Role of Linguistic in Literature

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Chapter 1

Ambiguity

Ambiguity is a type of meaning in which a phrase, statement or resolution is not explicitly defined, making several interpretations plausible. A common aspect of ambiguity is uncertainty. It is thus an attribute of any idea or statement whose intended meaning cannot be definitively resolved according to a rule or process with a finite number of steps. (The *ambi-* part of the term reflects an idea of "two", as in "two meanings".)

The concept of ambiguity is generally contrasted with vagueness. In ambiguity, specific and distinct interpretations are permitted (although some may not be immediately obvious), whereas with information that is vague, it is difficult to form any interpretation at the desired level of specificity.

Linguistic forms

Lexical ambiguity is contrasted with semantic ambiguity. The former represents a choice between a finite number of known and meaningful context-dependent interpretations. The latter represents a choice between any number of possible interpretations, none of which may have a standard agreed-upon meaning. This form of ambiguity is closely related to vagueness.

Linguistic ambiguity can be a problem in law, because the interpretation of written documents and oral agreements is often of paramount importance.

Lexical ambiguity

The lexical ambiguity of a word or phrase pertains to its having more than one meaning in the language to which the word belongs. "Meaning" here refers to whatever should be captured by a good dictionary. For instance, the word "bank" has several distinct lexical definitions, including "financial institution" and "edge of a river". Or consider "apothecary". One could say "I bought herbs from the apothecary". This could mean one actually spoke to the apothecary (pharmacist) or went to the apothecary (pharmacy).

The context in which an ambiguous word is used often makes it evident which of the meanings is intended. If, for instance, someone says "I buried $100 in the bank", most people would not think someone used a shovel to dig in the mud. However, some linguistic contexts do not provide sufficient information to disambiguate a used word.

Lexical ambiguity can be addressed by algorithmic methods that automatically associate the appropriate meaning with a word in context, a task referred to as word sense disambiguation.

The use of multi-defined words requires the author or speaker to clarify their context, and sometimes elaborate on their specific intended meaning (in which case, a less ambiguous term should have been used). The goal of clear concise communication is that the receiver(s) have no misunderstanding about what was meant to be conveyed. An exception to this could include a politician whose "weasel words" and obfuscation are necessary to gain support from

multiple constituents with mutually exclusive conflicting desires from their candidate of choice. Ambiguity is a powerful tool of political science.

More problematic are words whose senses express closely related concepts. "Good", for example, can mean "useful" or "functional" (*That's a good hammer*), "exemplary" (*She's a good student*), "pleasing" (*This is good soup*), "moral" (*a good person* versus *the lesson to be learned from a story*), "righteous", etc. "I have a good daughter" is not clear about which sense is intended. The various ways to apply prefixes and suffixes can also create ambiguity ("unlockable" can mean "capable of being unlocked" or "impossible to lock").

Semantic and syntactic ambiguity

Semantic ambiguity occurs when a word, phrase or sentence, taken out of context, has more than one interpretation. In "We saw her duck" (example due to Richard Nordquist), the words "her duck" can refer either

- to the person's bird (the noun "duck", modified by the possessive pronoun "her"), or
- to a motion she made (the verb "duck", the subject of which is the objective pronoun "her", object of the verb "saw").

Syntactic ambiguity arises when a sentence can have two (or more) different meanings because of the structure of the sentence—its syntax. This is often due to a modifying expression, such as a prepositional phrase, the application of which is unclear. "He ate the cookies on the couch", for example, could mean that he ate those cookies that were on

the couch (as opposed to those that were on the table), or it could mean that he was sitting on the couch when he ate the cookies. "To get in, you will need an entrance fee of $10 or your voucher and your drivers' license." This could mean that you need EITHER ten dollars OR BOTH your voucher and your license. Or it could mean that you need your license AND you need EITHER ten dollars OR a voucher. Only rewriting the sentence, or placing appropriate punctuation can resolve a syntactic ambiguity. For the notion of, and theoretic results about, syntactic ambiguity in artificial, formal languages (such as computer programming languages), see Ambiguous grammar.

Usually, semantic and syntactic ambiguity go hand in hand. The sentence "We saw her duck" is also syntactically ambiguous. Conversely, a sentence like "He ate the cookies on the couch" is also semantically ambiguous. Rarely, but occasionally, the different parsings of a syntactically ambiguous phrase result in the same meaning. For example, the command "Cook, cook!" can be parsed as "Cook (noun used as vocative), cook (imperative verb form)!", but also as "Cook (imperative verb form), cook (noun used as vocative)!". It is more common that a syntactically unambiguous phrase has a semantic ambiguity; for example, the lexical ambiguity in "Your boss is a funny man" is purely semantic, leading to the response "Funny ha-ha or funny peculiar?"

Spoken language can contain many more types of ambiguities which are called phonological ambiguities, where there is more than one way to compose a set of sounds into words. For example, "ice cream" and "I scream". Such ambiguity is generally resolved according to the context. A mishearing of

such, based on incorrectly resolved ambiguity, is called a mondegreen.

Metonymy involves referring to one entity by the name of a different but closely related entity (for example, using "wheels" to refer to a car, or "Wall Street" to refer to the stock exchanges located on that street or even the entire US financial sector). In the modern vocabulary of critical semiotics, metonymy encompasses any potentially ambiguous word substitution that is based on contextual contiguity (located close together), or a function or process that an object performs, such as "sweet ride" to refer to a nice car. Metonym miscommunication is considered a primary mechanism of linguistic humor.

Philosophy

Philosophers (and other users of logic) spend a lot of time and effort searching for and removing (or intentionally adding) ambiguity in arguments because it can lead to incorrect conclusions and can be used to deliberately conceal bad arguments. For example, a politician might say, "I oppose taxes which hinder economic growth", an example of a glittering generality. Some will think they oppose taxes in general because they hinder economic growth. Others may think they oppose only those taxes that they believe will hinder economic growth. In writing, the sentence can be rewritten to reduce possible misinterpretation, either by adding a comma after "taxes" (to convey the first sense) or by changing "which" to "that" (to convey the second sense) or by rewriting it in other ways. The devious politician hopes that each constituent will interpret the statement in the most desirable way, and think

the politician supports everyone's opinion. However, the opposite can also be true—an opponent can turn a positive statement into a bad one if the speaker uses ambiguity (intentionally or not). The logical fallacies of amphiboly and equivocation rely heavily on the use of ambiguous words and phrases.

In continental philosophy (particularly phenomenology and existentialism), there is much greater tolerance of ambiguity, as it is generally seen as an integral part of the human condition. Martin Heidegger argued that the relation between the subject and object is ambiguous, as is the relation of mind and body, and part and whole. In Heidegger's phenomenology, Dasein is always in a meaningful world, but there is always an underlying background for every instance of signification. Thus, although some things may be certain, they have little to do with Dasein's sense of care and existential anxiety, e.g., in the face of death. In calling his work Being and Nothingness an "essay in phenomenological ontology" Jean-Paul Sartre follows Heidegger in defining the human essence as ambiguous, or relating fundamentally to such ambiguity. Simone de Beauvoir tries to base an ethics on Heidegger's and Sartre's writings (The Ethics of Ambiguity), where she highlights the need to grapple with ambiguity: "as long as philosophers and they [men] have thought, most of them have tried to mask it ... And the ethics which they have proposed to their disciples have always pursued the same goal. It has been a matter of eliminating the ambiguity by making oneself pure inwardness or pure externality, by escaping from the sensible world or being engulfed by it, by yielding to eternity or enclosing oneself in the pure moment." Ethics cannot be based on the authoritative certainty given by mathematics and logic, or

prescribed directly from the empirical findings of science. She states: "Since we do not succeed in fleeing it, let us, therefore, try to look the truth in the face. Let us try to assume our fundamental ambiguity. It is in the knowledge of the genuine conditions of our life that we must draw our strength to live and our reason for acting". Other continental philosophers suggest that concepts such as life, nature, and sex are ambiguous. Corey Anton has argued that we cannot be certain what is separate from or unified with something else: language, he asserts, divides what is not, in fact, separate. Following Ernest Becker, he argues that the desire to 'authoritatively disambiguate' the world and existence has led to numerous ideologies and historical events such as genocide. On this basis, he argues that ethics must focus on 'dialectically integrating opposites' and balancing tension, rather than seeking a priori validation or certainty. Like the existentialists and phenomenologists, he sees the ambiguity of life as the basis of creativity.

Literature and rhetoric

In literature and rhetoric, ambiguity can be a useful tool. Groucho Marx's classic joke depends on a grammatical ambiguity for its humor, for example: "Last night I shot an elephant in my pajamas. How he got in my pajamas, I'll never know". Songs and poetry often rely on ambiguous words for artistic effect, as in the song title "Don't It Make My Brown Eyes Blue" (where "blue" can refer to the color, or to sadness).

In the narrative, ambiguity can be introduced in several ways: motive, plot, character. F. Scott Fitzgerald uses the latter type of ambiguity with notable effect in his novel *The Great Gatsby*.

Mathematical notation

Mathematical notation, widely used in physics and other sciences, avoids many ambiguities compared to expression in natural language. However, for various reasons, several lexical, syntactic and semantic ambiguities remain.

Names of functions

The **ambiguity** in the style of writing a function should not be confused with a multivalued function, which can (and should) be defined in a deterministic and unambiguous way. Several special functions still do not have established notations. Usually, the conversion to another notation requires to scale the argument or the resulting value; sometimes, the same name of the function is used, causing confusions. Examples of such underestablished functions:

- Sinc function
- Elliptic integral of the third kind; translating elliptic integral form MAPLE to Mathematica, one should replace the second argument to its square, see Talk:Ellipticintegral#List of notations; dealing with complex values, this may cause problems.
- Exponential integral
- Hermite polynomial

Ambiguous terms in physics and mathematics

Some physical quantities do not yet have established notations; their value (and sometimes even dimension, as in the case of the Einstein coefficients), depends on the system of

notations. Many terms are ambiguous. Each use of an ambiguous term should be preceded by the definition, suitable for a specific case. Just like Ludwig Wittgenstein states in TractatusLogico-Philosophicus: "... Only in the context of a proposition has a name meaning."

A highly confusing term is *gain*. For example, the sentence "the gain of a system should be doubled", without context, means close to nothing.

- It may mean that the ratio of the output voltage of an electric circuit to the input voltage should be doubled.
- It may mean that the ratio of the output power of an electric or optical circuit to the input power should be doubled.
- It may mean that the gain of the laser medium should be doubled, for example, doubling the population of the upper laser level in a quasi-two level system (assuming negligible absorption of the ground-state).

The term *intensity* is ambiguous when applied to light. The term can refer to any of irradiance, luminous intensity, radiant intensity, or radiance, depending on the background of the person using the term.

Also, confusions may be related with the use of atomic percent as measure of concentration of a dopant, or resolution of an imaging system, as measure of the size of the smallest detail which still can be resolved at the background of statistical noise. See also Accuracy and precision and its talk.

The Berry paradox arises as a result of systematic ambiguity in the meaning of terms such as "definable" or "nameable". Terms of this kind give rise to vicious circle fallacies. Other terms with this type of ambiguity are:satisfiable, true, false, function, property, class, relation, cardinal, and ordinal.

Constructed language

Some languages have been created with the intention of avoiding ambiguity, especially lexical ambiguity. Lojban and Loglan are two related languages which have been created for this, focusing chiefly on syntactic ambiguity as well. The languages can be both spoken and written. These languages are intended to provide a greater technical precision over big natural languages, although historically, such attempts at language improvement have been criticized. Languages composed from many diverse sources contain much ambiguity and inconsistency. The many exceptions to syntax and semantic rules are time-consuming and difficult to learn.

Biology

In structural biology, ambiguity has been recognized as a problem for studying protein conformations. The analysis of a protein three-dimensional structure consists in dividing the macromolecule into subunits called domains. The difficulty of this task arises from the fact that different definitions of what a domain is can be used (e.g. folding autonomy, function, thermodynamic stability, or domain motions), which sometimes results in a single protein having different—yet equally valid—domain assignments.

Christianity and Judaism

Christianity and Judaism employ the concept of paradox synonymously with "ambiguity". Many Christians and Jews endorse Rudolf Otto's description of the sacred as 'mysteriumtremendum et fascinans', the awe-inspiring mystery which fascinates humans. The orthodox Catholic writer G. K. Chesterton regularly employed paradox to tease out the meanings in common concepts which he found ambiguous or to reveal meaning often overlooked or forgotten in common phrases. (The title of one of his most famous books, Orthodoxy, itself employing such a paradox.)

Music

In music, pieces or sections which confound expectations and may be or are interpreted simultaneously in different ways are ambiguous, such as some polytonality, polymeter, other ambiguous meters or rhythms, and ambiguous phrasing, or (Stein 2005, p. 79) any aspect of music. The music of Africa is often purposely ambiguous. To quote Sir Donald Francis Tovey (1935, p. 195), "Theorists are apt to vex themselves with vain efforts to remove uncertainty just where it has a high aesthetic value."

Visual art

In visual art, certain images are visually ambiguous, such as the Necker cube, which can be interpreted in two ways. Perceptions of such objects remain stable for a time, then may

flip, a phenomenon called multistable perception. The opposite of such ambiguous images are impossible objects.

Pictures or photographs may also be ambiguous at the semantic level: the visual image is unambiguous, but the meaning and narrative may be ambiguous: is a certain facial expression one of excitement or fear, for instance?

Social psychology and the bystander effect

In social psychology, ambiguity is a factor used in determining peoples' responses to various situations. High levels of ambiguity in an emergency (e.g. an unconscious man lying on a park bench) make witnesses less likely to offer any sort of assistance, due to the fear that they may have misinterpreted the situation and acted unnecessarily. Alternately, non-ambiguous emergencies (e.g. an injured person verbally asking for help) illicit more consistent intervention and assistance. With regard to the bystander effect, studies have shown that emergencies deemed ambiguous trigger the appearance of the classic bystander effect (wherein more witnesses decrease the likelihood of any of them helping) far more than non-ambiguous emergencies.

Computer science

In computer science, the SI prefixes kilo-, mega- and giga- were historically used in certain contexts to mean either the first three powers of 1024 (1024, 1024 and 1024) contrary to

the metric system in which these units unambiguously mean one thousand, one million, and one billion. This usage is particularly prevalent with electronic memory devices (e.g. DRAM) addressed directly by a binary machine register where a decimal interpretation makes no practical sense.

Subsequently, the Ki, Mi, and Gi prefixes were introduced so that binary prefixes could be written explicitly, also rendering k, M, and G *unambiguous* in texts conforming to the new standard—this led to a *new* ambiguity in engineering documents lacking outward trace of the binary prefixes (necessarily indicating the new style) as to whether the usage of k, M, and G remains ambiguous (old style) or not (new style). 1 M (where M is ambiguously 1,000,000 or 1,048,576) is *less* uncertain than the engineering value 1.0e6 (defined to designate the interval 950,000 to 1,050,000), and that as non-volatile storage devices began to commonly exceed 1 GB in capacity (where the ambiguity begins to routinely impact the second significant digit), GB and TB almost always mean 10 and 10 bytes.

Accidental viewpoint

An accidental viewpoint (i.e. eccentric or fixed viewpoint) is a singular position from which an image can be perceived, creating either an ambiguous image or an illusion. The image perceived at this angle is viewpoint-specific, meaning it cannot be perceived at any other position, known as generic or non-accidental viewpoints. These view-specific angles are involved in object recognition. In its uses in art and other visual illusions, the accidental viewpoint creates the perception of

depth often on a two-dimensional surface with the assistance of monocular cues.

Object recognition

- According to the recognition-by-components theory, object recognition is viewpoint-invariant. However, viewpoint specific angles are a necessity in object recognition when identifiable features cannot be viewed from all angles. Object recognition is more accurate when identifying similarities between objects that are moving compared to objects that are static. In this case, viewing an object from an accidental viewpoint can result in altered perception in relation to mental prototypes. When viewing an object from an accidental viewpoint scene consistency is more critical for object recognition than when viewing that object from a non-accidental viewpoint, so in some cases viewing an object from its accidental viewpoint actually makes it harder to recognize the object, but we counteract that difficulty using contextual inference.

Controversy

2D symmetry was once thought to be able to facilitate 3D object recognition under accidental viewpoints. Some psychologists have proposed that the accidental viewpoints of 3D objects often involves the 2D symmetrical images that may not be perceived in the 3D objects. However, researches showed that 2D symmetry will not help object matching in

accidental viewpoints, and others have argued that accidental viewpoints with 2D symmetry will even hinder 3D object matching and object recognition. Results from face recognition study also agrees on the negative effect of symmetric face from accidental views.

Art

Accidental viewpoint contributes to the successful perception of anamorphic images, which intentionally appear distorted from non-accidental viewpoints. Other than viewing the image from a specific location, the distortion can be countered by looking at the image when reflected in a mirror (known as catoptric anamorphoses). How our brains interpret images make it so that the geometry of 2D object is related to that of 3D objects, rather than just taking the image for how it is, a drawing made from a single viewpoint. Related to this is the generic viewpoint assumption, which is the tendency to assume that image characteristics are not a result of an accidental viewpoint. The artist and mathematician Niceron developed a method of creating perspective anamorphic images by segmenting an image into a grid then distorting each segment of the grid from a square shape to a trapezoidal shape. The image can then be reconciled by viewing it from a specific point. Two dimensional art objects generally use the assumption of a single viewpoint to give the illusion of depth (monocular depth cues), Hans Holbein's *The Ambassadors* (1533) is no different in that sense, however, Holbein also includes an anamorphic image of a skull which has a completely different view point in order to accurately view the object. In the 17th century, perspective boxes (peep boxes,

raree shows) became popular attractions. These took advantage of the accidental viewpoint by creating a scene that appeared to be three dimensional when viewed through a single hole in the box. A modern representation of anamorphic images that makes use of an accidental viewpoint can be found in illusionistic street art.

Psychological illusion

Psychologists have exploited the assumption of the generic viewpoint by using an accidental viewpoint to trick the brain into perceiving a scene that is realistically impossible. One famous example of this is the Ames room which uses distortion to create the image of a room that looks regular from an accidental viewpoint. When people interact with the room they appear to be changing size.

The accidental viewpoint can also be used to trick Gestalt principles such that a curved line can appear straight when viewed from an accidental viewpoint. The accidental viewpoint it also used when creating possible versions of impossible object illusions.

Ambiguity (law)

Ambiguity occurs when a single word or phrase may be interpreted in two or more ways. As law frequently involves lengthy, complex texts, ambiguity is common. Thus, courts have evolved various doctrines for dealing with cases in which legal texts are ambiguous.

Criminal law

In criminal law, the rule of lenity holds that where a criminal statute is ambiguous, the meaning most favorable to the defendant—i.e., the one that imposes the lowest penalties—should be adopted. In the US context, Justice John Marshall stated the rule thus in *United States v. Wiltberger*:

The rule that penal laws are to be construed strictly, is perhaps not much less old than construction itself. It is founded on the tenderness of the law for the rights of individuals; and on the plain principle that the power of punishment is vested in the legislative, not in the judicial department. It is the legislature, not the Court, which is to define a crime, and ordain its punishment.

Contract law

In contract law, the *contra proferentem* rule holds that, depending on the circumstances, ambiguous terms in a contract may be construed in favor of the party with less bargaining power.

International law

In Canada, courts have developed rules of construction to interpret ambiguities in treaties between Indigenous peoples and the Crown.

In 1983, the Supreme Court of Canada held that "treaties and statutes relating to Indians should be liberally construed and doubtful expressions resolved in favour of the Indians."

Property law

In property law, a distinction is drawn between patent ambiguity and latent ambiguity. The two forms of ambiguity differ in two respects: (1) what led to the existence of the ambiguity; and (2) the type of evidentiary basis that might be allowed in resolving it.

Patent ambiguity

Patent ambiguity is that ambiguity which is apparent on the face of an instrument to any one perusing it, even if unacquainted with the circumstances of the parties. In the case of a patent ambiguity, parol evidence is admissible to explain only what has been written, not what the writer intended to write. For example, in *Saunderson v Piper* (1839), where a bill of exchange was drawn in figures for £245 and in words for two hundred pounds, evidence that "and forty-five" had been omitted by mistake was rejected. But where it appears from the general context of the instrument what the parties really meant, the instrument will be construed as if there was no ambiguity, as in *Saye* and *Sele*'s case (1795), where the name of the grantor had been omitted in the operative part of a grant, but, as it was clear from another part of the grant who he was, the deed was held to be valid.

Latent ambiguity

Latent ambiguity is where the wording of an instrument is on the face of it clear and intelligible, but may, at the same time, apply equally to two different things or subject matters, as where a legacy is given "to my nephew, John," and the testator is shown to have two nephews of that name. A latent ambiguity may be explained by parol evidence: the ambiguity has been brought about by circumstances extraneous to the instrument, so the explanation must necessarily be sought in such circumstances.

Ambiguity tolerance–intolerance

Ambiguity tolerance–intolerance is a psychological construct that describes the relationship that individuals have with ambiguous stimuli or events. Individuals view these stimuli in a neutral and open way or as a threat.

History

Ambiguity tolerance–intolerance is a construct that was first introduced in 1949 through the work of Else Frenkel-Brunswik while researching ethnocentrism in children and was perpetuated by her research of ambiguity intolerance in connection to authoritarian personality. It serves to define and measure how well an individual responds when presented with an event that results in ambiguous stimuli or situations. In her study, she tested the notion that children who are ethnically prejudiced also tend to reject ambiguity more so than their peers. She studied children who ranked high and

low on prejudice in a story recall test and then studied their responses to an ambiguous disc shaped figure. The children who scored high in prejudice were expected to take longer to give a response to the shape, less likely to make changes on their response, and less likely to change their perspectives. A study by Kenny and Ginsberg (1958) retesting Frenkel-Brunswik's original connection of ambiguity intolerance to ethnocentrism and authoritarian personality found that the results were unreplicable. However, it was discussed that this may be due to the fact that at the time the study was done incorrect methodology was used and that there lacked a concrete definition as to what the construct was. Most of the research on this subject was completed in the two decades after the publication of "The Authoritarian Personality", however the construct is still studied in psychological research today. Budner gives three examples as to what could be considered ambiguous situations: a situation with no familiar cues, a situation in which there are many cues to be taken into consideration, and a situation in which cues suggest the existence of different structures to be adhered to.

Conceptualization

There have been many attempts to conceptualize the construct of ambiguity tolerance–intolerance as to give researchers a more standard concept to work with. Many of these conceptualizations are based on the work of Frenkel-Brunswik.

Budner (1962) defines the construct as the following:

- Intolerance of ambiguity may be defined as ‘the tendency to perceive (i.e. interpret) ambiguous

situations as sources of threat'; tolerance of ambiguity as 'the tendency to perceive ambiguous situations as desirable.'

Additionally Bochner (1965) categorized attributes given by Frenkel-Brunswik's theory of individuals who are intolerant to ambiguity. The nine primary characteristics describe intolerance of ambiguity and are as follows:

- Need for categorization
- Need for certainty
- Inability to allow good and bad traits to exist in the same person
- Acceptance of attitude statements representing a white-black view of life
- A preference for familiar over unfamiliar
- Rejection of the unusual or different
- Resistance to reversal of fluctuating stimuli
- Early selection and maintenance of one solution in an ambiguous situation
- Premature closure

The secondary characteristics describe individuals who are intolerant to ambiguity as:

- authoritarian
- dogmatic
- rigid
- closed minded
- ethnically prejudiced
- uncreative
- anxious

- extra-punitive
- aggressive

Operationalization and measurement

Because of the lack of concrete conceptualization of what ambiguity intolerance is, there are a variety of ways in which to measure the construct. For example, Stanley Budner developed a scale with 16 items designed to measure how subjects would respond to an ambiguous situation.

Block and Block (1951) operationalized the construct by measuring the amount of time required to structure an ambiguous situation. The less amount of time required to structure, the higher a person would score in ambiguity intolerance.

Levitt (1953) studied intolerance of ambiguity in children and asserted that the Decision Location Test and Misconception Scale both served as accurate measures of ambiguity intolerance.

Psychological implications

The construct of Ambiguity Intolerance is found in different aspects of psychology and mental health. The construct is used in many branches of psychology including personality, developmental, and social psychology. Some examples of how

tolerance–intolerance of ambiguity is used within various branches are displayed below.

Personality psychology

The construct of ambiguity intolerance was conceptualized in the study of personality. While the original theory of ambiguity intolerance being positively correlated to authoritarian personalities has come under fire, the construct is still used in this branch. A study was done testing college students' tolerance for ambiguity and found that students who were involved in the arts had higher scores than business students on ambiguity tolerance, from which the assertion that creativity is linked to the construct.

Developmental psychology

Harington, Block, and Block (1978) assessed intolerance of ambiguity in children at an early age, ranging from 3.5–4.5 years. The children were assessed using two tests performed by caretakers in a daycare center. The researchers then re-evaluated the children when they turned seven, and their data showed that male students who were high in ambiguity intolerance at the early age had more anxiety, required more structure, and had less effective cognitive structure than their female peers who had also tested high in ambiguity intolerance.

Social psychology

Being intolerant to ambiguity can affect how an individual perceives others with whom they come into contact. Social

psychology uses ambiguity tolerance–intolerance to study these relationships and the relationship one holds with themselves. Research has been conducted on how ambiguity tolerance–intolerance interacts with racial identity, homophobia, marital satisfaction, and pregnancy adjustment.

Mental health

Research shows that being too far on either end of the spectrum of ambiguity tolerance–intolerance can be detrimental to mental health. Ambiguity intolerance is thought to serve as a cognitive vulnerability that can lead, in conjunction with stressful life events and negative rumination, to depression. Anderson and Schwartz hypothesize that this is because ambiguity intolerant individuals tend to see the world as concrete and unchanging, and when an event occurs which disrupts this view these individuals struggle with the ambiguity of their future. Therefore, those who are intolerant to ambiguity begin to have negative cognitions about their respective situation, and soon view these cognitions as a certainty. This certainty can serve as a predictive measure of depression.

Ambiguous grammar

In computer science, an **ambiguous grammar** is a context-free grammar for which there exists a string that can have more than one leftmost derivation or parse tree, while an **unambiguous grammar** is a context-free grammar for which every valid string has a unique leftmost derivation or parse tree. Many languages admit both ambiguous and unambiguous

grammars, while some languages admit only ambiguous grammars. Any non-empty language admits an ambiguous grammar by taking an unambiguous grammar and introducing a duplicate rule or synonym (the only language without ambiguous grammars is the empty language). A language that only admits ambiguous grammars is called an inherently ambiguous language, and there are inherently ambiguous context-free languages. Deterministic context-free grammars are always unambiguous, and are an important subclass of unambiguous grammars; there are non-deterministic unambiguous grammars, however.

For computer programming languages, the reference grammar is often ambiguous, due to issues such as the dangling else problem. If present, these ambiguities are generally resolved by adding precedence rules or other context-sensitive parsing rules, so the overall phrase grammar is unambiguous. Some parsing algorithms (such as (Earley or GLR parsers) can generate sets of parse trees (or "parse forests") from strings that are syntactically ambiguous.

Examples

Trivial language

The simplest example is the following ambiguous grammar for the trivial language, which consists of only the empty string:

- $A \rightarrow A \mid \varepsilon$

...meaning that a production can either be itself again, or the empty string. Thus the empty string has leftmost derivations of

length 1, 2, 3, and indeed of any length, depending on how many times the rule A → A is used.

This language also has the unambiguous grammar, consisting of a single production rule:

- A →ε

...meaning that the unique production can only produce the empty string, which is the unique string in the language.

In the same way, any grammar for a non-empty language can be made ambiguous by adding duplicates.

Unary string

The regular language of unary strings of a given character, say `'a'` (the regular expression `a*`), has the unambiguous grammar:

- A →aA | ε

...but also has the ambiguous grammar:

- A →aA | Aa | ε

These correspond to producing a right-associative tree (for the unambiguous grammar) or allowing both left- and right-association. This is elaborated below.

Addition and subtraction

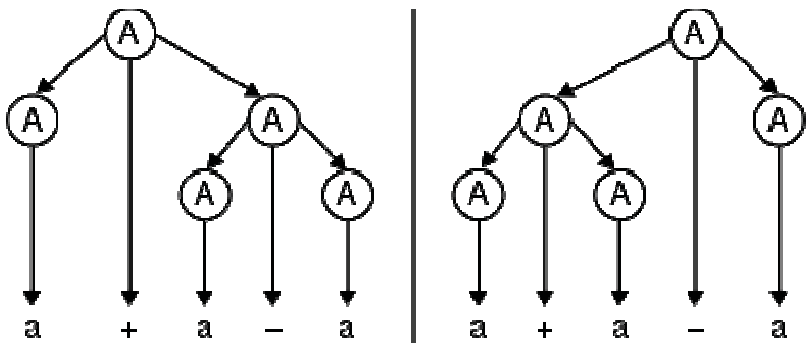
The context free grammar

$A \rightarrow A + A \mid A - A \mid a$

is ambiguous since there are two leftmost derivations for the string a + a + a:

$A \rightarrow A + A$	$A \rightarrow A + A$
$\rightarrow a + A$	$\rightarrow A + A + A$ (First A is replaced by A+A. Replacement of the second A would yield a similar derivation)
$\rightarrow a + A + A$	$\rightarrow a + A + A$
$\rightarrow a + a + A$	$\rightarrow a + a + A$
$\rightarrow a + a + a$	$\rightarrow a + a + a$

As another example, the grammar is ambiguous since there are two parse trees for the string a + a – a:



The language that it generates, however, is not inherently ambiguous; the following is a non-ambiguous grammar generating the same language:

A → A + a | A – a | a

Dangling else

A common example of ambiguity in computer programming languages is the dangling else problem. In many languages, the `else` in an If–then(–else) statement is optional, which results in nested conditionals having multiple ways of being recognized in terms of the context-free grammar.

