidate how the two competing explanantia derive equally good explananda. For detailed expositions and examples, the interested reader may look at:
Chapter 6: "Theoretical Research Part 1" and
Chapter 7: "Theoretical Research Part 2"
in our course materials for 'Introduction to Research', at https://www.thinq.education/itr

The asterisk (*) against the forms in (ii) under (17) indicate that when these stimuli are presented to a sample of experimental subjects (in this case, speakers of English), they judge the forms to be unacceptable. Linguistic theory needs to provide explanations for the contrasts between acceptable and unacceptable stimuli.[7]

Similar judgements under experimental conditions include: what the number of syllables or sounds in a word are; whether or not two sounds are the same or different; whether or not a reflexive can take a particular phrase in a sentence as its antecedent; and so on. To illustrate, suppose we train a sample of speakers of English in the use of the terms *syllables*, *sounds*, and *letters*, using examples like the following:

(18)

	SYLLABLES	SOUNDS	LETTERS
my	1	2 (mai)	2
bent	1	4 (bent)	4
him	1	3 (him)	3
hymn	1	3 (him)	4
debt	1	3 (det)	4
tax	1	4 (tæks)	3
stripes	1	6 (straips)	7
city	2	4 (siti)	4
tangle	2	5 (tæŋgl)	6
physics	2	6 (fiziks)	7
lightning	2	6 (laitniŋ)	9
interest	3	8 (intərest)	8
rapidity	4	8 (rəpiditi)	8

Given the priming in (18), the subjects would be able to provide judgments on the number of syllables and the number of sounds in other words like *cinema*, *psychology*, *hour*, and *hymnal*. They will also be able to say whether the initial sounds in *physics* and *fine*, the final sounds in *rice* and *rise*, and so on, are the same or different.

Given the distinction between sounds and syllables in the words in the table, they would also be able to give fairly robust judgments on the number of syllables in a word. Judgments on the co-reference of pronouns, reflexives, and reciprocals also need some initial training.

We can now use the units denoted by the English words *sound* and *syllable* in our statements of what needs to be explained and predicted. It is important to note that the observational statement:

> The sample of English speakers we consulted judge the first sound of *net* to be the same as the third sound of *tenth*,

is not the same as the assertion:

> The first sound of *net* is the same as the third sound of *tenth*.

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7 It is important to note that acceptability judgments are part of the ***observational reports*** of experimental researchers, which can be crosschecked by other experimental researchers. We often hear that the data for theories of language structure are speaker ***intuitions***. This is misleading, because intuitions of a human on words and sentences are part of the mind of the human, and hence are not observable. What we can observe are a speaker's behavior: how a speaker responds to stimulus words and sentences. And those responses are what count as the data.

The first statement is an observational report of how the sounds appear to a sample of humans, while the second statement is about external reality. To see this clearly, let us imagine that a set of alien scientists take a large random sample of humans to elicit their judgments on what they experience as 'reality'. Suppose they judge the stars to be moving in a circular orbit, and the moon to be bigger than the stars. If they are good scientists, they will not conclude that:

> The stars move in a circular orbit.
> The moon is bigger than the stars.

Rather, their observational reports would be:

> In the large random sample of the members of the human species we consulted, every member judged:
>
> > the stars to be moving in a circular orbit; and
> > the moon to be bigger than the stars.

From this, they would generalize to the human population as:

> The stars appear to humans as moving in a circular orbit; and
> The moon appears to humans as being bigger than the stars.

This is a statement of phenomena as they appear to humans, not a statement of reality. The distinction between appearance and reality has been one of the threads of discussion in philosophy since the ancient times.[8] But going beyond what is inter-subjectively constant, to the investigation of what is inter-subjectively variable, and exploring culture-dependent appearances, is a relatively recent enterprise. Just like the language-dependent variability of judgments on linguists' survey forms used for exploring language variation, the culture-dependent variability of beliefs, values, goals, and practices is an integral component of ethnography in cultural anthropology.

4.2 From Observations to Theoretical Abstractions

If we look at the history of any developed theory in any domain, we find that the concepts they start with are those of ordinary language. For instance, geometry began with concepts of length, distance, height, area, circumference, angle, etc., needed in land-surveying, architecture and building, and astronomy. A 'line' at this time was an outline of a shape. Questions of whether a line is finite or infinite, whether it has breadth, whether a finite line is composed of a finite number of points or infinitely many points, and so on were not relevant at that time. They came later, when geometry emerged as a mathematical theory and evolved.

In the physics of ancient Greece, the concept of 'force' was that which caused an object to move. When a moving ball collided with a stationary ball, the former caused motion (change of location) in the latter. The idea of force as that which causes a change of velocity came much later. In biology, people studied the anatomy, physiology, and behavior of cats, dogs, birds, fish, frogs, butterflies, earthworms, leaves, flowers, and so on without worrying about defining the concepts that these ordinary words denote. The meaning of the word 'animal' in English covered cats, dogs, and elephants, but excluded humans and ants. The inclusion of humans and ants as animals came much later. And the

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8

For a relatively accessible introduction, see
Part 1 at https://www.thinq.education/post/appearance-and-reality-1, and
Part 2 at https://www.thinq.education/post/appearance-vs-reality-2.
For a scholarly discussion, see Bradley, F.H. (1893). *Appearance and Reality*. London: Ruskin House.

issue of defining these concepts in such a way that those definitions, when combined with laws, would yield correct predictions, is still something that biological theory needs to engage with.

