LING 1010

Language and Mind

Prof. Jon Sprouse

02.17.21: Principles and Parameters

Navajo Code Talkers

Navajo (called Diné by the actual speakers) is a native american language spoken by about 150,000 members of the Navajo tribe in the southwest US.

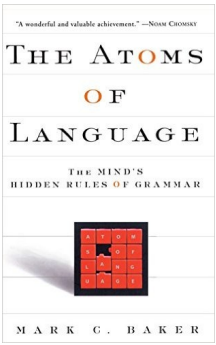
https://www.youtube.com/watch?v=VR13lIRLfic

During WWII, the Japanese easily broke US military codes. So in 1942, the Marines tried something a little different: they recruited Navajo to use their language to encode messages.

The Japanese never managed to decipher the language, and the Navajo are now credited with helping to turn the tide of the war in the pacific.

The Code Talker Paradox

In his book *The Atoms of Language* (highly recommended!), linguist Mark Baker points out the apparent paradox of Navajo Code Talkers.



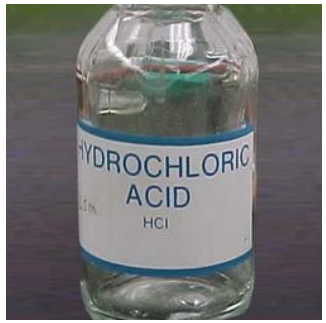
On the one hand, Navajo Code Talkers were able to accurately, and rapidly, translate from English to Navajo and back to English without losing any information. This suggests that the two languages are similar enough to directly translate from one to the other.

But on the other hand, Japanese cryptographers were not able to decipher the Navajo language. Remember, they had broken the very best codes the military had in a matter of months, but over the course of 3 years, they were unable to break the Navajo code. This suggests that Navajo and English were too dissimilar for the codebreakers to decode.

A chemical paradox

Baker makes a great analogy, and I am just going to steal it here. Chemistry is full of similar paradoxes, where substances with very different properties can nonetheless be converted into each other. Here is a classic example

HCl



NaOH

Hydrochloric acid and sodium hydroxide are two very caustic chemicals. They will burn you if you touch them.

You need water to survive, and table salt tastes awesome on food.

On the one hand, HCL and NaOH seem incredibly different from H_20 and NaCl.

H_20

NaCl

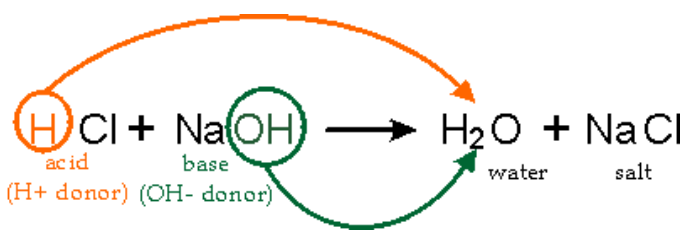
But on the other hand, if you combine HCL and NaOH in the right combination, you will end up with H_20 and NaCl.

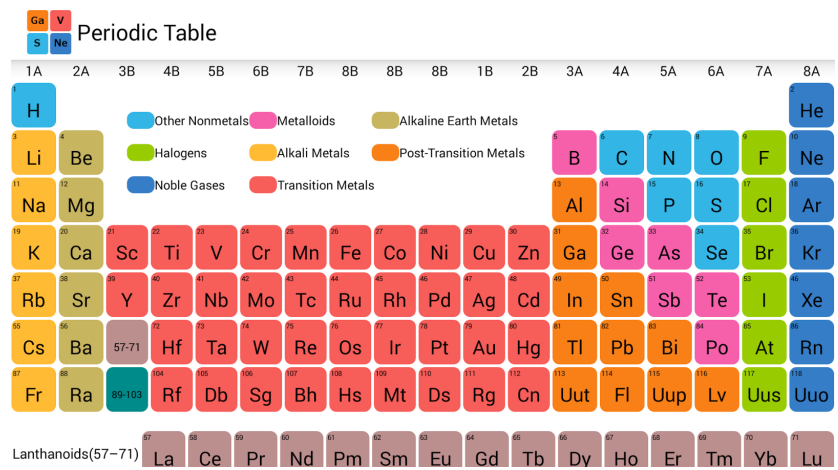
Solving the paradoxes

We all know how the chemical paradox is solved:

General Principles of Chemistry: Conservation of mass and energy, valences, etc.