Concretely, in many languages one may write conditionals in two valid forms: the if-then form, and the if-then-else form – in effect, making the else clause optional:

In a grammar containing the rules

Statement →**if** Condition **then** Statement |
if Condition **then** Statement **else** Statement |
...
Condition → ...

some ambiguous phrase structures can appear. The expression

if a **thenif** b **then** s **else** s2

can be parsed as either

if a **thenbeginif** b **then** s **endelse** s2

or as

if a **thenbeginif** b **then** s **else** s2 **end**

depending on whether the `else` is associated with the first `if` or second `if`.

This is resolved in various ways in different languages. Sometimes the grammar is modified so that it is unambiguous, such as by requiring an `endif` statement or making `else` mandatory. In other cases the grammar is left ambiguous, but the ambiguity is resolved by making the overall phrase grammar context-sensitive, such as by associating an `else` with the nearest `if`. In this latter case the grammar is unambiguous, but the context-free grammar is ambiguous.

An unambiguous grammar with multiple derivations

The existence of multiple derivations of the same string does not suffice to indicate that the grammar is ambiguous; only multiple *leftmost* derivations (or, equivalently, multiple parse trees) indicate ambiguity.

For example, the simple grammar

$S \rightarrow A + A$
$A \rightarrow 0 \mid 1$

is an unambiguous grammar for the language { 0+0, 0+1, 1+0, 1+1 }. While each of these four strings has only one leftmost derivation, it has two different derivations, for example

$S \Rightarrow A + A \Rightarrow 0 + A \Rightarrow 0 + 0$

and

$S \Rightarrow A + A \Rightarrow A + 0 \Rightarrow 0 + 0$

Only the former derivation is a leftmost one.

Recognizing ambiguous grammars

The decision problem of whether an arbitrary grammar is ambiguous is undecidable because it can be shown that it is equivalent to the Post correspondence problem. At least, there are tools implementing some semi-decision procedure for detecting ambiguity of context-free grammars.

The efficiency of context-free grammar parsing is determined by the automaton that accepts it. Deterministic context-free grammars are accepted by deterministic pushdown automata and can be parsed in linear time, for example by the LR parser. This is a subset of the context-free grammars which are accepted by the pushdown automaton and can be parsed in polynomial time, for example by the CYK algorithm. Unambiguous context-free grammars can be nondeterministic. For example, the language of even-length palindromes on the alphabet of 0 and 1 has the unambiguous context-free grammar $S \rightarrow 0S0 \mid 1S1 \mid \varepsilon$. An arbitrary string of this language cannot be parsed without reading all its letters first which means that a pushdown automaton has to try alternative state transitions to accommodate for the different possible lengths of a semi-parsed string. Nevertheless, removing grammar ambiguity may produce a deterministic context-free grammar and thus allow for more efficient parsing. Compiler generators such as YACC include features for resolving some kinds of ambiguity, such as by using the precedence and associativity constraints.

Inherently ambiguous languages

The existence of inherently ambiguous languages was proven with Parikh's theorem in 1961 by Rohit Parikh in an MIT research report.

Ambiguous image

Ambiguous images or **reversible figures** are visual forms which create ambiguity by exploiting graphical similarities and other properties of visual system interpretation between two or more distinct image forms. These are famous for inducing the phenomenon of multistable perception. Multistable perception is the occurrence of an image being able to provide multiple, although stable, perceptions. Classic examples of this are the rabbit-duck and the Rubin vase. Ambiguous images are important to the field of psychology because they are often research tools used in experiments. There is varying evidence on whether ambiguous images can be represented mentally, but a majority of research has theorized that they cannot be properly represented mentally. The rabbit-duck image seems to be one of the earliest of this type; first published in *FliegendeBlätter*, a German humor magazine (Oct. 23, 1892, p. 147); the My Wife and My Mother-in-Law drawing, which dates from a German postcard of 1888, is another early example.

Identifying and resolving ambiguous images

Middle vision is the stage in visual processing that combines all the basic features in the scene into distinct, recognizable object groups. This stage of vision comes before high-level vision (understanding the scene) and after early vision (determining the basic features of an image). When perceiving and recognizing images, mid-level vision comes into use when we need to classify the object we are seeing. Higher-level vision is used when the object classified must now be recognized as a specific member of its group. For example, through mid-level vision we perceive a face, then through high-level vision we recognize a face of a familiar person. Mid-level vision and high-level vision are crucial for understanding a reality that is filled with ambiguous perceptual inputs.

Perceiving the image in mid-level vision

When we see an image, the first thing we do is attempt to organize all the parts of the scene into different groups. To do this, one of the most basic methods used is finding the edges. Edges can include obvious perceptions such as the edge of a house, and can include other perceptions that the brain needs to process deeper, such as the edges of a person's facial features. When finding edges, the brain's visual system detects a point on the image with a sharp contrast of lighting. Being able to detect the location of the edge of an object aids in

recognizing the object. In ambiguous images, detecting edges still seems natural to the person perceiving the image. However, the brain undergoes deeper processing to resolve the ambiguity. For example, consider an image that involves an opposite change in magnitude of luminance between the object and the background (e.g. From the top, the background shifts from black to white, and the object shifts from white to black). The opposing gradients will eventually come to a point where there is an equal degree of luminance of the object and the background. At this point, there is no edge to be perceived. To counter this, the visual system connects the image as a whole rather than a set of edges, allowing one to see an object rather than edges and non-edges. Although there is no complete image to be seen, the brain is able to accomplish this because of its understanding of the physical world and real incidents of ambiguous lighting. In ambiguous images, an illusion is often produced from illusory contours. An illusory contour is a perceived contour without the presence of a physical gradient. In examples where a white shape appears to occlude black objects on a white background, the white shape appears to be brighter than the background, and the edges of this shape produce the illusory contours. These illusory contours are processed by the brain in a similar way as real contours. The visual system accomplishes this by making inferences beyond the information that is presented in much the same way as the luminance gradient.

Gestalt grouping rules

In mid-level vision, the visual system utilizes a set of heuristic methods, called Gestalt grouping rules, to quickly identify a

basic perception of an object that helps to resolve an ambiguity. This allows perception to be fast and easy by observing patterns and familiar images rather than a slow process of identifying each part of a group. This aids in resolving ambiguous images because the visual system will accept small variations in the pattern and still perceive the pattern as a whole. The Gestalt grouping rules are the result of the experience of the visual system. Once a pattern is perceived frequently, it is stored in memory and can be perceived again easily without the requirement of examining the entire object again. For example, when looking at a chess board, we perceive a checker pattern and not a set of alternating black and white squares.

Good continuation

The principle of good continuation provides the visual system a basis for identifying continuing edges. This means that when a set of lines is perceived, there is a tendency for a line to continue in one direction.

This allows the visual system to identify the edges of a complex image by identifying points where lines cross. For example, two lines crossed in an "X" shape will be perceived as two lines travelling diagonally rather than two lines changing direction to form "V" shapes opposite to each other.

An example of an ambiguous image would be two curving lines intersecting at a point. This junction would be perceived the same way as the "X", where the intersection is seen as the lines crossing rather than turning away from each other.

Illusions of good continuation are often used by magicians to trick audiences.

Similarity

The rule of similarity states that images that are similar to each other can be grouped together as being the same type of object or part of the same object. Therefore, the more similar two images or objects are, the more likely it will be that they can be grouped together. For example, two squares among many circles will be grouped together. They can vary in similarity of colour, size, orientation and other properties, but will ultimately be grouped together with varying degrees of membership.

Proximity, common region, and connectedness

The grouping property of *proximity (Gestalt)* is the spatial distance between two objects. The closer two objects are, the more likely they belong to the same group. This perception can be ambiguous without the person perceiving it as ambiguous. For example, two objects with varying distances and orientations from the viewer may appear to be proximal to each other, while a third object may be closer to one of the other objects but appear farther.

Objects occupying a common region on the image appear to already be members of the same group. This can include unique spatial location, such as two objects occupying a distinct region of space outside of their group's own. Objects can have close proximity but appear as though part of a

distinct group through various visual aids such as a threshold of colours separating the two objects.

Additionally, objects can be visually connected in ways such as drawing a line going from each object. These similar but hierarchical rules suggest that some Gestalt rules can override other rules.

Texture segmentation and figure-ground assignments

The visual system can also aid itself in resolving ambiguities by detecting the pattern of texture in an image. This is accomplished by using many of the Gestalt principles. The texture can provide information that helps to distinguish whole objects, and the changing texture in an image reveals which distinct objects may be part of the same group. Texture segmentation rules often both cooperate and compete with each other, and examining the texture can yield information about the layers of the image, disambiguating the background, foreground, and the object.

Size and surroundedness

When a region of texture completely surrounds another region of texture, it is likely the background. Additionally, the smaller regions of texture in an image are likely the figure.

Parallelism and symmetry

Parallelism is another way to disambiguate the figure of an image. The orientation of the contours of different textures in an image can determine which objects are grouped together. Generally, parallel contours suggest membership to the same object or group of objects. Similarly, symmetry of the contours can also define the figure of an image.

Extremal edges and relative motion

An extremal edge is a change in texture that suggests an object is in front of or behind another object. This can be due to a shading effect on the edges of one region of texture, giving the appearance of depth. Some extremal edge effects can overwhelm the segmentations of surroundedness or size. The edges perceived can also aid in distinguishing objects by examining the change in texture against an edge due to motion.

Using ambiguous images to hide in the real world: camouflage

In nature, camouflage is used by organisms to escape predators. This is achieved through creating an ambiguity of texture segmentation by imitating the surrounding environment. Without being able to perceive noticeable differences in texture and position, a predator will be unable to see their prey.

Occlusion

Many ambiguous images are produced through some occlusion, wherein an object's texture suddenly stops. An occlusion is the visual perception of one object being behind or in front of another object, providing information about the order of the layers of texture. The illusion of occlusion is apparent in the effect of illusory contours, where occlusion is perceived despite being non-existent. Here, an ambiguous image is perceived to be an instance of occlusion. When an object is occluded, the visual system only has information about the parts of the object that can be seen, so the rest of the processing must be done deeper and must involve memory.

Accidental viewpoints

An accidental viewpoint is a single visual position that produces an ambiguous image. The accidental viewpoint does not provide enough information to distinguish what the object is. Often, this image is perceived incorrectly and produces an illusion that differs from reality. For example, an image may be split in half, with the top half being enlarged and placed further away from the perceiver in space. This image will be perceived as one complete image from only a single viewpoint in space, rather than the reality of two separate halves of an object. Street artists often use tricks of point-of-view to create 2-dimensional scenes on the ground that appear 3-dimensional.

Recognizing an object through high-level vision

- To go further than just perceiving the object is to recognize the object. Recognizing an object plays a crucial role in resolving ambiguous images, and relies heavily on memory and prior knowledge. To recognize an object, the visual system detects familiar components of it, and compares the perceptual representation of it with a representation of the object stored in memory. This can be done using various templates of an object, such as "dog" to represent dogs in general. The template method is not always successful because members of a group may significantly differ visually from each other, and may look much different if viewed from different angles. To counter the problem of viewpoint, the visual system detects familiar components of an object in 3-dimensional space. If the components of an object perceived are in the same position and orientation of an object in memory, recognition is possible. Research has shown that people that are more creative in their imagery are better able to resolve ambiguous images. This may be due to their ability to quickly identify patterns in the image. When making a mental representation of an ambiguous image, in the same way as normal images, each part is defined and then put onto the mental representation. The more complex the scene is, the longer it takes to process and add to the representation.

Figures drawn in a way that avoids depth cues may become ambiguous. Classic examples of this phenomenon are the Necker cube, and the rhombille tiling (viewed as an isometric drawing of cubes).

Using memory and recent experience

Our memory has a large impact on resolving an ambiguous image, as it helps the visual system to identify and recognize objects without having to analyze and categorize them repeatedly. Without memory and prior knowledge, an image with several groups of similar objects will be difficult to perceive. Any object can have an ambiguous representation and can be mistakenly categorized into the wrong groups without sufficient memory recognition of an object. This finding suggests that prior experience is necessary for proper perception. Studies have been done with the use of Greebles to show the role of memory in object recognition. The act of priming the participant with an exposure to a similar visual stimulus also has a large effect on the ease of resolving an ambiguity.

Disorders in perception

Prosopagnosia is a disorder that causes a person to be unable to identify faces. The visual system undergoes mid-level vision and identifies a face, but high-level vision fails to identify who the face belongs to.

In this case, the visual system identifies an ambiguous object, a face, but is unable to resolve the ambiguity using memory, leaving the affected unable to determine who they are seeing.

In Media

From 1903 to 1905 Gustave Verbeek wrote his comic series "The UpsideDowns of Old Man Muffaroo and Little Lady Lovekins". These comics were made in such a way that one could read the 6 panel comic, flip the book and keep reading. He made 64 such comics in total. In 2012 a remake of a selection of the comics was made by Marcus Ivarsson in the book 'In Uppåner med LillaLisen&GamleMuppen'. (ISBN 978-91-7089-524-1). The children's book, *Round Trip*, by Ann Jonas used ambiguous image in the illustrations, where the reader could read the book front to back normally at first, and then flip it upside down to continue the story and see the pictures in a new perspective.

Auto-antonym

An **auto-antonym** or **autantonym**, also called a **contronym**, **contranym** or **Janus word**, is a word with multiple meanings (senses) of which one is the reverse of another. For example, the word *cleave* can mean "to cut apart" or "to bind together". This phenomenon is called **enantiosemy**, **enantionymy** (*enantio-* means "opposite"), **antilogy** or **autantonymy**. An enantiosemic term is necessarily polysemic.

Nomenclature

The terms "autantonym" and "contronym" were coined by Joseph Twadell Shipley in 1960 and Jack Herring in 1962, respectively. An auto-antonym is alternatively called an

antagonym, **Janus word** (after the Roman god Janus, who is usually depicted with two faces), **enantiodrome**, **enantionym**, **self-antonym**, **antilogy**, or **addad** (Arabic, singular **didd**).

Linguistic mechanisms

Some pairs of contronyms are true homographs, i.e., distinct words with different etymology which happen to have the same form. For instance *cleave* "separate" is from Old English *clēofan*, while *cleave* "adhere" is from Old English *clifian*, which was pronounced differently. The two verbs are still separate in the past tense, so 'cloven' can only mean 'split', where in the 'cling' sense the word would be 'cleaved'.

Other contronyms are a form of polysemy, but where a single word acquires different and ultimately opposite definitions. For example, *sanction*—"permit" or "penalize"; *bolt* (originally from crossbows)—"leave quickly" or "fix/immobilize"; *fast*—"moving rapidly" or "unmoving". Some English examples result from nouns being verbed in the patterns of "add <noun> to" and "remove <noun> from"; e.g. *dust*, *seed*, *stone*. Denotations and connotations can drift or branch over centuries. An apocryphal story relates how Charles II (or sometimes Queen Anne) described St Paul's Cathedral (using contemporaneous English) as "awful, pompous, and artificial," with the meaning (rendered in modern English) of "awe-inspiring, majestic, and ingeniously designed". Negative words such as *bad* and *sick* sometimes acquire ironic senses referring to traits that are impressive and admired, if not necessarily positive (*that outfit is bad as hell*; *lyrics full of sick burns*).

Some contronyms result from differences in varieties of English. For example, to *table* a bill means "to put it up for debate" in British English, while it means "to remove it from debate" in American English (where British English would have "shelve", which in this sense has an identical meaning in American English). To *barrack*, in Australian English, is to loudly demonstrate support, while in British English it is to express disapproval and contempt.

Some words contain simultaneous opposing or competing meanings in the same context, rather than alternative meanings in different contexts; examples include blend words such as *coopetition* (meaning a murky blend of cooperation and competition), *frenemy* (meaning a murky blend of friend and enemy), *glocalization*, etc. These are not usually classed as contronyms, but they share the theme of containing opposing meanings. Auto-antonyms exist in many languages, as the following examples show.

In Latin, *sacer* has the double meaning "sacred, holy" and "accursed, infamous". Greek δημιουργός gave Latin its *demiurgus*, from which English got its *demiurge*, which can refer either to God as the creator or to the devil, depending on philosophical context.

In many languages, a word stem associated with a single event may treat the action of that event as unitary, so it can refer to any of the doings or persons on either side of the transaction, that is, to the action of either the subject or the object, or to either the person who does something or the person to whom (or for whom) it is done. Other cues nail down the aspects of subject versus object. Thus there is a simple logic involved,

despite that discussions of such words sometimes fixate on a superficial appearance of illogic (that is, "how can one word mean both?!") such as in words for *borrow* and *lend*; see #Examples below.

Examples

English

- *Cleave* can mean "to cling" or "to split apart".
- *Clip* can mean "attach" or "cut off".
- *Dust* can mean "to remove dust (cleaning a house)" or "to add dust" (e.g. to dust a cake with powdered sugar).
- *Fast* can mean "without moving; fixed in place", (holding fast, also as in "steadfast"), or "moving quickly".
- *Literally* can mean "actually, in a literal sense" or "virtually, in effect".
- *Obbligato* in music can refer to a passage that is either "obligatory" or "optional".
- *Oversight* can mean "accidental omission or error", or "close scrutiny and control".
- *Peruse* can mean to "consider with attention and in detail" or "look over or through in a casual or cursory manner".
- *Ravel* can mean "to separate" (e.g. threads in cloth) or "entangle".
- *Sanction* can mean "approve" or "penalize".

- *Table* can mean "to discuss a topic at a meeting" (*British English*) or "to postpone discussion of a topic" (*American English*).
- *Deceptively* can mean "in a way that is incorrectly perceived", or "in a way that is incorrectly not perceived". That is to say, "the puddle was deceptively shallow" can either mean that the puddle was deep and appeared to be shallow, or that the puddle was shallow and appeared to be deep.

Other languages

- Nouns
- The Korean noun 앞(*ap*) may mean either "future" or "past" (distinguished by context).
- Verbs
- The German verb *ausleihen*, the Polish verb pożyczyć, the Russian verb одолжить (*odolžít'*) and the Finnish verb *lainata* can mean either "to lend" or "to borrow", with case, pronouns, and mention of persons making the sense clear. The verb stem conveys that "a lending-and-borrowing event is occurring", and the other cues convey who is lending to whom. This makes sense because anytime lending is occurring, borrowing is simultaneously occurring; one cannot happen without the other.
- The Romanian verb *aînchiria* means "to rent" (as the lessee does) as well as "to let" (as the lessor does).
- The Swahili verb *kutoa* means both "to remove" and "to add".
- In his *Limited Views: Essays on Ideas and Letters*, Qian Zhongshu gave some examples of Chinese auto-

antonyms, like "廢" meaning both "to abolish" and "to establish". He named this kind of phenomenon "reverse symbolism"(反象以徵).

- The Persian verb چیدن (*čidan*) means both " to pluck" and "to arrange" (i.e. by putting objects down).
- Adverbs
- Hindi: कल and Urdu: کل (*kal*[kəl]) may mean either "yesterday" or "tomorrow" (disambiguated by the verb in the sentence).
- Irish: *ar ball* can mean both "a while ago" and "in a little bit/later on"
- Agent nouns
- The Italian, Spanish and French cognates, *ospite*, *huésped* and *hôte*, respectively, also can mean "host" or "guest". The three words derive from the Latin *hospes*, which also carries both meanings.
- Adjectives
- The Latin *sinister* means both "auspicious" (from Roman tradition) and "inauspicious" (from Greek tradition). The negative Greek meaning was carried on into French and ultimately English.

Seeming auto-antonyms can occur from translation. In Hawaiian, for example, *aloha* is translated both as "hello" and as "goodbye", but the essential meaning of the word is "love", whether used as a greeting or farewell. The Italian greeting *ciao* is translated as "hello" or "goodbye" depending on the context; however, the original meaning was "(I'm your) slave".

Chapter 2

Emily Dickinson: The Poet as Linguistic and the Linguist as Poet

Emily Elizabeth Dickinson (December 10, 1830 – May 15, 1886) was an American poet. Little-known during her life, she has since been regarded as one of the most important figures in American poetry.

Dickinson was born in Amherst, Massachusetts into a prominent family with strong ties to its community. After studying at the Amherst Academy for seven years in her youth, she briefly attended the Mount Holyoke Female Seminary before returning to her family's house in Amherst.

Evidence suggests that Dickinson lived much of her life in isolation. Considered an eccentric by locals, she developed a penchant for white clothing and was known for her reluctance to greet guests or, later in life, to even leave her bedroom. Dickinson never married, and most friendships between her and others depended entirely upon correspondence.

While Dickinson was a prolific writer, her only publications during her lifetime were 10 of her nearly 1,800 poems, and one letter. The poems published then were usually edited significantly to fit conventional poetic rules. Her poems were unique for her era. They contain short lines, typically lack titles, and often use slant rhyme as well as unconventional

capitalization and punctuation. Many of her poems deal with themes of death and immortality, two recurring topics in letters to her friends, and also explore aesthetics, society, nature and spirituality.

Although Dickinson's acquaintances were most likely aware of her writing, it was not until after her death in 1886—when Lavinia, Dickinson's younger sister, discovered her cache of poems—that her work became public. Her first collection of poetry was published in 1890 by personal acquaintances Thomas Wentworth Higginson and Mabel Loomis Todd, though both heavily edited the content. A 1998 article in *The New York Times* revealed that of the many edits made to Dickinson's work, the name "Susan" was often deliberately removed. At least eleven of Dickinson's poems were dedicated to sister-in-law Susan Huntington Gilbert Dickinson, though all the dedications were obliterated, presumably by Todd. A complete, and mostly unaltered, collection of her poetry became available for the first time when scholar Thomas H. Johnson published *The Poems of Emily Dickinson* in 1955.

Life

Family and early childhood

Emily Elizabeth Dickinson was born at the family's homestead in Amherst, Massachusetts, on December 10, 1830, into a prominent, but not wealthy, family. Her father, Edward Dickinson was a lawyer in Amherst and a trustee of Amherst College. Two hundred years earlier, her patrilineal ancestors had arrived in the New World—in the Puritan Great Migration—

where they prospered. Emily Dickinson's paternal grandfather, Samuel Dickinson, was one of the founders of Amherst College. In 1813, he built the Homestead, a large mansion on the town's Main Street, that became the focus of Dickinson family life for the better part of a century. Samuel Dickinson's eldest son, Edward, was treasurer of Amherst College from 1835 to 1873, served in the Massachusetts House of Representatives (1838–1839; 1873) and the Massachusetts Senate (1842–1843), and represented Massachusetts's 10th congressional district in the 33rd U.S. Congress (1853–1855). On May 6, 1828, he married Emily Norcross from Monson, Massachusetts. They had three children:

- William Austin (1829–1895), known as Austin, Aust or Awe
- Emily Elizabeth
- Lavinia Norcross (1833–1899), known as Lavinia or Vinnie

By all accounts, young Emily was a well-behaved girl. On an extended visit to Monson when she was two, Emily's Aunt Lavinia described Emily as "perfectly well & contented—She is a very good child & but little trouble." Emily's aunt also noted the girl's affinity for music and her particular talent for the piano, which she called "the *moosic*".

Dickinson attended primary school in a two-story building on Pleasant Street. Her education was "ambitiously classical for a Victorian girl". Wanting his children well-educated, her father followed their progress even while away on business. When Emily was seven, he wrote home, reminding his children to "keep school, and learn, so as to tell me, when I come home,

how many new things you have learned". While Emily consistently described her father in a warm manner, her correspondence suggests that her mother was regularly cold and aloof. In a letter to a confidante, Emily wrote she "always ran Home to Awe [Austin] when a child, if anything befell me. He was an awful Mother, but I liked him better than none."

On September 7, 1840, Dickinson and her sister Lavinia started together at Amherst Academy, a former boys' school that had opened to female students just two years earlier. At about the same time, her father purchased a house on North Pleasant Street. Emily's brother Austin later described this large new home as the "mansion" over which he and Emily presided as "lord and lady" while their parents were absent. The house overlooked Amherst's burial ground, described by one local minister as treeless and "forbidding".

Teenage years

Dickinson spent seven years at the Academy, taking classes in English and classical literature, Latin, botany, geology, history, "mental philosophy," and arithmetic. Daniel Taggart Fiske, the school's principal at the time, would later recall that Dickinson was "very bright" and "an excellent scholar, of exemplary deportment, faithful in all school duties". Although she had a few terms off due to illness—the longest of which was in 1845–1846, when she was enrolled for only eleven weeks—she enjoyed her strenuous studies, writing to a friend that the Academy was "a very fine school".

Dickinson was troubled from a young age by the "deepening menace" of death, especially the deaths of those who were close

to her. When Sophia Holland, her second cousin and a close friend, grew ill from typhus and died in April 1844, Emily was traumatized. Recalling the incident two years later, Emily wrote that "it seemed to me I should die too if I could not be permitted to watch over her or even look at her face." She became so melancholic that her parents sent her to stay with family in Boston to recover. With her health and spirits restored, she soon returned to Amherst Academy to continue her studies. During this period, she met people who were to become lifelong friends and correspondents, such as Abiah Root, Abby Wood, Jane Humphrey, and Susan Huntington Gilbert (who later married Emily's brother Austin).

In 1845, a religious revival took place in Amherst, resulting in 46 confessions of faith among Dickinson's peers. Dickinson wrote to a friend the following year: "I never enjoyed such perfect peace and happiness as the short time in which I felt I had found my Savior." She went on to say it was her "greatest pleasure to commune alone with the great God & to feel that he would listen to my prayers." The experience did not last: Dickinson never made a formal declaration of faith and attended services regularly for only a few years. After her church-going ended, about 1852, she wrote a poem opening: "Some keep the Sabbath going to Church – / I keep it, staying at Home".

During the last year of her stay at the Academy, Emily became friendly with Leonard Humphrey, its popular new young principal. After finishing her final term at the Academy on August 10, 1847, Dickinson began attending Mary Lyon's Mount Holyoke Female Seminary (which later became Mount Holyoke College) in South Hadley, about ten miles (16 km) from

Amherst. She stayed at the seminary for only ten months. Although she liked the girls at Holyoke, Dickinson made no lasting friendships there. The explanations for her brief stay at Holyoke differ considerably: either she was in poor health, her father wanted to have her at home, she rebelled against the evangelical fervor present at the school, she disliked the discipline-minded teachers, or she was simply homesick. Whatever the reasons for leaving Holyoke, her brother Austin appeared on March 25, 1848, to "bring [her] home at all events". Back in Amherst, Dickinson occupied her time with household activities. She took up baking for the family and enjoyed attending local events and activities in the budding college town.

Early influences and writing

When she was eighteen, Dickinson's family befriended a young attorney by the name of Benjamin Franklin Newton. According to a letter written by Dickinson after Newton's death, he had been "with my Father two years, before going to Worcester – in pursuing his studies, and was much in our family." Although their relationship was probably not romantic, Newton was a formative influence and would become the second in a series of older men (after Humphrey) that Dickinson referred to, variously, as her tutor, preceptor or master.

Newton likely introduced her to the writings of William Wordsworth, and his gift to her of Ralph Waldo Emerson's first book of collected poems had a liberating effect. She wrote later that he, "whose name my Father's Law Student taught me, has touched the secret Spring". Newton held her in high regard, believing in and recognizing her as a poet. When he was dying

of tuberculosis, he wrote to her, saying he would like to live until she achieved the greatness he foresaw. Biographers believe that Dickinson's statement of 1862—"When a little Girl, I had a friend, who taught me Immortality – but venturing too near, himself – he never returned"—refers to Newton.

Dickinson was familiar with not only the Bible but also contemporary popular literature. She was probably influenced by Lydia Maria Child's *Letters from New York*, another gift from Newton (after reading it, she gushed "This then is a book!And there are more of them!"). Her brother smuggled a copy of Henry Wadsworth Longfellow's *Kavanagh* into the house for her (because her father might disapprove) and a friend lent her Charlotte Brontë's*Jane Eyre* in late 1849. *Jane Eyre*'s influence cannot be measured, but when Dickinson acquired her first and only dog, a Newfoundland, she named him "Carlo" after the character St. John Rivers' dog. William Shakespeare was also a potent influence in her life. Referring to his plays, she wrote to one friend, "Why clasp any hand but this?" and to another, "Why is any other book needed?"

Adulthood and seclusion

In early 1850, Dickinson wrote that "Amherst is alive with fun this winter ... Oh, a very great town this is!" Her high spirits soon turned to melancholy after another death. The Amherst Academy principal, Leonard Humphrey, died suddenly of "brain congestion" at age 25. Two years after his death, she revealed to her friend Abiah Root the extent of her sadness:

some of my friends are gone, and some of my friends are sleeping – sleeping the churchyard sleep – the hour of evening

is sad – it was once my study hour – my master has gone to rest, and the open leaf of the book, and the scholar at school *alone*, make the tears come, and I cannot brush them away; I would not if I could, for they are the only tribute I can pay the departed Humphrey.

During the 1850s, Emily's strongest and most affectionate relationship was with her sister-in-law, Susan Gilbert. Emily eventually sent her over three hundred letters, more than to any other correspondent, over the course of their relationship. Susan was supportive of the poet, playing the role of "most beloved friend, influence, muse, and adviser" whose editorial suggestions Dickinson sometimes followed. In an 1882 letter to Susan, Emily said, "With the exception of Shakespeare, you have told me of more knowledge than any one living."

The importance of Emily's relationship with Susan has widely been overlooked due to a point of view first promoted by Mabel Loomis Todd, who was involved for many years in a relationship with Austin Dickinson and who diminished Susan's role in Emily's life due to her own poor relationship with her lover's wife. However, the notion of a "cruel" Susan—as promoted by her romantic rival—has been questioned, most especially by Susan and Austin's surviving children, with whom Emily was close. Many scholars interpret the relationship between Emily and Susan as a romantic one. In *The Emily Dickinson Journal* Lena Koski wrote, "Dickinson's letters to Gilbert express strong homoerotic feelings." She quotes from many of their letters, including one from 1852 in which Emily proclaims, "Susie, will you indeed come home next Saturday, and be my own again, and kiss me ... I hope for you so much, and feel so eager for you, feel that I cannot wait, feel

that now I must have you—that the expectation once more to see your face again, makes me feel hot and feverish, and my heart beats so fast ... my darling, so near I seem to you, that I disdain this pen, and wait for a warmer language." The relationship between Emily and Susan is portrayed in the film *Wild Nights with Emily* and explored in the TV series *Dickinson*.

