Linguistic Systems and the Physiological Classification of Verbs

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INTRODUCTION

How does one ground a theory of linguistic forms? Noam Chomsky (1965, 1966), the founder of transformational grammar, attempted to ground his theory of language in mathematical formalism, Cartesian philosophy and in the biological faculty of language. His mathematical endeavor began when he expanded on the work of Zellig Harris (1970), a mathematical linguist, who proposed a model of co-occurrence transforms. Chomsky went on to create a more sophisticated model of transformational grammar.

Zellig Harris Co-occurrence Transforms	Sentential structures are not isolated entities but are co-related to each other by means of rules called co-occurrence transform	Active Sentence ⟷ Passive Sentence [An active sentence may be transformed into a passive and vice versa.] Statement ⟷ Interrogation [A statement may be questioned and vice versa] Affirmative ⟷ Negation [An affirmation may be negated and vice versa]
Noam Chomsky Transformational Grammar	Rules are ordered and applied to a basic underlying sentential structure (deep structure) to create an output (surface structure)	Deep Structure: John past see Mary Ordered Rules: Passive, Interrogation, Negation, etc. Possible Surface Structures: John saw Mary, Mary was seen by John, Did John see Mary, Did n't John see Mary, Wasn't Mary seen by John, etc.

Later, Chomsky argued that his model was grounded on the postulates of Cartesian philosophy (Chomsky 1966). This enabled him to situate his theory in a particular historical time and in a particular philosophical tradition. Gradually, Chomsky began to assert that linguistics was a sub-branch of psychology and he claimed that human beings are unique because they possess a faculty of language. What he meant by this, in essence, is that human beings are biologically wired for language, a rather strong biological claim.. Chomsky and his followers argue that human beings possess an instinct for language (Pinker, 1994).

Recently, Lakoff and Johnson (1999) have returned to the biological foundations of language, but from a different perspective. They are interested certain biological foundations to linguistic schemas. Their quest for universals is not necessary on language instinct, the faculty of language, but on biological schemas that underlie and provide the foundations and the motivation for linguistic schemas. Their arguments consist of inferring the former from

the latter. They want to infer that linguistic schemas provide evidence for biological schemas. There is a problem with this research paradigm. These inferences lack biological and physiological motivation. To correct the problem in this research paradigm, the authors of this paper argue that one must first investigation biological and physiological systems and compare them to linguistic schemas in order to ascertain just how and where these relationships are established. It makes more sense to investigate the physiology of the auditory system in order to better comprehend how auditory perception occurs prior to making claims about the verbs of hearing in English and their linguistic schemas. What this research demonstrates is that there are biological transducers that do have correlates with lexical and grammatical structures in language, but most of the linguistic schemas noted by Lakoff (1987) are not biological but due to analogical processes such as grammaticalization (Traugott and Heine, 1991a, 1991b) and metaphor (Lakoff and Johnson, 1980, 1999; Lakoff, 1987).

THE EMBODIED MIND HYPOTHESIS

George Lakoff and Mark Johnson (1991, 1999) have proposed a promising new paradigm for the cognitive science that they refer to as the embodied mind. This paradigm is not new to western philosophy as it can be found in its earlier stages in the writing of Maurice Merlau-Ponty (1964, 1994). It has also been articulated as a biological model by Varela (1991) and Maturana (1984). What is new about the paradigm proposed by Lakoff and Johnson (1999) is that it has been offered as a model for the cognitive sciences. Why is this important? Why should the concept of the embodied mind be treated as a revolutionary idea within cognitive linguistics? The answer is rather obvious to students of the first generation of the cognitive sciences (Gardner, 1987). Most of the earlier work on language and the mind done under cognitive linguistics were predicated on the Cartesian assumption that the mind functions as a separate entity from the body as a kind of computing machine that equate the brain with computer hardware and human language with computer software. This assumption has been labeled as the "separablility hypothesis" (Shapiro, 2004), but most scholars refer to this approach as "connectionism." What Lakoff and Johnson have done is revolutionary because their proposal counters the Cartesian assumption of the separation of the mind and the body (Damasio, 2000).

MODELING BRAIN RESEARCH

The cognitive sciences were used as a cover term for several academic disciplines that used the computer as a metaphor for the brain (connectionism). These disciplines included linguistics, psychology, anthropology, the computer sciences, and neurolinguistics. Investigators from each of these disciplines were fascinated by the computer as a research tool. Why were these disciplines included in the new paradigm and not others? What was it about computers that merited so much attention? Why did they use the metaphor of the brain as a computer? Why did they cherish this new machine metaphor and invest such extensive research efforts in explicating this new model? The answer to these questions can be found in the significance of the computer as a technological invention. It was a general problem solver. The computer was not just another machine; it was not merely another tool. Prior to the computer, machines were built for special purposes. A hammer, for example, was created to for the specific purpose of pounding on nails; the saw was created for the specific purpose of cutting through wood. Even when tools were improved upon, they remained as special

instruments. For example, a saw that cut through wood was a different kind of tool than a saw that cut through metal. What the computer brought into the world of technology was a general purpose instrument that could be used for different tasks. The computer could be used for different purposes. One only needed to substitute one kind of software for another and the computer would emerge as a new tool. It could be changed from a machine that does statistical analysis to one that operates some kind of expert system using artificial intelligence. Consequently, the computer was not just another tool. It was one that intrigued cognitive scientists. Why were these scientists intrigued by the new general problem solver? What is it that they saw in the computer that led them to create an interdisciplinary research paradigm known as the cognitive sciences? What they found in this new technology was the ability to create computer models that would simulate the functions of the human mind. The computer became the most power and inventive instrument of technology yet devised. It was this tremendous ability to simulate models of reality that led the cognitive scientists to adhere to the "multiple realizabiity thesis" (Shapiro, 2004: 3). According to this hypothesis the human minds are realized by human brains. These attempts by cognitive scientists to construct models of the human mind are based on how the human brain functions. The computer model of the mind is proposed as one of the realizations of the human brain.