A theory of elements: A list of the elements that can make up a substance, and the properties of those elements.





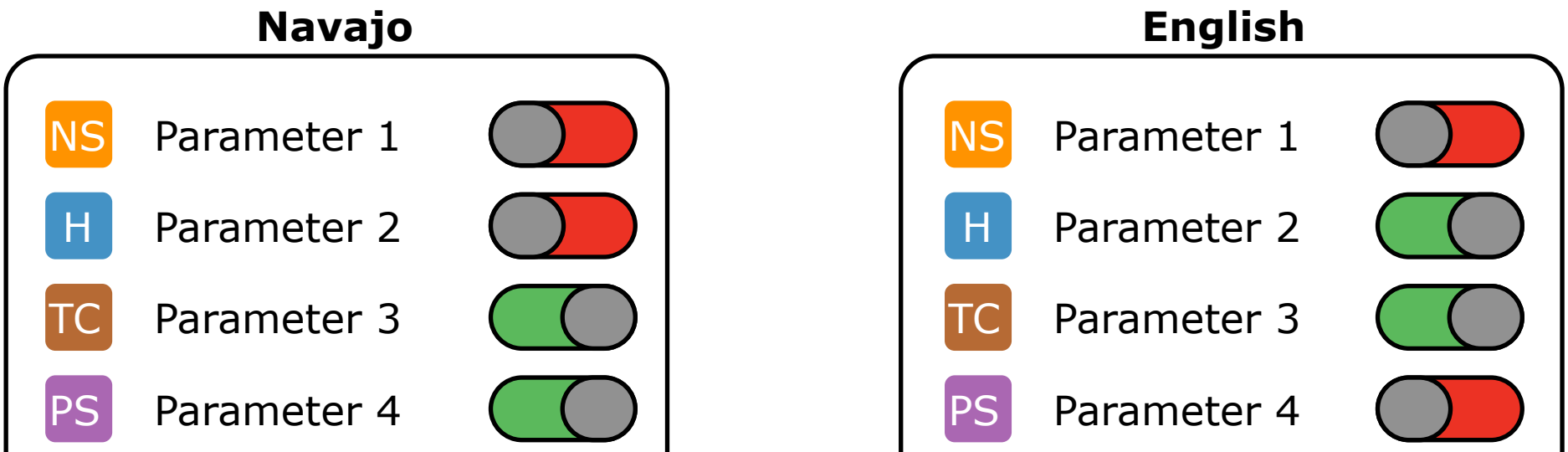
Solving the paradoxes

Linguists have proposed a similar solution to the paradoxes of linguistic variation. This theory is called **Principles and Parameters Theory**:

Principles: General principles that govern the way languages work. These properties are shared by all human languages.

Parameters: A finite set of options or settings that determine how languages can vary.

Though parameters are analogous to atoms in the work that they do, it is probably easier to think of them like a series of settings on an iphone. You can turn each one on or off, creating a distinct way for your iphone to work.