Sue married Austin in 1856 after a four-year courtship, though their marriage was not a happy one. Edward Dickinson built a house for Austin and Sue naming it the Evergreens, a stand of which was located on the west side of the Homestead.

Until 1855, Dickinson had not strayed far from Amherst. That spring, accompanied by her mother and sister, she took one of her longest and farthest trips away from home. First, they spent three weeks in Washington, where her father was representing Massachusetts in Congress. Then they went to Philadelphia for two weeks to visit family. In Philadelphia, she met Charles Wadsworth, a famous minister of the Arch Street Presbyterian Church, with whom she forged a strong friendship which lasted until his death in 1882. Despite seeing him only twice after 1855 (he moved to San Francisco in 1862), she variously referred to him as "my Philadelphia", "my Clergyman", "my dearest earthly friend" and "my Shepherd from 'Little Girl'hood".

From the mid-1850s, Emily's mother became effectively bedridden with various chronic illnesses until her death in 1882. Writing to a friend in summer 1858, Emily said she would visit if she could leave "home, or mother. I do not go out at all, lest father will come and miss me, or miss some little act, which I might forget, should I run away – Mother is much

as usual. I Know not what to hope of her". As her mother continued to decline, Dickinson's domestic responsibilities weighed more heavily upon her and she confined herself within the Homestead. Forty years later, Lavinia said that because their mother was chronically ill, one of the daughters had to remain always with her. Emily took this role as her own, and "finding the life with her books and nature so congenial, continued to live it".

Withdrawing more and more from the outside world, Emily began in the summer of 1858 what would be her lasting legacy. Reviewing poems she had written previously, she began making clean copies of her work, assembling carefully pieced-together manuscript books. The forty fascicles she created from 1858 through 1865 eventually held nearly eight hundred poems. No one was aware of the existence of these books until after her death.

In the late 1850s, the Dickinsons befriended Samuel Bowles, the owner and editor-in-chief of the *Springfield Republican*, and his wife, Mary. They visited the Dickinsons regularly for years to come. During this time Emily sent him over three dozen letters and nearly fifty poems. Their friendship brought out some of her most intense writing and Bowles published a few of her poems in his journal. It was from 1858 to 1861 that Dickinson is believed to have written a trio of letters that have been called "The Master Letters". These three letters, drafted to an unknown man simply referred to as "Master", continue to be the subject of speculation and contention amongst scholars.

The first half of the 1860s, after she had largely withdrawn from social life, proved to be Dickinson's most productive

writing period. Modern scholars and researchers are divided as to the cause for Dickinson's withdrawal and extreme seclusion. While she was diagnosed as having "nervous prostration" by a physician during her lifetime, some today believe she may have suffered from illnesses as various as agoraphobia and epilepsy.

Is "my Verse ... alive?"

In April 1862, Thomas Wentworth Higginson, a literary critic, radical abolitionist, and ex-minister, wrote a lead piece for *The Atlantic Monthly* titled, "Letter to a Young Contributor". Higginson's essay, in which he urged aspiring writers to "charge your style with life", contained practical advice for those wishing to break into print. Dickinson's decision to contact Higginson suggests that by 1862 she was contemplating publication and that it may have become increasingly difficult to write poetry without an audience. Seeking literary guidance that no one close to her could provide, Dickinson sent him a letter, which read in full:

Mr Higginson,

Are you too deeply occupied to say if my Verse is alive?

The Mind is so near itself – it cannot see, distinctly – and I have none to ask –

Should you think it breathed – and had you the leisure to tell me, I should feel quick gratitude –

If I make the mistake – that you dared to tell me – would give me sincerer honor – toward you –

I enclose my name – asking you, if you please – Sir – to tell me what is true?

That you will not betray me – it is needless to ask – since Honor is it's own pawn –

This highly nuanced and largely theatrical letter was unsigned, but she had included her name on a card and enclosed it in an envelope, along with four of her poems. He praised her work but suggested that she delay publishing until she had written longer, being unaware she had already appeared in print. She assured him that publishing was as foreign to her "as Firmament to Fin", but also proposed that "If fame belonged to me, I could not escape her". Dickinson delighted in dramatic self-characterization and mystery in her letters to Higginson. She said of herself, "I am small, like the wren, and my hair is bold, like the chestnut bur, and my eyes like the sherry in the glass that the guest leaves." She stressed her solitary nature, saying her only real companions were the hills, the sundown, and her dog, Carlo. She also mentioned that whereas her mother did not "care for Thought", her father bought her books, but begged her "not to read them – because he fears they joggle the Mind".

Dickinson valued his advice, going from calling him "Mr. Higginson" to "Dear friend" as well as signing her letters, "Your Gnome" and "Your Scholar". His interest in her work certainly provided great moral support; many years later, Dickinson told Higginson that he had saved her life in 1862. They corresponded until her death, but her difficulty in expressing her literary needs and a reluctance to enter into a cooperative exchange left Higginson nonplussed; he did not press her to

publish in subsequent correspondence. Dickinson's own ambivalence on the matter militated against the likelihood of publication. Literary critic Edmund Wilson, in his review of Civil War literature, surmised that "with encouragement, she would certainly have published".

The woman in white

In direct opposition to the immense productivity that she displayed in the early 1860s, Dickinson wrote fewer poems in 1866. Beset with personal loss as well as loss of domestic help, Dickinson may have been too overcome to keep up her previous level of writing. Carlo died during this time after having provided sixteen years of companionship; Dickinson never owned another dog. Although the household servant of nine years, Margaret O'Brien, had married and left the Homestead that same year, it was not until 1869 that the Dickinsons brought in a permanent household servant, Margaret Maher, to replace their former maid-of-all-work. Emily once again was responsible for the kitchen, including cooking and cleaning up, as well as the baking at which she excelled.

Around this time, Dickinson's behavior began to change. She did not leave the Homestead unless it was absolutely necessary and as early as 1867, she began to talk to visitors from the other side of a door rather than speaking to them face to face. She acquired local notoriety; she was rarely seen, and when she was, she was usually clothed in white. Dickinson's one surviving article of clothing is a white cotton dress, possibly sewn circa 1878–1882. Few of the locals who exchanged messages with Dickinson during her last fifteen years ever saw her in person. Austin and his family began to protect Emily's

privacy, deciding that she was not to be a subject of discussion with outsiders. Despite her physical seclusion, however, Dickinson was socially active and expressive through what makes up two-thirds of her surviving notes and letters. When visitors came to either the Homestead or the Evergreens, she would often leave or send over small gifts of poems or flowers. Dickinson also had a good rapport with the children in her life. Mattie Dickinson, the second child of Austin and Sue, later said that "Aunt Emily stood for *indulgence*." MacGregor (Mac) Jenkins, the son of family friends who later wrote a short article in 1891 called "A Child's Recollection of Emily Dickinson", thought of her as always offering support to the neighborhood children.

When Higginson urged her to come to Boston in 1868 so they could formally meet for the first time, she declined, writing: "Could it please your convenience to come so far as Amherst I should be very glad, but I do not cross my Father's ground to any House or town". It was not until he came to Amherst in 1870 that they met. Later he referred to her, in the most detailed and vivid physical account of her on record, as "a little plain woman with two smooth bands of reddish hair ... in a very plain & exquisitely clean white piqué & a blue net worsted shawl." He also felt that he never was "with any one who drained my nerve power so much. Without touching her, she drew from me. I am glad not to live near her."

Posies and poesies

Scholar Judith Farr notes that Dickinson, during her lifetime, "was known more widely as a gardener, perhaps, than as a poet". Dickinson studied botany from the age of nine and,

along with her sister, tended the garden at Homestead. During her lifetime, she assembled a collection of pressed plants in a sixty-six-page leather-bound herbarium. It contained 424 pressed flower specimens that she collected, classified, and labeled using the Linnaean system. The Homestead garden was well known and admired locally in its time. It has not survived, but efforts to revive it have begun. Dickinson kept no garden notebooks or plant lists, but a clear impression can be formed from the letters and recollections of friends and family. Her niece, Martha Dickinson Bianchi, remembered "carpets of lily-of-the-valley and pansies, platoons of sweetpeas, hyacinths, enough in May to give all the bees of summer dyspepsia. There were ribbons of peony hedges and drifts of daffodils in season, marigolds to distraction—a butterfly utopia". In particular, Dickinson cultivated scented exotic flowers, writing that she "could inhabit the Spice Isles merely by crossing the dining room to the conservatory, where the plants hang in baskets". Dickinson would often send her friends bunches of flowers with verses attached, but "they valued the posy more than the poetry".

Later life

On June 16, 1874, while in Boston, Edward Dickinson suffered a stroke and died. When the simple funeral was held in the Homestead's entrance hall, Emily stayed in her room with the door cracked open. Neither did she attend the memorial service on June 28. She wrote to Higginson that her father's "Heart was pure and terrible and I think no other like it exists." A year later, on June 15, 1875, Emily's mother also suffered a stroke, which produced a partial lateral paralysis and impaired

memory. Lamenting her mother's increasing physical as well as mental demands, Emily wrote that "Home is so far from Home".

Otis Phillips Lord, an elderly judge on the Massachusetts Supreme Judicial Court from Salem, in 1872 or 1873 became an acquaintance of Dickinson's. After the death of Lord's wife in 1877, his friendship with Dickinson probably became a late-life romance, though as their letters were destroyed, this is surmised. Dickinson found a kindred soul in Lord, especially in terms of shared literary interests; the few letters which survived contain multiple quotations of Shakespeare's work, including the plays *Othello*, *Antony and Cleopatra*, *Hamlet* and *King Lear*. In 1880 he gave her Cowden Clarke's *Complete Concordance to Shakespeare* (1877). Dickinson wrote that "While others go to Church, I go to mine, for are you not my Church, and have we not a Hymn that no one knows but us?" She referred to him as "My lovely Salem" and they wrote to each other religiously every Sunday. Dickinson looked forward to this day greatly; a surviving fragment of a letter written by her states that "Tuesday is a deeply depressed Day".

After being critically ill for several years, Judge Lord died in March 1884. Dickinson referred to him as "our latest Lost". Two years before this, on April 1, 1882, Dickinson's "Shepherd from 'Little Girl'hood", Charles Wadsworth, also had died after a long illness.

Decline and death

- Although she continued to write in her last years, Dickinson stopped editing and organizing her poems. She also exacted a promise from her sister Lavinia to

burn her papers. Lavinia, who never married, remained at the Homestead until her own death in 1899.

The 1880s were a difficult time for the remaining Dickinsons. Irreconcilably alienated from his wife, Austin fell in love in 1882 with Mabel Loomis Todd, an Amherst College faculty wife who had recently moved to the area. Todd never met Dickinson but was intrigued by her, referring to her as "a lady whom the people call the *Myth*". Austin distanced himself from his family as his affair continued and his wife became sick with grief. Dickinson's mother died on November 14, 1882. Five weeks later, Dickinson wrote, "We were never intimate ... while she was our Mother – but Mines in the same Ground meet by tunneling and when she became our Child, the Affection came." The next year, Austin and Sue's third and youngest child, Gilbert—Emily's favorite—died of typhoid fever.

As death succeeded death, Dickinson found her world upended. In the fall of 1884, she wrote, "The Dyings have been too deep for me, and before I could raise my Heart from one, another has come." That summer she had seen "a great darkness coming" and fainted while baking in the kitchen. She remained unconscious late into the night and weeks of ill health followed. On November 30, 1885, her feebleness and other symptoms were so worrying that Austin canceled a trip to Boston. She was confined to her bed for a few months, but managed to send a final burst of letters in the spring. What is thought to be her last letter was sent to her cousins, Louise and Frances Norcross, and simply read: "Little Cousins, Called Back. Emily". On May 15, 1886, after several days of worsening symptoms, Emily Dickinson died at the age of 55. Austin wrote

in his diary that "the day was awful ... she ceased to breathe that terrible breathing just before the [afternoon] whistle sounded for six." Dickinson's chief physician gave the cause of death as Bright's disease and its duration as two and a half years.

Lavinia and Austin asked Susan to wash Emily's body upon her death. Susan also wrote Emily's obituary for the *Springfield Republican*, ending it with four lines from one of Emily's poems: "Morns like these, we parted; Noons like these, she rose; Fluttering first, then firmer, To her fair repose." Lavinia was perfectly satisfied that Sue should arrange everything, knowing it would be done lovingly. Dickinson was buried, laid in a white coffin with vanilla-scented heliotrope, a lady's slipper orchid, and a "knot of blue field violets" placed about it. The funeral service, held in the Homestead's library, was simple and short; Higginson, who had met her only twice, read "No Coward Soul Is Mine", a poem by Emily Brontë that had been a favorite of Dickinson's. At Dickinson's request, her "coffin [was] not driven but carried through fields of buttercups" for burial in the family plot at West Cemetery on Triangle Street.

Publication

Despite Dickinson's prolific writing, only ten poems and a letter were published during her lifetime. After her younger sister Lavinia discovered the collection of nearly 1800 poems, Dickinson's first volume was published four years after her death. Until Thomas H. Johnson published Dickinson's *Complete Poems* in 1955, Dickinson's poems were considerably

edited and altered from their manuscript versions. Since 1890 Dickinson has remained continuously in print.

Contemporary

A few of Dickinson's poems appeared in Samuel Bowles' *Springfield Republican* between 1858 and 1868. They were published anonymously and heavily edited, with conventionalized punctuation and formal titles. The first poem, "Nobody knows this little rose", may have been published without Dickinson's permission. The *Republican* also published "A Narrow Fellow in the Grass" as "The Snake", "Safe in their Alabaster Chambers –" as "The Sleeping", and "Blazing in the Gold and quenching in Purple" as "Sunset". The poem "I taste a liquor never brewed –" is an example of the edited versions; the last two lines in the first stanza were completely rewritten.

Original wording	***Republican* version**
I taste a liquor never brewed – From Tankards scooped in Pearl – *Not all the Frankfort Berries* *Yield such an Alcohol!*	I taste a liquor never brewed – From Tankards scooped in Pearl – *Not Frankfort Berries yield the sense* *Such a delirious whirl!*

In 1864, several poems were altered and published in *Drum Beat*, to raise funds for medical care for Union soldiers in the war. Another appeared in April 1864 in the *Brooklyn Daily Union*.

In the 1870s, Higginson showed Dickinson's poems to Helen Hunt Jackson, who had coincidentally been at the Academy with Dickinson when they were girls. Jackson was deeply involved in the publishing world, and managed to convince Dickinson to publish her poem "Success is counted sweetest" anonymously in a volume called *A Masque of Poets*. The poem, however, was altered to agree with contemporary taste. It was the last poem published during Dickinson's lifetime.

Posthumous

After Dickinson's death, Lavinia Dickinson kept her promise and burned most of the poet's correspondence. Significantly though, Dickinson had left no instructions about the 40 notebooks and loose sheets gathered in a locked chest. Lavinia recognized the poems' worth and became obsessed with seeing them published. She turned first to her brother's wife and then to Mabel Loomis Todd, his lover, for assistance. A feud ensued, with the manuscripts divided between the Todd and Dickinson houses, preventing complete publication of Dickinson's poetry for more than half a century.

The first volume of Dickinson's *Poems,* edited jointly by Mabel Loomis Todd and T. W. Higginson, appeared in November 1890. Although Todd claimed that only essential changes were made, the poems were extensively edited to match punctuation and capitalization to late 19th-century standards, with occasional

rewordings to reduce Dickinson's obliquity. The first 115-poem volume was a critical and financial success, going through eleven printings in two years. *Poems: Second Series* followed in 1891, running to five editions by 1893; a third series appeared in 1896. One reviewer, in 1892, wrote: "The world will not rest satisfied till every scrap of her writings, letters as well as literature, has been published".

Nearly a dozen new editions of Dickinson's poetry, whether containing previously unpublished or newly edited poems, were published between 1914 and 1945. Martha Dickinson Bianchi, the daughter of Susan and Austin Dickinson, published collections of her aunt's poetry based on the manuscripts held by her family, whereas Mabel Loomis Todd's daughter, Millicent Todd Bingham, published collections based on the manuscripts held by her mother. These competing editions of Dickinson's poetry, often differing in order and structure, ensured that the poet's work was in the public's eye.

The first scholarly publication came in 1955 with a complete new three-volume set edited by Thomas H. Johnson. Forming the basis of later Dickinson scholarship, Johnson's variorum brought all of Dickinson's known poems together for the first time. Johnson's goal was to present the poems very nearly as Dickinson had left them in her manuscripts. They were untitled, only numbered in an approximate chronological sequence, strewn with dashes and irregularly capitalized, and often extremely elliptical in their language. Three years later, Johnson edited and published, along with Theodora Ward, a complete collection of Dickinson's letters, also presented in three volumes.

In 1981, *The Manuscript Books of Emily Dickinson*was published. Using the physical evidence of the original papers, the poems were intended to be published in their original order for the first time. Editor Ralph W. Franklin relied on smudge marks, needle punctures and other clues to reassemble the poet's packets. Since then, many critics have argued for thematic unity in these small collections, believing the ordering of the poems to be more than chronological or convenient.

Dickinson biographer Alfred Habegger wrote in *My Wars Are Laid Away in Books: The Life of Emily Dickinson* (2001) that "The consequences of the poet's failure to disseminate her work in a faithful and orderly manner are still very much with us".

Poetry

Dickinson's poems generally fall into three distinct periods, the works in each period having certain general characters in common.

- **Pre-1861**. These are often conventional and sentimental in nature. Thomas H. Johnson, who later published *The Poems of Emily Dickinson*, was able to date only five of Dickinson's poems before 1858. Two of these are mock valentines done in an ornate and humorous style, and two others are conventional lyrics, one of which is about missing her brother Austin. The fifth poem, which begins "I have a Bird in spring", conveys her grief over the feared loss of friendship and was sent to her friend Sue Gilbert.

- **1861–1865**. This was her most creative period—these poems represent her most vigorous and creative work. Johnson estimated that she composed 86 poems in 1861, 366 in 1862, 141 in 1863, and 174 in 1864. He also believed that during this period, she fully developed her themes of life and mortality.
- **Post-1866**. It is estimated that two-thirds of the entire body of her poetry was written before this year.

Structure and syntax

The extensive use of dashes and unconventional capitalization in Dickinson's manuscripts, and the idiosyncratic vocabulary and imagery, combine to create a body of work that is "far more various in its styles and forms than is commonly supposed". Dickinson avoids pentameter, opting more generally for trimeter, tetrameter and, less often, dimeter. Sometimes her use of these meters is regular, but oftentimes it is irregular. The regular form that she most often employs is the ballad stanza, a traditional form that is divided into quatrains, using tetrameter for the first and third lines and trimeter for the second and fourth, while rhyming the second and fourth lines (ABCB). Though Dickinson often uses perfect rhymes for lines two and four, she also makes frequent use of slant rhyme. In some of her poems, she varies the meter from the traditional ballad stanza by using trimeter for lines one, two and four; while using tetrameter for only line three.

Since many of her poems were written in traditional ballad stanzas with ABCB rhyme schemes, some of these poems can

be sung to fit the melodies of popular folk songs and hymns that also use the common meter, employing alternating lines of iambic tetrameter and iambic trimeter.

Dickinson scholar and poet Anthony Hecht finds resonances in Dickinson's poetry not only with hymns and song-forms but also with psalms and riddles, citing the following example: "Who is the East? / The Yellow Man / Who may be Purple if he can / That carries in the Sun. / Who is the West? / The Purple Man / Who may be Yellow if He can / That lets Him out again."

Late 20th-century scholars are "deeply interested" by Dickinson's highly individual use of punctuation and lineation (line lengths and line breaks). Following the publication of one of the few poems that appeared in her lifetime – "A Narrow Fellow in the Grass", published as "The Snake" in the *Republican* – Dickinson complained that the edited punctuation (an added comma and a full stop substitution for the original dash) altered the meaning of the entire poem.

Original wording	***Republican* version**
A narrow Fellow in the Grass Occasionally rides – You may have met Him – did you not His notice sudden is –	A narrow Fellow in the Grass Occasionally rides – You may have met Him – did you not, His notice sudden is.

As Farr points out, "snakes instantly notice you"; Dickinson's version captures the "breathless immediacy" of the encounter; and *The Republican*'s punctuation renders "her lines more commonplace". With the increasingly close focus on Dickinson's structures and syntax has come a growing appreciation that they are "aesthetically based". Although Johnson's landmark 1955 edition of poems was relatively unaltered from the original, later scholars critiqued it for deviating from the style and layout of Dickinson's manuscripts. Meaningful distinctions, these scholars assert, can be drawn from varying lengths and angles of dash, and differing arrangements of text on the page. Several volumes have attempted to render Dickinson's handwritten dashes using many typographic symbols of varying length and angle. R. W. Franklin's 1998 variorum edition of the poems provided alternate wordings to those chosen by Johnson, in a more limited editorial intervention. Franklin also used typeset dashes of varying length to approximate the manuscripts' dashes more closely.

Major themes

Dickinson left no formal statement of her aesthetic intentions and, because of the variety of her themes, her work does not fit conveniently into any one genre. She has been regarded, alongside Emerson (whose poems Dickinson admired), as a Transcendentalist. However, Farr disagrees with this analysis, saying that Dickinson's "relentlessly measuring mind ... deflates the airy elevation of the Transcendental". Apart from the major themes discussed below, Dickinson's poetry frequently uses humor, puns, irony and satire.

Flowers and gardens: Farr notes that Dickinson's "poems and letters almost wholly concern flowers" and that allusions to gardens often refer to an "imaginative realm ... wherein flowers [are] often emblems for actions and emotions". She associates some flowers, like gentians and anemones, with youth and humility; others with prudence and insight. Her poems were often sent to friends with accompanying letters and nosegays. Farr notes that one of Dickinson's earlier poems, written about 1859, appears to "conflate her poetry itself with the posies": "My nosegays are for Captives – / Dim – long expectant eyes – / Fingers denied the plucking, / Patient till Paradise – / To such, if they sh'd whisper / Of morning and the moor – / They bear no other errand, / And I, no other prayer".

The Master poems: Dickinson left a large number of poems addressed to "Signor", "Sir" and "Master", who is characterized as Dickinson's "lover for all eternity". These confessional poems are often "searing in their self-inquiry" and "harrowing to the reader" and typically take their metaphors from texts and paintings of Dickinson's day. The Dickinson family themselves believed these poems were addressed to actual individuals but this view is frequently rejected by scholars. Farr, for example, contends that the Master is an unattainable composite figure, "human, with specific characteristics, but godlike" and speculates that Master may be a "kind of Christian muse".

Morbidity: Dickinson's poems reflect her "early and lifelong fascination" with illness, dying and death. Perhaps surprisingly for a New England spinster, her poems allude to death by many methods: "crucifixion, drowning, hanging, suffocation, freezing, premature burial, shooting, stabbing and guillotinage". She

reserved her sharpest insights into the "death blow aimed by God" and the "funeral in the brain", often reinforced by images of thirst and starvation. Dickinson scholar Vivian Pollak considers these references an autobiographical reflection of Dickinson's "thirsting-starving persona", an outward expression of her needy self-image as small, thin and frail. Dickinson's most psychologically complex poems explore the theme that the loss of hunger for life causes the death of self and place this at "the interface of murder and suicide". Death and morbidity in Dickinson's poetry is also heavily connected to winter themes. Critic Edwin Folsom analyzes how "winter for Dickinson is the season that forces reality, that strips all hope of transcendence. It is a season of death and a metaphor for death".

Gospel poems: Throughout her life, Dickinson wrote poems reflecting a preoccupation with the teachings of Jesus Christ and, indeed, many are addressed to him. She stresses the Gospels' contemporary pertinence and recreates them, often with "wit and American colloquial language". Scholar Dorothy Oberhaus finds that the "salient feature uniting Christian poets ... is their reverential attention to the life of Jesus Christ" and contends that Dickinson's deep structures place her in the "poetic tradition of Christian devotion" alongside Hopkins, Eliot and Auden. In a Nativity poem, Dickinson combines lightness and wit to revisit an ancient theme: "The Savior must have been / A docile Gentleman – / To come so far so cold a Day / For little Fellowmen / The Road to Bethlehem / Since He and I were Boys / Was leveled, but for that twould be / A rugged billion Miles –".

The Undiscovered Continent: Academic Suzanne Juhasz considers that Dickinson saw the mind and spirit as tangible visitable places and that for much of her life she lived within them. Often, this intensely private place is referred to as the "undiscovered continent" and the "landscape of the spirit" and embellished with nature imagery. At other times, the imagery is darker and forbidding—castles or prisons, complete with corridors and rooms—to create a dwelling place of "oneself" where one resides with one's other selves. An example that brings together many of these ideas is: "Me from Myself – to banish – / Had I Art – / Impregnable my Fortress / Unto All Heart – / But since myself—assault Me – / How have I peace / Except by subjugating / Consciousness. / And since We're mutual Monarch / How this be / Except by Abdication – / Me – of Me?".

Reception

The surge of posthumous publication gave Dickinson's poetry its first public exposure. Backed by Higginson and with a favorable notice from William Dean Howells, an editor of *Harper's Magazine*, the poetry received mixed reviews after it was first published in 1890. Higginson himself stated in his preface to the first edition of Dickinson's published work that the poetry's quality "is that of extraordinary grasp and insight", albeit "without the proper control and chastening" that the experience of publishing during her lifetime might have conferred. His judgment that her opus was "incomplete and unsatisfactory" would be echoed in the essays of the New Critics in the 1930s.

Maurice Thompson, who was literary editor of *The Independent* for twelve years, noted in 1891 that her poetry had "a strange mixture of rare individuality and originality". Some critics hailed Dickinson's effort, but disapproved of her unusual non-traditional style. Andrew Lang, a British writer, dismissed Dickinson's work, stating that "if poetry is to exist at all, it really must have form and grammar, and must rhyme when it professes to rhyme. The wisdom of the ages and the nature of man insist on so much". Thomas Bailey Aldrich, a poet and novelist, equally dismissed Dickinson's poetic technique in *The Atlantic Monthly* in January 1892: "It is plain that Miss Dickinson possessed an extremely unconventional and grotesque fancy. She was deeply tinged by the mysticism of Blake, and strongly influenced by the mannerism of Emerson ... But the incoherence and formlessness of her — versicles are fatal ... an eccentric, dreamy, half-educated recluse in an out-of-the-way New England village (or anywhere else) cannot with impunity set at defiance the laws of gravitation and grammar".

Critical attention to Dickinson's poetry was meager from 1897 to the early 1920s. By the start of the 20th century, interest in her poetry became broader in scope and some critics began to consider Dickinson as essentially modern. Rather than seeing Dickinson's poetic styling as a result of lack of knowledge or skill, modern critics believed the irregularities were consciously artistic. In a 1915 essay, Elizabeth Shepley Sergeant called the poet's inspiration "daring" and named her "one of the rarest flowers the sterner New England land ever bore". With the growing popularity of modernist poetry in the 1920s, Dickinson's failure to conform to 19th-century poetic form was no longer surprising nor distasteful to new

generations of readers. Dickinson was suddenly referred to by various critics as a great woman poet, and a cult following began to form.

In the 1930s, a number of the New Critics – among them R. P. Blackmur, Allen Tate, Cleanth Brooks and Yvor Winters – appraised the significance of Dickinson's poetry. As critic Roland Hagenbüchle pointed out, their "affirmative and prohibitive tenets turned out to be of special relevance to Dickinson scholarship". Blackmur, in an attempt to focus and clarify the major claims for and against the poet's greatness, wrote in a landmark 1937 critical essay: "... she was a private poet who wrote as indefatigably as some women cook or knit. Her gift for words and the cultural predicament of her time drove her to poetry instead of antimacassars ... She came ... at the right time for one kind of poetry: the poetry of sophisticated, eccentric vision."

The second wave of feminism created greater cultural sympathy for her as a female poet. In the first collection of critical essays on Dickinson from a feminist perspective, she is heralded as the greatest woman poet in the English language. Biographers and theorists of the past tended to separate Dickinson's roles as a woman and a poet. For example, George Whicher wrote in his 1952 book *This Was a Poet: A Critical Biography of Emily Dickinson*, "Perhaps as a poet [Dickinson] could find the fulfillment she had missed as a woman." Feminist criticism, on the other hand, declares that there is a necessary and powerful conjunction between Dickinson being a woman and a poet. Adrienne Rich theorized in *Vesuvius at Home: The Power of Emily Dickinson* (1976) that Dickinson's identity as a woman poet brought her power: "[she] chose her seclusion, knowing

she was exceptional and knowing what she needed ... She carefully selected her society and controlled the disposal of her time ... neither eccentric nor quaint; she was determined to survive, to use her powers, to practice necessary economics."

Some scholars question the poet's sexuality, theorizing that the numerous letters and poems that were dedicated to Susan Gilbert Dickinson indicate a lesbian romance, and speculating about how this may have influenced her poetry. Critics such as John Cody, Lillian Faderman, Vivian R. Pollak, Paula Bennett, Judith Farr, Ellen Louise Hart, and Martha Nell Smith have argued that Susan was the central erotic relationship in Dickinson's life.

Legacy

In the early 20th century, Martha Dickinson Bianchi and Millicent Todd Bingham kept the achievement of Emily Dickinson alive. Bianchi promoted Dickinson's poetic achievement. Bianchi inherited The Evergreens as well as the copyright for her aunt's poetry from her parents, publishing works such as *Emily Dickinson Face to Face* and *Letters of Emily Dickinson*, which stoked public curiosity about her aunt. Bianchi's books perpetrated legends about her aunt in the context of family tradition, personal recollection and correspondence. In contrast, Millicent Todd Bingham's took a more objective and realistic approach to the poet.

Emily Dickinson is now considered a powerful and persistent figure in American culture. Although much of the early reception concentrated on Dickinson's eccentric and secluded nature, she has become widely acknowledged as an innovative,

proto-modernist poet. As early as 1891, William Dean Howells wrote that "If nothing else had come out of our life but this strange poetry, we should feel that in the work of Emily Dickinson, America, or New England rather, had made a distinctive addition to the literature of the world, and could not be left out of any record of it." Critic Harold Bloom has placed her alongside Walt Whitman, Wallace Stevens, Robert Frost, T. S. Eliot, and Hart Crane as a major American poet, and in 1994 listed her among the 26 central writers of Western civilization.