It is instructive to look at how the academic vocabulary in biological classification has evolved from everyday vocabulary. Take terms like *cat, tiger, lion, dog, and wolf*, which even illiterate speakers of English use. The Wikipedia entries on cats (https://en.wikipedia.org/wiki/Cat) and dogs (https://en.wikipedia.org/wiki/Dog) tell us that biologists use the Latin expression ***Felis catus*** for cats, and ***Canis Familiaris*** for dogs. Other classificatory labels for the taxa for 'cat' and 'dog' are:

(19)

RANK	*cat*: TAXA LABELS	*dog*: TAXA LABELS
Kingdom	Animalia	Animalia
Phylum	Chordata	Chordata
Class	Mammalia	Mammalia
Order	Carnivora	Carnivora
Suborder	Feliformia	Caniformia
Family	Felidae	Canidae
Subfamily	Felinae	Caninae
Genus	Felis	Canis
Species	Felis catus	Canis familiaris

Questions such as the following may not concern lay speakers of English:

> "Are dogs, wolves, foxes, and jackals varieties of the same species, or do they belong to distinct species?"

But since the ranks and taxa labels in the table above are academic terms, every expression in it needs to be defined. For the academic terminology of species and subspecies, this is an important consideration that calls for clear definitions of genus, species and subspecies.

As we will see in the following sections, similar considerations apply to the terminologies in linguistics as well.

4.3 Descriptive and Theoretical Terminology

A novice who wishes to learn how to construct theories, and a teacher who wishes to help her develop the ability to construct theories, would do well to pay attention to the concepts denoted by the words and phrases in ordinary language, including those concepts that a lay individual can learn through examples without definitions and without theories. For instance, suppose we point the attention of a five-year old to a few examples of what we think are bamboos, with the statement, "Look, those are bamboo trees, those others (oaks, pines, coconut trees, …rose bushes) are not bamboo." The child would form a concept denoted by the English word *bamboo*, such that her use of the word coincides with the use of that word in adult speech.

Such everyday terms are part of the descriptive terminology for articulating what needs to be explained by a scientific theory, but not necessarily part of the *explanantia* of that theory. Take the word *bamboo*. In the initial stages of constructing theories of the plant world, there is no need to define *bamboo*. If, however, at a later stage in the evolution of a theory of plants, *bamboo* is to be used to refer to an academic concept, we would need to provide evidence for the concept of bamboo as a natural category, define it, and show how that concept lends itself to the optimal formulation of laws governing life forms.

In a similar manner, suppose we tell a group of English-speaking children:

(20) "The following expressions are ***words***:
happy, happiness, unfortunately, renegotiate, centralization, books;

the following are ***phrases***, not words:
the water in a bucket, negotiate again, those heavy books,
all the pretty flowers in the pond; and

the following are ***sentences***:
Unfortunately, those little girls are not happy.
Who did you say that they promised to help?"

The children will learn the concepts that the expressions *word*, *phrase*, and *sentence* denote; and they will be able to identify words, phrases, and sentences in spoken or written forms.[9] At this stage, these expressions are descriptive terms. At a later stage in theory construction, we would need to doubt and question the legitimacy of the terms *word*, *phrase*, and *sentence* as denoting theoretical concepts in linguistic theory.

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9 We may assume that this claim is true for most cases, even though there might be gray or confusing areas when it comes to expressions like *isn't* in *Isn't Jay a farmer*? and *looked up* in *Jay looked the word up in a dictionary*.

Having defended the use of the ***units*** denoted by the terms *word*, *phrase*, and *sentence*, we now turn to the ***categories*** of these units, namely, noun, verb, adjective, preposition, noun phrase, prepositional phrase, declarative sentence, interrogative sentence, and the like.

For descriptive purposes, it would be reasonable to assume that most linguists agree on the following descriptive concepts:

(21)

Word	Feature
Phrase	Sound
Sentence	Syllable

and the following dimensions of the organization of the concept 'word':

(22) ***morpho-phonology***,
morpho-semantics, and
morpho-syntax.

As phenomenological concepts (what appears to a language user), these terms are legitimate. However, that does not mean that we have defended their use as theoretical constructs. That humans experience the moon as being bigger than the stars, or the earth as being flat and stationary, does not legitimize the claim that the moon is bigger than the stars, or that the earth is flat and stationary.

5 Explanations in a Theory of Words

Let us use the term ***composite*** to refer to a unit composed of other units. Under this use, molecules are composite units, composed of atoms; and atoms are composite, because they are composed of fundamental particles. As far as current Physics is concerned, fundamental particles are not composite; they are ***atomic***.