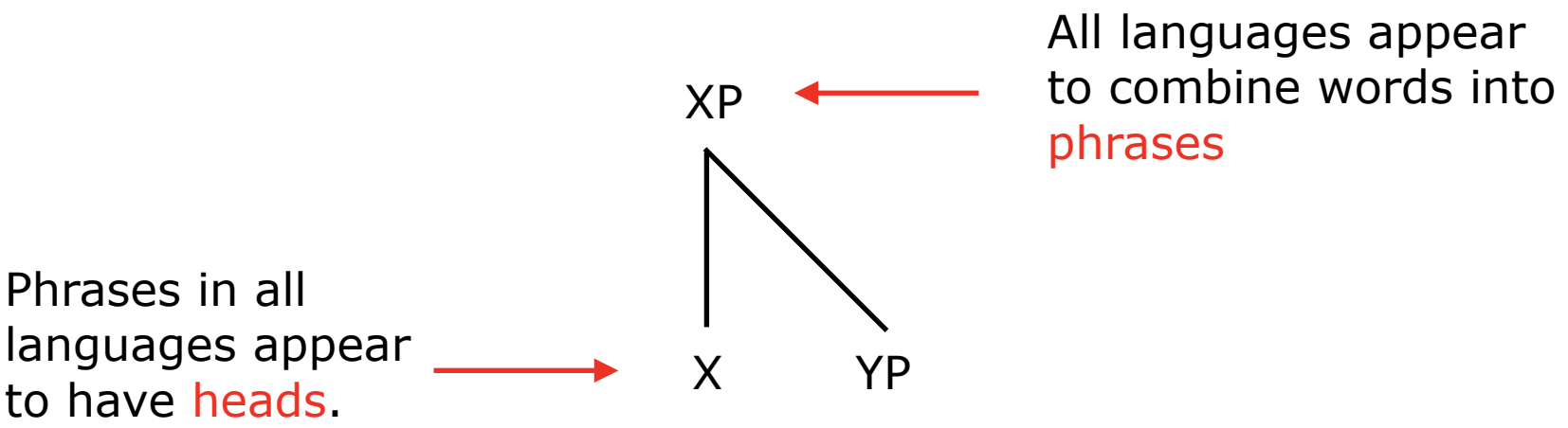
Some examples of Principles

Warning 1: Principles and Parameters Theory is a very abstract theory, like the theory of chemistry. So the principles will be very abstract.

Warning 2: Principles and Parameters Theory is a very complex theory, like chemistry. We haven't had time to really delve into the complexity in this course, so what I present here is simplified a bit. If you want to get into more details, keep taking Linguistics courses, like 2010Q!

An example of a syntactic principle: Phrase Structure

As far as we can tell, all of the languages we've studied in detail (around 2000) use phrase structure rules to create hierarchical structure:



A phonetic principle: Articulatory Features

As far as we can tell, all of the languages we've studied in detail (around 2000) use the same set of articulatory features to create phonemes:

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Different languages use different subsets of consonants (and vowels), but all use the same articulatory features to create those consonants (and vowels)

Some examples of Parameters

Warning 1: Principles and Parameters Theory is a very abstract theory, like the theory of chemistry. So the parameters will be abstract.

Warning 2: Principles and Parameters Theory is a very complex theory, like chemistry. We haven't had time to really delve into the complexity in this course, so what I present here are simplified examples. If you want to get into details, take Ling 2010Q!

The Null Subject Parameter

If you took Spanish or Italian as a second language in high school, you may have noticed that subjects of sentences in these languages behave a bit differently than subjects in English (and French).

All four languages allow the typical English order:

English	John will arrive.	Spanish	Juan llegará.
French	Jean arrivera.	Italian	Gianni verrà.

But, in Spanish and Italian, if the subject has already been discussed, you can omit the subject completely. In English and French, you have to use a pronoun:

English	He will arrive.	Spanish	Llegará.
French	Il arrivera.	Italian	Verrà.

The Null Subject Parameter

And this obsession with subjects goes even further. Certain verbs about the weather don't really have an entity that is the subject, but in English and French, you have to use an empty subject "it":

English

It is raining.

It is snowing.

French

Il pleut.

Il neige.

Spanish and Italian don't ever use a subject for these verbs:

Spanish

Llueve.

Nieva.

Italian

Piove.

Nevica.

The Null Subject Parameter

And there is more. In Spanish and Italian, you can put the subject after the verb. But it looks like you can't do this in English and French:

English *Will arrive John.

French *Arrivera Jean.

The asterisk means impossible.

Spanish Llegará Juan

Italian Verrà Gianni.

In fact, it is a bit more complicated than this. You can put the subject after the verb in English and French under certain circumstances, but you have to put a dummy subject in the subject position!

English There is a man in the garden.

French Il est arrivé trois hommes.

It is arrived three men

These subjects don't refer to anything. The real subjects are a man and three men.

The Null Subject Parameter

So it looks like these four languages split into two types:

English/French

Always have a subject.

Spanish/Italian

Omit known subjects.

Omit weather subjects.