Dickinson is taught in American literature and poetry classes in the United States from middle school to college. Her poetry is frequently anthologized and has been used as text for art songs by composers such as Aaron Copland, Nick Peros, John Adams and Michael Tilson Thomas. Several schools have been established in her name; for example, Emily Dickinson Elementary Schools exist in Bozeman, Montana;Redmond, Washington; and New York City. A few literary journals — including *The Emily Dickinson Journal*, the official publication of the Emily Dickinson International Society — have been founded to examine her work. An 8-cent commemorative stamp in honor of Dickinson was issued by the United States Postal Service on August 28, 1971, as the second stamp in the "American Poet" series. Dickinson was inducted into the National Women's Hall of Fame in 1973. A one-woman play titled *The Belle of Amherst* appeared on Broadway in 1976, winning several awards; it was later adapted for television.

Dickinson's herbarium, which is now held in the Houghton Library at Harvard University, was published in 2006 as *Emily Dickinson's Herbarium* by Harvard University Press. The

original work was compiled by Dickinson during her years at Amherst Academy, and consists of 424 pressed specimens of plants arranged on 66 pages of a bound album. A digital facsimile of the herbarium is available online. The town of Amherst Jones Library's Special Collections department has an Emily Dickinson Collection consisting of approximately seven thousand items, including original manuscript poems and letters, family correspondence, scholarly articles and books, newspaper clippings, theses, plays, photographs and contemporary artwork and prints. The Archives and Special Collections at Amherst College has substantial holdings of Dickinson's manuscripts and letters as well as a lock of Dickinson's hair and the original of the only positively identified image of the poet. In 1965, in recognition of Dickinson's growing stature as a poet, the Homestead was purchased by Amherst College. It opened to the public for tours, and also served as a faculty residence for many years. The Emily Dickinson Museum was created in 2003 when ownership of the Evergreens, which had been occupied by Dickinson family heirs until 1988, was transferred to the college.

Modern influence and inspiration

Emily Dickinson's life and works have been the source of inspiration to artists, particularly to feminist-oriented artists, of a variety of mediums. A few notable examples are as follows:

- The feminist artwork *The Dinner Party*, by Judy Chicago, first exhibited in 1979, features a place setting for Dickinson.

- Jane Campion's film *The Piano* and its novelization (co-authored by Kate Pullinger) were inspired by the poetry of Emily Dickinson as well as the novels by the Brontë sisters.
- A character who is a literary scholar at a fictional New England college in the comic campus novel by Pamela Hansford Johnson *Night and Silence Who Is Here?*is intent on proving that Emily Dickinson was a secret dipsomaniac. His obsession costs him his job.
- The 2012 book *The Emily Dickinson Reader* by Paul Legault is an English-to-English translation of her complete poems published by McSweeney's.
- Dickinson's work has been set by numerous composers including Aaron Copland, Samuel Barber, Chester Biscardi, Elliot Carter, John Adams, Libby Larsen, Peter Seabourne, Michael Tilson Thomas, and Judith Weir.
- A public garden is named in her honor in Paris: 'square Emily-Dickinson', in the 20th arrondissement.
- Jazz saxophonist Jane Ira Bloom released the 2017 double album *Wild Lines: Improvising Emily Dickinson* inspired by the poet's works.
- English director Terence Davies directed and wrote *A Quiet Passion*, a 2016 biographical film about the life of Emily Dickinson. The film stars Cynthia Nixon as the reclusive poet. The film premiered at the 66th Berlin International Film Festival in February 2016 and was released in the United Kingdom on April 7, 2017.
- *Dickinson* is a TV series about the life of the poet launched in 2019 on Apple TV+.

Translation

Emily Dickinson's poetry has been translated into languages including French, Spanish, Mandarin Chinese, Persian, Kurdish, Georgian, Swedish, and Russian. A few examples of these translations are the following:

- *The Queen of Bashful Violets*, a Kurdish translation by MadehPiryonesi published in 2016.
- French translation by Charlotte Melançon which includes 40 poems.
- Mandarin Chinese translation by Professor Jianxin Zhou
- Swedish translation by Ann Jäderlund.
- Persian translations: Three Persian translations of Emily Dickinson are available from Saeed Saeedpoor, MadehPiryonesi and Okhovat.

Chapter 3

Benefits of Interdisciplinary Work

Interdisciplinarity or **interdisciplinary studies** involves the combination of two or more academic disciplines into one activity (e.g., a research project). It draws knowledge from several other fields like sociology, anthropology, psychology, economics etc. It is about creating something by thinking across boundaries. It is related to an *interdiscipline* or an *interdisciplinary field,* which is an organizational unit that crosses traditional boundaries between academic disciplines or schools of thought, as new needs and professions emerge. Large engineering teams are usually interdisciplinary, as a power station or mobile phone or other project requires the melding of several specialties. However, the term "interdisciplinary" is sometimes confined to academic settings.

The term *interdisciplinary*is applied within education and training pedagogies to describe studies that use methods and insights of several established disciplines or traditional fields of study. Interdisciplinarity involves researchers, students, and teachers in the goals of connecting and integrating several academic schools of thought, professions, or technologies—along with their specific perspectives—in the pursuit of a common task.

The epidemiology of HIV/AIDS or global warming requires understanding of diverse disciplines to solve complex problems. *Interdisciplinary*may be applied where the subject is felt to have been neglected or even misrepresented in the traditional disciplinary structure of research institutions, for

example, women's studies or ethnic area studies. Interdisciplinaritycan likewise be applied to complex subjects that can only be understood by combining the perspectives of two or more fields.

The adjective *interdisciplinary*is most often used in educational circles when researchers from two or more disciplines pool their approaches and modify them so that they are better suited to the problem at hand, including the case of the team-taught course where students are required to understand a given subject in terms of multiple traditional disciplines. For example, the subject of land use may appear differently when examined by different disciplines, for instance, biology, chemistry, economics, geography, and politics.

Development

Although "interdisciplinary" and "interdisciplinarity" are frequently viewed as twentieth century terms, the concept has historical antecedents, most notably Greek philosophy. Julie Thompson Klein attests that "the roots of the concepts lie in a number of ideas that resonate through modern discourse—the ideas of a unified science, general knowledge, synthesis and the integration of knowledge", while Giles Gunn says that Greek historians and dramatists took elements from other realms of knowledge (such as medicine or philosophy) to further understand their own material. The building of Roman roads required men who understood surveying, material science, logistics and several other disciplines. Any broadminded humanist project involves interdisciplinarity, and history shows a crowd of cases, as seventeenth-century Leibniz's task to create a system of universal justice, which

required linguistics, economics, management, ethics, law philosophy, politics, and even sinology.

Interdisciplinary programs sometimes arise from a shared conviction that the traditional disciplines are unable or unwilling to address an important problem. For example, social science disciplines such as anthropology and sociology paid little attention to the social analysis of technology throughout most of the twentieth century. As a result, many social scientists with interests in technology have joined science, technology and society programs, which are typically staffed by scholars drawn from numerous disciplines. They may also arise from new research developments, such as nanotechnology, which cannot be addressed without combining the approaches of two or more disciplines. Examples include quantum information processing, an amalgamation of quantum physics and computer science, and bioinformatics, combining molecular biology with computer science. Sustainable development as a research area deals with problems requiring analysis and synthesis across economic, social and environmental spheres; often an integration of multiple social and natural science disciplines. Interdisciplinary research is also key to the study of health sciences, for example in studying optimal solutions to diseases. Some institutions of higher education offer accredited degree programs in Interdisciplinary Studies.

At another level, interdisciplinarityis seen as a remedy to the harmful effects of excessive specialization and isolation in information silos. On some views, however, interdisciplinarity is entirely indebted to those who specialize in one field of study—that is, without specialists, interdisciplinarians would

have no information and no leading experts to consult. Others place the focus of interdisciplinarity on the need to transcend disciplines, viewing excessive specialization as problematic both epistemologically and politically. When interdisciplinary collaboration or research results in new solutions to problems, much information is given back to the various disciplines involved. Therefore, both disciplinarians and interdisciplinariansmay be seen in complementary relation to one another.

Barriers

Because most participants in interdisciplinary ventures were trained in traditional disciplines, they must learn to appreciate differences of perspectives and methods. For example, a discipline that places more emphasis on quantitative rigor may produce practitioners who are more scientific in their training than others; in turn, colleagues in "softer" disciplines who may associate quantitative approaches with difficulty grasp the broader dimensions of a problem and lower rigor in theoretical and qualitative argumentation. An interdisciplinary program may not succeed if its members remain stuck in their disciplines (and in disciplinary attitudes). Those who lack experience in interdisciplinary collaborations may also not fully appreciate the intellectual contribution of colleagues from those discipline. From the disciplinary perspective, however, much interdisciplinary work may be seen as "soft", lacking in rigor, or ideologically motivated; these beliefs place barriers in the career paths of those who choose interdisciplinary work. For example, interdisciplinary grant applications are often refereed by peer reviewers drawn from established disciplines;

not surprisingly, interdisciplinary researchers may experience difficulty getting funding for their research. In addition, untenured researchers know that, when they seek promotion and tenure, it is likely that some of the evaluators will lack commitment to interdisciplinarity. They may fear that making a commitment to interdisciplinary research will increase the risk of being denied tenure.

Interdisciplinary programs may also fail if they are not given sufficient autonomy. For example, interdisciplinary faculty are usually recruited to a joint appointment, with responsibilities in both an interdisciplinary program (such as women's studies) and a traditional discipline (such as history). If the traditional discipline makes the tenure decisions, new interdisciplinary faculty will be hesitant to commit themselves fully to interdisciplinary work. Other barriers include the generally disciplinary orientation of most scholarly journals, leading to the perception, if not the fact, that interdisciplinary research is hard to publish. In addition, since traditional budgetary practices at most universities channel resources through the disciplines, it becomes difficult to account for a given scholar or teacher's salary and time. During periods of budgetary contraction, the natural tendency to serve the primary constituency (i.e., students majoring in the traditional discipline) makes resources scarce for teaching and research comparatively far from the center of the discipline as traditionally understood. For these same reasons, the introduction of new interdisciplinary programs is often resisted because it is perceived as a competition for diminishing funds.

Due to these and other barriers, interdisciplinary research areas are strongly motivated to become disciplines themselves.

If they succeed, they can establish their own research funding programs and make their own tenure and promotion decisions. In so doing, they lower the risk of entry. Examples of former interdisciplinary research areas that have become disciplines, many of them named for their parent disciplines, include neuroscience, cybernetics, biochemistry and biomedical engineering. These new fields are occasionally referred to as "interdisciplines". On the other hand, even though interdisciplinary activities are now a focus of attention for institutions promoting learning and teaching, as well as organizational and social entities concerned with education, they are practically facing complex barriers, serious challenges and criticism. The most important obstacles and challenges faced by interdisciplinary activities in the past two decades can be divided into "professional", "organizational", and "cultural" obstacles.

Interdisciplinary studies and studies of interdisciplinarity

An initial distinction should be made between interdisciplinary studies, which can be found spread across the academy today, and the study of interdisciplinarity, which involves a much smaller group of researchers. The former is instantiated in thousands of research centers across the US and the world. The latter has one US organization, the Association for Interdisciplinary Studies (founded in 1979), two international organizations, the International Network of Inter- and Transdisciplinarity (founded in 2010) and the Philosophy of/as Interdisciplinarity Network (founded in 2009), and one

research institute devoted to the theory and practice of interdisciplinarity, the Center for the Study of Interdisciplinarity at the University of North Texas (founded in 2008). As of 1 September 2014, the Center for the Study of Interdisciplinarity has ceased to exist. This is the result of administrative decisions at the University of North Texas.

An **interdisciplinary study** is an academic program or process seeking to synthesize broad perspectives, knowledge, skills, interconnections, and epistemology in an educational setting. Interdisciplinary programs may be founded in order to facilitate the study of subjects which have some coherence, but which cannot be adequately understood from a single disciplinary perspective (for example, women's studies or medieval studies). More rarely, and at a more advanced level, interdisciplinarity may itself become the focus of study, in a critique of institutionalized disciplines' ways of segmenting knowledge.

In contrast, **studies of interdisciplinarity** raise to self-consciousness questions about how interdisciplinarity works, the nature and history of disciplinarity, and the future of knowledge in post-industrial society. Researchers at the Center for the Study of Interdisciplinarity have made the distinction between philosophy 'of' and 'as' interdisciplinarity, the former identifying a new, discrete area within philosophy that raises epistemological and metaphysical questions about the status of interdisciplinary thinking, with the latter pointing toward a philosophical practice that is sometimes called 'field philosophy'.

Perhaps the most common complaint regarding interdisciplinary programs, by supporters and detractors alike, is the lack of synthesis—that is, students are provided with multiple disciplinary perspectives, but are not given effective guidance in resolving the conflicts and achieving a coherent view of the subject. Others have argued that the very idea of synthesis or integration of disciplines presupposes questionable politico-epistemic commitments. Critics of interdisciplinary programs feel that the ambition is simply unrealistic, given the knowledge and intellectual maturity of all but the exceptional undergraduate; some defenders concede the difficulty, but insist that cultivating interdisciplinarity as a habit of mind, even at that level, is both possible and essential to the education of informed and engaged citizens and leaders capable of analyzing, evaluating, and synthesizing information from multiple sources in order to render reasoned decisions.

While much has been written on the philosophy and promise of interdisciplinarity in academic programs and professional practice, social scientists are increasingly interrogating academic discourses on interdisciplinarity, as well as how interdisciplinarity actually works—and does not—in practice. Some have shown, for example, that some interdisciplinary enterprises that aim to serve society can produce deleterious outcomes for which no one can be held to account.

Politics of interdisciplinary studies

Since 1998, there has been an ascendancy in the value of interdisciplinary research and teaching and a growth in the number of bachelor's degrees awarded at U.S. universities classified as multi- or interdisciplinary studies. The number of

interdisciplinary bachelor's degrees awarded annually rose from 7,000 in 1973 to 30,000 a year by 2005 according to data from the National Center of Educational Statistics (NECS). In addition, educational leaders from the Boyer Commission to Carnegie's President Vartan Gregorian to Alan I. Leshner, CEO of the American Association for the Advancement of Science have advocated for interdisciplinary rather than disciplinary approaches to problem-solving in the 21st century. This has been echoed by federal funding agencies, particularly the National Institutes of Health under the direction of Elias Zerhouni, who has advocated that grant proposals be framed more as interdisciplinary collaborative projects than single-researcher, single-discipline ones.

At the same time, many thriving longstanding bachelor's in interdisciplinary studies programs in existence for 30 or more years, have been closed down, in spite of healthy enrollment. Examples include Arizona International (formerly part of the University of Arizona), the School of Interdisciplinary Studies at Miami University, and the Department of Interdisciplinary Studies at Wayne State University; others such as the Department of Interdisciplinary Studies at Appalachian State University, and George Mason University's New Century College, have been cut back.

Stuart Henry has seen this trend as part of the hegemony of the disciplines in their attempt to recolonize the experimental knowledge production of otherwise marginalized fields of inquiry. This is due to threat perceptions seemingly based on the ascendancy of interdisciplinary studies against traditional academia.

Historical examples

There are many examples of when a particular idea, almost on the same period, arises in different disciplines. One case is the shift from the approach of focusing on "specialized segments of attention" (adopting one particular perspective), to the idea of "instant sensory awareness of the whole", an attention to the "total field", a "sense of the whole pattern, of form and function as a unity", an "integral idea of structure and configuration". This has happened in painting (with cubism), physics, poetry, communication and educational theory. According to Marshall McLuhan, this paradigm shift was due to the passage from an era shaped by mechanization, which brought sequentiality, to the era shaped by the instant speed of electricity, which brought simultaneity.

Efforts to simplify and defend the concept

An article in the *Social Science Journal* attempts to provide a simple, common-sense, definition of interdisciplinarity, bypassing the difficulties of defining that concept and obviating the need for such related concepts as transdisciplinarity, pluridisciplinarity, and multidisciplinary:

"To begin with, a discipline can be conveniently defined as any comparatively self-contained and isolated domain of human experience which possesses its own community of experts. Interdisciplinarityis best seen as bringing together distinctive components of two or more disciplines. In academic discourse,

interdisciplinarity typically applies to four realms: knowledge, research, education, and theory. Interdisciplinary knowledge involves familiarity with components of two or more disciplines. Interdisciplinary research combines components of two or more disciplines in the search or creation of new knowledge, operations, or artistic expressions. Interdisciplinary education merges components of two or more disciplines in a single program of instruction. Interdisciplinary theory takes interdisciplinary knowledge, research, or education as its main objects of study."

In turn, interdisciplinary *richness* of any two instances of knowledge, research, or education can be ranked by weighing four variables: number of disciplines involved, the "distance" between them, the novelty of any particular combination, and their extent of integration.

Interdisciplinary knowledge and research are important because:

- "Creativity often requires interdisciplinary knowledge.
- Immigrants often make important contributions to their new field.
- Disciplinarians often commit errors which can be best detected by people familiar with two or more disciplines.
- Some worthwhile topics of research fall in the interstices among the traditional disciplines.
- Many intellectual, social, and practical problems require interdisciplinary approaches.

- Interdisciplinary knowledge and research serve to remind us of the unity-of-knowledge ideal.
- Interdisciplinarians enjoy greater flexibility in their research.
- More so than narrow disciplinarians, interdisciplinarians often treat themselves to the intellectual equivalent of traveling in new lands.
- Interdisciplinarians may help breach communication gaps in the modern academy, thereby helping to mobilize its enormous intellectual resources in the cause of greater social rationality and justice.
- By bridging fragmented disciplines, interdisciplinarians might play a role in the defense of academic freedom."

Quotations

"The modern mind divides, specializes, thinks in categories: the Greek instinct was the opposite, to take the widest view, to see things as an organic whole [...]. The Olympic games were designed to test the arete of the whole man, not a merely specialized skill [...]. The great event was the pentathlon, if you won this, you were a man. Needless to say, the Marathon race was never heard of until modern times: the Greeks would have regarded it as a monstrosity." "Previously, men could be divided simply into the learned and the ignorant, those more or less the one, and those more or less the other. But your specialist cannot be brought in under either of these two categories. He is not learned, for he is formally ignorant of all that does not enter into his specialty; but neither is he ignorant, because he is 'a scientist,' and 'knows' very well his

own tiny portion of the universe. We shall have to say that he is a learned ignoramus, which is a very serious matter, as it implies that he is a person who is ignorant, not in the fashion of the ignorant man, but with all the petulance of one who is learned in his own special line."

"It is the custom among those who are called 'practical' men to condemn any man capable of a wide survey as a visionary: no man is thought worthy of a voice in politics unless he ignores or does not know nine-tenths of the most important relevant facts."

Interdisciplinary teaching

Interdisciplinary teaching is a method, or set of methods, used to teach across curricular disciplines or "the bringing together of separate disciplines around common themes, issues, or problems." often Interdisciplinary instruction associated with or a component of several other instructional approaches. For example, in a review of literature on the subject published in 1994, Kathy Lake identified seven elements common to integrated curriculum models: a combination of subjects; an emphasis on projects; the use of a wide variety of source material, not just textbooks; highlighting relationships among concepts; thematic units; flexible schedules; and flexible student grouping.

Types

There are many different types, or levels, of interdisciplinary teaching. On one end, schools might employ an

interdisciplinary team approach, in which teachers of different content areas assigned to one group of students who are encouraged to correlate some of their teaching (Vars, 1991). The most common method of implementing integrated, interdisciplinary instruction is the *thematic unit*, in which a common theme is studied in more than one content area (Barton & Smith, 2000).

The example given above about rivers would be considered*multidisciplinary or parallel design*, which is defined as lessons or units developed across many disciplines with a common organizing topic (Jackson & Davis, 2000).

One of the foremost scholars of interdisciplinary teaching techniques is James Beane, who advocates for *curriculum integration*, which is curriculum that is collaboratively designed around important issues. It has four major components: the integration of experiences, social integration, the integration of knowledge, and integration as a curriculum design. It differs from other types of interdisciplinary teaching in that it begins with a central theme that emerges from questions or social concerns students have, without regard to subject delineations (Beane, 1997).

In 1989, the seminal work, Interdisciplinary Curriculum: Design and Implementation, edited by Heidi Hayes Jacobs was published by ASCD (Alexandria, Va). In this work, she presented a continuum of options for design spanning focused disciplined work to parallel to multidisciplinary to full integration.

Examples

- Travel and vacation can serve as a theme for cross-curricular interdisciplinary instruction. In social studies, student might study the geography of popular travel destinations, the history of tourist sites in the local community, and how travel changed dramatically during the 19th century Industrial Revolution. Analysis of travel promotion and advertising are relevant to media literacy education. Thousands of travel accounts have been published over the centuries that could be read and discussed in English classes. The impact of tourism on the environment relevant to science curriculum. In business education, students might examine the impact of tourism on the local, regional, or world economy.
- An interdisciplinary unit on rivers is appropriate for elementary or middle school Language Arts, Science and Social Studies. The local river system would be the unifying idea, but the English teacher would link it to Language Arts by studying river vocabulary and teaching students how to do a research report. The science teacher might teach children about the life systems that exist in the river, while the Social Studies teacher might help students research the local history and peoples who used the river for food and transport.
- Food is studied in every discipline and can serve as a theme for interdisciplinary instruction. Psychologists and sociologists explore how individuals and cultures decide what to eat, how to prepare it, and

how to consume it. Anthropologists explore the meaning and symbolism of food in a culture or how food relates to social class, sex, gender, or ethnicity. Economists study the production, distribution, marketing, sales, trade, and prices of food. Political scientists examine the government food policies such as taxation, regulation and debate the government's role in feeding its citizens. Scientists from the fields of nutrition, medicine, chemistry, biology, and agriculture study every aspect of food, from diet, health, and nutrition to chemical composition, production, and preservation. Food historians use interdisciplinary approaches to study food and its place in social class, religious practice, immigration, urbanization, technological change, the growth of the food industry, counterculture movements, and government policy.

Implementation

Heidi Hayes Jacobs presents a four-phase approach to curriculum integration planning. (1989, ASCD, Alexandria, Va) First, she suggests that a school conduct action research to learn more about how to implement curriculum integration. This should be done six months to a year ahead of when the school is going to attempt curriculum integration. Next, phase two calls for the development of a proposal. Phase three consists of implementing and monitoring the pilot unit; this should take place in the second year of the curriculum integration plan. Phase four takes place in the third year of the

plan, and calls for staff adoption of the program based on the findings from phase three (1991).

Choosing a theme to focus interdisciplinary instruction is a key step in implementing this approach. Themes should be of interest to students and relevant to the required curriculum. In some situations, students might choose the thematic topic. Themes should also be topics of interest to the teacher(s) because successful thematic instructions often requires additional research and preparation. Interdisciplinary themes related to multiple academic disciplines can be reinforced in lessons throughout the school day.

Essential questions are helpful in focusing the theme of interdisciplinary curriculum units. Essential questions are open-ended, intellectually engaging questions that demand higher-order thinking. Essential questions help teachers chose the most important facts and concepts relative to the theme and serve to focus planning efforts. For students, essential questions highlight key facts and concepts related to the interdisciplinary theme. They also serve as a focus for analysis and evaluation. Good essential questions can not be answered with a simple yes/no or true/false; students must discuss, defend, and debate issues related to the theme. Designing interdisciplinary instruction around essential questions require students to learn both content and develop critical analysis skills.

Benefits

A school district in Michigan created integration plans for thematic units, based on the ideas of Howard Gardner about

multiple intelligences, in a yearlong pilot program. The results of the program included "sustained enthusiasm" from the staff, parents, and students, increased attendance rates, and improvement in standardized test scores, "especially from students with the poorest test results" (Bolak, Bialach, &Duhnphy, 2005).

Flowers, Mertens, &Mulhall identify five important outcomes and findings of their experiences with interdisciplinary teaching and planning: common planning time is vital, schools that team have a more positive work climate, parental contact is more frequent, teachers report a higher job satisfaction, and student achievement scores in schools that team are higher than those that do not team (1999).

Additionally, Pumerantz&Galanto find that interdisciplinary teaching allows for students to, "Proceed at a pace commensurate with their interests, skills, and experiences" (1972).

Integrated instruction helps teachers better utilize instructional time and look deeper into subjects through a variety of content-specific lens. Another benefit of integrated instruction is that teachers can better differentiate instruction to individual student needs. Integrated instruction also allows for authentic assessment (Barton & Smith, 2000). A final benefit of interdisciplinary teaching is that students have a chance to work with multiple sources of information, thus ensuring they are receiving a more inclusive perspective than they would from consulting one textbook (Wood, 1997).

Criticism

Scholars that advocate for curriculum integration argue that the topics studied should originate with students and their teachers, and not from district-imposed curriculum packages. This raises the important issue of accountability (Stevenson, 1998). As school districts often have decision-making panels that consist of stakeholders such as teachers, parents, and students, curriculum integration may take away their agency to make curricular choices. In addition to issues of local control, truly integrated curricula may or may not prepare students for the high-stakes tests that have become a reality for most high schools around the world, depending on whether they cover the same material. Finally, there is also concern that integrated teaching discounts the value of deep subject-specific knowledge, which is essential for specialization in areas such as medicine, law, and engineering (Gatewood, 1998).

Thematic units can also fall short of teaching in-depth content to students. Often a theme, such as apples, is used to link unrelated subjects, with little deference to students' prior knowledge or interests. This superficial coverage of a topic can give students the wrong idea about school, perhaps missing the idea of curriculum integration in the first place (Barton & Smith, 2000). Thematic units can contain pointless busywork and activities created solely to create a link to a theme; for example, the alphabetizing of state capitals in a social studies unit, attempting to integrate it with language arts (Brophy&Alleman, 1991).

Research has also suggested that some students may have less capacity to cope with broad interdicisplinary curricula that spans diverse combination of subjects from different fields.

Interdisciplinarity

Interdisciplinarity is when two or more subjects (academic disciplines) join up. This happens when a problem overlaps traditional academic boundaries. Other terms which mean almost the same thing are **multidisciplinarity** and **crossdisciplinarity**.

An examples makes clear what is meant:

In order to investigate living cells, these subjects joined together: genetics, physics, chemistry, cytology.

When they joined up, the field they formed was called cell biology at the level of cells, or molecular biology at the level of macromolecules.

Other examples include artificial intelligence, cultural studies, cybernetics, computational linguistics, biomedical engineering, and so on. Physical chemistry, biochemistry and astrophysics must have been some of the first.

In many universities, traditional departments (e.g. botany, zoology) were scrapped, and new broader departments like 'School of biological sciences' were formed. Inside this umbrella, research and teaching teams were based on interdisciplinary problems, such as ecology or cell division or Earth history. There are some necessary specialities which do

not fit easily into the new system. Examples are taxonomy (you still need people to identify animals) and areas like parasitology and agricultural botany.

A system which works in some universities is to appoint staff to the Schools (usually Humanities, Science. Social sciences and Technology) and let the staff join those groups which best fit their expertise.

Interdisciplinary arts

Interdisciplinary arts are a combination of arts that use an interdisciplinary approach involving more than one artistic discipline.

Examples of different arts include visual arts, performing arts, musical arts, digital arts, conceptual arts, etc. Interdisciplinary artists apply at least two different approaches to the arts in their artworks. Often a combination of art and technology, typically digital in nature, is involved.

Commensurability

Commensurability is a concept in the philosophy of science whereby scientific theories are commensurable if scientists can discuss them using a shared nomenclature that allows direct comparison of theories to determine which theory is more valid or useful. On the other hand, theories are **incommensurable** if they are embedded in starkly contrasting conceptual frameworks whose languages do not overlap sufficiently to permit scientists to directly compare the theories or to cite

empirical evidence favoring one theory over the other. Discussed by Ludwik Fleck in the 1930s, and popularized by Thomas Kuhn in the 1960s, the problem of incommensurability results in scientists talking past each other, as it were, while comparison of theories is muddled by confusions about terms, contexts and consequences.

Introduction of the term

In 1962, Thomas Kuhn and Paul Feyerabend both independently introduced the idea of incommensurability to the philosophy of science. In both cases, the concept came from mathematics; in its original sense, it is defined as the absence of a common unit of measurement that would allow a direct and exact measurement of two variables, such as the prediction of the diagonal of a square from the relationship of its sides.

The term commensurability was coined because of a series of problems that both authors found when trying to interpret successive scientific theories. Its implementation is better understood thanks to the critiques that both Kuhn and Feyerabend have made in response to certain theses proposed by followers of the received view of theories. These include the famous *thesis on the accumulation of scientific knowledge*, which states that the body of scientific knowledge has been increasing with the passage of time. Both Kuhn and Feyerabend reject this thesis, in favor of a model that sees both revolutions and periods of normalcy in the history of science.

Another equally important thesis proposes the existence of a neutral language of comparison which can be used to formulate the empirical consequences of two competing theories. This would allow one to choose the theory with the greatest empirically verified contents or explanatory powers—or the greatest content that is not falsified if the formulation is Popperian.

The idea at the root of this second thesis does not just relate to the existence of said language but also implies at least two further postulates.

Firstly, this choice between theories presupposes that they can be intertranslated, for example between theory A and its successor B – and in the case of Popper that B can be deduced from A. Secondly, it is assumed that the choice is always carried out under the same standards of rationality.

In both cases, the concept of incommensurability makes the viability of the thesis impossible. In the first, by showing that certain empirical consequences are lost between successive theories.

In the second case, by confirming that it is possible to make a rational choice between theories even when they can not be translated into a neutral language. However, although the reasons for the introduction of these counter arguments, and the criticism from which they arise, are the same, the sense in which the coauthors use them are in no way identical. For this reason the idea of incommensurability will be discussed for each coauthor separately.

Perspectives

Feyerabend's perspectives

Feyerabend locates incommensurability within a principle from the field of semantics which has the underlying idea that the change in significance in the basic terms of a theory changes the totality of the terms of the new theory, so that there are no empirically common meanings between T and T'.