The IPA classification of speech sounds treats phonemes as atomic units, while the distinctive feature classification treats them as composite. The general considerations on descriptive and theoretical vocabularies, discussed in the previous section, apply in a theory of words to the idea of atomic and composite words as well. Words like *happy, city,* and *ox* are taken to be ***atomic*** words, while words like *unhappily, cities,* and *oxen* are ***composite*** words in that ***unhappily*** is composed of *un, happy,* and *-ly*; *cities* is composed of *city* and *-es*; and *oxen* is composed of *ox* and *-en*.

While this concept of compositionality extends to *rats* being composed of *rat* and *s*, it does not extend to *mice*, or to the plural of *sheep*. It is hard to segment *mice* and *sheep* in a similar manner. So, as far as a description of the phenomenon is concerned, it would be perfectly legitimate to treat *mice* and *sheep* as atomic words, regardless of what a particular theory of words would say about the formal expression of such compositionality.

In the preceding sections, we saw examples of the kinds of phonological, semantic, and syntactic information that a theory of words needs to provide explanations for. To make productive debates possible in case of disagreements, it is crucial that those who subscribe to distinct theories of words clearly formulate the explananda that they agree on.

To illustrate this process, let us imagine a few experiments using novel coinages. Take the coinage *conceptology*, which a sample of English-speaking college students are unlikely

to have come across. Suppose we conduct the experiments below, where the experimenter provides a set of stimuli (S), and the experimental subjects provide their responses (R).

Experiment 1

S: You are familiar with the word *concept*, but have you come across the word *conceptology*?

R: No.

S: Can you guess the meaning of *conceptology*?

R: It's the study of *concepts.*

S: How about *kitchenology, gardenology, fruitology,* and *rabbitology?* Can you guess their meanings?

R: *Kitchenology* is the study of kitchens, *gardenology* is the study of gardens, *fruitology* is the study of fruit, and *rabbitology* is the study of rabbits.

Experiment 2

S: So, if X is a word in English, you would agree that X*ology* is the study of X?

R: Yes.

S: What about ologyX, say, *ologyfruit*?

R: That doesn't make sense. Xology is okay, but not ologyX.

S: So to combine X and *ology* to form a word, X must come before *ology*?

R: Yes

Experiment 3:

S: Can you combine *ology* with *grief, fear, father,* and *daughter*?

R: Sure, *griefology* would be the study of grief, *fearology* is the study of fear, *fatherology* is the study of fathers, and *daughterology* the study of daughters.

S: How about combining *ology* with *happy, sad, masculine,* and *feminine?*

R: You can't do that. You can't combine *ology* with those words.

Experiment 1 elicits judgments on the meanings of novel forms, experiment 2 elicits judgments on the acceptability of words in terms of the sequencing of units, and experiment 3 elicits acceptability judgments that would call for grammatical categories for an explanation.

We may continue in this manner with another experiment, to elicit judgments on pronunciation. For instance, even though word stress falls on the first syllable in the word *concept*, it falls on the third syllable from the right in *conceptology*. Regardless of the word stress on X, Xology is systematically pronounced with word stress on the third syllable from the right.

Likewise, we may elicit the pronunciation of words of the form X*ic* (e.g., ***an****gel~ an****ge****lic*), X*y* (***pre****sident~presi****de****ncy*), X*ity* (e.g., ***ra****pid~ra****pi****dity*), where members of the pairs involve differences in word stress as well as in segments. The results of such stimulus-response experiments constitute observational generalizations that theories of words need to explain.

Now, there exist languages (e.g., English, Malay) in which the continuous strings of sounds of some composite words can be segmented into two or more substrings such that:

(23) a. *each of those substrings is associated with its own syntactic and semantic properties; and*

b. *the properties of pronunciation, meaning, and syntax of the composite word can be deduced from the properties of pronunciation, meaning, and syntax of the substrings.*

We must hasten to add that a statement like: "*cities* and *oxe*n are complex words, while *sheep* and *mice* is atomic words," is part of the description of the phenomena we wish to explain, and not part of the theory that seeks to explain them. In this sense, such statements of atomicity are analogous to the statements on appearances discussed earlier.

6 Dimensions of the Properties of Words

We now turn to what we mentioned at the end of Section 3: word phonology, word semantics, and word syntax. These constitute the dimensions of word grammar needed for morphological representations, as well as for the formulation of rules and constraints governing the representations.

6.1 Morpho-Phonology

We assume a distinction between ***morpho-phonological laws*** governing instances of distribution and alternation that have access to morpho-syntactic information, and ***phonological laws*** governing instances of distribution and alternation that appeal only to phonological information. For instance, the vowel alternation in pairs like *metre~metric*, the stress alternation in *photograph~photography*, and the f~v alternation in *knife~knives* are examples of morpho-phonological alternation. In contrast, the so-called allophonic alternations in the English sound system, such as those involving the aspiration of voiceless plosives at the beginning of a stressed syllable, the velarization of laterals in the rime (nucleus or coda) of a syllable, the assimilation of the alveolar nasal to the place of articulation of the following plosive in fast speech, the devoicing of voiced plosives immediately before or after a pause, and so on, are purely phonological.