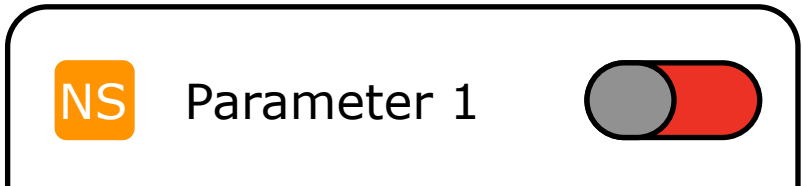
Omit subjects when the subject is after the verb.

Principles and Parameters Theory can account for all three of these properties by postulating a single parameter: **The Null Subject Parameter**

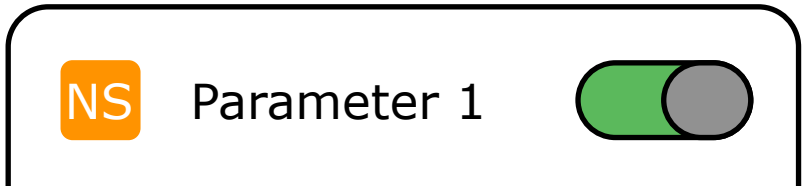
Null Subject Parameter

If set to no, a subject is always required in (tensed) sentences. If set to yes, subjects are not required if they can be recovered from the context.

English/French



Spanish/Italian



The Null Subject Parameter

So it looks like these four languages split into two types:

English/French

Spanish/Italian

This is the power of a parameter. If you ever studied these language in school, you would probably just have to memorize these facts about the languages.

But as linguists, we can see that they all derive from a deeper fact — the Null Subject Parameter!

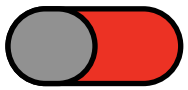
Principles and Parameters Theory can account for all three of these properties by postulating a single parameter: **The Null Subject Parameter**

Null Subject Parameter

If set to no, a subject is always required in (tensed) sentences. If set to yes, subjects are not required if they can be recovered from the context.

English/French

NS Parameter 1



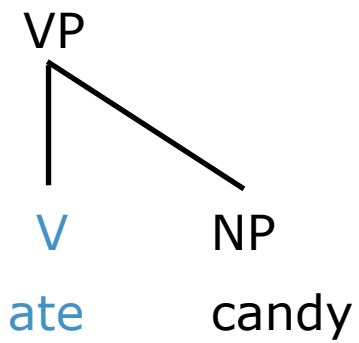
Spanish/Italian

NS Parameter 1

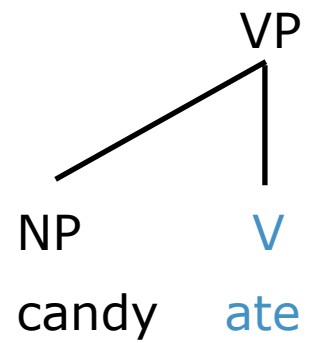
The Head Parameter

Another important syntactic parameter is called the **Head Parameter**. The Head Parameter determines whether heads come first in their phrases (head-initial), or whether they come last (head-final):

Head initial: John ate candy



Head final: John candy ate



English vs Japanese

Here is a sentence in Japanese, with the word-by-word translation in the second line (called a gloss in linguistics) and an equivalent English sentence below it in quotes to show you what the sentence means (called the translation in linguistics):

	Taro-ga	Hiro-ga	Hanako-ni	neko-no	syasino	miseta	to	omotte	iru
gl:	Taro	Hiro	Hanako-to	cats-of	pictures	showed	that	thinking	is