LINGUISTIC SCHEMAS

The focus of the research paradigm advocated in this essay begins with the embodied mind hypothesis and the claim made by philosophers (Merleau-Pony, 1964, 1992, 1994; Johnson, 1991) and linguists (Lakoff, 1987; Lakoff and Johnson, 1999) that the embodied mind plays a significant role in the epistemological construction of human cognition. Lakoff and Johnson (1991, 1999) argue that biological schemas are the motivating forces behind the creation of linguistic schemas. Other linguists such as Bernd Heine (1987) and Dirven and Verspoor (1998) have also provided examples of linguistic schemas, but they argue that these are metaphorical creations rather than biologically induced schemas. Since these schemas are based on actions and relationships and consequently they are represented as verbal schemas:

Source Schema	Label of Schema	English Examples of Schemas
X takes Y	Action	**Agent + Verb of Manipulation + Object** The man takes the book from the shelf. I am taking Mary with me **Agent +Verb of Manipulation +Object** I seized him by the arm
Y is located at X	Location	**Agent + Existential Be + Locative** The mail carrier is here. **Person + verb of location** I am at home
X is with Y	Companion	**Agent + Companion + Verb**. Mary is with child **Person + Verb + with Accompaniment** I will go with Mary

		Person and Accompaniment Verb Mary and I are going.
Y exists from X	Source	**Person + verb of movement +from Place** Mary came from Louisville **Person +verb of movement + from Source.** Mr. Tanaka came from Tokyo.
As for X, Y Verb	Topic	**Agent as Topic + Verb of Perception + Object** As for Mary, she saw the event take place **Topic, Subject + Verb + Object** It was John who he saw Mary
Y is X's (Y)	Equation	
Being Schema	Identification Class Membership Attribution Location Existential	**Subject + be + Predicate Nominative** You are Mr. Smith **Subject be Membership Class** He is a student **Subject is Predicate Adjective.** Fruit is expensive) **Person + Locative BE + Location** John is here **Entity + Existential BE** The phenomenon exists God is!
Happening Schema	Eventing	**(Dummy) Subject + Event Verb BE + Natural Event** The sun is shinning It is raining It is snowing
Doing Schema	Agent	**Agent + Verb of Making or doing + Event or Object** Mary is reading a book They are doing the Vista Tour
Experiencing Schema	Patient Experiencer	**Experiencer as Subject + Verb + Object Experienced** Harry saw a snake He knows that it is dangerous He thinks that he feels better He feels happy

Having Schema	Material Possession	**Agent +Verb of Possession + object-** Do you have a book? Martha owns a home
	Mental Position	**Affected Person Verb of Possession and Affection** John has an idea John has a flu
	Whole-part	
	Kinship	The table has four legs
	Relations	John has two sisters
Moving Schema	Source-Path-Goal	**Subject or Agent + Verb of Motion + from Source to Goal** The apple fell from the tree (to the ground) They searched from noon to midnight
	Spatial	
	Temporal	The weather changed from dark to sunny
	States	The events turned ugly.
Transferring Schema	Transfer From X to Y	**Agent + Verb of Transfer + Object + Receiver** John gave a cake to Mary John gave Mary a cake (variant)
	Receiver and Goal	John gave the door a coat of paint

There are several things implicit in this new framework of the second generation of cognitive linguistics.

- The concept that language forms that represents reality has been challenged. Language, it is argued, is used to order concepts and not forms.
- The categories in language are no longer seen as classifications based on forms, but are organized around ideal exemplars or prototypes. The concept of a bird is best represented, for example, by an ideal bird, for example, a robin, and the other birds are radially organized around this ideal type.
- Ideas are no longer treated as treated as separate units but as complex units that are associated with other entities through experience or other forms of association. A door, for example, also connotes a door knob, a key hole, a door jamb, etc.

GROUNDING COGNITIVE LINGUISTICS IN THE EMBODIED MIND

What this investigation into the classification of verbs in this essay offers is predicated on the Lakoff and Johnson (1999), but with one major exception. Rather than classify verbs linguistically and infer their biological transducers, the model proposed here begins with biological systems and uses these systems to classify verbs and what they constitute as linguistic concepts and forms. In other words, verbs are classified by means of the biological systems that they represent.

- The olfactory system and verbs of smell

- The auditory system and verbs of hearing
- The motor cortex system and verbs of manipulation
- The somatological system and verbs of space
- The limbic system and verbs of emotion
- The visual system and verbs of seeing
- The gastronomical system and verbs of ingesting

Linguists prefer to classify verbs in accordance with their linguistic properties (Levin, 1993). This approach may satisfy linguistic criteria, but it in no way provides insight into how the embodied mind works and how biological schemas can be correlated to linguistic schemas. Hence, this new approach based on biological systems and subsystems come closer to explains just what verbs are determined by biological factors and which are not. Those verbs that are not determined by biological factors may function either as metaphorical extensions or as grammaticalizations (Traugott and Heine, 1991a, 1991b).

Alleged biologically constructed verbs: I see the problem.
Metaphorically constructed verbs: I understand the problem..
Grammatical Metaphor: John went crazy.

Seeing is based on the fact that human beings have biological systems of vision. It implies that there is a whole system of vision in which light enters the eye and its visual record is transmitted to the occipital region of the brain where it is further processed for color, shape, etc. The act of understanding may appear to be a biological function, but this expression is being used metaphorically and not biologically. This metaphor of vision comes from classical Greek thought where one understood the nature of an object by holding it up, standing under it, and inspecting its properties. Hence, the expression "I see the problem" means "I understand the problem." These are obviously metaphorical constructions. These are metaphorical constructions. Grammatical metaphors as exemplified by "John went crazy" emerge from regular grammatical constructions.

Grammatical Schema.	John went to town (AGENT GO TO LOCATION)
Grammatical Metaphor.	John went crazy (Agent goes to a new state of mind)

Grammaticalization is a linguistic process in which grammatical markers, function words, or constructions are created metaphorically. The source of this metaphor is usually a basic linguistic schema or a pattern that is expanded into a new and innovative construction. The normal pattern, in this case, is the linguistic schema of movement to a physical location (John went to the store) and it is expanded into a new construction in which one does not go to a physical location, but one goes instead to a new state of mind (John went crazy). Before discussing the organization of this book, it is important to look at how linguists classify verbs and then contrast this with how physiologists look at human biological systems that are related to the same phenomena.