Classical phonemics expressed the intuition of phonological vs. morpho-phonological as phonemic and morpho-phonemic alternations. But they also restricted the purely phonological to the distribution and alternation governing allophones, grouping the distribution and alternation governing phonemes under morpho-phonological. As a result, the assimilation of the alveolar to the following dental in *ten~tenth* was treated as allophonic, while the assimilation of the alveolar to the following labial and velar — as in ten~tem~teŋ in *ten apples, ten pounds* and *ten kings* was treated as morpho-phonological (resulting in a duplication in the statement of the pattern). Similar remarks can be made about the requirement of voicing agreement in adjacent obstruents within in a syllable (e.g., the alternation of the plural marker ([s] vs. [z]) in *cats* [kæt**s**] and *bags* [bæg**z**].

A telling example of a morpho-phonological constraint is one that can be stated as:

(24) Within a morph in English:
- ~ a coda has no more than three consonants.
- ~ if the last two consonants in a coda are obstruents, the last consonant must be alveolar.

This constraint allows the codas in monomorphic words like *send* /se**nd**/ and *text* /te**kst**/, and the ones in polymorphic words like *texts* /te**ksts**/ and *width* /wi**dθ**/. But it disallows

morph-internal codas like /reksts/ and /rempθ/. This constraint is morpho-phonological.[10], [11]

6.2 Morpho-Semantics

Consider the contrast between (25a) and (25b):

(25) a. If Zoe goes to Boston tomorrow, when will he return?
b. If Zoe went to Boston tomorrow, when would he return?

While *goes* in (25a) is in the present tense, and *went* in (25b) is in the past tense, they both refer to future time. The *if*-clause in (25b) carries the implication that the event in question is unlikely to happen. The corresponding clause in (25a) carries no such implication. The relation between grammatical tense and time reference is a classic example that falls within morpho-semantics.

To take another example, English adjectives of the form V-PRESENT PARTICIPAL and V-PAST PARTICIPAL exhibit an interesting difference in meaning. (Bresnan 1978; 1982; and the references therein). Compare examples like those in (26a) with those in (26b):

(26) a. *falling snow, growing tree, melting ice*
b. *freshly fallen snow*, *fully grown tree*, *melted ice*.

While the adjectives in (26a) describe an entity going through a process that the verb refers to, those in (26b) describe an entity in a state resulting from a process that the verb refers to. The difference is clearer if the verb is transitive, as in *dog-biting mouse* and *dog-bitten mouse*. While the first phrase refers to a mouse that bites dogs, the second phrase refers to a mouse that has been bitten by a dog. Such differences also come under morpho-semantics.

For yet another set of examples of morpho-semantics, consider the meaning differences between the pairs in (27):

(27) a. *rearrange* vs. *arrange again*
b *unpacked* vs. *not packed*
c. *redden* vs. *become red*

We will not go into a discussion of such examples here.[12]

6.3 Morpho-Syntax

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10 As pointed out in Mohanan and Mohanan (1984), the intervocalic dental nasal in Malayalam can occur only at the beginning of a morph. This is also a morpho-phonological constraint, and an exceptionless one. Theories that deny the legitimacy of the morph as a theoretical construct must look for ways of expressing such morpho-phonological regularities of distribution and alternation.

11 Whole Word Morphology (Ford et al 1997; Singh and Agnihotri 1997; Dasgupta, Ford, and Singh 2000; Singh and Ford 2000; Singh 2006) uses the term 'phonotactics' as a cover term for phonological patterns of distribution and alternation, using the notation of the double arrow X ⇓ Y for morpho-phonological distribution and alternation.

12 For a detailed discussion of a number of examples of morpho-semantics including contrasts like those in (9), see Mohanan and Mohanan (1999).

The term morpho-syntax, if interpreted as the syntax of words, can mean two things: either *the syntactic properties of words relevant for sentence syntax*, or *word-internal syntax*.

The first meaning is illustrated by the singular-plural alternation between the words *boy* and *boys*. This is relevant for syntax, as illustrated by the following distributional asymmetry:

(28) a. This boy These boys
b. * This boys * These boy

We can account for such asymmetries by postulating the following:

(29) The DETERMINER and the HEAD NOUN must agree in NUMBER.

The constraint/rule in (29) presupposes the following representations:

(30) a. This: SING boy: SING
b. These: PLUR boys: PLUR

The second meaning of morpho-syntax is illustrated by the following expressions:

(31)

	A	B	C	D
i.	sharp	dark	rich	danger
ii.	sharpen	darken	enrich	endanger
iii.	* sharping	* darking	* riching	* dangering
iv.	sharpening	darkening	enriching	endangering

How is it that the words in (iii) are ungrammatical, while those in (iv) are not? This asymmetry can be explained if we assume the category specifications in (32) for the words, and the requirements in (33):

(32) a. *sharp*, *dark*, *rich*: ADJECTIVE
b. danger: NOUN
c. *sharpen*, *darken*, *enrich*, *endanger*: VERB

(33) a. *-ing* requires that its sister be a VERB.
b. *-en* and *en-* require that their mother be a VERB.

Notice that the formulation of (15) avoids the issue of whether *-ing*, *-en* and *en-* are morpho-syntactic units, or just arbitrary phonological strings. In the context of this volume, this is an important issue, but in this chapter we will not advance a claim, nor provide arguments for one of these options.