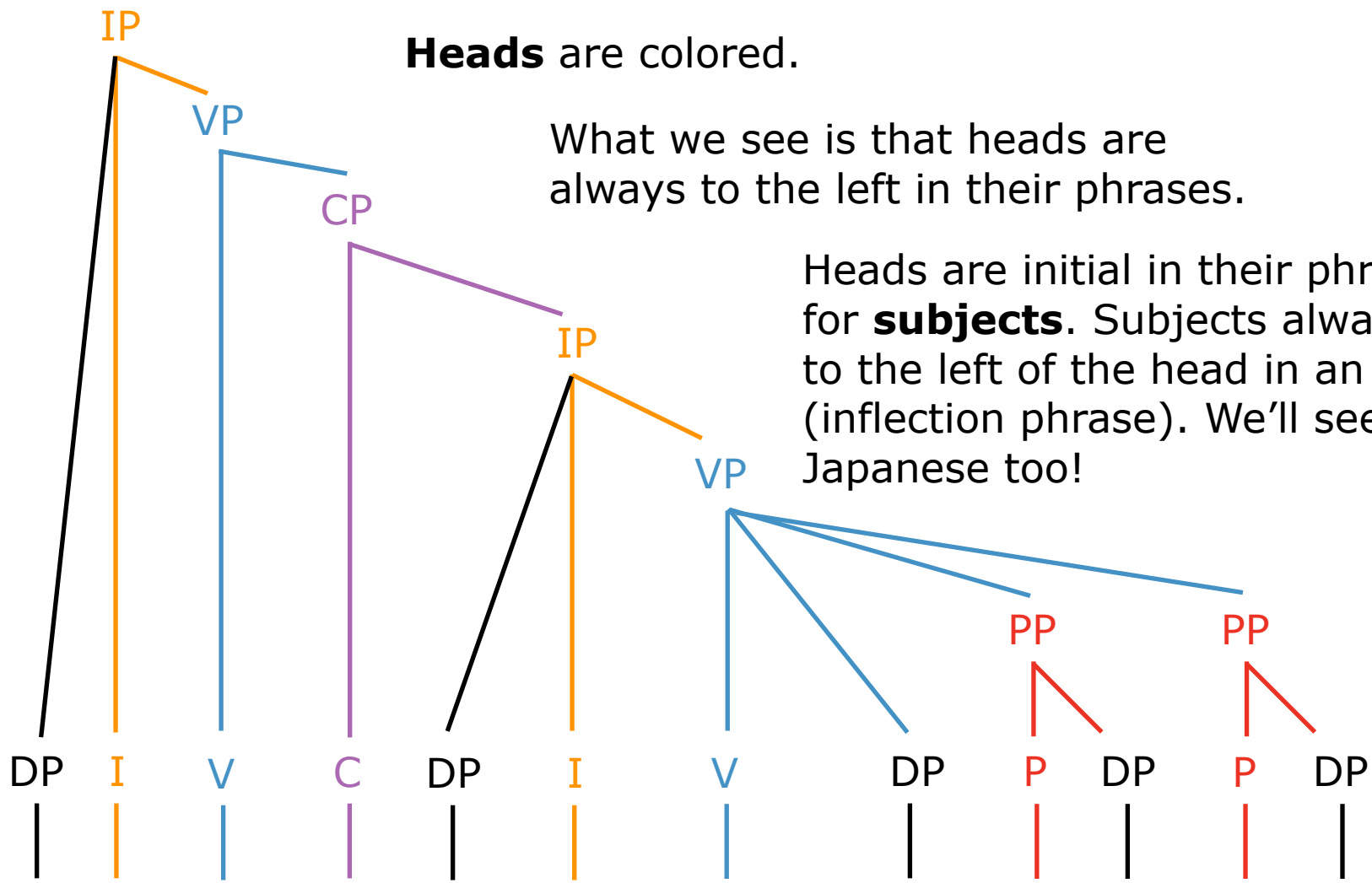
tr: 'Taro is thinking that Hiro showed pictures of cats to Hanako.'

Most English speakers feel as though Japanese word order is very different from English. In fact, when given glosses, many English speakers have no idea what the sentence means. It comes across as gibberish.

What I want to show you now is pretty amazing. All of the differences can be captured by a single parametric difference between English and Japanese: English sets the head parameter to head initial, and Japanese sets it to head final.

English phrases and their heads

The first step is to find all of the phrases in the English sentence, and identify their heads. We want to prove that all of the heads are first in their phrases:



Heads are colored.

What we see is that heads are always to the left in their phrases.