THE LINGUISTIC CATEGORIZATION OF VERBS

There are many ways of classifying English verbs that are based on forms or formal properties. One such attempt can be found in the work of Levin (1993). She placed verbs into different classes on the basis of their patterns of alternation.

Verbs of Contact by Impact	Hit verbs, swat verbs, spank verbs, contact verbs, poke verbs, and touch verbs
Verbs of Cutting	Cut verbs, carve verbs,
Verbs of Combining and Attaching	Mix verbs, shake verbs, verbs of amalgamation, tape verbs, and cling verbs.
Verbs of Separation and Disassembly	Separate verbs, split verbs disassemble verbs, differ verbs and diverse verbs.
Image Creation Verbs	Verbs of image impression, scribble verbs, illustrate verbs, and transcribe verbs.
Verbs of Creation and Transformation	Build verbs, grow verbs, verbs of preparation, knead verbs, create verbs, turn verbs, performance verbs, and engender verbs.
Verbs of Perception	See verbs, sight verbs, peer verbs, and stimulus perception verbs.
Verbs of Psychological State	Amuse verbs, admire verbs, marvel verbs, and appeal verbs.
Verbs of Desire	Want verbs, and long for verbs.
Verbs of Judgment	Verbs of positive judgment, verbs of negative judgment, and verbs of assessment
Verbs of Social Interaction	Correspond verbs, marry verbs and meet verbs
Verbs of Communication	Verbs that transfer messages, verbs of manner of speaking, verbs of instruments of communication, say verbs, chitchat verbs, complain verbs, and advice verbs.
Verbs of Ingestion	Eat verbs, chew verbs, gobble verbs, devour verbs, dine verbs, and gorge verbs.
Verbs Involving the Body	Hiccup verbs, breathe verbs, exhale verbs, non-verbal expression verbs, curtsey verbs, snooze verbs, flinch verbs, internal body state verbs, suffocate verbs, hurt verbs, change of body state verbs, dress verbs, floss verbs, braid verbs, verbs of dressing well, and verbs of being dressed.
Verbs of Killing and Destruction	Murder verbs, poison verbs and destroy verbs
Verbs of Change of State	Break verbs, bend verbs, cooking verbs, basic change of state verbs, change of color verbs, causative verbs, intensify verbs, harmonize verbs, deteriorate verbs, germinate verbs, and calibrated change of state verbs.
Verbs of Existence	Exist verbs, verbs of modes of being, verbs of being involving motion, verbs of the existence of sounds, verbs of the existence of groups, herd verbs, bulge verbs, verbs of spatial configuration, meander verbs, and verbs of continuous location.
Verbs of Appearance and Disappearance	Verbs of appearance, verbs of disappearance, verbs of occurrence, verbs of body internal motion, verbs of assuming a position, verbs of inherently directed motion, leave verbs, roll verbs, run verbs, verbs of motion involving a vehicle, waltz verbs, chase verbs, and avoid verbs.

Verbs Involving Lingering and Rushing	Verbs of lingering, and verbs of rushing
Measure Verbs	Register verbs, cost verbs, fit verbs, and price verbs.
Aspectual Verbs	Begin verbs, end verbs, and complete verbs.
Weather verbs	Verbs of rain, verbs of snow, verbs of sunshine, verbs of sleet, and verbs of drizzle

The nomenclature of verb patterns and their classification developed by Levin are supposed to be based on linguistic form and transformational patterns; however, they suggest that certain cognitive processes underlying these categories. In particular, the labels that she has assigned to these verb classes are suggestive of verbal systems that exemplify the embodied mind hypothesis (Lakoff and Johnson, 1991, 1999). These verbs provide information on how one navigates through a biological and social environment as a human being. Of course there are many ways of accomplishing these biological navigations, but those that relate to biological systems and their functions are of special importance because they suggest that biological transducers are inherently responsible for these verb classes. Consider, for example, verbs of movement. One is able to specify through verbs how one moves through a route. There are verbs that focus means of movement such as walking, running, driving, flying, swimming, etc. Verbs are important because they enable language users to articulate human physiological actions in detail.

Verbs are not the only linguistic components that relate to the physiological actions carried out by human beings. Nouns, it should be noted, also play a role in the articulation of the human environment. They enable one to specify and clarify distinctions between events. Such distinctions, it should be noted, are not limited to nouns. They also can be found among verbs and adjectives as they also contribute to a theory of lexical and biological knowledge. This essay will only focus of verb classes in English but when necessary, the focus will shift to other linguistic phenomena of relevant interest.

THE SYSTEMS ANATOMY AND PHYSIOLOGY APPROACH

As noted earlier, whereas most linguistic accounts of verbs focus on grammatical forms and classes, their names are suggestive of a biological and physiological classification. Just how and why these relationships exist need to be investigates and that is the subject of an ongoing project by the authors of this paper. (St. Clair, Rodriguez, and Joshua, 2005).

There are certain advantages in grounding the study of language and the classification of verbs in English by focusing in systems anatomy. For example, Joseph LeDoux (1998, 2004) worked with Michael Gazzaniga (1970) on the split-brain research and went on to specialize in the study of the limbic system. In order to a person to perform a series of sequential behaviors (Hebb, 1949), this information must be orchestrated by means of the limbic system. Many of the linguistic schemas that are used to organize ideas and concepts in the mind have to do with sequential ordering of events. This is why Philip Lieberman (1975, 2001) argued that language began in the limbic system. Contrary to Chomsky (1965) who argued that language is innate, Lieberman sees language as a learned skill.

> "The human capacity for language is based on a 'functional language system' (FLS), distributed across many subsystems of the brain, many of which link directly to the subcortical basal ganglia." (Lieberman, 2000: 1)

The point this attack was the claim made by Chomsky that language is innate. Lieberman claims that language can be explained in terms of Darwinian evolution. It is not biologically special and is not based on some recent biological development which Chomsky has proposed as the rational for a universal grammar. He even counters the work of Fodor (1983) and his claims about the linguistic modularity of the mind. The neural architecture of the functional language system, he notes, differs profoundly from that implied by current "modular" theories of Mind (Chomsky 1980; 1983). These linguists argue that the human brain contains a unique localized "language organ."