Feyerabendis credited with coining the modern philosophical sense of "incommensurability," which lays the foundation for much of his philosophy of science. He first presented his notion of incommensurability in 1952 to Karl Popper's London School of Economics seminar and to a gathering of illustrious Wittgensteinians (Elizabeth Anscombe, Peter Geach, H. L. A. Hart and Georg Henrik von Wright) in Anscombe's Oxford flat. Feyerabend argued that frameworks of thought, and thus scientific paradigms, can be incommensurable for three reasons. Briefly put, Feyerabend's notion of incommensurability is as follows:

- The interpretation of observations is implicitly influenced by theoretical assumptions. It is therefore impossible to describe or evaluate observations independently of theory.
- Paradigms often have different assumptions about which intellectual and operational scientific methods result in valid scientific knowledge.
- Paradigms can be based on different assumptions regarding the structure of their domain, which

> makes it impossible to compare them in a meaningful way. The adoption of a new theory includes and is dependent upon the adoption of new terms. Thus, scientists are using different terms when talking about different theories. Those who hold different, competing theories to be true will be talking over one another, in the sense that they cannot a priori arrive at agreement given two different discourses with two different theoretical language and dictates.

According to Feyerabend, the idea of incommensurability cannot be captured in formal logic, because it is a phenomenon outside of logic's domain.

Theories

In 1989, Feyerabend presented an idea informed by Popper's critical rationalism whereby "investigation starts with a problem. The problem is the result of a conflict between an expectation and an observation, which, in its turn, is formed by the expectation." (Feyerabend, 1989; pp. 96). Scientific methodology then resolves problems by inventing theories that should be relevant and falsifiable, at least to a greater degree than any other alternative solution. Once an alternative theory is presented the critical phase commences regarding T' which must answer the following questions: (a) why has theory T been successful up until now and (b) why has it failed. If the new theory T' answers both questions then T is discarded.

That is, a new theory T', in order to be an adequate successor to the refuted theory T, must have a collection of additional

predictions regarding T (Class A), as well as a collection of successful predictions that coincide to a certain degree with the old theory (Class S). These Class S predictions constitute those parts of the new theory containing new truths and they therefore exclude a series of consequences of T, the failures in the old theory, which are part of the untrue (false) contents of the new theory (Class F).

Given this model it is possible to construct relational statements between certain terms from T and from T', which will be the basis for the comparison between the theories. This will allow a choice between the two in the light of their empirical contents. But, if we come across a theory T' in which Class S is empty then the theories are incommensurable with each other.

However, Feyerabend clarifies this by stating that, incommensurability between T and T' will depend on the interpretation given to the theories. If this is instrumental, every theory that refers to the same language of observation will be commensurable. In the same way, if a realist perspective is sought then it will favour a unified position which employs the most highly abstracted terms of whatever theory is being considered in order to describe both theories, giving a significance to the observational statements as a function of these terms, or, at least to replace the habitual use they are given.

It can be noted that the instrumentalist interpretation recognizes the existence of certain statements whose truth is not only dependent on the observational statements but also on the evaluation criteria they are subjected to, which are

anchored in the theories. For example, to affirm the relational character of longitude, this asseveration can not be decided solely using observational terms. Its truth value, in part, depends on the theory that establishes the sense in which the terms are used. In this case they relate to quantum mechanics (QM) as opposed to classical mechanics (CM). In this sense, the instrumentalist position only deals with the empirical consequences and leaves to one side the relationship that the concepts have with each other.

In this same wayFeyerabend comments that:

It is certain, of course, that the relativist scheme has very often given us numbers that are practically identical to the numbers obtained from CM, but this does not mean that the concepts are very similar...[For] even if ...yielding strictly identical predictions can be used as an argument to show that the concepts must match, at least in this case, different magnitudes based on different concepts can give identical values for their respective scales while being different magnitudes...[So] it is not possible to make a comparison of the contents, nor is it possible to make a judgement regarding its verisimilitude.

- — *Paul Feyerabend*

Realist objections

In relation to realist objections, Feyerabend returns to an argument elaborated by Carnap and comments that the use of such abstract concepts leads to an impossible position, as "...theoretical terms receive their interpretation by being connected with an observational language and those terms are

empty without that connection." (Feyerabend, pp. 373). As before it follows that they can not be used to confer significance to the observational language as this observational language is its only source of significance, with which it is not possible to make a translation but only a restatement of the term.

Therefore, Feyerabend considers that both the instrumentalist and the realist interpretations are flawed, as they try to defend the idea that incommensurability is a legitimately unsolvable idea with which to revoke the theses of the accumulation of knowledge and panrationalism in science.

This leads to the following consideration: if each new theory has its own observational basis, within the meaning of the theoretical framework, how can we hope that the observations that are produced could eventually refute it. Furthermore, how can we actually recognize that the new position explains what it is supposed to explain or if it is deviating off into other areas and therefore how can the theories be definitively compared.

Feyerabend's answer to the first consideration lies in noting that the initial terms of a theory depend on the postulates of the theory and their associated grammatical rules, in addition, the predictions derived from the theory also depend on the underlying conditions of the system. Feyerabenddoesn't explore the point further, but it can be assumed that if the prediction does not agree with the observation and if we have a high degree of confidence in the description that we have made from the initial conditions than we can be sure that the error must be present in our theory and in its underlying terms.

In dealing with the second considerationFeyerabend asks "why should it be necessary to have a terminology that allows us to say that two theories refer to the same experiment. This supposes aunificationist or possibly a realist aspiration, whose objective appears to be the truth, however, it is assumed that the theory can be compared under a criterion of empirical adequacy. Such an approach would build on the relationship established between the observational statement that describes the outcome of an experiment formulated for each theory independently, which is compared with the predictions that each theory posits. In this way the selection is made when a theory is an empirically better fit. If the objection to the possible deviation of the new theory is not answered it is irrelevant as often history has shown that in fact differing points of view change or modify their fields of application, for example the physics of Aristotle and Newton."

Theory selection

The above implies that the process of choosing between theories does not obey a universal rationality. Feyerabend has the following view regarding whether the absence of a universal rationality constitutes an irrational position:

No, because each individual event is rational in the sense that some of its features can be explained by reasons that are or were accepted at the time in which they occurred, or that were invented in the course of their development. Yes, because even these local reasons, which change over time, are not sufficient to explain all the important features of a particular event.

- — *Paul Feyerabend,*

Feyerabend uses this reasoning to try to shed light on one of Popper's arguments, which says that we are always able to change any statement, even those reference systems that guide our critical thinking. However, the two thinkers reach different conclusions, Popper assumes that it is always possible to make a criticism once the new criteria have been accepted, so the selection can be seen as the result of a rationality "*a posteriori*" to the selection. While, Feyerabend's position is that this solution is merely a verbal ornament whenever the standards are influenced by Popper's first world, the physical world, and they are not just developed in the third world. That is, the standards are influenced by the expectations of their originators, the stances they imply and the ways of interpreting the world they favour, but this is strictly analogous to the same process of the scientific revolution, that leads us to believe that the thesis of incommensurability can also be applied to standards, as is shown by the following asseveration:

Even the most puritanical rationalist will be forced to stop arguing and use propaganda, for example, not because some of their arguments have become invalid, but because the psychological conditions have disappeared that allowed effective argument and therefore influence over the others

- — *Paul Feyerabend,*

Feyerabend states that the Popperian criticism is either related to certain clearly defined procedures, or is totally abstract and leaves others with the task of fleshing it out later with specific contents, making Popper's rationality a "mere verbal ornament." This does not imply that Feyerabend is an

irrationalist but that he considers that the process of scientific change can not be explained in its totality in the light of some rationality, precisely because of incommensurability.

Kuhn's perspectives

The second coauthor of the thesis of incommensurability is Thomas Kuhn, who introduced it in his 1962 book, *The structure of scientific revolutions*, in which he describes it as a universal property that defines the relationship between successive paradigms. Under this meaning incommensurability goes beyond the field of semantics and covers everything relating to its practical application, from the study of problems to the associated methods and rules for their resolution. However, the meaning of the term was continually refined throughout Kuhn's work, he first placed it within the field of semantics and applied a narrow definition, but later he redefined it in a taxonomic sense, wherein changes are found in the relationships between similarities and differences that the subjects of a defining matrix draw over the world.

In The Structure of Scientific Revolutions Kuhn wrote that "the historian of science may be tempted to exclaim that when paradigms change, the world itself changes with them". According to Kuhn, the proponents of different scientific paradigms cannot fully appreciate or understand the other's point of view because they are, as a way of speaking, living in different worlds. Kuhn gave three reasons for this inability:

- Proponents of competing paradigms have different ideas about the importance of solving various

scientific problems, and about the standards that a solution should satisfy.

- The vocabulary and problem-solving methods that the paradigms use can be different: the proponents of competing paradigms utilize a different conceptual network.
- The proponents of different paradigms see the world in a different way because of their scientific training and prior experience in research.

In a postscript (1969) to *The Structure of Scientific Revolutions*, Kuhn added that he thought that incommensurability was, at least in part, a consequence of the role of similarity sets in normal science.

Competing paradigms group concepts in different ways, with different similarity relations. According to Kuhn, this causes fundamental problems in communication between proponents of different paradigms. It is difficult to change such categories in one's mind, because the groups have been learned by means of exemplars instead of definitions. This problem cannot be resolved by using a neutral language for communication, according to Kuhn, since the difference occurs prior to the application of language.

Kuhn's thinking on incommensurability was probably in some part influenced by his reading of Michael Polanyi who held that there can be a logical gap between belief systems and who also said that scientists from different schools, "think differently, speak a different language, live in a different world."

Phases

Given his changing definition of incommensurability Pérez Ransanz has identified three phases in Kuhn's work, or at least in how it deals with this concept. As we have seen above the first phase was seen in *The Structure of Scientific Revolutions* (SSR) and it is characterized by an overall vision that is applied to paradigms. This perspective was replaced in the 1970s by a localist and semanticist vision in which incommensurability is now defined as the relationship between two theories that are articulated in two languages that are not completely interchangeable, as Kuhn states in the following extract:

The phrase "without common measure" is converted into "without common language". To state that two theories are incommensurable means that there is no neutral language, or other type of language, into which both theories, conceived as sets of statements, can be translated without remainder or loss... [Although] the majority of the terms shared by the two theories function in the same way in both...

- — *Thomas Kuhn*

The above only prohibits one type of comparison, that which is carried out between the statements of these two theories in a one-to-one relationship. An idea that underlies this formulation is that translation implies symmetry and transitivity so that if theory T is translatable with theory T', then T' can be translated to T, and furthermore if there is a third theory T *and this can be translated to T', then theories T and T' cannot be incommensurable, as long as the transitive*

relationship and the symmetrical relationship assures that their statements can be compared one to another.

Kuhn did not deny that two incommensurable theories may have a common reference environment and in this sense he did not state that it was impossible to compare them, his thesis solely refers to the ability to translate the statements belonging to two theories in a one-to-one relationship, as is shown in the following passage:

The terms that retain their meanings following a change in theory provide a suitable base for the discussion of the differences and for the comparisons that are relevant in the selection of theories. [Continued in a footnote] It may be noted that these terms are not independent of the theory, but they are simply used in the same way in the two theories in question. It follows that the comparison is a process that compares the two theories, it is not a process that can evaluate the theories separately.

- *— Thomas Kuhn*

This is relevant because it allow us to elucidate that Kuhn's sense of rationality is linked to the ability to comprehend, and not to the same capacity for translation.

In the third stage of Kuhn's work the formulation of the thesis of incommensurability became refined in taxonomic terms and is explained as a function of the change in the relations of similarity and difference between two theories. Kuhn declared that this change relates to the concepts of Class A not only because there is a change in the way of referring to the concepts but also because their underlying structure becomes

altered, that is, the meaning changes – its intention – but also its reference. In this way Kuhn states that not all of the semantic changes are changes that lead to incommensurability, they are only those that, by being made in the basic categories, operate in a holistic manner meaning that all the relationships between these terms becomes altered. This uses taxonomic terms to define incommensurability as the impossibility to prove the taxonomic structures of two theories, an impossibility that is expressed as a necessarily incomplete translation of the terms.

Taxonomic characterization

Taxonomic characterization allowed Kuhn to postulate his no-overlap principle, since, if the taxonomic categories are divisions in a logical sense then this implies that the relations established between these concepts and the rest are necessarily hierarchical. It is for exactly this type of relationship that the changes in categories are holistic, as the modification of a category necessarily implies the modification of the surrounding categories, which explains why once the change takes place the taxonomiescan not be comparable – they are isomorphic.

This characterization was already present in Kuhn's writing along with remnants of semantic characterization, which he developed in full towards the end of the 1980s in his taxonomic characterization. An advantage of this characterization is the belief that the criteria that allow the identification of a concept with its references are many and varied, so that a coincidence of criteria is not necessary for successful communication except for those categories that are implicated. Kuhn saw the

relations between concepts as existing in a multidimensional space, the categories consist of partitions in this space and they must coincide between the communicators, although this is not the case for the criteria that establish a connection between this space and the associated reference.

Reluctance

An important clarification that should be made, and which constantly appears in Kuhn's writing, is his reluctance to equate translation and interpretation, a comparison that Kuhn attributes to the analytical tradition of philosophy. Translation is an almost mechanical activity which produces a Quinean translation manual that relates sequences of words in such a way that their truth values are conserved. However, the process of interpretation implies the development of translation hypotheses, which have to be successful when they allow external preferences to be understood in a coherent and meaningful way. Kuhn then rejected the idea of a universal translatability but not the principle of universal intelligibility, a distinction that is very important in understanding Kuhn's rejection of his critics, such as Popper and Davidson.

However, without a doubt the previous idea invites us to question how is it that we are able to interpret in the first place. Kuhn's solution consists in affirming that this is like learning a new language. How is it that we are able to learn a new language when we are confronted with a holistic change such as is implied by the notion of incommensurability? Kuhn's work suggests four aspects to this question:

- Firstly, in order to carry out such an assimilation it is necessary that the complementary vocabulary is easily understood.
- Secondly, definitions must fulfill a minimal role, it is the paradigmatic examples that introduce the use of the new concepts, in such a way that an ostensive or stipulative component is essential.
- Thirdly, class concepts cannot be learned in isolation, but in relation to a series of contrast sets.
- Fourthly, the process of learning involves the generation of expectations, which are the basis of the projectability of the class terms, in such a way that in their turn they form the basis of, among other things, inductive inferences. And lastly, as the criteria for relating the class and its reference vary, this forms the way of learning the subject matter.

Conclusion

It can be concluded that Kuhn's idea of incommensurability, despite its various reformulations, manages to seriously problematize both the idea of accumulation of a neutral language as well as of the very idea of a neutral language, without falling into irrationalism nor stating that the common reference level is irrelevant. An idea that differentiates him from Feyerabend who states in books such as *Problems of Empiricism* and *Against Method* that if the new theory deviates into new areas, this is not a problem of the theory, as often the conceptual progress leads to the disappearance and not to the refutation or resolution of the old questions.

Meta-incommensurability

A more general notion of incommensurability has been applied to the sciences at the meta-level in two significant ways.

Eric Oberheim and Paul Hoyningen-Huene argue that realist and anti-realist philosophies of science are also incommensurable, thus scientific theories themselves may be meta-incommensurable.

Similarly, Nicholas Best describes a different type of incommensurability between philosophical theories of meaning. He argues that if the meaning of a first-order scientific theory depends on its second-order theory of meaning, then two first order theories will be meta-incommensurable if they depend on substantially different theories of meaning. Whereas Kuhn and Feyerabend's concepts of incommensurability do not imply complete incomparability of scientific concepts, this incommensurability of meaning does.

Domon group

The Domon Group, or Domon Research Group, is an interdisciplinary research group founded by former IBM researcher Eduard Domon in 1973. The group is organized in a loose affiliation of scientists, artists, and activists in laboratories and studios around the world. The Domon Group's research is wide-ranging, but is generally concerned with issues in artificial intelligence, information theory, self-organizing systems and language.

The distributed structure of the group has helped maintain the relative anonymity of members, while providing support and community to researchers working at the fringes of established fields. While there is no available master list of members, former members are believed to include Shawn Brixey of DXARTS at University of Washington, Jacque Servin of the Yes Men, and the model and philosopher Lorianna Tuck. It has also been suggested that Domon Group members have a relatively strong presence in the research department of Google.

Encyclopedism

Encyclopedism is an outlook that aims to include a wide range of knowledge in a single work. The term covers both encyclopedias themselves and related genres in which comprehensiveness is a notable feature. The word encyclopedia is a Latinization of the Greek *enkýkliospaideía*, which means all-around education. The encyclopedia is "one of the few generalizing influences in a world of overspecialization. It serves to recall that knowledge has unity," according to Lewis Shore, editor of *Collier's Encyclopedia*. It should not be "a miscellany, but a concentration, a clarification, and a synthesis", according to British writer H. G. Wells.

Besides comprehensiveness, encyclopedic writing is distinguished by its lack of a specific audience or practical application. The author explains facts concisely for the benefit of a reader who will then use the information in a way that the writer does not try to anticipate. Early examples of encyclopedic writing include discussions of agriculture and craft by Roman writers such as Pliny the Elder and Varro – discussions presumably not intended as practical advice to

farmers or craftsmen. The vast majority of classical learning was lost during the Dark Ages. This enhanced the status of encyclopedic works which survived, including those of Aristotle and Pliny. With the development of printing in the 15th century, the range of knowledge available to readers expanded greatly. Encyclopedic writing became both a practical necessity and a clearly distinguished genre. Renaissance encyclopedists were keenly aware of how much classical learning had been lost. They hoped to recover and record knowledge and were anxious to prevent further loss.

In their modern form, encyclopedias consist of alphabetized articles written by teams of specialists. This format was developed in the 18th century by expanding the technical dictionary to include non-technical topics. The *Encyclopédie* (1751–1772), edited by Diderot and D'Alembert, was a model for many later works. Like Renaissance encyclopedists, Diderot worried about the possible destruction of civilization and selected knowledge he hoped would survive.

Etymology

The word "encyclopedia" is a Latinization of the Greek *enkýkliospaideía.* The Greek phrase refers to the education that a well-round student should receive. Latin writer Quintilian uses it to refer to the subjects a student of oratory should be familiar with before beginning an apprenticeship. It translates literally as "in (*en*) the circle (*kýklios*) of knowledge (*paideía*)." The earliest citation for "encyclopedia" given in *Oxford English Dictionary* refers to the Greek curriculum and is dated 1531.

The use of the term to refer to a genre of literature was prompted by a line that Pliny used in the preface of *Natural History*:</ref> "My object is to treat of all those things which the Greeks include in the Encyclopædia [*tḗsenkyklíoupaideías*], which, however, are either not generally known or are rendered dubious from our ingenious conceits." Pliny writes the relevant phrase using Greek letters. Latin printers of incunabula lacked the typeface to render it. Some printers substituted *encyclopædia* or another Latin phrase. Others just left a blank space. This led to the misunderstanding that Pliny had called his work an encyclopedia.

In the Renaissance, writers who wanted their work compared to that of Pliny used the word. In 1517, Bavarian Johannes Aventinus wrote *Encyclopedia orbisqvedoctrinarum,* a Latin reference work. Ringelberg's*Cyclopedia* was published in 1541 and Paul Scalich's*Encyclopedia* in 1559. Both of these reference works were written in Latin. The French Encyclopédistes popularized the word in the 18th century.

The *Oxford English Dictionary*'s first citation of "enyclopedism" is dated 1833. The context is a book on Diderot.

History

Aristotle

The Greek writer and teacher Aristotle (384–322 BC) had much to say on a broad range of subjects, including biology, anatomy, psychology, physics, meteorology, zoology, poetics, rhetoric, logic, epistemology, metaphysics, ethics, and political thought. He was among the first writers to describe how to

classify material by subject, the first step in writing an encyclopedia. Aristotle wrote to help his students follow his teaching, so his corpus did not much resemble an encyclopedia during his lifetime. Long after his death, commentators filled in the gaps, reordered his works, and put his writing in a systematic form. Catalogs of his work were produced by Andronicus in the first century and by Ptolemy in the second century. As Aristotle's corpus was one of the few encyclopedic works to survive the Middle Ages, it became a widely used reference work in late medieval and Renaissance times.

Alexandria

Dorotheus (mid first century AD) and Pamphilus (late first century AD) both wrote enormous lexicons. Neither work has survived, but their lengths suggest that they were considerably more than just dictionaries. Pamphilus's work was 95 books long and was a sequel to a lexicon of four books by Zopyrion. This passage from the *Souda* suggests that it was made up of alphabetized entries:

Pamphilus, of Alexandria, a grammarian of the school of Aristarchus. He wrote *A Meadow,* which is a summary of miscellaneous contents. *On rare words; i.e. vocabulary* in 95 books (it contains entries from epsilon to omega, because Zopyrion had done letters alpha to delta.) *On unexplained matters in Nicander* and the so called*Optica; Art of Criticism* and a large number of other grammatical works.

Hesychius (fifth century) credits Diogenianus as a source, who in turn used Pamphilus. This is the only form in which any of Pamphilus's work may have survived.

Rome

A Roman who wanted to learn about a certain subject would send a slave to a private library with orders to copy relevant passages from whatever books were available. As they were less likely to withdraw or buy a book, readers were little concerned with the scope of a given work. So the emergence of encyclopedic writing cannot be explained by practical need. Instead, it may have been inspired by Cato's ideal of the *vir bonus*, the informed citizen able to participate in the life of the Republic.

Three Roman works are commonly identified as encyclopedic: The collected works of Varro (116–27 BC), Pliny the Elder's (c. 77–79 AD) *Natural History*, and *On the Arts* by Cornelius Celsus (c. 25 BC – c. 50 AD). These three were grouped together as a genre, not by the Romans themselves, but by later writers in search of antique precedent.

In Cicero's time, the study of literature was still controversial. In *Pro Archia*, Cicero explains that he studied literature to improve his rhetorical skills and because it provides a source of elevating moral examples. Varro's emphasis on the city's history and culture suggests patriotic motives. Pliny emphasized utilitarian motives and public service. He criticized Livy for writing history simply for his own pleasure.

Varro

Varro's *Antiquities* consisted of 41 books on Roman history. His *Disciplines* was nine books on liberal arts. Varro also wrote 25 books on Latin and 15 on law. Only fragments of Varro's work

survive. According to Cicero, Varro's comprehensive work allowed the Romans to feel at home in their own city.

Cornelius Celsus

Celsus wrote prolifically on many subjects. "Cornelius Celsus, a man of modest intellect, could write not only about all these arts but also left behind accounts of military science, agriculture, and medicine: indeed, he deserves, on the basis on this design alone, to be thought to have known all things," according to Quintilian. Only the medical section of his massive *On the Arts* has survived. This is eight books long. Celsus followed the structure of the medical writers that had gone before him. He summarized their views in a workmanlike manner. He seldom presented insights of his own. He struggled to manage the overwhelming quantity of relevant source material. His medical books were rediscovered in 1426-1427 at libraries in the Vatican and in Florence and published in 1478. He is our main source concerning Roman medical practices.

Pliny the Elder

If Varro made the Romans feel at home their own city, Pliny tried to do the same for the natural world and for the Empire. Pliny's approach was very different than that of Celsus. He was a man ahead of his time. Not content to build on what went before, he reorganized the world of knowledge to fit his encyclopedic vision. In a Latin preface, the writer customarily listed the models he hoped to surpass. Pliny found no model in previous writing. Instead, he emphasized that his work was *novicium* (new), a word suitable for describing a major discovery. Although Pliny was widely read, no later Roman

writer followed his structure or claimed him as a model. NiccolòLeoniceno published an essay in 1492 listing Pliny's many scientific errors.

In the introduction of *Natural History*, Pliny writes:

... in Thirty-six Books I have comprised 20,000 Things that are worthy of Consideration, and these I have collected out of about 2000 Volumes that I have diligently read (and of which there are few that Men otherwise learned have ventured to meddle with, for the deep Matter therein contained), and those written by one hundred several excellent Authors; besides a Multitude of other Matters, which either were unknown to our former Writers, or Experience has lately ascertained.

With an entire book dedicated to listing sources, *Natural History* is 37 books long. (It's 10 volumes in the modern translation.) Eschewing established disciplines and categories, Pliny begins with a general description of the world. Book 2 covers astronomy, meteorology, and the elements. Books 3–6 cover geography. Humanity is covered in Book 7, animals in Books 8–11, trees in 12–17, agriculture in 18–19, medicine in 20–32, metals in 33–34, and craft and art in 35–37.

Following Aristotle, Pliny counts four elements: fire, earth, air and water. There are seven planets: Saturn, Jupiter, Mars ("of a fiery and burning nature"), the Sun, Venus, Mercury, and the Moon ("the last of the stars"). The earth is a "perfect globe," suspended in the middle of space, that rotates with incredible swiftness once every 24 hours. As a good Stoic, Pliny dismisses astrology: "it is ridiculous to suppose, that the great head of all things, whatever it be, pays any regard to human affairs." He considers the possibility of other worlds ("there will be so

many suns and so many moons, and that each of them will have immense trains of other heavenly bodies") only to dismiss such speculation as "madness." The idea of space travel is "perfect madness."

Pliny had opinions on a wide variety of subjects often interjected them. He tells us which uses of plants, animals, and stone are proper, and which ones are improper. Was the Roman Empire benefiting or corrupting the classical world? Pliny returns to this theme repeatedly. He analogizes Rome's civilizing mission to the way poisonous plants of all nation were tamed into medicines. Pliny also wants us to know that he is a heroic explorer, a genius responsible for a highly original and most remarkable work. The extensive reading and note taking of his slave secretaries is rarely mentioned.

At the very end of the work, Pliny writes, "Hail Nature, parent of all things, and in recognition of the fact that I alone have praised you in all your manifestations, look favorably upon me." Here Pliny points to comprehensiveness as his project's outstanding asset. Nature awarded Pliny a heroic death that gave him "a kind of eternal life," according to his nephew. The great encyclopedist was commander of the Naples fleet and died trying to assist the local inhabitants during the eruption of Vesuvius in AD 79.

The Middle Ages

While classical and modern encyclopedic writers sought to distribute knowledge, those of the Middle Ages were more interested in establishing orthodoxy. They produced works to be used as educational texts in schools and universities.

Students could consider the knowledge within them as safely orthodox and thus be kept from heresy. Limiting knowledge was an important part of their function.

As a Stoic, Pliny began with astronomy and ended with the fine arts. Cassiodorus attempted to write a Christian equivalent to Pliny's work. His *Institutiones* (560) begins with discussions of scripture and the church. Other subjects are treated briefly toward the end of the work. With onset of the Dark Ages, access to Greek learning and literacy in Greek declined. The works of Boethius (c. 480–524) filled the gap by compiling Greek handbooks and summarizing their content in Latin. These works served as general purpose references in the early Middle Ages.

The Etymologies (c. 600–625) by Isidore of Seville consisted of extracts from earlier writers. Three of the Isidore's twenty books represent material from Pliny. Isidore was the most widely read and fundamental text in terms of medieval encyclopedic writing.

These early medieval writers organized their material in the form of a *trivium* (grammar, logic, rhetoric) followed by a *quadrivium* (geometry, arithmetic, astronomy, music). This division of seven liberal arts was a feature of monastic education as well as the medieval universities, which developed beginning in the 12th century.

From the fourth to the ninth centuries, Byzantium experienced a series of religious debates. As part of these debates, excerpts were compiled and organized thematically to support the theological views of the compiler. Once orthodoxy was established, the energy of the compilation tradition transferred

to other subjects. The tenth century, or Macedonian dynasty, saw a flowering of encyclopedic writing. The Sudais believed to have been compiled at this time. This is the earliest work that a modern reader would recognize as an encyclopedia. It contains 30,000 alphabetized entries. The *Suda*is not mentioned until the 12th century, and it might have been put together in stages.

The most massive encyclopedia of the Middle Ages was *Speculum Maius* (*The Great Mirror*) by Vincent of Beauvais. It was 80 books long and was completed in 1244. With a total of 4.5 million words, the work is presumably the product of an anonymous team. (By comparison, the current edition of *Britannica* has 44 million words.) It was divided into three sections. "Naturale" covered God and the natural world; "Doctrinale" covered language, ethics, crafts, medicine; and "Historiale" covered world history. Vincent had great respect for classical writers such Aristotle, Cicero, and Hippocrates. The encyclopedia shows a tendency toward "exhaustiveness," or systemic plagiarism, typical of the medieval period. Vincent was used as a source by Chaucer. The full version of *Speculum* proved to be too long to circulate in the era of manuscripts and manual copying. However, an abridged version by Bartholomeus Anglicus did enjoy a wide readership.

The Arab counterpart to these works was *Kitab al-Fehrest* by Ibn al-Nadim.

Renaissance

With the advent of printing and a dramatic reduction in paper costs, the volume of encyclopedic writing exploded in the

Renaissance. This was an age of "info-lust" and enormous compilations. Many compilers cited the fear of a traumatic loss of knowledge to justify their efforts. They were keenly aware of how much classical learning had been lost in the Dark Ages. Pliny was their model. His axiom that, "there is no book so bad that some good cannot be got from it" was a favorite. Conrad Gesner listed over 10,000 books in *Bibliotheca universalis* (1545). By including both Christian and barbarian works, Gesner rejected the medieval quest for orthodoxy. Ironically, Jesuit Antonio Possevino used *Bibliotheca universalis* as a basis to create a list of forbidden books.

England

The invention of printing helped spread new ideas, but also revived old misconceptions. Printers of incunabulia were eager to publish books, both ancient and modern. The best-known encyclopedia of Elizabethan England was *Batman upon Bartholomew*, published in 1582. This book is based on a work compiled by BartholomaeusAnglicus in the 13th century. It was translated by John Trevisa in 1398, revised by Thomas Berthelet in 1535, and revised again by Stephen Batman. In Shakespeare's day, it represented a worldview already four centuries old, only modestly updated. Yet several ideas inspired by Batman can be found in Shakespeare. The idea that the rays of the moon cause madness can be found *Measure for Measure* and *Othello*, hence the word "lunacy." The discussion of the geometric properties of the soul in *King Lear* is likely to reflect the influence of Batman as well. An encyclopedia that Shakespeare consulted more obviously than Batman is *French Academy* by Pierre de la Primaudaye. Primaudayewas much taken with analogies, some of which

have found their way into Shakespeare: the unweeded garden, death as an unknown country, and the world as a stage. (Various other sources have also been suggested for the last analogy.) Both Batman and Primaudaye were Protestant.