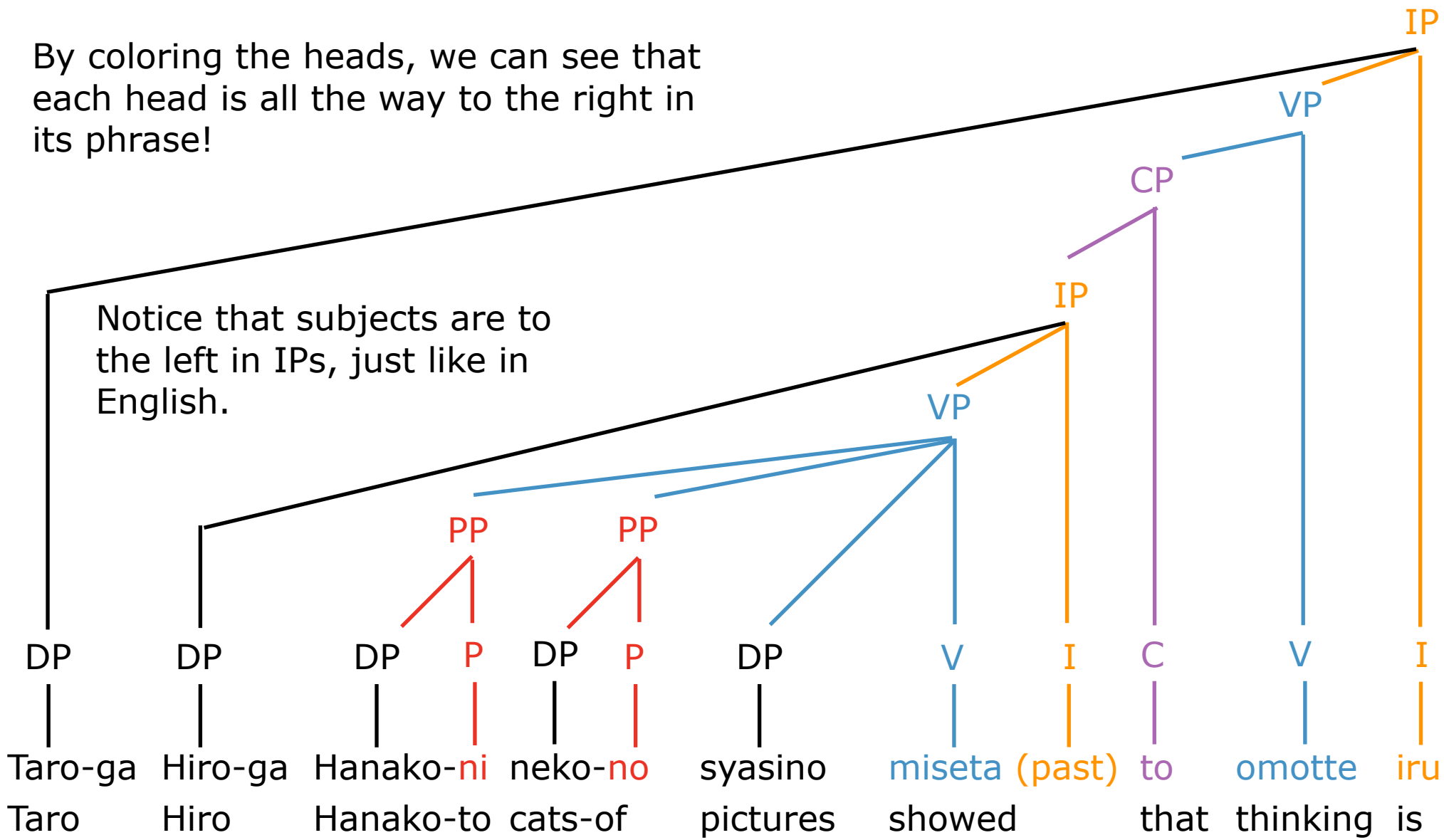
Heads are initial in their phrases except for **subjects**. Subjects always appear to the left of the head in an IP (inflection phrase). We'll see this in Japanese too!

Japanese phrases and their heads

The next step is to find all of the phrases in the Japanese sentence, and identify their heads. We will see that they are always last in the phrase!

By coloring the heads, we can see that each head is all the way to the right in its phrase!

Notice that subjects are to the left in IPs, just like in English.



English and Japanese: Mirror images

From these trees we see two things:

1. Subjects are strange. They are always to the left in IPs. This appears to be a deep fact about IPs in human language. So let's ignore them for now.

2. Once we ignore subjects, English and Japanese are **mirror images of each other**. This is exactly what **the head parameter** predicts if they have opposite settings!