It is clear that basal ganglia circuits regulate sequential, self-paced, manual motor control tasks in humans. However, it cannot be claimed that speech motor control or syntax resides in the basal ganglia. The FLS model provided by Lieberman integrates activity from many parts of the human brain, including the subcortical cerebellum, thalamus, motor cortex, premotor cortex, prefrontal regions, and sensory cortex. What Lieberman is claiming is that brain mechanisms that were originally initially adapted for motor control were modified by Darwinian evolution processes to make higher cognitive and linguistic ability possible. Hence, the following simple structural classification of verbs into predicate classes has to do with the primordial constraints by the basal ganglia on syntax as serially ordered behavior..

Predicates	Abstract Structure	Examples
One-Place Predicate	Verb + Noun Adjective + Noun	John sings (intransitive verb) John is tall (predicate adjective) John is here (locative) Humans exist
Two-Place Predicate	Noun + Verb + Noun	John is a student
Three-Place Predicate	Agent + Ditransitive Verb + Direct Object + Indirect Object	John gave a book to Mary

The focus of this investigation, however, will not be on whether a verb is transitive, intransitive, stative or non-stative, but rather on how these verbs are used as expressions of the embodied mind thesis. One more factor should be discussed before elaborating on the many verb classes in English. There are two systems of lexical items in English: Latinate and Native vocabulary. This discussion is necessary because it demonstrates that there are many verbs in English that function as social class markers. Latinate vocabulary, for example, is employed in speaking and writing prose. It is part of the language of formal English. It is part of the language of academic literacy. Native vocabulary, on the other hand, is associated with conversational English. It is associated with oral communication styles. They form correlated systems of cognition. Hence, there are situations in which either Latinate or Native Lexical verbal systems are used to reveal and document the claims made in this investigation of biological transducers.

NATIVE AND LATINATE VOCABULARY SYSTEMS

The English language, which is essentially a Germanic language, has undergone a long process of borrowing words from other languages. Of these, the Classical languages of Greek and Latin and the French language have proven to be more significant. These languages (Greek, Latin, and French) play a major role in formal English whereas the native

words that entered the language through Germanic routes (Anglo-Saxon, Danish, and Norwegian) constitute informal English. For example, students who enters medical school will need to learn about 10,000 new words that are used to introduce them to the new conceptual fields of anatomy and medicine. Most of those new words are made up of Greek and Latin roots. This is because the native vocabulary of English cannot function adequately in articulating the nature and the structure of this new framework. The native vocabulary is not precise enough. It fails as a language fopr the medical sciences. This use of technological language is referred to as technological registers. It is part of a larger phenomenon of the social uses of linguistic codes known as diglossia. In countries in which there are levels of distinction between those who command literacy and those that do not, diglossia acts as a marker of social achievement and one who commands the formal language also commands mobility and access within that society. In the United States, there are two levels of diglossia, formal and informal English. Within formal English, there are many different kinds of professional registers such as the language codes of science, medicine, law and other professional disciplines.

English Diglossia Formal and Informal English	
Formal English	Words borrowed from Latin, Greek, and French. Prose style based on the logical organization of events Use of the subjunctive Use of counterfactuals (if x, then Y) Embedded phrasal structures Use of third person perspective
Informal English	Words that entered the language through German, Danish, Norwegian, and Plattdeutsch (lowland dialects of German) Narrative style based on temporal organization of events Mainly used in the indicative Use of first and second person perspective

The term given to the lexical items that constitute Formal English is referred to as Latinate Vocabulary. It includes Latin, Greek, and French loan words. It is not just limited to Latin loan words. Why have these languages greatly influenced English Prose? The answer comes from the historical record. Britain fell in love with the classics and established the command of these languages and their literature as a marker of the higher social classes. Students were required to study Latin and Greek as part of their formal education. Knowledge of these languages was used as sign of social achievement. This aspect of English lexicography is readily comprehensible, but why is French considered to be a significant part of Formal English? The answer to this question can be found in the Battle of Hastings in 1066 when France invaded England and won the battle over England that gave them the right to use French as the language of government and to rule that country in a foreign tongue for nearly 300 years. In the process of that time span, England became a bilingual nation. The language of the government was French and the language of the people was Old English, a Germanic tongue. The interface between these two languages led to the rise of a new language, a creole language known as Middle English. Since the government of England was under French rule,

French words were given special status and endowed with greater value. Even in Modern English, one finds this system of endowing Greek, Latin, and French loan words with special status.

Informal English	Formal English (Latin, Greek, French)
go in	enter
go out	exit
go up	ascend
go down	descend
go through	penetrate
go around	circumnavigate, periphrasis
at the present time	contemporary, synchronic
through time	diachronic
ahead of the times	avant-garde
to hide	camouflage
back	posterior
front	anterior
side	lateral
after the flood	postdiluvian
dog	canine
smart	erudite, intelligent
sharp	perspicacious
understand	comprehend
to create	to establish
to keep something going	to sustain, to maintain, to manage

This process of elevating Latinate vocabulary in English is a cultural artifact, a social construction of reality shared by English speakers in the United Kingdom. American, Canadian, New Zealand, and Australian English share in this heritage. This tradition is very deep and it even can be found embedded among intelligence tests, which are in many ways culture-bound assessments of intelligence. For example, one may gain some 20-30 points on an intelligence test just by knowing Greek and Latin root words. What is important about this excursion into the Latinate nature of English is the fact that when verbs are classified linguistics, they are also further subclassified socially into formal and informal English. This further social demarcation is not central to the classification of verbs discussed within the embodied mind hypothesis.

BIOLOGICALLY-BASED CATEGORIZATION OF VERBS

Courses on sensation and perception teach far more than the focus of this investigation, which is an investigation of biological systems of hearing, vision, touch, taste, and smell. In addition to these topics, such books (Goldstein, 2002) discuss receptors and neural processing, the lateral geniculate nucleus and the striate cortex, theories of perception, color perception, and clinical aspects of vision and hearing. What is interesting about textbooks on sense and perception is that they include the following areas of analysis:

- The cutaneous senses and the tactile system
- The chemical senses and the olfactory system
- Perceiving objects and the visual system
- Perceiving color and the visual system
- Perceiving Depth and Size within the visual system
- Perception of action
- Sound and the auditory system
- Speech perception

If one is trying to prove the embodied mind thesis, then it seems more reasonable to begin the investigation of these claims with the biological and physiological systems within the human body and their intrinsic relationships to language and the human brain. This is, essentially, the approach taken in this essay. At some point one will either have strong evidence for the hypothesis or not. It will be argued that the hypothesis is correct and that human perception and cognition is embodied. The question, then, becomes one of asking whether or not language is also embodied. If it is, then how is it is embodied. With regard to English verbs, it is argued that verbs are not rules nor do they represent biological functions. Verbs function as markers of biological networks whether they are wired into the neuronal system or subsequently developed as social constructs. The kinds of verbs that are being investigated in this essay invoke biological systems and function as systems markers. These are verbs that relate to basic physiological systems within the brain. Those verbs that are based on social metaphors do have biological consequences, but they are housed within the cerebral cortex within neuronal complexes that are more distant than the biological systems investigated in this book.