Francis Bacon wrote a plan for an encyclopedia in *Instauratio magna* (1620). He drew up a checklist of the major areas of knowledge a complete encyclopedia needed to contain. Bacon's plan influenced Diderot and thus indirectly later encyclopedias, which generally follow Diderot's scheme.

The Enlightenment

While ancient and medieval encyclopedism emphasized the classics, liberal arts, informed citizenship, or law, the modern encyclopedia springs from a separate tradition. The advance of technology meant that there was much unfamiliar terminology to explain. John Harris's *Lexicon Technicum* (1704) proclaims itself, "An Universal English Dictionary of Arts and Sciences: Explaining not only the Terms of Art, but the Arts Themselves." This was the first alphabetical encyclopedia written in English. Harris's work inspired Ephraim Chambers's*Cyclopedia* (1728). Chambers's two-volume work is considered the first modern encyclopedia.

Encyclopédie (1751–1777) was a massively expanded version of Chambers's idea. This 32-volume work, edited by Diderot and D'Alembert, was the pride of Enlightenment France. It consisted of 21 volumes of text and 11 volumes of illustrations. There were 74,000 articles written by more than 130 contributors. It presented a secular worldview, drawing the ire of several Church officials. It sought to empower its readers

with knowledge and played a role in fomenting the dissent that led to the French Revolution. Diderot explained the project this way:

This is a work that cannot be completed except by a society of men of letters and skilled workmen, each working separately on his own part, but all bound together solely by their zeal for the best interests of the human race and a feeling of mutual good will.

This realization that no one person, not even a genius like Pliny assisted by slave secretaries, could produce a work of the comprehensiveness required, is the mark of the modern era of encyclopedism.

Diderot's project was a great success and inspired several similar projects, including Britain's *Encyclopædia Britannica* (first edition, 1768) as well as Germany's *BrockhausEnzyklopädie* (beginning 1808). Enlightenment encyclopedias also inspired authors and editors to undertake or critique "encyclopedic" knowledge projects in other genres and formats: the 65-volume Universal History (Sale et al) (1747-1768), for example, far exceeded its predecessors in terms of scope, and *The General Magazine of Arts and Sciences* (1755-1765) published by Benjamin Martin (lexicographer) sought to bring encyclopedism to the monthly periodical. A loyal subscriber, he wrote, would “be allowed to make a great Proficiency, if he can make himself Master of the useful Arts and Sciences in the Compass of Ten Years.” In Laurence Sterne's *The Life and Opinions of TristramShandy, Gentleman* (1759-1767), the title character satirically refers to his fictional autobiography as a “cyclopædia of arts and sciences."

Such "experiments in encyclopedism" demonstrate the widespread literary and cultural influence of the form in the 18th century.

The 19th and 20th centuries

Once solely for society's elites, in the 19th and 20th centuries encyclopedias were increasingly written, marketed to, and purchased by middle and working class households. Different styles of encyclopedism emerged which would target particular age groups, presenting the works as educational tools—even made available through payment plans advertised on TV.

One of the earliest individuals to advocate for a technologically enhanced encyclopedia indexing all the world's information was H. G. Wells. Inspired by the possibilities of microfilm, he put forward his idea of a global encyclopedia in the 1930s through a series of international talks and his essay *World Brain*.

It would be another several decades before the earliest electronic encyclopedias were published in the 1980s and 1990s. The production of electronic encyclopedias began as conversions of printed work, but soon added multimedia elements, requiring new methods of content gathering and presentation. Early applications of hypertext similarly had a great benefit to readers but did not require significant changes in writing. The launching of Wikipedia in the 2000s and its subsequent rise in popularity and influence, however, radically altered popular conception of the ways in which an encyclopedia is produced (collaboratively, openly) and consumed (ubiquitously).

China

The nearest Chinese equivalent to an encyclopedia is the *leishu*. These consist of extensive quotations arranged by category. The earliest known Chinese encyclopedia is *Huang Lan* (*Emperor's mirror*), produced around 220 under the Wei dynasty. No copy has survived. The best-known *leishu* are those of Li Fang (925–996), who wrote three such works during the Song dynasty. These three were later combined with a fourth work, *CefuYuangui*, to create *Four Great Books of Song*.

Holism

Holism (from Greek ὅλος*holos* "all, whole, entire") is the idea that various systems (e.g. physical, biological, social) should be viewed as wholes, not merely as a collection of parts. The term "holism" was coined by Jan Smuts in his 1926 book *Holism and Evolution*.

Meaning

The exact meaning of "holism" depends on context. Smuts originally used "holism" to refer to the tendency in nature to produce wholes from the ordered grouping of unit structures. However, in common usage, "holism" usually refers to the idea that a whole is greater than the sum of its parts. In this sense, "holism" may also be spelled "**wholism**" (although the two are not etymologically related), and it may be contrasted with reductionism or atomism.

Diet and health

The term holistic when applied to diet or medical health refers to an intuitive approach to food, eating, or lifestyle. One example is in the context of holistic medicine, where "holism" refers to treating all aspects of a person's health, including psychological and societal factors, rather than only their physical conditions or symptoms. In this sense, holism may also be called "**holiatry.**" Several approaches are used by medical doctors, dietitians, and religious institutions, and are usually recommended based on an individual basis. Adherents of religious institutions that practice a holistic dietary and health approach, such as Hinduism, Shinto, and the Seventh-day Adventist Church, have been shown to have longer lifespans than those of surrounding populations [citation needed].

Philosophy

In Philosophy of science, logical holism is the concept that a theory can only be understood in its entirety.

Holism in science

Holism in science, and **holistic science**, is an approach to research that emphasizes the study of complex systems. Systems are approached as coherent wholes whose component parts are best understood in context and in relation to one another and to the whole.

This practice is in contrast to a purely analytic tradition (sometimes called reductionism) which aims to gain

understanding of systems by dividing them into smaller composing elements and gaining understanding of the system through understanding their elemental properties. The holism-reductionism dichotomy is often evident in conflicting interpretations of experimental findings and in setting priorities for future research.

Overview

David Deutsch calls holism anti-reductionist and refers to the concept of thinking as the only legitimate way to think about science in as a series of emergent, or higher level phenomena. He argues that neither approach is purely correct.

Two aspects of Holism are:

- The way of doing science, sometimes called "whole to parts", which focuses on observation of the specimen within its ecosystem first before breaking down to study any part of the specimen.
- The idea that the scientist is not a passive observer of an external universe but rather a participant in the system.

Proponents claim that Holistic science is naturally suited to subjects such as ecology, biology, physics and the social sciences, where complex, non-linear interactions are the norm. These are systems where emergent properties arise at the level of the whole that cannot be predicted by focusing on the parts alone, which may make mainstream, reductionist science ill-equipped to provide understanding beyond a certain level. This principle of emergence in complex systems is often captured in

the phrase 'the whole is greater than the sum of its parts'. Living organisms are an example: no knowledge of all the chemical and physical properties of matter can explain or predict the functioning of living organisms. The same happens in complex social human systems, where detailed understanding of individual behaviour cannot predict the behaviour of the group, which emerges at the level of the collective.

The phenomenon of emergence may impose a theoretical limit on knowledge available through reductionist methodology, arguably making complex systems natural subjects for holistic approaches.

Science journalist John Horgan has expressed this view in the book *The End of Science*. He wrote that a certain pervasive model within holistic science, self-organized criticality, for example, "is not really a theory at all. Like punctuated equilibrium, self-organized criticality is merely a description, one of many, of the random fluctuations, the noise, permeating nature." By the theorists' own admissions, he said, such a model "can generate neither specific predictions about nature nor meaningful insights. What good is it, then?"

One of the reasons that holistic science attracts supporters is that it seems to offer a progressive, 'socio-ecological' view of the world, but Alan Marshall's book *The Unity of Nature* offers evidence to the contrary; suggesting holism in science is not 'ecological' or 'socially-responsive' at all, but regressive and repressive.

Examples in various fields of science

Physical science

Agriculture

Permaculture takes a systems level approach to agriculture and land management by attempting to copy what happens in the natural world. Holistic management integrates ecology and social sciences with food production. It was originally designed as a way to reverse desertification. Organic farming is sometimes considered a holistic approach.

In physics

Richard Healey offered a modal interpretation and used it to present a model account of the puzzling correlations which portrays them as resulting from the operation of a process that violates both spatial and spatiotemporal separability. He argued that, on this interpretation, the nonseparability of the process is a consequence of physical property holism; and that the resulting account yields genuine understanding of how the correlations come about without any violation of relativity theory or Local Action. Subsequent work by Clifton, Dickson and Myrvold cast doubt on whether the account can be squared with relativity theory's requirement of Lorentz invariance but leaves no doubt of an spatially entangled holism in the theory. Paul Davies and John Gribbin further observe that Wheeler's delayed choice experiment shows how the quantum world

displays a sort of holism in time as well as space. In the holistic approach of David Bohm, any collection of quantum objects constitutes an indivisible whole within an implicate and explicate order. Bohm said there is no scientific evidence to support the dominant view that the universe consists of a huge, finite number of minute particles, and offered instead a view of undivided wholeness: "ultimately, the entire universe (with all its 'particles', including those constituting human beings, their laboratories, observing instruments, etc.) has to be understood as a single undivided whole, in which analysis into separately and independently existent parts has no fundamental status".

Chaos and complexity

Scientific holism holds that the behavior of a system cannot be perfectly predicted, no matter how much data is available. Natural systems can produce surprisingly unexpected behavior, and it is suspected that behavior of such systems might be computationally irreducible, which means it would not be possible to even approximate the system state without a full simulation of all the events occurring in the system. Key properties of the higher level behavior of certain classes of systems may be mediated by rare "surprises" in the behavior of their elements due to the principle of interconnectivity, thus evading predictions except by brute force simulation.

Ecology

Holistic thinking can be applied to ecology, combining biological, chemical, physical, economic, ethical, and political insights. The complexity grows with the area, so that it is

necessary to reduce the characteristic of the view in other ways, for example to a specific time of duration.

Medicine

In primary care the term "holistic," has been used to describe approaches that take into account social considerations and other intuitive judgements. The term holism, and so-called approaches, appear in psychosomatic medicine in the 1970s, when they were considered one possible way to conceptualize psychosomatic phenomena. Instead of charting one-way causal links from psyche to soma, or vice versa, it aimed at a systemic model, where multiple biological, psychological and social factors were seen as interlinked.

Other, alternative approaches in the 1970s were psychosomatic and somatopsychic approaches, which concentrated on causal links only from psyche to soma, or from soma to psyche, respectively. At present it is commonplace in psychosomatic medicine to state that psyche and soma cannot really be separated for practical or theoretical purposes.

The term systems medicine first appeared in 1992 and takes an integrative approach to all of the body and environment.

Social science

Economics

Some economists use a causal holism theory in their work. That is they view the discipline in the manner of Ludwig Wittgenstein and claim that it can't be defined by necessary and sufficient conditions.

Education reform

The Taxonomy of Educational Objectives identifies many levels of cognitive functioning, which it is claimed may be used to create a more holistic education. In authentic assessment, rather than using computers to score multiple choice tests, a standards based assessment uses trained scorers to score open-response items using holistic scoring methods. In projects such as the North Carolina Writing Project, scorers are instructed not to count errors, or count numbers of points or supporting statements. The scorer is instead instructed to judge holistically whether "as a whole" is it more a "2" or a "3". Critics question whether such a process can be as objective as computer scoring, and the degree to which such scoring methods can result in different scores from different scorers.

Anthropology

There is an ongoing dispute as to whether anthropology is intrinsically holistic. Supporters of this concept consider anthropology holistic in two senses. First, it is concerned with all human beings across times and places, and with all dimensions of humanity (evolutionary, biophysical, sociopolitical, economic, cultural, psychological, etc.) Further, many academic programs following this approach take a "four-field" approach to anthropology that encompasses physical anthropology, archeology, linguistics, and cultural anthropology or social anthropology.

Some leading anthropologists disagree, and consider anthropological holism to be an artifact from 19th century

social evolutionary thought that inappropriately imposes scientific positivism upon cultural anthropology.

The term "holism" is additionally used within social and cultural anthropology to refer to an analysis of a society as a whole which refuses to break society into component parts. One definition says: "as a methodological ideal, holism implies ... that one does not permit oneself to believe that our own established institutional boundaries (e.g. between politics, sexuality, religion, economics) necessarily may be found also in foreign societies."

Psychology of perception

A major holist movement in the early twentieth century was gestalt psychology. The claim was that perception is not an aggregation of atomic sense data but a field, in which there is a figure and a ground. Background has holistic effects on the perceived figure. Gestalt psychologists included Wolfgang Koehler, Max Wertheimer, KurtKoffka. Koehler claimed the perceptual fields corresponded to electrical fields in the brain. Karl Lashley did experiments with gold foil pieces inserted in monkey brains purporting to show that such fields did not exist. However, many of the perceptual illusions and visual phenomena exhibited by the gestaltists were taken over (often without credit) by later perceptual psychologists. Gestalt psychology had influence on Fritz Perls' gestalt therapy, although some old-line gestaltists opposed the association with counter-cultural and New Age trends later associated with gestalt therapy. Gestalt theory was also influential on phenomenology. Aron Gurwitsch wrote on the role of the field of consciousness in gestalt theory in relation to

phenomenology. Maurice Merleau-Ponty made much use of holistic psychologists such as work of Kurt Goldstein in his "Phenomenology of Perception."

Teleological psychology

Alfred Adler believed that the individual (an integrated whole expressed through a self-consistent unity of thinking, feeling, and action, moving toward an unconscious, fictional final goal), must be understood within the larger wholes of society, from the groups to which he belongs (starting with his face-to-face relationships), to the larger whole of mankind. The recognition of our social embeddedness and the need for developing an interest in the welfare of others, as well as a respect for nature, is at the heart of Adler's philosophy of living and principles of psychotherapy. Edgar Morin, the French philosopher and sociologist, can be considered a holist based on the transdisciplinary nature of his work.

Degree programs

Schumacher College in the UK, offers an MSc degree program in Holistic Science

Skeptical reception

According to skeptics, the phrase "holistic science" is often misused by pseudosciences. In the book *Science and Pseudoscience in Clinical Psychology*it's noted that "Proponents of pseudoscientific claims, especially in organic medicine, and mental health, often resort to the "mantra of holism" to explain

away negative findings. When invoking the mantra, they typically maintain that scientific claims can be evaluated only within the context of broader claims and therefore cannot be evaluated in isolation." This is an invocation of Karl Popper's demarcation problem and in a posting to *Ask a Philosopher* Massimo Pigliucci clarifies Popper by positing, "Instead of thinking of science as making progress by inductive generalization (which doesn't work because no matter how many times a given theory may have been confirmed thus far, it is always possible that new, contrary, data will emerge tomorrow), we should say that science makes progress by conclusively disconfirming theories that are, in fact, wrong."

Victor J. Stengerstates that "holistic healing is associated with the rejection of classical, Newtonian physics. Yet, holistic healing retains many ideas from eighteenth and nineteenth century physics. Its proponents are blissfully unaware that these ideas, especially superluminal holism, have been rejected by modern physics as well".

Some quantum mystics interpret the wave function of quantum mechanics as a vibration in a holistic ether that pervades the universe and wave function collapse as the result of some cosmic consciousness. This is a misinterpretation of the effects of quantum entanglement as a violation of relativistic causality and quantum field theory.

Chapter 4

Theoretical Linguistics

Theoretical linguistics is a term in linguistics which, like the related term **general linguistics**, can be understood in different ways. Both can be taken as a reference to theory of language, or the branch of linguistics which inquires into the nature of language and seeks to answer fundamental questions as to what language is, or what the common ground of all languages is. The goal of theoretical linguistics can also be the construction of a general theoretical framework for the description of language.

Another use of the term depends on the organisation of linguistics into different sub-fields. The term theoretical linguistics is commonly juxtaposed with applied linguistics. This perspective implies that the aspiring language professional, e.g. a teacher student, must first learn the *theory* i.e. properties of the linguistic system, or what Ferdinand de Saussure called *internal linguistics*. This is followed by *practice,* or studies in the applied field. The dichotomy is not fully unproblematic because language pedagogy, language technology and other aspects of applied linguistics include theory, too.

Similarly, the term general linguistics is used to distinguish core linguistics from other types of study. However, because college and university linguistics is largely distributed with the institutes and departments of a relatively small number of national languages, some larger universities also offer courses and research programmes in 'general linguistics' which may

cover exotic and minority languages, cross-linguistic studies and various other topics outside the scope of the main philological departments.

Fields of linguistics proper

When the concept of theoretical linguistics is taken as referring to *core* or *internal linguistics*, it means the study of the parts of the language system. This traditionally means phonology, morphology, syntax and semantics. Pragmatics and discourse can also be included; delimitation varies between institutions. Furthermore, Saussure's definition of general linguistics consists of the dichotomy of synchronic and diachronic linguistics, thus including historical linguistics as a core issue.

Linguistic theories

There are various frameworks of linguistic theory which include a general theory of language and a general theory of linguistic description. Current humanistic approaches include theories within structural linguistics and functional linguistics. Evolutionary linguistics includes various frameworks of generative grammar and cognitive linguistics.

Cognitive linguistics

Cognitive linguistics is an interdisciplinary branch of linguistics, combining knowledge and research from cognitive science, cognitive psychology, neuropsychology and linguistics.

Models and theoretical accounts of cognitive linguistics are considered as psychologically real, and research in cognitive linguistics aims to help understand cognition in general and is seen as a road into the human mind.

There has been scientific and terminological controversy around the label 'cognitive linguistics'; there is no consensus on what specifically is meant with the term.

Background

The roots of cognitive linguistics are in Noam Chomsky's 1959 critical review of B. F. Skinner's *Verbal Behavior*. Chomsky's rejection of behavioural psychology and his subsequent anti-behaviourist activity helped bring about a shift of focus from empiricism to mentalism in psychology under the new concepts of cognitive psychology and cognitive science.

Chomsky considered linguistics as a subfield of cognitive science in the 1970s but called his model transformational or generative grammar. Having been engaged with Chomsky in the linguistic wars, George Lakoff united in the early 1980s with Ronald Langacker and other advocates of neo-Darwinian linguistics in a so-called "Lakoff—Langacker agreement". It is suggested that they picked the name "cognitive linguistics" for their new framework to undermine the reputation of generative grammar as a cognitive science.

Consequently, there are three competing approaches that today consider themselves as true representatives of cognitive linguistics. One is the Lakoffian—Langackerian brand with capitalised initials (Cognitive Linguistics). The second is

generative grammar, while the third approach is proposed by scholars whose work falls outside the scope of the other two. They argue that cognitive linguistics should not be taken as the name of a specific selective framework, but as a whole field of scientific research that is assessed by its evidential rather than theoretical value.

Approaches

Generative Grammar

Generative grammar functions as a source of hypotheses about language computation in the mind and brain. It is argued to be the study of 'the cognitive neuroscience of language'. Generative grammar studies behavioural instincts and the biological nature of cognitive-linguistic algorithms, providing a computational–representational theory of mind.

This in practice means that sentence analysis by linguists is taken as a way to uncover cognitive structures. It is argued that a random genetic mutation in humans has caused syntactic structures to appear in the mind. Therefore, the fact that people have language does not rely on its communicative purposes.

For a famous example, it was argued by linguist Noam Chomsky that sentences of the type "*Is the man who is hungry ordering dinner*" are so rare that it is unlikely that children will have heard them. Since they can nonetheless produce them, it was further argued that the structure is not learned but *acquired* from an innate cognitive language component. Generative grammarians then took as their task to find out all

about innate structures through introspection in order to form a picture of the hypothesised language faculty.

Generative grammar promotes a modular view of the mind, considering language as an autonomous mind module. Thus, language is separated from mathematical logic to the extent that inference plays no role in language acquisition. The generative conception of human cognition is also influential in cognitive psychology and computer science.

Cognitive Linguistics (linguistics framework)

One of the approaches to cognitive linguistics is called Cognitive Linguistics, with capital initials, but it is also often spelled cognitive linguistics with all lowercase letters. This movement saw its beginning in early 1980s when George Lakoff's metaphor theory was united with Ronald Langacker's Cognitive Grammar, with subsequent models of Construction Grammar following from various authors. The union entails two different approaches to linguistic and cultural evolution: that of the conceptual metaphor, and the construction.

Cognitive Linguistics defines itself in opposition to generative grammar, arguing that language functions in the brain according to general cognitive principles. Lakoff's and Langacker's ideas are applied across sciences. In addition to linguistics and translation theory, Cognitive Linguistics is influential in literary studies, education, sociology, musicology, computer science and theology.

A. Conceptual metaphor theory

According to American linguist George Lakoff, *metaphors* are not just figures of speech, but modes of thought. Lakoffhypothesises that principles of abstract reasoning may have evolved from visual thinking and mechanisms for representing spatial relations that are present in lower animals. Conceptualisationis regarded as being based on the *embodiment* of knowledge, building on physical experience of vision and motion. For example, the 'metaphor' of emotion builds on downward motion while the metaphor of reason builds on upward motion, as in saying “The discussion *fell* to the emotional level, but I *raised it back up* to the rational plane." It is argued that language is not a cognitive capacity, but instead relies on other cognitive skills which include perception, attention, motor skills, and visual and spatial processing. Same is said of other cognitive phenomena such as the sense of time:

- "In our visual systems, we have detectors for motion and detectors for objects/locations. We do not have detectors for time (whatever that could mean). Thus, it makes good biological sense that time should be understood in terms of things and motion." —George Lakoff

In Cognitive Linguistics, thinking is argued to be mainly automatic and unconscious. Like in neuro-linguistic programming, language is approached via the senses. Cognitive linguists study the embodiment of knowledge by seeking expressions which relate to modal schemas. For example, in the expression "It is quarter to eleven", the preposition *to* represents a modal schema which is manifested in language as a visual or sensorimotoric 'metaphor'.

B. Cognitive and construction grammar

Constructions, as the basic units of grammar, are conventionalised form–meaning pairings which are comparable to memes as units of linguistic evolution. These are considered multi-layered. For example, idioms are higher-level constructions which contain words as middle-level constructions, and these may contain morphemes as lower-level constructions. It is argued that humans do not only share the same body type, allowing a common ground for embodied representations; but constructions provide common ground for uniform expressions within a speech community. Like biological organisms, constructions have life cycles which are studied by linguists.

According to the cognitive and *constructionist* view, there is no grammar in the traditional sense of the word. What is commonly perceived as grammar is an inventory of constructions; a complex adaptive system; or a population of constructions. Constructions are studied in all fields of language research from language acquisition to corpus linguistics.

Integrative cognitive linguistics

There is also a third approach to cognitive linguistics which neither directly supports the modular (Generative Grammar) nor the anti-modular (Cognitive Linguistics) view of the mind. Proponents of the third view argue that, according to brain research, language processing is specialised although not autonomous from other types of information processing. Language is thought of as one of human cognitive abilities

along with perception, attention, memory, motor skills, and visual and spatial processing, rather than being subordinate to them. Emphasis is laid on a cognitive semantics that studies the contextual–conceptual nature of meaning.

Computational Approaches

Cognitive Perspective on Natural Language Processing

Cognitive Linguistics offers a scientific First Principle direction for quantifying states-of-mind through Natural language processing. As mentioned earlier Cognitive Linguistics approaches grammar with a nontraditional view. Traditionally Grammar has been defined as a set of structural rules governing the composition of clauses, phrases and words in a natural language. From the perspective of Cognitive Linguistics, grammar is seen as the rules of arrangement of language which best serve communication of the experience of the human organism through its cognitive skills which include perception, attention, motor skills, and visual and spatial processing. Such rules are derived from observing the conventionalized pairings of meaning to understand sub-context in the evolution of language patterns. The cognitive approach to identifying sub-context by observing what comes before and after each linguistic construct provides a grounding of meaning in terms of sensorimotoric embodied experience. When taken together, these two perspectives form the basis of defining approaches in Computational linguistics with strategies to work through the Symbol grounding problem which posits that, for a computer, a word is merely a symbol, which is a symbol for another symbol and so on in an

unending chain without grounding in human experience. The broad set of tools and methods of Computational linguistics are available as Natural language processing or NLP. Cognitive Linguistics adds a new set of capabilities to NLP. These cognitive NLP methods enable software to analyze sub-context in terms of internal embodied experience.

Methods

The goal of Natural language processing (NLP) is to enable a computer to "understand" the contents of text and documents, including the contextual nuances of the language within them. The perspective of Traditional Chomskyan Linguistics offers NLP three approaches or methods to identify and quantify the literal contents, the who, what, where and when in text – in linguistic terms, the semantic meaning or Semantics of the text. The perspective of Cognitive linguistics offers NLP a direction to identify and quantify the contextual nuances, the why and how in text – in linguistics terms, the implied pragmatic meaning or Pragmatics of text.

The three NLP approaches to understanding literal semantics in text based on traditional linguistics are Symbolic NLP, Statistical NLP, and Neural NLP. The first method, Symbolic NLP (1950s - early 1990s) is based on first principles and rules of traditional linguistics. The second method, Statistical NLP (1990s - 2010s), builds upon the first method with a layer of human curated & machine-assisted corpora for multiple contexts. The third approach Neural NLP (2010 onwards), builds upon the earlier methods by leveraging advances in deep neural network-style methods to automate tabulation of corpora & parse models for multiple contexts in shorter periods

of time. All three methods are used to power NLP techniques like Stemming and Lemmatisation in order to obtain statistically relevant listing of the who, what, where & when in text through Named-entity recognition and Topic model programs. The same methods have been applied with NLP techniques like a Bag-of-words model to obtain statistical measures of emotional context through Sentiment analysis programs. The accuracy of a sentiment analysis system is, in principle, how well it agrees with human judgments. Because evaluation of sentiment analysis is becoming more and more specialty based, each implementation needs a separate training model and specialized human verification raising Inter-rater reliability issues. However, the accuracy is considered generally acceptable for use in evaluating emotional context at a statistical or group level.

A developmental trajectory of NLP to understand contextual pragmatics in text involving emulating intelligent behavior and apparent comprehension of natural language is Cognitive NLP. This method is a rules based approach which involves assigning meaning to a word, phrase, sentence or piece of text based on the information presented before and after the piece of text being analyzed.

Controversy

The specific meaning of cognitive linguistics, the proper address of the name, and the scientific status of the enterprise have been called into question. It is claimed that much of so-called cognitive linguistics fails to live up to its name.

"It would seem to me that [cognitive linguistics] is the sort of linguistics that uses findings from cognitive psychology and neurobiology and the like to explore how the human brain produces and interprets language. In other words, cognitive linguistics is a cognitive science, whereas Cognitive Linguistics is not. Most of generative linguistics, to my mind, is not truly cognitive either."

- *— Bert Peeters*

It is suggested that the aforementioned frameworks, which make use of the label 'cognitive', are pseudoscience because their views of the mind and brain defy basic modern understanding of neuroscience, and are instead based on scientifically unjustified guru teachings. Members of such frameworks are also said to have used other researchers' findings to present them as their own work. While this criticism is accepted for most part, it is claimed that some of the research has nonetheless produced useful insights.

Generative grammar

Generative grammar is a concept in generative linguistics, a linguistic theory that regards linguistics as the study of a hypothesised innate grammatical structure. It is a biological or biologistic modification of structuralist theories, deriving ultimately from glossematics. Generative grammar considers grammar as a system of rules that generates exactly those combinations of words that form grammatical sentences in a given language. The difference from structural and functional models is that the object is base-generated within the verb phrase in generative grammar. This purportedly cognitive

structure is thought of as being a part of a universal grammar, a syntactic structure which is caused by a genetic mutation in humans.

Generativists have created numerous theories to make the NP VP (NP) analysis work in natural language description. That is, the subject and the verb phrase appearing as independent constituents, and the object placed within the verb phrase. A main point of interest remains in how to appropriately analyseWh-movement and other cases where the subject appears to separate the verb from the object. Although claimed by generativists as a cognitively real structure, neuroscience has found no evidence for it. In other words, generative grammar encompasses proposed models of linguistic cognition; but as of yet there is no specific indication that these are quite correct.

Frameworks

There are a number of different approaches to generative grammar. Common to all is the effort to come up with a set of rules or principles that formally defines each and every one of the members of the set of well-formed expressions of a natural language. The term *generative grammar* has been associated with at least the following schools of linguistics:

- Transformational grammar (TG)
- Standard theory (ST)
- Extended standard theory (EST)
- Revised extended standard theory (REST)
- Principles and parameters theory (P&P)
- Government and binding theory (GB)

- Minimalist program (MP)
- Monostratal (or non-transformational) grammars
- Relational grammar (RG)
- Lexical-functional grammar (LFG)
- Generalized phrase structure grammar (GPSG)
- Head-driven phrase structure grammar (HPSG)
- Categorial grammar
- Tree-adjoining grammar
- Optimality Theory (OT)

Historical development of models of transformational grammar

Leonard Bloomfield, an influential linguist in the American Structuralist tradition, saw the ancient Indian grammarian Pāṇini as an antecedent of structuralism. However, in *Aspects of the Theory of Syntax*, Chomsky writes that "even Panini's grammar can be interpreted as" a fragment of a generative grammar, a view that he reiterated in an award acceptance speech delivered in India in 2001, where he claimed that "The first generative grammar in the modern sense was Panini's grammar".

Military funding to generativist research was influential to its early success in the 1960s.

Generative grammar has been under development since the mid 1950s, and has undergone many changes in the types of rules and representations that are used to predict grammaticality. In tracing the historical development of ideas within generative grammar, it is useful to refer to the various stages in the development of the theory:

Standard theory (1956–1965)

The so-called standard theory corresponds to the original model of generative grammar laid out by Chomsky in 1965.