	I	V	C		I	V	DP	P	DP	P	DP
Taro	is	thinking	that	Hiro	(past)	showed	pictures	of	cats	to	Hanako

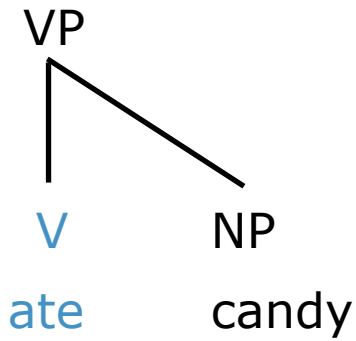
		DP	P	DP	P	DP	V	I	C	V	I	
Taro-ga	Hiro-ga	Hanako	-ni	neko-	no	syasino	miseta	(past)	to	omotte	iru	
Taro	Hiro	Hanako	-to	cats-	of	pictures	showed		that	thinking	is	

The Head Parameter

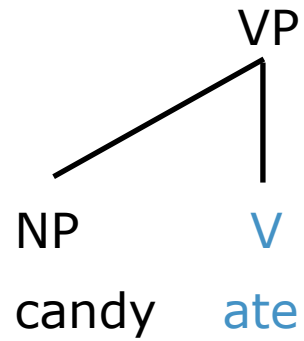
Head Parameter

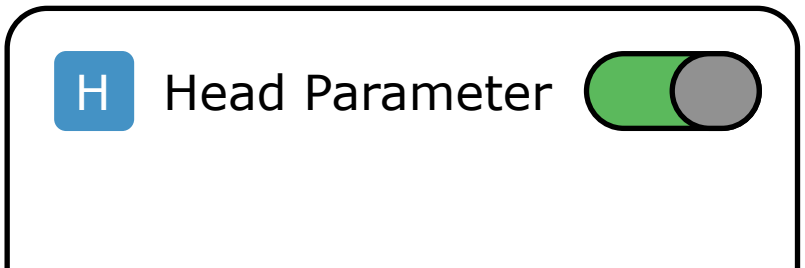
The Head Parameter determines whether heads come first in their phrases (head-initial), or whether they come last (head-final):

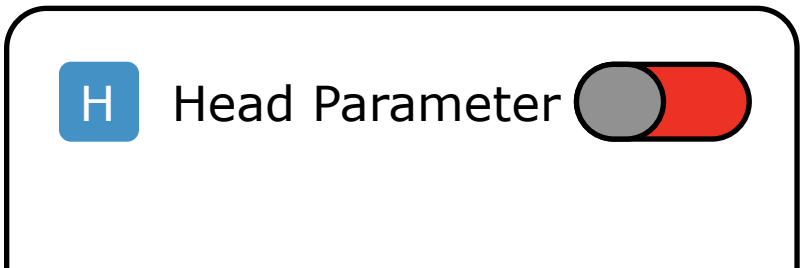
English: John ate candy



Japanese: John candy ate







Principles and Parameters Theory is a very powerful idea

The first power of P&P is the ability to capture abstract universal properties of language as principles. The fact that all human languages look roughly the same in terms of things like Phrase Structure is a great example of **structure in the mind**.

The second power of P&P is the ability to **capture large amounts of variation with very few parameters**. If the number of parameters is P, and each parameter has 2 values, then the number of languages that can be created is defined by this equation: number of languages = 2^P