A slightly more complicated case of morpho-syntax is illustrated by the behavior of the genitive marker *–'s* in examples like *the girl next door's hat*. We agree that the meaning of this expression can be paraphrased as 'the hat of the girl next door,' such that the owner of the hat is the girl, not the door. Interestingly, the possessive expression *door's* exhibits word-like properties even when the possessive construction is *the girl next door's*, and is a phrase, not a word. The genitive marker at the end of such possessive phrases can appear with nouns and prepositions, but not with verbs:

(34) a. The girl I spoke to's hat
b. * The girl I married's hat

If there is conclusive evidence to show that the genitive marker forms a single word with its host, and yet the result is a possessive phrase, the morpho-syntax of this construction

constitutes an interesting challenge for any morphological theory. We will not offer a solution to this challenge here.

Our last example comes from the behavior of *not* and its related form *n't* in sentences like the following:

(35) a. Zoe is not arriving tomorrow.
b. Zoe isn't arriving tomorrow.

While the combination of the verb and *not* in such constructions behaves as two words, the combination of the verb and *n't* behaves as a single word, both syntactically and phonologically.[13]

Evidence for *n't* not being a word syntactically is illustrated by its behavior in interrogative constructions:

(36) a. Are you not arriving tomorrow?
b. * Are not you arriving tomorrow?
c. Aren't you arriving tomorrow?
d. * Are youn't arriving tomorrow?

Interestingly, even though verb+*n't* is a single word both phonologically and syntactically, the scope of the meaning of *n't* is the entire clause, not just the word. The sentence, *Zoe isn't arriving tomorrow*, means:

(**NOT-TRUE**) (Zoe is arriving tomorrow.)

As can be seen from the above discussion, the NEG-contraction in English lies at the intersection between phonology, syntax, and semantics of words and sentences.

6.4 Compositionality and Opacity

In Section 3, we introduced the concepts of compositionality, composite units, and atomic units. And in Section 4, we introduced the concepts of dimensions of the structure of linguistic expressions in terms of pronunciation (phonology), meaning (semantics), and what connects the two (syntax), along with the concept of levels of structure: word, phrase, and sentence.

A strong intuition underlying compositionality stems from the assumption of reductionism, the basic tenet of which can be stated in terms of a moderate version and a radical version:

(37) a. *Moderate Reductionism*: Many properties of the whole can be explained and predicted on the basis of properties of the parts, and the interaction among them.

b. *Radical Reductionism*: All properties of the whole are explained and predicted on the basis of the properties of the parts, and the interaction among them.

What is called ***opacity*** in linguistics is a phenomenon that illustrates the failure of the radical version of reductionism. Take, for instance, idioms like *kick the bucket a*nd *keep tabs on*. Radical Reductionism assumes that these expressions are composed of words,

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The reason why *n't* does not form a word on its own phonologically is that it does not contain a vowel, nor does it have a potential syllabic consonant, leaving it an incomplete syllable, and hence not permitted as a word.

and all their phonological, semantic, and syntactic properties can be predicted from assumptions on their composition, together with the properties of their parts.

It is true that we can derive the phonological properties of the expressions from those of the parts, including stress assignment, as well as syntactic properties such as tense (present/past from *kicks*/*kicked the bucket* and *keeps*/*kept tabs on*), and the appearance of the passive in *tabs were kept on*.

In spite of these regularities that are predictable from the parts, the meaning of these idioms is not derivable from the meanings of the words combined with the composition of the entire expression. What we have here is an instance of semantic opacity, despite phonological and syntactic transparency. The important point here is this: that the semantics of these expressions is non-compositional, and hence opaque, is not an argument against their syntactic and phonological compositionality, and hence transparency.

Similar phenomena of opacity are found in morphology as well. Thus, while the noun phrase *black birds* is a composite unit, and its phonology, semantics, and syntax are derivable from the properties of the parts together with the composition of the whole, the noun *blackbirds*, though composite and transparent in terms of phonology and syntax, is semantically opaque. The expression *sang* as the past tense counterpart of *sings* is syntactically and semantically composite (and transparent), but its morpho-phonology is largely opaque because we cannot break up the phonological representation of *sang* into two discrete units, one following the other. Such opacity in *sang*, however, is not an argument against the compositionality of *sings*.

7 An Illustration: The Auxiliary Construction in English

In Section 2.3, we spelt out our commitments in constructing and defending theories, repeated below for convenient reference:

(38) A. Articulating what needs to be explained (the ***explananda***) in a shared vocabulary is the starting point for a scientific theory of words;

B. Articulating what yields the explanation (the ***explanantia***) as the premises (definitions and axioms; rules/constraints/laws/principles) of the theory that we seek to defend;

C. Deducing the logical consequences (predictions) of (B) to show that they match the statements of A;

D. Comparing the theory we seek to defend with alternative theories in terms of A-C, and choosing the best combination of the premises of the explananda.