LINGUISTIC ACCOUNTS OF VERBS OF HEARING

How does one go about classifying verbs of hearing? Beth Levin (1993: 185, 187, and 199) placed these verbs under three separate classifications. .

Verb of Hearing	Classification	Rationale
Hear	Verb of SEEING	These verbs describe the actual perception of some entity. The take the perceiver as the subject (agent) and the perceived entity as the object.
Listen to	Classified under PEERING	Verbs of peering form a subset of verbs of perception and are not used transitively. They take a prepositional phrase complement. These verbs do not necessarily describe the apprehension of something via a sense.
Listen	Classified under RUMMAGE	Verbs of rummaging form a subset of verbs of searching. Members of this class show only one of three possible patterns of argument expression available to verbs of searching. Both arguments are expressed using prepositional phrases.

Jeffrey Gruber (1967) provided a more insightful way of classifying verbs of hearing. He argued that certain verbs form pairs that are distinguished by the prepositional phrases that

follow them. Consider, for example, the verb to rent. One may rent something to someone or rent something from someone. RENT TO and RENT FROM are two parts of the same verb to RENT. With most verbs, however, the abstract verb has two surface forms that are context sensitive. One form is used before the preposition TO and the other is used before the preposition FROM.

ABSTRACT VERB	Before a To-Prepositional Phrase	Before FROM-Prepositional Phrase
BUY-SELL	Sell to	Buy from
GIVE-TAKE	Give to	Take from
GO-COME	Go to	Come from
LISTEN-HEAR	Listen to	Hear from

Gruber argued that abstract verbs are needed to explain how language is used. There are many examples throughout the history of English in which certain lexical forms remain in the abstract only to surface as concrete forms many generations later. For example, the agentive form "editor" was used in English for almost a century before its verbal form "edit" appeared. Since one needs the verbal root to form the agentive noun, it can be argued that the verb "edit" existed as an abstract verb long before it finally surfaced as a concrete lexical form in the language. This process is called "backformation." How does one explain the use of these abstract verbs in linguistic theory? What are their motivating structures? Consider, for example, the abstract verb BUY-SELL. The deep structure of this verb has the following form.

ABSTRACT VERB	Object	From Prepositional Phrase	To Prepositional Phrase
BUY-SELL	a book	Buy from John	Sell to Mary

If the From Prepositional Phrase is chosen as the topic of the sentence, the following interim structure occurs:

Topic	Verb (past)	Object	To Prepositional Phrase
From John	BUY-SELL	a book	to Mary
John	sold	a book	to Mary

The preposition "from" is deleted at the beginning of the topic phrase and the concrete verb is chosen by its prepositional context, i.e., sell to, buy from. If "to Mary" were chosen as the topic of the sentence, the following process would result:

Topic	Verb (Past	Object	From Prepositional Phrase
To Mary	BUY-SELL	a book	from John
Mary	bought	a book	from John

There are several problems with this analysis. One of them has to do with the fact that the verbs in the underlying forms are abstract, but the prepositions are not. Another problem has to do with the fact that other kinds of prepositional phrases are needed to more fully

complement the underlying structure. In "John bought a book from Mary for three dollars," one needs to account for the "for prepositional phrase." The following reanalysis corrects these problems:

Abstract Verb	Object	Source	Goal	Transaction Value
BUY-SELL	book	From John	To Mary	for $3

According to Gruber, LISTEN-HEAR is also an abstract verb. However, the deep structure of HEAR-Listen verbs is more complex. How, for example, does on account for the following sentences?

John heard the news from his parents
John listened to the news
John listened for the news
John heard about the news.

There are some verbs that are based on grammaticality or metaphorical constructions (listen up, hear out, listen in, and listen out for) and these are not the focus of this discussion. The problem is that there is evidence that HEAR and LISTEN are two separate verbs and that they merit different underlying constructions. First, the act of hearing is involuntary. Individuals hear whether or not they want to. Listening, on the other hand, involves that one focus attention on what is being heard. Linguists need to extend their understanding of the auditory process by going beyond the study of only linguistic information. Theories of grammar must include physiological and biological systems associated with the embodied mind.

EXPLICATING PHONOLOGICAL THEORY

Before beginning a journey into the structures and the functions that are characteristically associated with the auditory system, it is necessary to first outline some of the phonological concerns that play a role in phonological theory. Linguistic must explain the concept of phonetics and how phonetic sounds form a natural class of abstract sounds known as the phoneme. Consider, for example the bilabial voiceless consonants associated with the following words: pin, spin, and up. The voiceless bilabial phone of "pin" is aspirated, [p^h] whereas those of "spin" and "up" are not, [p]. By what kind of physiological process do the two allophones [p] and [p^h] constitute a natural class, the phoneme /p/?

Another problem comes from acoustic phonetics. Native speakers of English designate the phoneme /p/ to be the same consonant before all vowels, but the acoustic evidence shows that each of these consonants are different due to the consonant to vowel transitions involved. The phoneme /p/ actually consists of several acoustic allophones, [p^i], [p^e], [p^u], [p^o] , etc. How do these acoustic allophones constitute the same abstract sound, the phoneme /p/? Not only are the unaspirated allophones of /p/ different before each vowel, but so are the aspirated ones /p^h/.