A core aspect of standard theory is the distinction between two different representations of a sentence, called deep structure and surface structure. The two representations are linked to each other by transformational grammar.

Extended standard theory (1965–1973)

The so-called extended standard theory was formulated in the late 1960s and early 1970s. Features are:

- syntactic constraints
- generalized phrase structures (X-bar theory)

Revised extended standard theory (1973–1976)

The so-called revised extended standard theory was formulated between 1973 and 1976. It contains

- restrictions upon X-bar theory (Jackendoff (1977)).
- assumption of the complementizer position.
- Move α

Relational grammar (ca. 1975–1990)

An alternative model of syntax based on the idea that notions like subject, direct object, and indirect object play a primary role in grammar.

Government and binding/principles and parameters theory (1981–1990)

Chomsky's *Lectures on Government and Binding* (1981) and *Barriers* (1986).

Minimalist program (1990–present)

The minimalist program is a line of inquiry that hypothesizes that the human language faculty is optimal, containing only what is necessary to meet humans' physical and communicative needs, and seeks to identify the necessary properties of such a system. It was proposed by Chomsky in 1993.

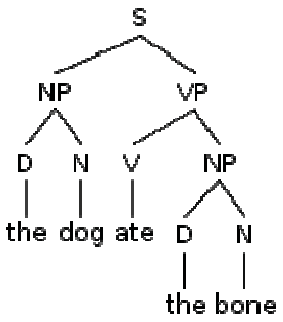
Context-free grammars

Generative grammars can be described and compared with the aid of the Chomsky hierarchy (proposed by Chomsky in the 1950s). This sets out a series of types of formal grammars with increasing expressive power. Among the simplest types are the regular grammars (type 3); Chomsky claims that these are not adequate as models for human language, because of the allowance of the center-embedding of strings within strings, in all natural human languages.

At a higher level of complexity are the context-free grammars (type 2). The derivation of a sentence by such a grammar can be depicted as a derivation tree. Linguists working within generative grammar often view such trees as a primary object of study. According to this view, a sentence is not merely a string of words. Instead, adjacent words are combined into

constituents, which can then be further combined with other words or constituents to create a hierarchical tree-structure.

The derivation of a simple tree-structure for the sentence "the dog ate the bone" proceeds as follows. The determiner *the* and noun *dog* combine to create the noun phrase *the dog*. A second noun phrase *the bone* is created with determiner *the* and noun *bone*. The verb *ate* combines with the second noun phrase, *the bone*, to create the verb phrase *ate the bone*. Finally, the first noun phrase, *the dog*, combines with the verb phrase, *ate the bone*, to complete the sentence: *the dog ate the bone*. The following tree diagram illustrates this derivation and the resulting structure:



Such a tree diagram is also called a phrase marker. They can be represented more conveniently in text form, (though the result is less easy to read); in this format the above sentence would be rendered as:

$[_{S}\ [_{NP}\ [_{D}$ The] $[_{N}$ dog]] $[_{VP}\ [_{V}$ ate] $[_{NP}\ [_{D}$ the] $[_{N}$ bone]]]]

Chomsky has argued that phrase structure grammars are also inadequate for describing natural languages, and formulated the more complex system of transformational grammar.

Evidentiality

Noam Chomsky, the main proponent of generative grammar, believed to have found linguistic evidence that syntactic structures are not learned but 'acquired' by the child from universal grammar. This led to the establishment of the poverty of the stimulus argument in the 1980s. However, critics claimed Chomsky's linguistic analysis had been inadequate. Linguistic studies had been made to prove that children have innate knowledge of grammar that they could not have learned. For example, it was shown that a child acquiring English knows how to differentiate between the place of the verb in main clauses from the place of the verb in relative clauses. In the experiment, children were asked to turn a declarative sentence with a relative clause into an interrogative sentence. Against the expectations of the researchers, the children did not move the verb in the relative clause to its sentence initial position, but to the main clause initial position, as is grammatical. Critics however pointed out that this was not evidence for the poverty of the stimulus because the underlying structures that children were proved to be able to manipulate were actually highly common in children's literature and everyday language. This led to a heated debate which resulted in the rejection of generative grammar from mainstream psycholinguistics and applied linguistics around 2000. In the aftermath, some professionals argued that decades of research had been wasted due to generative grammar, an approach which has failed to make a lasting impact on the field.

There is no evidence that syntactic structures are innate. While some hopes were raised at the discovery of the *FOXP2* gene, there is not enough support for the idea that it is 'the grammar gene' or that it had much to do with the relatively recent emergence of syntactical speech.

Neuroscientific studies using ERPs have found no scientific evidence for the claim that human mind processes grammatical objects as if they were placed inside the verb phrase. Instead, brain research has shown that sentence processing is based on the interaction of semantic and syntactic processing. However, since generative grammar is not a theory of neurology, but a theory of psychology, it is completely normal in the field of neurology to find no concreteness of the verb phrase in the brain. In fact, these rules do not exist in our brains, but they do model the external behaviour of the mind. This is why GG claims to be a theory of psychology and is considered to be real cognitively.

Generativists also claim that language is placed inside its own mind module and that there is no interaction between first-language processing and other types of information processing, such as mathematics. This claim is not based on research or the general scientific understanding of how the brain works.

Chomsky has answered the criticism by emphasising that his theories are actually counter-evidential. He however believes it to be a case where the real value of the research is only understood later on, as it was with Galileo.

Music

Generative grammar has been used to a limited extent in music theory and analysis since the 1980s. The most well-known approaches were developed by Mark Steedman as well as Fred Lerdahl and Ray Jackendoff, who formalized and extended ideas from Schenkerian analysis. More recently, such early generative approaches to music were further developed and extended by various scholars. French Composer Philippe Manoury applied the systematic of generative grammar to the field of contemporary classical music.

Formalism (linguistics)

In linguistics, the term **formalism** is used in a variety of meanings which relate to formal linguistics in different ways. In common usage, it is merely synonymous with a **grammatical model** or a **syntactic model**: a method for analyzing sentence structures. Such formalisms include different methodologies of generative grammar which are especially designed to produce grammatically correct strings of words; or the likes of Functional Discourse Grammar which builds on predicate logic.

Additionally, *formalism*can be thought of as a theory of language. This is most commonly a reference to mathematical formalism which argues that syntax is purely axiomatic being based on sequences generated by mathematical operations. This idea stands in contradistinction to psychologism and logicism which, respectively, argue that syntax is based on

human psychology; or on semantic a priori structures which exist independently of humans.

Definitions

Rudolph Carnap defined the meaning of the adjective *formal* in 1934 as follows:

"A theory, a rule, a definition, or the like is to be called *formal* when no reference is made in it either to the meaning of the symbols (for example, the words) or to the sense of the expressions (e.g. the sentences), but simply and solely to the kinds and order of the symbols from which the expressions are constructed."

Martin Kusch defines linguistic formalism as "a purely syntactical treatment of language".

History

The term 'formalism' originally pertains to late-nineteenth-century debates in the philosophy of mathematics, but these discussions would also lead to the development of formal syntax and formal semantics. In such debates, advocates of psychologism argued that arithmetic arises from human psychology, claiming that there are no absolute mathematical truths. Thus, in principle, an equation like 1 + 1 = 2 depends on a human way of thinking and therefore cannot have objective value. So was argued by psychologist Wilhelm Wundt among others. Many mathematicians disagreed and proposed "formalism" which considered mathematical sequences and

operations as purely axiomatic with no mental content and thus disconnected from human psychology. Edmund Husserl disagreed with both claims. He argued that both cardinal numbers and arithmetic operations are fundamentally meaningful, and that our ability to carry out complex mathematical tasks is based on the extension of simple concepts such as low non-imaginary numbers, addition, subtraction, and so on. Based on mathematical logic, Husserl also created a "formal semantics" arguing that linguistic meaning is composed of series of logical propositions. Additionally, he argued on the one hand that human thought, and thus the world as we perceive it, is similarly composed; and on the other, that syntax is also composed of logical propositions.

Advocates of early formalism had compared mathematics to a game of chess where all valid moves are based on a handful of arbitrary rules void of any truly meaningful content. In his *Course in General Linguistics* (posthumous, 1916), Ferdinand de Saussure likewise compares the grammatical rules of a language to a game of chess, suggesting he may have been familiar with "game formalism". He however develops the idea to a different direction, attempting to demonstrate that each synchronic state of a language is similar to a chess composition in that its history is irrelevant to the players. Unlike the mathematical formalists, Saussure considers all signs as meaningful by definition, and argues that the "rules"—in his thesis, laws of the semiotic system—are universal and eternal. Thus, he is not talking about specific grammatical rules, but constant phenomena such as analogy and opposition.

In 1943, Louis Hjelmslev combined Saussure's concept of the bilateral sign (meaning + form) with Rudolph Carnap's mathematical grammars. Hjelmslevwas deeply influenced by the functional linguistics of the Prague linguistic circle, considering pragmatics as integral to grammar. Some advocates of functional linguistics however disagreed with Hjelmslev'slogico-mathematical approach and his terminology where the word 'function' indicates a mere structural dependency in contradistinction with classical functionalism where it means 'purpose'. Hjelmslevwas consequently called "formalist". In such reference, Hjelmslevian "formalism" is closer to Husserlianlogicism than game formalism because semantics constitutes one the two fundamental planes of his notion of language.

Again, Roman Jakobson, who was indeed a member of the Prague functionalist school, was also an advocate of a literary theory or movement called Russian formalism. This approach was not particularly mathematical, but aimed at analyzing the text in its own right. It received this name from its opponents who considered it as falsely separating literature from psychology.

Wundt's idea of analyzing culture as the product of psychology was rejected by his successors in Europe. In mathematics, most scholars at the time sided with Husserl, although today philosopher Martin Kusch argues that Husserl failed to deliver a definitive refutation of psychologism. European structural and functional linguists agreed with Husserl and Saussure, both opposed to Wundt's psychological–historical view of language, giving semantics a core explanatory role in their

linguistic theories.Interest in mathematical linguistics nonetheless remained limited in general linguistics in Europe.

The situation was different in the US where Franz Boas imported Wundt's.ideas to form the Boasian school of anthropology. His students included linguists Edward Sapir and Benjamin Whorf. Leonard Bloomfield, on the other hand, traveled to Germany to attend Wundt's lectures in linguistics. Based on his ideas, Bloomfield wrote his 1914 textbook *An Introduction to the Study of Language* becoming the leading figure in American linguistics until his death in 1949. Bloomfield proposed a "philosophical-descriptive" approach to the study of language suggesting that the linguist's task is to document and analyze linguistic samples leaving further theoretical questions to psychologists.

The post-Bloomfieldian school of the 1950s was also increasingly keen on mathematical linguistics. Based on Carnap's model of arithmetic syntax, Zellig Harris and Charles Hockett proposed a version of generative grammar whose ultimate purpose is just to generate grammatical word sequences. They advocated distributionalism as an attempt to define syntactic constitutes. It was suggested, for example, that a noun phrase like *a beautiful home* is not based on its meaning constitution, but on the fact that such words (determiner, adjective, noun) tend to appear jointly in texts. This attempt was abandoned after Noam Chomsky proposed that the study of syntax is the study of knowledge of language, and therefore a cognitive science. His justification for the analysis became that the syntactic structures uncovered by a generative linguist are innate and based on a random genetic mutation. Chomsky has argued since the beginning that

mathematics has no explanatory value for linguistics which he defines as a sub-field of cognitive psychology. Therefore, his approach is opposed to game formalism.

"When generative grammar was being first developed, a language was defined as a set of sentences, generated by the rules of a grammar, where ‘‘generated’’ is a term taken over from mathematics and just means formally or rigorously described [...} Chomsky’s early work included a demonstration that any such definition of language could not have a decisive role to play in linguistic theory."

In other words, Chomsky's psychologism replaced mathematical formalism in generative linguistics in the 1960s. Chomsky does not however argue against formalism or logicism in mathematics, only that such approaches are not relevant to the study of natural language. He is nonetheless interested in the precise *form* of the correct syntactic representation. When developing his theory, Chomsky took influences from molecular biology. More recently, he has described "universal grammar" as having a crystalline form, comparing it to a snowflake. In other words, a formalism (i.e. a syntactic model) is used to reveal hidden patterns or symmetries underlying human language. This practice became opposed by American "functionalism" which argues that language is not crystallized but dynamic and ever-changing. This type of functionalism includes various frameworks which are inspired by memetics and linked with the cognitive linguistics of George Lakoff and his associates. Like Wundt, Lakoff also proposes a psychologism for mathematics.

Some frameworks advocating mathematical formalism do however exist today. Categorial grammar is a type of generative grammar which was developed by mathematicians and logicians including by Kazimierz Ajdukiewicz, Yehoshua Bar-Hillel, and Joachim Lambek. Their method includes a separate model for syntax and semantics. Thus, even categorial grammar includes a meaningful component. It is however not psychologistic because it does not claim that syntactic structures stem from human psychology; nor is it logicistic because, unlike Husserl, it does not consider structures of natural language as being logical. Furthermore, unlike structuralism, their approach adheres to a mathematical rather than a semiotic view of language. Such a framework, then, is purely descriptivist and atheoretical—that is, it does not aim to explain *why* languages are the way they are—or only theoretical as pertains to the concept of the word 'theory' in mathematics, especially model theory.

Ideas

A central assumption of linguistic formalism, and of generative linguistics in particular, is called the autonomy of syntax, according to which syntactic structures are built by operations which make no reference to meaning, discourse, or use. In one formulation, this notion is defined as syntax being arbitrary and self-contained with respect to meaning, semantics, pragmatics, and other factors external to language. Because of this, those approaches that adopt that assumption have also been called autonomist linguistics. The assumption of the autonomy of syntax is what most prominently distinguishes linguistic formalism from linguistic functionalism, and it is at

the core of the debate between the two. Over the decades, multiple instances have been found of cases in which syntactic structures are actually determined or influenced by semantic traits, and some formalists and generativits have reacted to that by shrinking those parts of semantics that they consider autonomous. Over the decades, in the changes that Noam Chomsky has made to his generative formulation, there has been a shift from a claim of the autonomy of the syntax to that of an autonomy of grammar.

Another central idea of linguistic formalism is that human language can be defined as a formal language like the language of mathematics and programming languages. Additionally, formal rules can be applied outside of logic or mathematics to human language, treating it as a mathematical formal system with a formal grammar.

A characteristic stance of formalist approaches is the primacy of form (like syntax), and the conception of language as a system in isolation from the outer world. An example of this is de Saussure's principle of arbitrariness of sign, according to which there is no intrinsic relationship between a signifier (a word) and the signified (concept) to which it refers. This is contrasted by the principle of iconicity, according to which a sign, like a word, can be influenced by its usage and by the concepts it refers to. The principle of iconicity is shared by functionalist approaches, like cognitive linguistics and usage-based linguistics, and also by linguistic typology.

Generative linguistics has been characterized, and parodied, as the view that a dictionary and a grammar textbook adequately describe a language. The increasingly abstract way in which

syntactic rules have been defined in generative approaches has been criticized by cognitive linguistics as having little regard for the cognitive reality of how language is actually represented in the human mind. Another criticism is directed toward the principle of autonomy of syntax and encapsulation of the language system, pointing out that "structural aspects of language have been shaped by the functions it needs to perform," which is also an argument in favor of the opposite principle of iconicity.

Functional linguistics

Functional linguistics is an approach to the study of language characterized by taking systematically into account the speaker's and the hearer's side, and the communicative needs of the speaker and of the given language community. Linguistic functionalism spawned in the 1920s to 1930s from Ferdinand de Saussure's systematic structuralist approach to language (1916).

Functionalism sees functionality of language and its elements to be the key to understanding linguistic processes and structures. Functional theories of language propose that since language is fundamentally a tool, it is reasonable to assume that its structures are best analyzed and understood with reference to the functions they carry out. These include the tasks of conveying meaning and contextual information.

Functional theories of grammar belong to structural and humanistic linguistics, considering language as a rational human construction. They take into account the context where linguistic elements are used and study the way they are

instrumentally useful or functional in the given environment. This means that pragmatics is given an explanatory role, along with semantics. The formal relations between linguistic elements are assumed to be functionally-motivated.

Simon Dik characterizes the functional approach as follows:

In the functional paradigm a language is in the first place conceptualized as an instrument of social interaction among human beings, used with the intention of establishing communicative relationships. Within this paradigm one attempts to reveal the instrumentality of language with respect to what people do and achieve with it in social interaction. A natural language, in other words, is seen as an integrated part of the communicative competence of the natural language user. (2, p. 3)

Since the 1970s, studies by American functional linguists in languages other than English from Asia, Africa, Australia and the Americas (like Mandarin Chinese and Japanese), led to insights about the interaction of form and function, and the discovery of functional motivations for grammatical phenomena, which apply also to the English language.

History

1920s to 1970s: early developments

The establishment of functional linguistics follows from a shift from structural to functional explanation in 1920s sociology. Prague, at the crossroads of western European structuralism and Russian formalism, became an important centre for

functional linguistics. The shift was related to the organic analogy exploited by Émile Durkheim and Ferdinand de Saussure. Saussure had argued in his *Course in General Linguistics* that the 'organism' of language should be studied anatomically, and not in respect with its environment, to avoid the false conclusions made by August Schleicher and other social Darwinists. The post-Saussurean functionalist movement sought ways to account for the 'adaptation' of language to its environment while still remaining strictly anti-Darwinian.

Russian émigrés Roman Jakobson and Nikolai Trubetzkoy disseminated insights of Russian grammarians in Prague, but also the evolutionary theory of Lev Berg, arguing for teleology of language change. As Berg's theory failed to gain popularity outside the Soviet Union, the organic aspect of functionalism was diminished, and Jakobson adopted a standard model of functional explanation from Ernst Nagel's philosophy of science. It is, then, the same mode of explanation as in biology and social sciences; but it became emphasised that the word 'adaptation' is not to be understood in linguistics in the same meaning as in biology.

Work on functionalist linguistics by the Prague school resumed in the 1950s after a hiatus caused by World War II and Stalinism. In North America, Joseph Greenberg published his 1963 seminal paper on language universals that not only revived the field of linguistic typology, but coined the approach of seeking functional explanations for typological patterns. Greenberg's approach has been highly influential for the movement of North American functionalism that formed from the early 1970s, which has since been characterized by a

profound interest in typology. Greenberg's paper was influenced by the Prague School and in particular it was written in response to Roman Jakobson's call for an 'implicational typology'. While North American functionalism was initially influenced by the functionalism of the Prague school, such influence has been later discontinued.

1980s onward: name controversy

The term 'functionalism' or 'functional linguistics' became controversial in the 1980s with the rise of a new wave of evolutionary linguistics. Johanna Nichols argued that the meaning of 'functionalism' had changed, and the terms formalism and functionalism, respectively, should be taken as referring to generative grammar, and the emergent linguistics of Paul Hopper and Sandra Thompson; and that the term structuralism should be reserved for frameworks derived from the Prague linguistic circle. William Croft argued subsequently that it is a fact to be agreed by all linguists that form does not follow from function. He proposed autonomous linguistics,opposing the idea that language arises functionally from the need to express meaning:

"The notion of autonomy emerges from an undeniable fact of all languages, 'the curious lack of accord ... between form and function'"

Croft explains that, until the 1970s, functionalism related to semantics and pragmatics, or the 'semiotic function'. But around 1980s the notion of function changed from semiotics to "external function". Croft has also explained that he advocates a neo-Darwinian view of language change as based on natural

selection. Croft proposes that 'structuralism' and 'formalism' should both be taken as referring to generative grammar; and 'functionalism' to usage-based and cognitive linguistics; while neither André Martinet, Systemic functional linguistics nor Functional discourse grammar properly represents any of the three concepts.

The situation was further complicated by the arrival of evolutionary psychological thinking in linguistics, with Steven Pinker, Ray Jackendoff and others hypothesising that the human language faculty, or universal grammar, could have developed through normal evolutionary processes, thus defending an adaptational explanation of the origin and evolution of the language faculty. This brought about a functionalism versus formalism debate, with Frederick Newmeyer arguing that the evolutionary psychological approach to linguistics should also be considered functionalist.

The terms functionalism and functional linguistics nonetheless continue to be used by the Prague linguistic circle and its derivatives, including SILF, Danish functional school, Systemic functional linguistics and Functional discourse grammar; and the American framework Role and reference grammar which sees itself as the midway between formal and functional linguistics.

Functional analysis

Since the earliest work of the Prague School, language was conceived as a *functional system*, where term *system* references back to De Saussure structuralist approach. The term function seems to have been introduced by VilémMathesius, possibly

influenced from works in sociology. Functional analysis is the examination of how linguistic elements function on different layers of linguistic structure, and how the levels interact with each other. Functions exist on all levels of grammar, even in phonology, where the phoneme has the function of distinguishing between lexical material.

- Syntactic functions: (e.g. Subject and Object), defining different perspectives in the presentation of a linguistic expression.
- Semantic functions: (Agent, Patient, Recipient, etc.), describing the role of participants in states of affairs or actions expressed.
- Pragmatic functions: (Theme and Rheme, Topic and Focus, Predicate), defining the informational status of constituents, determined by the pragmatic context of the verbal interaction.

Functional explanation

In the functional mode of explanation, a linguistic structure is explained with an appeal to its function. Functional linguistics takes as its starting point the notion that communication is the primary purpose of language. Therefore, general phonological, morphosyntactic and semantic phenomena are thought of as being motivated by the needs of people to communicate successfully with each other. Thus, the perspective is taken that the organisation of language reflects its use value.

Many prominent functionalist approaches, like Role and reference grammar and Functional discourse grammar, are also

typologically-oriented, that is they aim their analysis cross-linguistically, rather than only to a single language like English (as it's typical of formalist/generativism approaches).

Economy

The concept of economy is metaphorically transferred from a social or economical context to a linguistic level. It is considered as a regulating force in language maintenance. Controlling the impact of language change or internal and external conflicts of the system, the economy principle means that systemic coherence is maintained without increasing energy cost. This is why all human languages, no matter how different they are, have high functional value as based on a compromise between the competing motivations of speaker-easiness (simplicity or *inertia*) versus hearer-easiness (clarity or *energeia*).

The principle of economy was elaborated by the French structural–functional linguist André Martinet. Martinet's concept is similar to Zipf's principle of least effort; although the idea had been discussed by various linguists in the late 19th and early 20th century. The functionalist concept of economy is not to be confused with economy in generative grammar.

Information structure

Some key adaptations of functional explanation are found in the study of information structure. Based on earlier linguists' work, Prague Circle linguists VilémMathesius, Jan Firbas and others elaborated the concept of theme–rheme relations (topic

and comment) to study pragmatic concepts such as sentence focus, and givenness of information, to successfully explain word-order variation. The method has been used widely in linguistics to uncover word-order patterns in the languages of the world. Its importance, however, is limited to within-language variation, with no apparent explanation of cross-linguistic word order tendencies.

Functional principles

Several principles from pragmatics have been proposed as functional explanations of linguistic structures, often in a typological perspective.

- Theme first: languages prefer placing the theme before the rheme; and the subject typically carries the role of the theme; therefore, most languages have subject before object in their basic word order.
- Animated first: similarly, since subjects are more likely to be animate, they are more likely to precede the object.
- Given before new: old information comes before new information.
- First things first: more important or more urgent information comes before other information.
- Lightness: light (short) constituents are ordered before heavy (long) constituents.
- Uniformity: word order choices are generalised. For example, languages tend to have either prepositions or postpositions; and not both equally.
- Functional load: elements within a linguistic sub-system are made distinct to avoid confusion.

Frameworks

There are several distinct grammatical frameworks that employ a functional approach.

- The structuralist functionalism of the Prague school was the earliest functionalist framework developed in the 1920s.
- André Martinet's Functional Syntax, with two major books, *A functional view of language* (1962) and *Studies in Functional Syntax* (1975). Martinet is one of the most famous French linguists and can be regarded as the father of French functionalism. Founded by Martinet and his colleagues, SILF (*Sociétéinternationale de linguistiquefonctionnelle*) is an international organisation of functional linguistics which operates mainly in French.
- Simon Dik's Functional Grammar, originally developed in the 1970s and 80s, has been influential and inspired many other functional theories. It has been developed into Functional Discourse Grammar by the linguist KeesHengeveld.
- Michael Halliday's systemic functional grammar argues that the explanation of how language works "needed to be grounded in a functional analysis, since language had evolved in the process of carrying out certain critical functions as human beings interacted with their ... 'eco-social' environment". Halliday draws on the work of Bühler and Malinowski. The link between Firthian linguistics and Alfred North Whitehead also deserves a mention.

- Role and reference grammar, developed by Robert Van Valin employs functional analytical framework with a somewhat formal mode of description. In RRG, the description of a sentence in a particular language is formulated in terms of its semantic structure and communicative functions, as well as the grammatical procedures used to express these meanings.
- Danish functional grammar combines Saussurean/Hjelmslevian structuralism with a focus on pragmatics and discourse.

Chapter 5

Phonetics

History

Antiquity

The first known phonetic studies were carried out as early as the 6th century BCE by Sanskrit grammarians. The Hindu scholar Pāṇiniis among the most well known of these early investigators, whose four-part grammar, written around 350 BCE, is influential in modern linguistics and still represents "the most complete generative grammar of any language yet written". His grammar formed the basis of modern linguistics and described several important phonetic principles, including voicing. This early account described resonance as being produced either by tone, when vocal folds are closed, or noise, when vocal folds are open. The phonetic principles in the grammar are considered "primitives" in that they are the basis for his theoretical analysis rather than the objects of theoretical analysis themselves, and the principles can be inferred from his system of phonology.

Modern

Advancements in phonetics after Pāṇini and his contemporaries were limited until the modern era, save some limited investigations by Greek and Roman grammarians. In the millennia between Indic grammarians and modern phonetics, the focus shifted from the difference between spoken and

written language, which was the driving force behind Pāṇini's account, and began to focus on the physical properties of speech alone. Sustained interest in phonetics began again around 1800 CE with the term "phonetics" being first used in the present sense in 1841. With new developments in medicine and the development of audio and visual recording devices, phonetic insights were able to use and review new and more detailed data. This early period of modern phonetics included the development of an influential phonetic alphabet based on articulatory positions by Alexander Melville Bell. Known as visible speech, it gained prominence as a tool in the oral education of deaf children.

Before the widespread availability of audio recording equipment, phoneticians relied heavily on a tradition of practical phonetics to ensure that transcriptions and findings were able to be consistent across phoneticians. This training involved both ear training—the recognition of speech sounds—as well as production training—the ability to produce sounds. Phoneticians were expected to learn to recognize by ear the various sounds on the International Phonetic Alphabet and the IPA still tests and certifies speakers on their ability to accurately produce the phonetic patterns of English (though they have discontinued this practice for other languages). As a revision of his visible speech method, Melville Bell developed a description of vowels by height and backness resulting in 9cardinal vowels. As part of their training in practical phonetics, phoneticians were expected to learn to produce these cardinal vowels in order to anchor their perception and transcription of these phones during fieldwork. This approach was critiqued by Peter Ladefoged in the 1960s based on experimental evidence where he found that cardinal vowels

were auditory rather than articulatory targets, challenging the claim that they represented articulatory anchors by which phoneticians could judge other articulations.

Production

Language production consists of several interdependent processes which transform a nonlinguistic message into a spoken or signed linguistic signal. Linguists debate whether the process of language production occurs in a series of stages (serial processing) or whether production processes occur in parallel. After identifying a message to be linguistically encoded, a speaker must select the individual words—known as lexical items—to represent that message in a process called lexical selection. The words are selected based on their meaning, which in linguistics is called semantic information. Lexical selection activates the word's lemma, which contains both semantic and grammatical information about the word.

After an utterance has been planned, it then goes through phonological encoding. In this stage of language production, the mental representation of the words are assigned their phonological content as a sequence of phonemes to be produced. The phonemes are specified for articulatory features which denote particular goals such as closed lips or the tongue in a particular location. These phonemes are then coordinated into a sequence of muscle commands that can be sent to the muscles, and when these commands are executed properly the intended sounds are produced. Thus the process of production from message to sound can be summarized as the following sequence:

- Message planning
- Lemma selection
- Retrieval and assignment of phonological word forms
- Articulatory specification
- Muscle commands
- Articulation
- Speech sounds

Place of articulation

Sounds which are made by a full or partial constriction of the vocal tract are called consonants. Consonants are pronounced in the vocal tract, usually in the mouth, and the location of this constriction affects the resulting sound. Because of the close connection between the position of the tongue and the resulting sound, the place of articulation is an important concept in many subdisciplines of phonetics.

Sounds are partly categorized by the location of a constriction as well as the part of the body doing the constricting. For example, in English the words *fought* and *thought* are a minimal pair differing only in the organ making the construction rather than the location of the construction. The "f" in *fought* is a labiodental articulation made with the bottom lip against the teeth. The "th" in *thought* is a linguodental articulation made with the tongue against the teeth. Constrictions made by the lips are calledlabials while those made with the tongue are called lingual.

Constrictions made with the tongue can be made in several parts of the vocal tract, broadly classified into coronal, dorsal and radical places of articulation. Coronal articulations are

made with the front of the tongue, dorsal articulations are made with the back of the tongue, and radical articulations are made in the pharynx. These divisions are not sufficient for distinguishing and describing all speech sounds. For example, in English the sounds [s] and [ʃ] are both coronal, but they are produced in different places of the mouth. To account for this, more detailed places of articulation are needed based upon the area of the mouth in which the constriction occurs.

Labial

Articulations involving the lips can be made in three different ways: with both lips (bilabial), with one lip and the teeth (labiodental), and with the tongue and the upper lip (linguolabial). Depending on the definition used, some or all of these kinds of articulations may be categorized into the class of labial articulations. Bilabial consonantsare made with both lips. In producing these sounds the lower lip moves farthest to meet the upper lip, which also moves down slightly, though in some cases the force from air moving through the aperture (opening between the lips) may cause the lips to separate faster than they can come together. Unlike most other articulations, both articulators are made from soft tissue, and so bilabial stops are more likely to be produced with incomplete closures than articulations involving hard surfaces like the teeth or palate. Bilabial stops are also unusual in that an articulator in the upper section of the vocal tract actively moves downwards, as the upper lip shows some active downward movement. Linguolabial consonantsare made with the blade of the tongue approaching or contacting the upper lip. Like in bilabial articulations, the upper lip moves slightly towards the more active articulator. Articulations in this group

do not have their own symbols in the International Phonetic Alphabet, rather, they are formed by combining an apical symbol with a diacritic implicitly placing them in the coronal category. They exist in a number of languages indigenous to Vanuatu such as Tangoa.