What do these commitments imply in the actual practice of learning how to construct theories of words? To answer that question, let us consider the challenges facing a ***grammar*** of *English words*, which is the same as a ***theory*** *of English words,* as distinct from a ***universal grammar*** *of words* (a ***theory*** *of words*). To get a sense of those challenges, let us take the auxiliary construction in English, relevant both for theories of words and for theories of sentences.

By 'auxiliary construction', we mean the syntax, semantics, and phonology of the word sequences given in bold italics in the following sentences:

(39) a. Zeno ***wrote*** the letter.

b. Zeno ***is writing*** the letter.

c. Zeno ***has written*** the letter.
d. Zeno ***has been writing*** the letter.
e. Zeno ***might write*** the letter.
f. Zeno ***might have been writing*** the letter.
g. Zeno ***might have written*** the letter.

(40) a. The letter ***was written*** by Zeno.
b. The letter ***has been written*** by Zeno.
c. The letter ***might have been being written*** by Zeno.

(41) a. Zeno ***did not write*** it. b. Zeno ***was not writing*** it.

(42) a. ***Did*** Zeno ***write*** it? b. ***Was*** Zeno ***writing*** it?

(43) a. Zeno ***DID write*** it. b. Zeno ***WAS writing*** it.

(44) a. Zeno ***wrote*** it, ***didn't*** he? b. Zeno ***was writing*** it, wasn't he?

There is nothing to explain in the data given above. But when we compare the acceptable sentences above with their unacceptable counterparts, a set of puzzles emerge:

(45) a. That letter ***might have been being written*** by Jay in 1902.
b. * That letter ***have might been being written*** by Jay in 1902.
c. * That letter ***might have being written been*** by Jay in 1902.

(46) a. Jay ***might have been writing*** that letter in 1902.
b. * Jay ***have might been writing*** that letter in 1902.
c. * Jay ***might been have writing*** that letter in 1902.

(47) a. Jay ***has been writing*** that letter.
b. * Jay ***been has writing*** that letter.
c. * Jay ***has writing been*** that letter.

(48) a. Jay ***might write*** that letter.
b. * Jay ***write might*** that letter.

What theoretical vocabulary do we employ for the explanation of contrasts such as those illustrated above? Clearly, statements such as the following are inadequate.

(49) In an auxiliary construction in English:
a. if it has the words *might* and *have*, *might* must precede *have*.
b. if it has the words *been* and *being*, *been* must precede *being*.
c. if it has the words *being* and *written*, *being* must precede *written*.

Why are they inadequate? The reason is that they are not sufficiently general, because they are stated in terms of sequences of particular words, and not in terms of abstract units or categories of words. The generalization ought to include examples like the following, but does not:

(50) a. That letter ***may/could/would have been being burnt*** by Jay.
b. * That letter ***have may/could/would been being burnt*** by Jay.
c. * That letter ***may/could/would have being burnt been*** by Jay.

What the data in (45)-(48) and in (50) illustrate are certain regularities in the relative order of words. The ***rules/constraints/laws*** that express those regularities must be stated on the ***representation***s of those words, not in terms of the words themselves, as in (49).

What does it mean to say that the rules/constraints/laws must be stated on representations? Let us look at some possible representations. Consider first the following morpho-phonological representation of the phrase *might have been being written*, where a hyphen indicates a syllable boundary:

(51) Morpho-phonology: mait hæv bin bii-ing ri-tn

As for the morpho-syntactic representation, we might consider the following:

(52) Morpho-syntax: {MODAL, PST TNS} > {HAVE, INF} > {BE, PST PART} > {BE, PR PART} > {WRITE, PST PART}

The main verb form *written* is represented in (32) as the past participial form. However, it could equally well have been represented as the passive form. This is because the *–en* ending is ambiguous: in the sequence *has written*, it marks the past participle, while in the sequence *was written*, it marks the passive. What this means is that we must specify that the *–en* in *x-en* must be specified as passive when preceded by a form of *be*:

(53) Morpho-syntax: {MODAL, PST TNS} > {HAVE, INF} > {BE, PST PART} > {BE, PR PART} > {WRITE, PST PART, PASSIVE}

The specification {PST PART} on the main verb determines its allomorphy —the morpho-phonological information. The specification {PASSIVE} governs the active-passive alternation — the syntactic information relevant for the alignment of argument meanings (theta roles) and grammatical functions.

Regardless of the active-passive alternation, the past participial forms of the verbs *write*, *raise*, and *cut* are *written*, *raised*, and *cut*. Hence the need for specifying both {PST PART} as well as {PASSIVE} with the main verb in (33). What this example sheds light on is the interaction between word grammar and sentence grammar.

8 Constructing and Evaluating Theories of Words

To engage in the collective activity of constructing a theory of words, it is crucial that we agree on a shared vocabulary of explananda. As mentioned earlier, unless those who subscribe to competing theories of words have an inventory of observational generalizations that they are committed to explaining, it would be impossible to engage in rational justification of those theories, and in rational debates on them.

Having agreed on the explananda, the next step would be to acquiring a feel for theory construction. A good way to do this would be to construct explanations for the results of experiments such as those given above, by postulating representations, and laws governing those representations, as part of the grammar of the language under investigation.