Another problem in phonological theory comes from those linguists who have noticed several similarities between phonological theory and music theory. Both deal with sign systems based on resonance. Both have structure, but what is this structure? How are

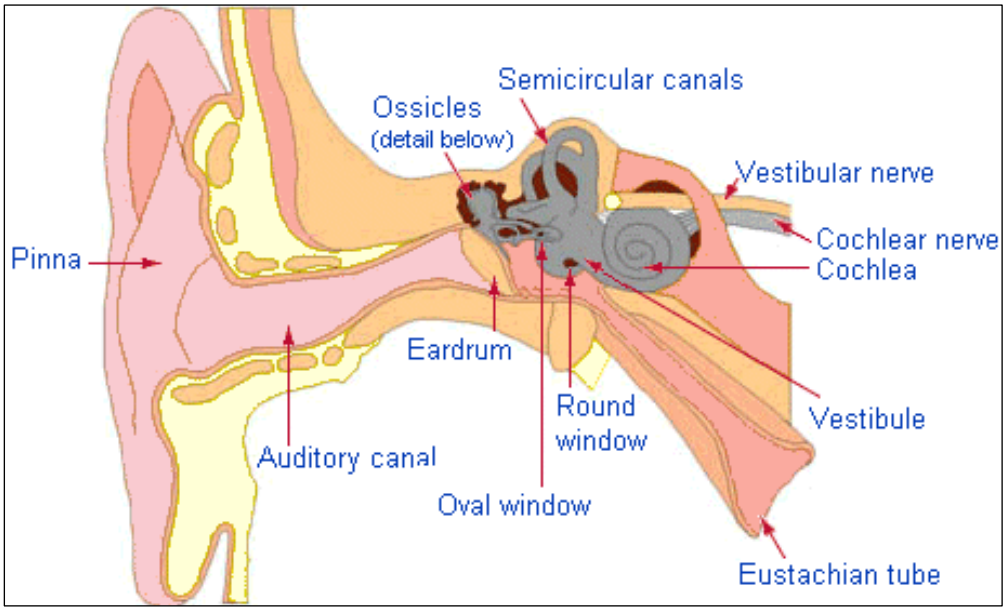
they related? Could it be that vowels are really musical chords? These and other concerns of phonological theory are discussed after the auditory system is explicated.

THE FUNCTIONS OF THE AUDITORY SYSTEM

There are many functions involved in hearing and listening. Some of these functions are more significant than others with regard to phonological theory. Each of these functions are discussed in this section of this essay and those that relate to phonemic theory include an expanded discussion.

The auditory system is organized to detect several aspects of sounds, including pitsch, loudness, and direction. The anatomical components of the system are the external ear, the middle ear, and the inner ear.

THE OUTER EAR: Sound waves are collected by the external ear and channeled along the ear canal to the eardrum or the tympanic membrane. When the sound hits the tympanic membranes, the impact creates vibrations that cause the three bones of the middle ear, the ossicles, to move. The smallest of these bones is called the stapes and it fits into the oval window between the middle and inner ear. When the oval window vibrates, the fluid in the inner ear transmits the vibrations into a delicate, snail-shaped structure called the cochlea.



What are the functions associated with the outer ear? One of them is determined by the outer ear, the pinna and its extension into the ear canal. It is shaped to detect sounds and direct them into the ear canal. Humans are structured to receive sounds that are before them. Unlike some species that can move its ears to locate sounds, humans are limited in this physiological function and need to channel sounds from the acoustic spaces around them into the ear canal. The next function of the out ear is to send these sound vibrations towards the tympanic membrane where the impact causes that membrane to vibrate. The outer ear detects air vibrations and directs them to the middle ear where they are converted into mechanical

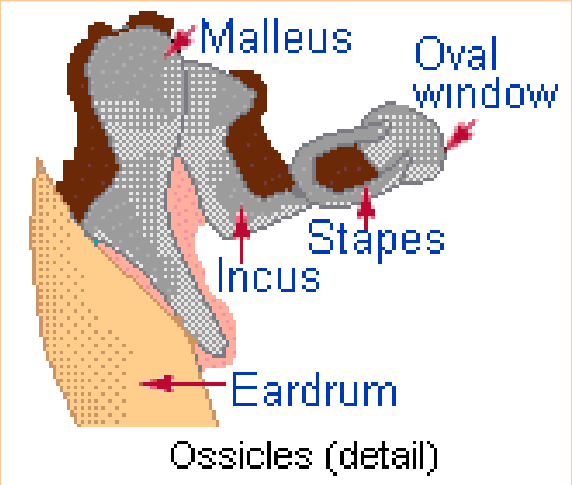
vibrations. One other function needs to noted: the pinner protects the tympanic membrane (the eardrum) at the end of the ear canal.

THE MIDDLE EAR: The middle ear is a small chamber between the tympanic membrane and the inner ear. It consists of the tympanic cavity and contains the auditory ossicles. The function of the middle ear is to transmit and amplify the sound vibrations from the tympanic membrane to the inner ear[1]. The tympanic cavity is divided into the epitympanum, the mesotympanum, and hypotympanum.

The typmpanic membrane	
Epitympanum	It contains the malleus and incus. It is the malleus that is set into vibration by the tympanic membrane. These vibrations are sent to the incus which in turn sends them to the stapes. The stapes transmits these vibrations to the inner ear by pushing against the oval window of the cochlea.
Mesotympanum	This is the part behind the tympanum and it consists of the stapes, a part of the incus, and two muscles
Hypotympanum	This is the part of the tympanum that lies under the level of the bottom of the external auditory canal.

The tympanic membrane has an irregularly round, slightly conical shape. The apex of the cone is located at the umbo, the projecting center of the tympanic membrane that corresponds to the point of attachment to manubrium or tip of the malleus. The angle between the between the tympanum and the external auditory canal is approximately 140 degrees (Goldstein, 2002: 344-355).