Labiodental consonants are made by the lower lip rising to the upper teeth. Labiodental consonants are most often fricatives while labiodental nasals are also typologically common. There is debate as to whether true labiodental plosives occur in any natural language, though a number of languages are reported to have labiodental plosives including Zulu, Tonga, and Shubi.

Coronal

Coronal consonants are made with the tip or blade of the tongue and, because of the agility of the front of the tongue, represent a variety not only in place but in the posture of the tongue. The coronal places of articulation represent the areas of the mouth where the tongue contacts or makes a constriction, and include dental, alveolar, and post-alveolar locations. Tongue postures using the tip of the tongue can be apical if using the top of the tongue tip, laminal if made with the blade of the tongue, or sub-apical if the tongue tip is curled back and the bottom of the tongue is used. Coronals are unique as a group in that every manner of articulation is attested. Australian languagesare well known for the large number of coronal contrasts exhibited within and across languages in the region. Dental consonantsare made with the tip or blade of the tongue and the upper teeth. They are divided into two groups based upon the part of the tongue used to produce them: apical dental consonants are produced with

the tongue tip touching the teeth; interdental consonants are produced with the blade of the tongue as the tip of the tongue sticks out in front of the teeth. No language is known to use both contrastively though they may exist allophonically. Alveolar consonantsare made with the tip or blade of the tongue at the alveolar ridge just behind the teeth and can similarly be apical or laminal.

Crosslinguistically, dental consonants and alveolar consonants are frequently contrasted leading to a number of generalizations of crosslinguistic patterns. The different places of articulation tend to also be contrasted in the part of the tongue used to produce them: most languages with dental stops have laminal dentals, while languages with apical stops usually have apical stops. Languages rarely have two consonants in the same place with a contrast in laminality, though Taa (!Xóõ) is a counterexample to this pattern. If a language has only one of a dental stop or an alveolar stop, it will usually be laminal if it is a dental stop, and the stop will usually be apical if it is an alveolar stop, though for example Temne and Bulgarian do not follow this pattern. If a language has both an apical and laminal stop, then the laminal stop is more likely to be affricated like in Isoko, though Dahalo show the opposite pattern with alveolar stops being more affricated.

Retroflex consonants have several different definitions depending on whether the position of the tongue or the position on the roof of the mouth is given prominence. In general, they represent a group of articulations in which the tip of the tongue is curled upwards to some degree. In this way, retroflex articulations can occur in several different locations on the roof of the mouth including alveolar, post-

alveolar, and palatal regions. If the underside of the tongue tip makes contact with the roof of the mouth, it is sub-apical though apical post-alveolar sounds are also described as retroflex. Typical examples of sub-apical retroflex stops are commonly found in Dravidian languages, and in some languages indigenous to the southwest United States the contrastive difference between dental and alveolar stops is a slight retroflexion of the alveolar stop. Acoustically, retroflexion tends to affect the higher formants.

Articulations taking place just behind the alveolar ridge, known as post-alveolar consonants, have been referred to using a number of different terms. Apical post-alveolar consonants are often called retroflex, while laminal articulations are sometimes called palato-alveolar; in the Australianist literature, these laminal stops are often described as 'palatal' though they are produced further forward than the palate region typically described as palatal. Because of individual anatomical variation, the precise articulation of palato-alveolar stops (and coronals in general) can vary widely within a speech community.

Dorsal

Dorsal consonants are those consonants made using the tongue body rather than the tip or blade and are typically produced at the palate, velum or uvula. Palatal consonantsare made using the tongue body against the hard palate on the roof of the mouth. They are frequently contrasted with velar or uvular consonants, though it is rare for a language to contrast all three simultaneously, with Jaqaru as a possible example of a three-way contrast. Velar consonantsare made using the

tongue body against the velum. They are incredibly common cross-linguistically; almost all languages have a velar stop. Because both velars and vowels are made using the tongue body, they are highly affected by coarticulation with vowels and can be produced as far forward as the hard palate or as far back as the uvula. These variations are typically divided into front, central, and back velars in parallel with the vowel space. They can be hard to distinguish phonetically from palatal consonants, though are produced slightly behind the area of prototypical palatal consonants. Uvular consonants are made by the tongue body contacting or approaching the uvula. They are rare, occurring in an estimated 19 percent of languages, and large regions of the Americas and Africa have no languages with uvular consonants. In languages with uvular consonants, stops are most frequent followed by continuants (including nasals).

Pharyngeal and laryngeal

Consonants made by constrictions of the throat are pharyngeals, and those made by a constriction in the larynx are laryngeal. Laryngeals are made using the vocal folds as the larynx is too far down the throat to reach with the tongue. Pharyngeals however are close enough to the mouth that parts of the tongue can reach them.

Radical consonants either use the root of the tongue or the epiglottis during production and are produced very far back in the vocal tract. Pharyngeal consonants are made by retracting the root of the tongue far enough to almost touch the wall of the pharynx. Due to production difficulties, only fricatives and approximants can produced this way. Epiglottal consonantsare

made with the epiglottis and the back wall of the pharynx. Epiglottal stops have been recorded in Dahalo. Voiced epiglottal consonants are not deemed possible due to the cavity between the glottis and epiglottis being too small to permit voicing.

Glottal consonants are those produced using the vocal folds in the larynx. Because the vocal folds are the source of phonation and below the oro-nasal vocal tract, a number of glottal consonants are impossible such as a voiced glottal stop. Three glottal consonants are possible, a voiceless glottal stop and two glottal fricatives, and all are attested in natural languages. Glottal stops, produced by closing the vocal folds, are notably common in the world's languages. While many languages use them to demarcate phrase boundaries, some languages like Huatla Mazatec have them as contrastive phonemes. Additionally, glottal stops can be realized as laryngealization of the following vowel in this language. Glottal stops, especially between vowels, do usually not form a complete closure. True glottal stops normally occur only when they'regeminated.

The larynx

The larynx, commonly known as the "voice box", is a cartilaginous structure in the trachea responsible for phonation. The vocal folds (chords) are held together so that they vibrate, or held apart so that they do not. The positions of the vocal folds are achieved by movement of the arytenoid cartilages. The intrinsic laryngeal muscles are responsible for moving the arytenoid cartilages as well as modulating the tension of the vocal folds. If the vocal folds are not close or tense enough, they will either vibrate sporadically or not at all.

If they vibrate sporadically it will result in either creaky or breathy voice, depending on the degree; if don't vibrate at all, the result will be voicelessness.

In addition to correctly positioning the vocal folds, there must also be air flowing across them or they will not vibrate. The difference in pressure across the glottis required for voicing is estimated at 1 – 2 cm H_2O (98.0665 – 196.133 pascals). The pressure differential can fall below levels required for phonation either because of an increase in pressure above the glottis (superglottal pressure) or a decrease in pressure below the glottis (subglottal pressure). The subglottal pressure is maintained by the respiratory muscles. Supraglottal pressure, with no constrictions or articulations, is equal to about atmospheric pressure. However, because articulations—especially consonants—represent constrictions of the airflow, the pressure in the cavity behind those constrictions can increase resulting in a higher supraglottal pressure.

Lexical access

According to the lexical access model two different stages of cognition are employed; thus, this concept is known as the two-stage theory of lexical access. The first stage, lexical selection provides information about lexical items required to construct the functional level representation. These items are retrieved according to their specific semantic and syntactic properties, but phonological forms are not yet made available at this stage. The second stage, retrieval of wordforms, provides information required for building the positional level representation.

Articulatory models

When producing speech, the articulators move through and contact particular locations in space resulting in changes to the acoustic signal. Some models of speech production take this as the basis for modeling articulation in a coordinate system that may be internal to the body (intrinsic) or external (extrinsic). Intrinsic coordinate systems model the movement of articulators as positions and angles of joints in the body. Intrinsic coordinate models of the jaw often use two to three degrees of freedom representing translation and rotation. These face issues with modeling the tongue which, unlike joints of the jaw and arms, is a muscular hydrostat—like an elephant trunk—which lacks joints. Because of the different physiological structures, movement paths of the jaw are relatively straight lines during speech and mastication, while movements of the tongue follow curves.

Straight-line movements have been used to argue articulations as planned in extrinsic rather than intrinsic space, though extrinsic coordinate systems also include acoustic coordinate spaces, not just physical coordinate spaces. Models that assume movements are planned in extrinsic space run into an inverse problem of explaining the muscle and joint locations which produce the observed path or acoustic signal. The arm, for example, has seven degrees of freedom and 22 muscles, so multiple different joint and muscle configurations can lead to the same final position. For models of planning in extrinsic acoustic space, the same one-to-many mapping problem applies as well, with no unique mapping from physical or acoustic targets to the muscle movements required to achieve them. Concerns about the inverse problem may be exaggerated,

however, as speech is a highly learned skill using neurological structures which evolved for the purpose.

The equilibrium-point model proposes a resolution to the inverse problem by arguing that movement targets be represented as the position of the muscle pairs acting on a joint. Importantly, muscles are modeled as springs, and the target is the equilibrium point for the modeled spring-mass system. By using springs, the equilibrium point model can easily account for compensation and response when movements are disrupted. They are considered a coordinate model because they assume that these muscle positions are represented as points in space, equilibrium points, where the spring-like action of the muscles converges.

Gestural approaches to speech production propose that articulations are represented as movement patterns rather than particular coordinates to hit. The minimal unit is a gesture that represents a group of "functionally equivalent articulatory movement patterns that are actively controlled with reference to a given speech-relevant goal (e.g., a bilabial closure)." These groups represent coordinative structures or "synergies" which view movements not as individual muscle movements but as task-dependent groupings of muscles which work together as a single unit. This reduces the degrees of freedom in articulation planning, a problem especially in intrinsic coordinate models, which allows for any movement that achieves the speech goal, rather than encoding the particular movements in the abstract representation. Coarticulationis well described by gestural models as the articulations at faster speech rates can be explained as composites of the independent gestures at slower speech rates.

Acoustics

Speech sounds are created by the modification of an airstream which results in a sound wave. The modification is done by the articulators, with different places and manners of articulation producing different acoustic results. Because the posture of the vocal tract, not just the position of the tongue can affect the resulting sound, the manner of articulation is important for describing the speech sound. The words *tack* and *sack* both begin with alveolar sounds in English, but differ in how far the tongue is from the alveolar ridge. This difference has large affects on the air stream and thus the sound that is produced. Similarly, the direction and source of the airstream can affect the sound. The most common airstream mechanism is pulmonic—using the lungs—but the glottis and tongue can also be used to produce airstreams.

Voicing and phonation types

A major distinction between speech sounds is whether they are voiced. Sounds are voiced when the vocal folds begin to vibrate in the process of phonation. Many sounds can be produced with or without phonation, though physical constraints may make phonation difficult or impossible for some articulations. When articulations are voiced, the main source of noise is the periodic vibration of the vocal folds. Articulations like voiceless plosives have no acoustic source and are noticeable by their silence, but other voiceless sounds like fricatives create their own acoustic source regardless of phonation.

Phonation is controlled by the muscles of the larynx, and languages make use of more acoustic detail than binary voicing. During phonation, the vocal folds vibrate at a certain rate. This vibration results in a periodic acoustic waveform comprising a fundamental frequency and its harmonics. The fundamental frequency of the acoustic wave can be controlled by adjusting the muscles of the larynx, and listeners perceive this fundamental frequency as pitch. Languages use pitch manipulation to convey lexical information in tonal languages, and many languages use pitch to mark prosodic or pragmatic information.

For the vocal folds to vibrate, they must be in the proper position and there must be air flowing through the glottis. Phonation types are modeled on a continuum of glottal states from completely open (voiceless) to completely closed (glottal stop). The optimal position for vibration, and the phonation type most used in speech, modal voice, exists in the middle of these two extremes. If the glottis is slightly wider, breathy voice occurs, while bringing the vocal folds closer together results in creaky voice.

The normal phonation pattern used in typical speech is modal voice, where the vocal folds are held close together with moderate tension. The vocal folds vibrate as a single unit periodically and efficiently with a full glottal closure and no aspiration. If they are pulled farther apart, they do not vibrate and so produce voiceless phones. If they are held firmly together they produce a glottal stop.

If the vocal folds are held slightly further apart than in modal voicing, they produce phonation types like breathy voice (or

murmur) and whispery voice. The tension across the vocal ligaments (vocal cords) is less than in modal voicing allowing for air to flow more freely. Both breathy voice and whispery voice exist on a continuum loosely characterized as going from the more periodic waveform of breathy voice to the more noisy waveform of whispery voice. Acoustically, both tend to dampen the first formant with whispery voice showing more extreme deviations.

Holding the vocal folds more tightly together results in a creaky voice. The tension across the vocal folds is less than in modal voice, but they are heldtightly together resulting in only the ligaments of the vocal folds vibrating. The pulses are highly irregular, with low pitch and frequency amplitude.

Some languages do not maintain a voicing distinction for some consonants, but all languages use voicing to some degree. For example, no language is known to have a phonemic voicing contrast for vowels with all known vowels canonically voiced. Other positions of the glottis, such as breathy and creaky voice, are used in a number of languages, like Jalapa Mazatec, to contrast phonemes while in other languages, like English, they exist allophonically.

There are several ways to determine if a segment is voiced or not, the simplest being to feel the larynx during speech and note when vibrations are felt. More precise measurements can be obtained through acoustic analysis of a spectrogram or spectral slice. In a spectrographic analysis, voiced segments show a voicing bar, a region of high acoustic energy, in the low frequencies of voiced segments. In examining a spectral splice, the acoustic spectrum at a given point in time a model of the

vowel pronounced reverses the filtering of the mouth producing the spectrum of the glottis. A computational model of the unfiltered glottal signal is then fitted to the inverse filtered acoustic signal to determine the characteristics of the glottis. Visual analysis is also available using specialized medical equipment such as ultrasound and endoscopy.

Vowels

Vowels are broadly categorized by the area of the mouth in which they are produced, but because they are produced without a constriction in the vocal tract their precise description relies on measuring acoustic correlates of tongue position. The location of the tongue during vowel production changes the frequencies at which the cavity resonates, and it is these resonances—known as formants—which are measured and used to characterize vowels.

Vowel height traditionally refers to the highest point of the tongue during articulation. The height parameter is divided into four primary levels: high (close), close-mid, open-mid and low (open). Vowels whose height are in the middle are referred to as mid. Slightly opened close vowels and slightly closed open vowels are referred to as near-close and near-open respectively. The lowest vowels are not just articulated with a lowered tongue, but also by lowering the jaw.

While the IPA implies that there are seven levels of vowel height, it is unlikely that a given language can minimally contrast all seven levels. Chomsky and Halle suggest that there are only three levels, although four levels of vowel height seem

to be needed to describe Danish and it's possible that some languages might even need five.

Vowel backness is dividing into three levels: front, central and back. Languages usually do not minimally contrast more than two levels of vowel backness. Some languages claimed to have a three-way backness distinction include Nimboran and Norwegian.

In most languages, the lips during vowel production can be classified as either rounded or unrounded (spread), although other types of lip positions, such as compression and protrusion, have been described. Lip position is correlated with height and backness: front and low vowels tend to be unrounded whereas back and high vowels are usually rounded. Paired vowels on the IPA chart have the spread vowel on the left and the rounded vowel on the right.

Together with the universal vowel features described above, some languages have additional features such as nasality, length and different types of phonation such as voiceless or creaky. Sometimes more specialized tongue gestures such as rhoticity, advanced tongue root, pharyngealization, stridency and frication are required to describe a certain vowel.

Manner of articulation

Knowing the place of articulation is not enough to fully describe a consonant, the way in which the stricture happens is equally important. Manners of articulation describe how exactly the active articulator modifies, narrows or closes off the vocal tract.

Stops (also referred to as plosives) are consonants where the airstream is completely obstructed. Pressure builds up in the mouth during the stricture, which is then released as a small burst of sound when the articulators move apart. The velum is raised so that air cannot flow through the nasal cavity. If the velum is lowered and allows for air to flow through the nose, the result in a nasal stop. However, phoneticians almost always refer to nasal stops as just "nasals".Affricates are a sequence of stops followed by a fricative in the same place.

Fricatives are consonants where the airstream is made turbulent by partially, but not completely, obstructing part of the vocal tract. Sibilants are a special type of fricative where the turbulent airstream is directed towards the teeth, creating a high-pitched hissing sound.

Nasals (sometimes referred to as nasal stops) are consonants in which there's a closure in the oral cavity and the velum is lowered, allowing air to flow through the nose.

In an approximant, the articulators come close together, but not to such an extent that allows a turbulent airstream.

Laterals are consonants in which the airstream is obstructed along the center of the vocal tract, allowing the airstream to flow freely on one or both sides. Laterals have also been defined as consonants in which the tongue is contracted in such a way that the airstream is greater around the sides than over the center of the tongue. The first definition does not allow for air to flow over the tongue.

Trills are consonants in which the tongue or lips are set in motion by the airstream. The stricture is formed in such a way

that the airstream causes a repeating pattern of opening and closing of the soft articulator(s). Apical trills typically consist of two or three periods of vibration.

Taps and flaps are single, rapid, usually apical gestures where the tongue is thrown against the roof of the mouth, comparable to a very rapid stop. These terms are sometimes used interchangeably, but some phoneticians make a distinction. In a tap, the tongue contacts the roof in a single motion whereas in a flap the tongue moves tangentially to the roof of the mouth, striking it in passing.

During a glottalic airstream mechanism, the glottis is closed, trapping a body of air. This allows for the remaining air in the vocal tract to be moved separately. An upward movement of the closed glottis will move this air out, resulting in it an ejective consonant. Alternatively, the glottis can lower, sucking more air into the mouth, which results in an implosive consonant.

Clicks are stops in which tongue movement causes air to be sucked in the mouth, this is referred to as a velaric airstream. During the click, the air becomes rarefied between two articulatory closures, producing a loud 'click' sound when the anterior closure is released. The release of the anterior closure is referred to as the click influx. The release of the posterior closure, which can be velar or uvular, is the click efflux. Clicks are used in several African language families, such as the Khoisan and Bantu languages.

Pulmonary and subglottal system

The lungs drive nearly all speech production, and their importance in phonetics is due to their creation of pressure for

pulmonic sounds. The most common kinds of sound across languages are pulmonic egress, where air is exhaled from the lungs. The opposite is possible, though no language is known to have pulmonic ingressive sounds as phonemes. Many languages such as Swedish use them for paralinguistic articulations such as affirmations in a number of genetically and geographically diverse languages. Both egressive and ingressive sounds rely on holding the vocal folds in a particular posture and using the lungs to draw air across the vocal folds so that they either vibrate (voiced) or do not vibrate (voiceless). Pulmonic articulations are restricted by the volume of air able to be exhaled in a given respiratory cycle, known as the vital capacity.

The lungs are used to maintain two kinds of pressure simultaneously in order to produce and modify phonation. To produce phonation at all, the lungs must maintain a pressure of 3–5 cm H_2O higher than the pressure above the glottis. However small and fast adjustments are made to the subglottal pressure to modify speech for suprasegmental features like stress. A number of thoracic muscles are used to make these adjustments. Because the lungs and thorax stretch during inhalation, the elastic forces of the lungs alone can produce pressure differentials sufficient for phonation at lung volumes above 50 percent of vital capacity. Above 50 percent of vital capacity, the respiratory muscles are used to "check" the elastic forces of the thorax to maintain a stable pressure differential. Below that volume, they are used to increase the subglottal pressure by actively exhaling air.

During speech, the respiratory cycle is modified to accommodate both linguistic and biological needs. Exhalation,

usually about 60 percent of the respiratory cycle at rest, is increased to about 90 percent of the respiratory cycle. Because metabolic needs are relatively stable, the total volume of air moved in most cases of speech remains about the same as quiet tidal breathing. Increases in speech intensity of 18 dB (a loud conversation) has relatively little impact on the volume of air moved. Because their respiratory systems are not as developed as adults, children tend to use a larger proportion of their vital capacity compared to adults, with more deep inhales.

Source–filter theory

The source–filter model of speech is a theory of speech production which explains the link between vocal tract posture and the acoustic consequences. Under this model, the vocal tract can be modeled as a noise source coupled onto an acoustic filter. The noise source in many cases is the larynx during the process of voicing, though other noise sources can be modeled in the same way. The shape of the supraglottal vocal tract acts as the filter, and different configurations of the articulators result in different acoustic patterns. These changes are predictable. The vocal tract can be modeled as a sequence of tubes, closed at one end, with varying diameters, and by using equations for acoustic resonance the acoustic effect of an articulatory posture can be derived. The process of inverse filtering uses this principle to analyze the source spectrum produced by the vocal folds during voicing. By taking the inverse of a predicted filter, the acoustic effect of the supraglottal vocal tract can be undone giving the acoustic spectrum produced by the vocal folds. This allows quantitative study of the various phonation types.

Perception

Language perception is the process by which a linguistic signal is decoded and understood by a listener. In order to perceive speech the continuous acoustic signal must be converted into discrete linguistic units such as phonemes, morphemes, and words. In order to correctly identify and categorize sounds, listeners prioritize certain aspects of the signal that can reliably distinguish between linguistic categories. While certain cues are prioritized over others, many aspects of the signal can contribute to perception. For example, though oral languages prioritize acoustic information, the McGurk effect shows that visual information is used to distinguish ambiguous information when the acoustic cues are unreliable.

While listeners can use a variety of information to segment the speech signal, the relationship between acoustic signal and category perception is not a perfect mapping. Because of coarticulation, noisy environments, and individual differences, there is a high degree of acoustic variability within categories. Known as the problem of **perceptual invariance**, listeners are able to reliably perceive categories despite the variability in acoustic instantiation. In order to do this, listeners rapidly accommodate to new speakers and will shift their boundaries between categories to match the acoustic distinctions their conversational partner is making.

Audition

Audition, the process of hearing sounds, is the first stage of perceiving speech. Articulators cause systematic changes in air

pressure which travel as sound waves to the listener's ear. The sound waves then hit the listener's ear drum causing it to vibrate. The vibration of the ear drum is transmitted by the ossicles—three small bones of the middle ear—to the cochlea. The cochlea is a spiral-shaped, fluid-filled tube divided lengthwise by the organ of Corti which contains the basilar membrane. The basilar membrane increases in thickness as it travels through the cochlea causing different frequencies to resonate at different locations. This tonotopic design allows for the ear to analyze sound in a manner similar to a Fourier transform.

The differential vibration of the basilar causes the hair cells within the organ of Corti to move. This causes depolarization of the hair cells and ultimately a conversion of the acoustic signal into a neuronal signal. While the hair cells do not produce action potentials themselves, they release neurotransmitter at synapses with the fibers of the auditory nerve, which does produce action potentials. In this way, the patterns of oscillations on the basilar membrane are converted to spatiotemporal patterns of firings which transmit information about the sound to the brainstem.

Prosody

Besides consonants and vowels, phonetics also describes the properties of speech that are not localized to segments but greater units of speech, such as syllables and phrases. Prosody includes auditory characteristics such as pitch, speech rate, duration, and loudness. Languages use these properties to different degrees to implement stress, pitch accents, and intonation — for example, stress in English and Spanishis

correlated with changes in pitch and duration, whereas stress in Welsh is more consistently correlated with pitch than duration and stress in Thai is only correlated with duration.

Theories of speech perception

Early theories of speech perception such as motor theory attempted to solve the problem of perceptual invariance by arguing that speech perception and production were closely linked. In its strongest form, motor theory argues that speech perception *requires* the listener to access the articulatory representation of sounds; in order to properly categorize a sound, a listener reverse engineers the articulation which would produce that sound and by identifying these gestures is able to retrieve the intended linguistic category. While findings such as the McGurk effect and case studies from patients with neurological injuries have provided support for motor theory, further experiments have not supported the strong form of motor theory, though there is some support for weaker forms of motor theory which claim a non-deterministic relationship between production and perception.

Successor theories of speech perception place the focus on acoustic cues to sound categories and can be grouped into two broad categories: abstractionist theories and episodic theories. In abstractionist theories, speech perception involves the identification of an idealized lexical object based on a signal reduced to its necessary components and normalizing the signal to counteract speaker variability. Episodic theories such as the exemplar model argue that speech perception involves accessing detailed memories (i.e., episodic memories) of previously heard tokens. The problem of perceptual invariance

is explained by episodic theories as an issue of familiarity: normalization is a byproduct of exposure to more variable distributions rather than a discrete process as abstractionist theories claim.

Subdisciplines

Acoustic phonetics

Acoustic phonetics deals with the acoustic properties of speech sounds. The sensation of sound is caused by pressure fluctuations which cause the eardrum to move. The ear transforms this movement into neural signals that the brain registers as sound. Acoustic waveforms are records that measure these pressure fluctuations.

Articulatory phonetics

Articulatory phonetics deals with the ways in which speech sounds are made.

Auditory phonetics

Auditory phonetics studies how humans perceive speech sounds. Due to the anatomical features of the auditory system distorting the speech signal, humans do not experience speech sounds as perfect acoustic records. For example, the auditory impressions of volume, measured in decibels (dB), does not linearly match the difference in sound pressure.

The mismatch between acoustic analyses and what the listener hears is especially noticeable in speech sounds that have a lot

of high-frequency energy, such as certain fricatives. To reconcile this mismatch, functional models of the auditory system have been developed.

Describing sounds

Human languages use many different sounds and in order to compare them linguists must be able to describe sounds in a way that is language independent. Speech sounds can be described in a number of ways. Most commonly speech sounds are referred to by the mouth movements needed to produce them. Consonants and vowels are two gross categories that phoneticians define by the movements in a speech sound. More fine-grained descriptors are parameters such as place of articulation. Place of articulation, manner of articulation, and voicingare used to describe consonants and are the main divisions of the International Phonetic Alphabet consonant chart. Vowels are described by their height, backness, and rounding. Sign language are described using a similar but distinct set of parameters to describe signs: location, movement, hand shape, palm orientation, and non-manual features. In addition to articulatory descriptions, sounds used in oral languages can be described using their acoustics. Because the acoustics are a consequence of the articulation, both methods of description are sufficient to distinguish sounds with the choice between systems dependent on the phonetic feature being investigated.

Consonants are speech sounds that are articulated with a complete or partial closure of the vocal tract. They are generally produced by the modification of an airstream exhaled from the lungs. The respiratory organs used to create and

modify airflow are divided into three regions: the vocal tract (supralaryngeal), the larynx, and the subglottal system. The airstream can be either egressive (out of the vocal tract) or ingressive (into the vocal tract). In pulmonic sounds, the airstream is produced by the lungs in the subglottal system and passes through the larynx and vocal tract. Glottalic sounds use an airstream created by movements of the larynx without airflow from the lungs. Click consonants are articulated through the rarefaction of air using the tongue, followed by releasing the forward closure of the tongue.

Vowels are syllabic speech sounds that are pronounced without any obstruction in the vocal tract. Unlike consonants, which usually have definite places of articulation, vowels are defined in relation to a set of reference vowels called cardinal vowels. Three properties are needed to define vowels: tongue height, tongue backness and lip roundedness. Vowels that are articulated with a stable quality are called monophthongs; a combination of two separate vowels in the same syllable is a diphthong. In the IPA, the vowels are represented on a trapezoid shape representing the human mouth: the vertical axis representing the mouth from floor to roof and the horizontal axis represents the front-back dimension.

Transcription

Phonetic transcription is a system for transcribing phones that occur in a language, whether oral or sign. The most widely known system of phonetic transcription, the International Phonetic Alphabet (IPA), provides a standardized set of symbols for oral phones. The standardized nature of the IPA enables its users to transcribe accurately and consistently the phones of

different languages, dialects, and idiolects. The IPA is a useful tool not only for the study of phonetics, but also for language teaching, professional acting, and speech pathology.

While no sign language has a standardized writing system, linguists have developed their own notation systems that describe the handshape, location and movement. The Hamburg Notation System (HamNoSys) is similar to the IPA in that it allows for varying levels of detail. Some notation systems such as KOMVA and the Stokoe systemwere designed for use in dictionaries; they also make use of alphabetic letters in the local language for handshapes whereas HamNoSys represents the handshape directly. SignWriting aims to be an easy-to-learn writing system for sign languages, although it has not been officially adopted by any deaf community yet.

Sign languages

Unlike spoken languages, words in sign languagesare perceived with the eyes instead of the ears. Signs are articulated with the hands, upper body and head. The main articulators are the hands and arms. Relative parts of the arm are described with the terms proximal and distal. Proximal refers to a part closer to the torso whereas a distal part is further away from it. For example, a wrist movement is distal compared to an elbow movement. Due to requiring less energy, distal movements are generally easier to produce. Various factors – such as muscle flexibility or being consideredtaboo – restrict what can be considered a sign. Native signers do not look at their conversation partner's hands. Instead, their gaze is fixated on the face. Because peripheral vision is not as focused as the center of the visual field, signs articulated near the face allow

for more subtle differences in finger movement and location to be perceived. Unlike spoken languages, sign languages have two identical articulators: the hands. Signers may use whichever hand they prefer with no disruption in communication. Due to universal neurological limitations, two-handed signs generally have the same kind of articulation in both hands; this is referred to as the Symmetry Condition. The second universal constraint is the Dominance Condition, which holds that when two handshapes are involved, one hand will remain stationary and have a more limited set handshapes compared to the dominant, moving hand. Additionally, it is common for one hand in a two-handed sign to be dropped during informal conversations, a process referred to as weak drop. Just like words in spoken languages, coarticulation may cause signs to influence each other's form. Examples include the handshapes of neighboring signs becoming more similar to each other (assimilation) or weak drop (an instance of deletion).