Having done that, we can identify the theoretical assumptions implicit in those explanations, and where possible, the name of the theories that subscribe to those assumptions — A-Morphous Morphology (Anderson 1992); Distributed Morphology (Halle and Marantz 1993; 1994); Lexeme Based Morphology (Beard 1995); Lexical Morphology (Kiparsky 1982); Minimalist Morphology (Wunderlich 1992; 1995); Whole Word Morphology (Ford et al 1997; Singh and Agnihotri 1997; Dasgupta, Ford, and Singh 2000; Singh and Ford 2000; Singh 2006); Word and Paradigm Morphology (Blevins 2016; Blevins, Ackerman, and Malouf 2018); Morphology as Syntax (Collins and Kayne 2023); and so on. What is important here is the unearthing of the cluster of theoretical assumptions, reserving the name of the theory as a convenient shorthand for the particular combination of assumptions.

Finally, to get a sense of comparing alternative theories, it would be useful to construct alternative explanations within at least two or three competing theories (e.g., those which postulate morphs and those which deny the existence of morphs). We need to ask: Do they explain what needs to be explained? Is there a difference between them in their predictions? If there is, does one of them yield incorrect predictions, or fail to yield correct predictions?

It is only at this stage that we can begin to critically evaluate the central claims of a given theory. To illustrate, the Wikipedia entry on Distributed Morphology (DM) says:

> "The central claim of Distributed Morphology is that there is no divide between the construction of words and sentences. The syntax is the single generative engine that forms sound-meaning correspondences, both complex phrases and complex words. This approach challenges the traditional notion of the Lexicon as the unit where derived words are formed and idiosyncratic word-meaning correspondences are stored. In Distributed Morphology there is no unified Lexicon as in earlier generative treatments of word-formation. Rather, the functions that other theories ascribe to the Lexicon are distributed among other components of the grammar."

A number of questions arise.

> What would constitute evidence against the claim that there is no divide between the construction of words and of sentences?
>
> Does it mean that there is no such thing as a theory of words or a grammar of words? Or does it mean that a theory of words and a theory of sentences have theoretical concepts and propositions in common, and there are no theoretical concepts and propositions that are specific to a theory of words? For instance, does it mean that there are no laws/constraints that refer to the concept of word, or of lexical categories like noun and verb, stem, root, morph, and affix?
>
> What does it mean to say that there is no lexicon? Does it mean that there is no sequentially organized lexical module such that the application of all the lexical rules/constraints precede the application of all the laws/constraints of the grammar of sentences? Or does it mean that lexicon as a module is untenable even in a theory of language structure that eschews sequential application of constraints/rules?
>
> Exactly what kind of representation or law does the theory prohibit? And what kinds of observational generalizations does that prohibition predict to not exist?

Suppose we compare the Wikipedia characterization of DM with what we have outlined in Sections 4-6, in terms of compositionality of units of representations, multi-dimensionality of representations, and rules/constraints across units and across dimensions. Suppose we interpret the central insight of DM as what we have sketched in Sections 4-6. If we do, would the proponents of other theories of words disagree?

Theoretical claims in linguistics are evaluated on the basis of explanations, not on the basis of raw data. And it is only when the theoretical claims are clearly and precisely formulated that they can be evaluated against the explanations provided by alternative grammars that subscribe to different theories.

Consider another claim, closely paralleling the DM position, advanced as the central claim in a version of the minimalist theory of morphology, called Morphology as Syntax (Collins and Kayne 2023):

> "(1) Morphology as Syntax (MaS)
> Morphological generalizations are accounted for in terms of syntactic operations and principles. There is no morphological component in Universal Grammar (UG), nor are there post-syntactic morphological operations."

The abstract of the article says:

> "Phenomena traditionally thought of as morphological can be accounted for in terms of syntactic operations and principles, hence bringing forth questions that traditional morphology fails to ask (for instance, concerning the licensing of empty morphemes). The language faculty contains no specific morphological component, nor any post-syntactic morphological operations. "

Such statements should prompt questions such as the following from those who engage in research in theoretical morphology:

> What exactly is/are the difference(s) between DM and MaS in their central claim(s)?
>
> What differences in predictions do these claims lead to? Do the differences allow us to choose between DM and MaS?
>
> If they do not make distinct predictions that can be tested by a larger community of morphological theorists, are DM and MaS two distinct theories, or are they terminological or rhetorical variants of the same theory?

Though called a 'theory' of morphology in the paper, the authors also say:

> "MaS is a program for research, which has as an underlying assumption that separation of morphology and syntax cannot be achieved in any natural way. In other words, it is impossible to analyze morphology in isolation from syntax."

The switch of phrasing between 'theory' and 'research program' is confusing. The critical evaluation of theories and research programs involve different considerations. Given two distinct theories of the same phenomena, the academic community has a responsibility to look for ways of choosing between them on the basis of differences in their predictions. In contrast, given two distinct research programs, the academic community does not need to choose between them. If they are both promising, they must both be allowed to develop into theories that can then be compared and evaluated.