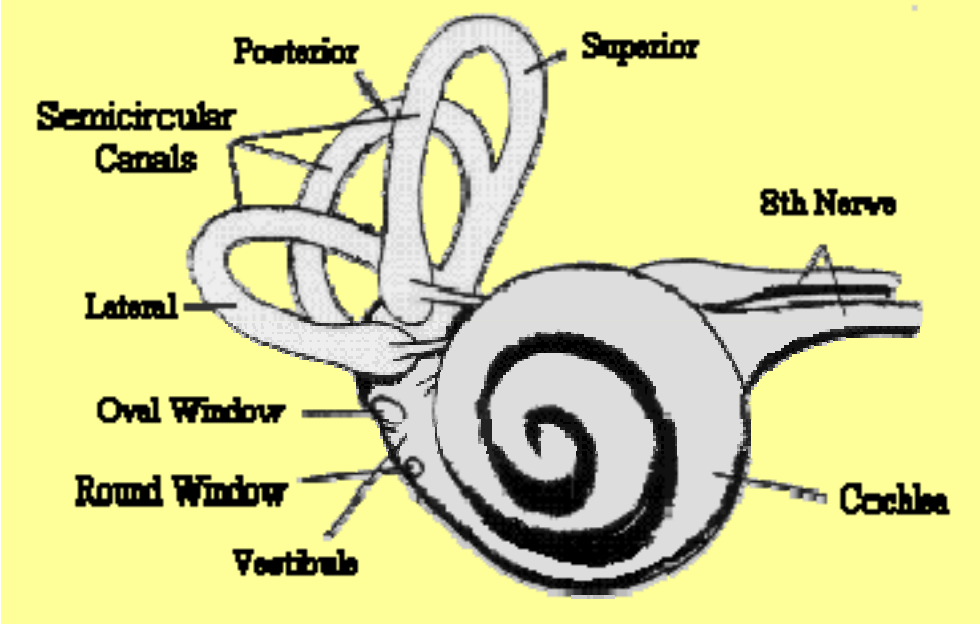
The ossicles serve to transmit the sound energy from the tympanic membrane to the inner ear. The malleus, one of the ossicles, is attached to the tympanic membrane. The incus is the link between the malleus and the stapes, the bone that connects to the inner ear. Since sound waves cannot be readily transmitted into the liquid medium of the cochlea, they need to be amplified. In addition to the function of transmitting air vibrations into a liquid medium, the bones of the middle ear also protect the cochlea from damaging vibrations. It masks low frequency sounds in



[1] The process of transmitting air vibrations directly to the much denser fluid of the cochlea is not efficient. Hence, these sounds need to be amplified and this is the function of the bones of the inner ear. It concentrates the vibrations of the larger tympanic membrane into the smaller stapes by means of a lever system.

loud environments by removing background noises under 1000 Hz. It also decreases sensitivity to a person's own speech. It should be noted that the contraction of the stapedius muscle and the tensor tympani muscle occurs as a reflex to high volume sounds. This contraction makes the ossicular chair more rigid and dampens the response to acoustic stimulation, especially those frequencies under 2000 Hz.

THE INNER EAR: In the inner ear, there are thousand of microscopic hair cells that are bent by the wave-like action of fluid inside of the cochlea. These impulses are then passed through to the auditory nerve and to the hear center of the brain. The relative length of the hair cell vibrations determine the different frequencies that are send to the hearing center in the brain. Short fibers correspond to higher frequencies and vice versa. The inner ear is also filled with a maze of fluid-filled tubes that can be found throughout the temporal bone of the skull. The bony tubes, the bony labyrinth, are filled with a fuild called perilymph. Within this labyrinth one finds a second series of delicate cellular tubes called the membranous labyrinth and they are filled with a fuild called the endolymph. It is in the membranous labyrinth that one finds the actual hearing cells, the hair cells of the organ of corti (Anthony and Thibodeau, 1983: 338-344)..



What are the functions of the inner ear? The front portion is the snail-shaped cochlea which functions in hearing. It performs a Fourier analysis of incoming complex sound waves and breaks them down into fundamental frequencies. The rear part consists of semicircular canals in the vestibule and they are responsible for balance. The three semicircular canals (known collectively as the crista ampullaris) are perpendicular to each other. This arrangement allows it to sense movement in each of the three spatial planes. The static head position is sensed by the vestibule, specifically the utricle and saccule, which contain the position hair cells. Different head positions produce different gravity effects on these hair cells. The impulses from these cells travel over the vestibular nerve to synapse in the brain

stem, cerebellum and spinal chord. These impulses produce reflex actions to produce corrective responses (DeLisa and Stolov, 1981: 51-54). The crista ampullaris provides a sense of equilibrium and a reference center by means of which one is also able to sense the location of sounds in space.

AUDITORY NERVE OR CRABUAK NERVE VIII: The perception of pitch must be determined not just by the activity in the cochlea, but by the way in which the brain analyzes the information that originated in the cochlea. The first-order neurons of the auditory system are cells of the spiral ganglion situation within the modiolus or central core of the cochlea, approximately 32,000 myelinated cochlear nerve fibers. The chochlear nerve occupies the anterior-inferior portion of the internal auditory canal and the vestibular nerve occupies the posterior half. Axons leaving the cochlear nucleus pass between the pontomedullary junction and the midbrain. The auditory fibers from the dorsal and ventral cochlear nuclear form three pathways which are called the striae. The fibers from the anterior ventral portion of the ventral cochlear nucleus send an ipsilateral pathway to reach the superior olivary complex (Goldstein, 2002). It also sends information to theipsilateral lemniscus which is the principal ascending auditory pathway in the brainstem. Projections of these cells proceed to the midbrain and terminate in the inferior colliculus. What is important about the inferior colliculus is that it is located in the midbrain tectus and serves as a relay center for all of the ascending and descending fibers. These ascending fibers and some of the lateral lemniscus constitute the afferent bundkle known as the brachium of the inferior colliculus. These fibers synpas in the medial geniculate body of the thalamus. .

Rather than go into greater detail on the auditory system and the hearing center in the brain, a task that would take several chapters of a book, it is time to return to certain theoretical concepts in linguistics and rephrase them in physiological terms.

THE AUDITORY SYSTEM AND PHONOLOGICAL PERCEPTION

One of the most interesting questions that a linguist could ask has to do with the digitizing of the continuum of complex sound waves into units that are perceived as consonants and vowels. How do the sounds of language, which exist in a continuum of resonance, get transferred into digital information in the brain? The cochlea takes these complex sounds that exist in a continuum and breaks them down into harmonic frequencies by a process known as Fourier analysis. The inner ear is a biological transducer. It takes in information and restructures it for internal use.