9 The Authors' Theoretical Positions

In the preceding sections, we have tried our best to adopt a neutral position with respect to the debates across logically contradictory theoretical positions. But we are also aware that this is an impossible ideal to achieve. What we imagine to be a position of neutrality is often shaped by our own favourite positions. It is therefore important to be transparent on these issues and acknowledge where we stand in these debates. In this section, therefore, we offer an equilvalent of a literature review restricted to our own research so that the reader can critically evaluate our work, and extend it to the critical evaluation of what we have shared in sections 1-8 above.

K P Mohanan's (henceforth KPM) work in morpho-syntax (1982b) began with his exploration of the role of the lexicon in language structure. His PhD thesis, 'Lexical Phonology' (1982; revised: 1986), is an attempt to outline a theory of the interaction between (lexical) morphology and (lexical) phonology.

The central ideas in this theory can be outlined as follows:

Words, phrases, and sentences are distinct units of linguistic theory, each with three dimensions of representation.

The organisation of words comes under the lexical module; the organisation of phrases and sentences comes under the post-lexical module.

The lexical module is composed of submodules (called 'strata' in KPM (1982b) and 'levels' in Kiparsky (1982)).

Laws of language structure (rules/constraints/principles…) do not *belong* to any (sub)module, but can be specified for their application in terms of (sub)modules. A given law can be specified for more than one (sub)module for its application.

The input to the lexical module is the underlying level of representation. Its output is the lexical level of representation, which is the input to the post-lexical module. The output of the post-lexical module is the phonetic level of representation.

The phenomena that the work draws upon come largely from Malayalam and English.

In subsequent work (KPM 1993; 1995) the formulation of laws as rules is replaced by laws as constraints on representations. Consequently, the mechanism of rule ordering is replaced by the idea of defeasible laws of language structure, within the formalism of defeasible logic. In Optimality theory (REF), the equivalent of defeasible laws is expressed as ranked constraints.

Tara Mohanan's (henceforth TM) work incorporates the LFG-Lexical Morphology idea of the lexicon as a module. The work questions the idea of 'word' as a monolythic entity, to argue, in the context of noun incorporation, that there are distinct concepts of wordhood, each of which has its own representation: phonological word, categorial word, grammatical function word, argument structure word, and grammatical semantic word. (1990, 1994, 1995)

TM's central contribution to the theory of language structure in general and word grammar in particular is the idea of the multi-dimensionality of multi-leveled structure (MDS). Using such structures, TM shows that a given constraint can be simultaneously sensitive to different dimensions of representation. The constraint of case OCP in Hindi (TM 1994), for instance, refers at once to argument structure, grammatical function structure, case formatives, and adjacency. The need for MDS is laid out in her thesis (1990; 1994), and developed further in her article on complex predicate constructions (1997; 2015)

TM and KPM have worked on the passive construction (REF), the causative construction (REF), the applicative construction (REF), the complex predicate construction (REF), and the interactions among these constructions in Hindi and in Malayalam. (REF) Each of these constructions involves word grammar and sentence grammar, and interesting mismatches between wordhood in terms of grammatical categories, grammatical functions, and argument structure. In their joint work, they have argued for the distinction between morph/formative and morpheme, showing the need to allow the relation between them to be many-to-many in different ways. (KPM and TM 1999; 2009). Most of these ideas are articulated in KPM and TM (1998).

Ignoring the technical aspects of the class of theories that come under lexical morphology, both KPM and TM subscribe to the idea that representations of words must express wordhood, as well as the different kinds of information on the structure of words. They also subscribe to the position that laws of language structure are sensitive to

whether or not the relevant unit that they apply to is a word unit, as well as to the internal structure of words.

10 Learning to Construct Theories of Words

As far as theories are concerned, there are three related goals that textbooks and professors in Higher Education can aim at, namely, to help learners:

(54) A. become familiar with existing theories, and understand them;
B. acquire the ability to apply the theories to a variety of problems; and
C. develop the capacity to construct and evaluate theories.

Goal A can be achieved through exposition, spoken (classroom lectures) or written (textbooks). Goal B calls for tasks that learners engage in with systematic feedback from and regular interaction with the professors. Without considerable investment of time on both sides, these goals are not attainable.

Goal C is even more challenging than B. It requires textbook writers and professors to have had first-hand experience of constructing theories from scratch (going beyond contributing to theory validation), evaluating theories, as well as comparing and choosing between theories. Goal C also calls for tasks that involve these activities on the part of learners.

In the preceding sections, we tried to sketch a rudimentary conceptual framework for that enterprise, with a big picture background of the construction of knowledge in general, scientific theory being a special case of knowledge construction, with linguistic theory and morphological theory as enterprises with narrower and deeper pursuits. Having done that, we gave concrete illustrations of what it takes to articulate what a theory needs to explain and predict, and to provide explanations for those explananda by constructing theories.

Needless to say, a chapter in a book cannot hope to develop in students the capacity to construct and evaluate theories of words. For that, we need full-length textbooks and courses. But we hope that we have been able to point to what needs to be done to accomplish goal C.

The seed of goal C and its value in education was planted in us by late Prof. Ken Hale of Massachusetts Institute of Technology. We dedicate this chapter to his memory.

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