Another interesting question has to do with the fact that the auditory system is able to detect vowels and separate them from consonants. How is this done? Studies in acoustic analysis (Goldstein, 2002) demonstrate that vowels have a unique structure. They consist of formants or resonant bars that correlate to buccal pockets of resonance above and below the tongue during phonation. There is a small compartment of resonating air under the tongue that produces a high pitch; there is a large cavity of resonating sound near the pharyngeal area at the back of the tongue that produces a low resonating sound; and there is another compartment of resonating sound on the dorsal region of the tongue and the palate that produces sounds in the medial range. When these sounds are emitted during phonation, they produce a complex sound wave. The inner ear receives this complex sound in the form of liquid vibrations and transforms them into digitized harmonic sounds. Each vowel has its own configuration of harmonic sounds. If a sound is nasalized, it contains another resonant

bar that was created by vibrations in the nasal cavity. Consonants differ structurally from vowels. In acoustic terms, they have a point of origin and gradually interface with vowels which are more steady state vibrations. The transitions from consonants to vowels leave a distinct pattern.

The problem for a physiological account of this phenomenon has to do with phonological constancy. The phenomenon of constancy is not new to the study of human perception. There is evidence for size constancy, shape constancy, and color constancy. Consider shape constancy as an example of how the mind perceives many shapes but is only conscious of one of them. When one looks at a rectangular desk, the mind sees that desk as a rectangular shaped object. From on angle, the desk may appear as a trapezoid or a square, but the mind sees a rectangular object. Phonological constancy also exists. The brain perceives many consonant to vowel transitions. The sound of [p] contains a different consonant to vowel transition patterns before each vowel, but the mind hears these differences as the same sound, /p/. How does this constancy occur? Where along the path from the inferior colliculus to the brachium and the geniculate body of the thalamus did this imposition of constancy occur? If one can answer this, one is able to provide physiological evidence for one of the basic tenets of phoneme theory within linguistics.

Another problem that merits concern is how does the brain distinguish vocalic sounds from musical sounds? They apparently have similar structures. They consist of resonating bands of frequencies that are spatially organized and co-occur simultaneously. The chord of C, for example, consists of three resonating sound, C, A, and E. The sound of /i/, on the other hand, also consists of three resonating frequencies, two higher frequencies and one lower. All of these sounds occur within the range of 20-4,000 Hz. Perhaps the answer has to do with the fact that human vocal sounds are emitted as complex sounds. However, once these sounds have been subjected to a Fourier analysis by the cochlea, they are electronically equivalent to strata of pure vowels. How does the hearing center of the brain distinguish these patterns? There is evidence that human beings sing their language, but only students of the auditory system are aware of this. For the average person, one signs a song and speaks a language. They are seen as different processes and there are even different verbs in English to mark the distinction.

Linguists believe that phonetics, the study of speech sounds, are merely combined and placed into a category known as phonemes. From the aforementioned discussions of human perception, this cannot be the case. What a linguist calls a phoneme is merely a cover term for a system of sound production and perception in which each member of the class of sounds innervates a whole complex process of biological and physiological associations. What appears to be an entity in linguistic analysis is really a physiological process. There is one process for each perception of a consonant and vowel sequence. A phoneme, under this analysis, is a marker of sound constancy. It treats the sound of [p] before [a] in the same ways as it occurs before [i], and so on. However, each of these processes is separate. They are held together by the process of phonological constancy. The problem is how does this constancy occurs. It is not new to human perception. How does one account for its occurrence physiologically?

The final problem that needs to be addressed with regard to the focus of this paper is how individuals distinguish verbs of hearing from verbs of listening. Gruber (1967), one may recall, had a theory of abstract verbs in which HEAR-LISTEN was an abstract verb. Evidently, such is not the case. They represent two different verbs physiologically. So the

question is how does the mind go from hearing to listening? How does one focus attention on an incoming involuntary signal? Perhaps this is a topic that needs to be left for those who are involved in consciousness studies.

CONCLUDING REMARKS

There are several issues addressed in this essay. One has to do with the grounding linguistic models in a solid tradition of research. The embodied mind hypothesis provides an informative model by which to investigate the biological foundations of language. The only problem with this research is that the model proposed by Lakoff and Johnson (1999) does not include enough biological and physiological research. It claims that linguistic schemas have a biological basis, but go no further than that. The model proposed by Lieberman (2001) is far more effective, but his concern was mainly with attacking the claims of universal grammar and as a consequence he focused on the fact that the basal ganglia provides a biological rationale for the organization of serial behavior and syntax is orchestrated by these motor functions. The approach being presented in this paper is a synopsis of a larger work on Language and the Embodied Mind (St. Clair, Rodriguez and Joshua, 2005) in which various physiological systems related to language are investigated as the foundations of upon which linguistic theories should be developed. A synopsis of one such system, the auditory system, was presented. This systems anatomy approach provided greater insight into hearing verbs, the relationship between the tonal structure of vowels and musical chords, and the organization of phonological constancy in language perception. It also brought into focus how formants in acoustic phonetics and the articulation of vowels are related to the tonal structure of vowels.

The classification of verbs in English was merely the starting point of this investigation into the embodied mind. The reason that the classification of verbs was chosen as a topic is because it was so narrowly defined and articulated by linguists who limited themselves to syntactic information. The problem is not that these linguistics limited themselves by means of linguistic methodology, but that they went on to make strong claims about the biology of language. Chomsky (1965, 1966) wanted to argue that language is a faculty of the mind, a innate biological mechanism that accounts for his claims about universals of language. All of these claims are inferred and not based on research in the medical sciences. He eventually had to relinquish this claim (Hauser, Chomsky, and Fitch, 2002). Another set of biological inference came from the work of Lakoff and Johnson (1999) who advocate the embodied mind hypothesis and made several generalization about biological schemas based on their findings of linguistic schemas. The problem here is that they did not document their research biologically. What the authors of this essay advocate is that linguistics who want to make claims about the biology and the physiology of language should begin with the study of physiological systems and base their theories on this established domain of scientific research. The biology of language needs to be grounded in the biology and the physiology of human systems.

The example of how the embodied mind research can better explain the verbs of hearing and listening came from a general overview of the auditory system in human beings. A more expanded version of this account with more detailed explications can be found in a forthcoming book by the authors (St. Clair, Rodriguez, and Joshua, 2005).

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