2 parameters = 2^2 = 4 languages

3 parameters = 2^3 = 8 languages

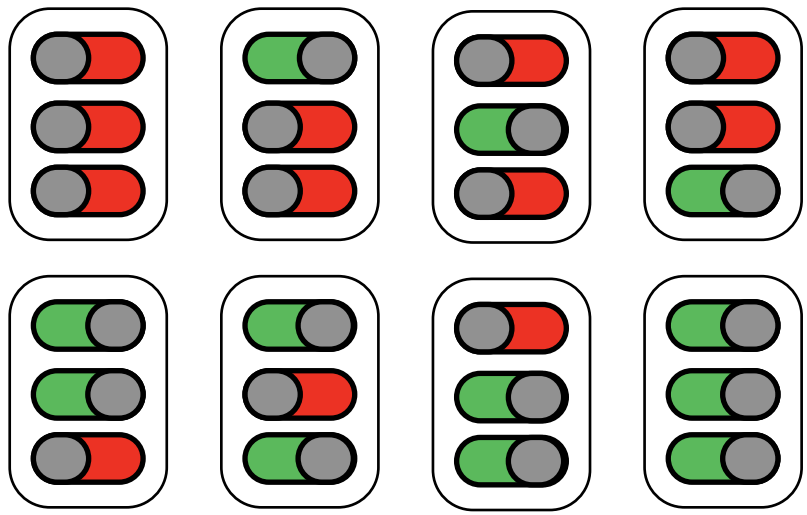
4 parameters = 2^4 = 16 languages

8 parameters = 2^8 = 256 languages

16 parameters = 2^{16} = 65536 languages

32 parameters = 2^{32} = 4 billion languages

Here are 3 parameters:



Do parameters capture all of the variation?

It is important to note that parameters are only intended to capture systematic variation. By systematic, we mean variation that has relatively few options (perhaps only two) and has far reaching consequences.

There is variation between languages that is not systematic (i.e., has lots of potential values, and does not have far reaching consequences). This variation must be captured some other way… perhaps simply through memorization.

For example, the variation between languages is fairly large when it comes to which phonemes they use.

They all choose from the same set of consonants, but the specific choices vary!

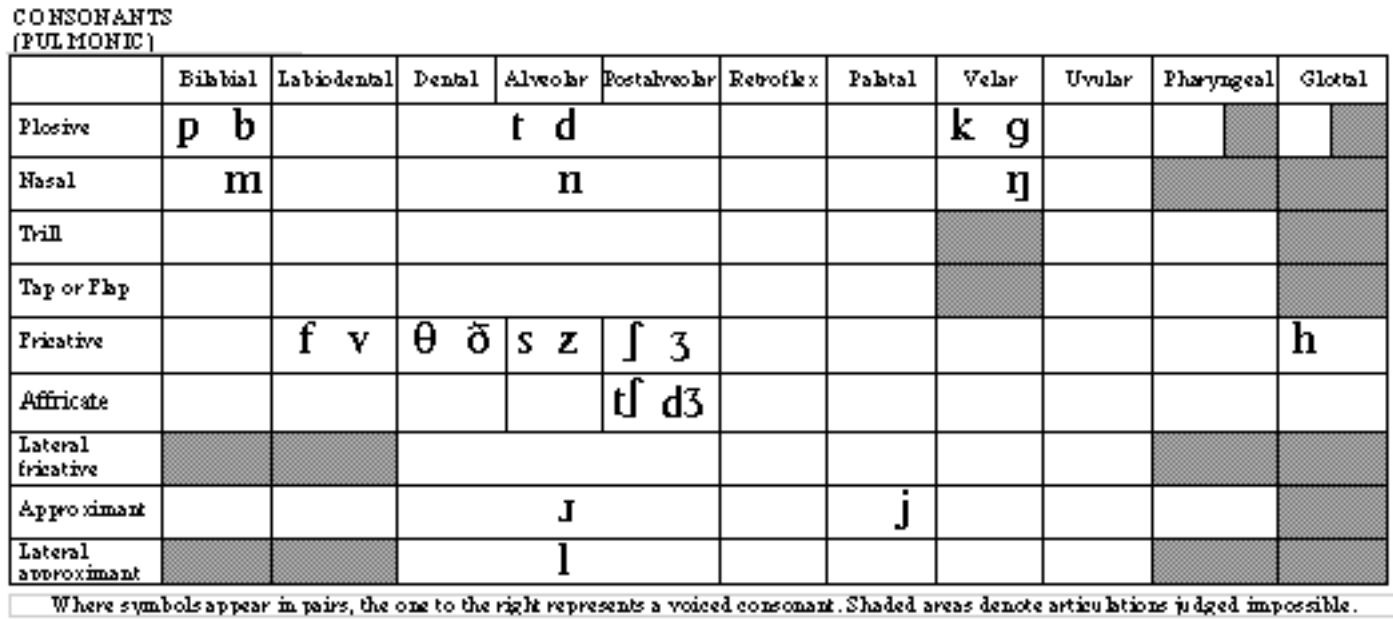
CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Variation in Consonant Inventories

English

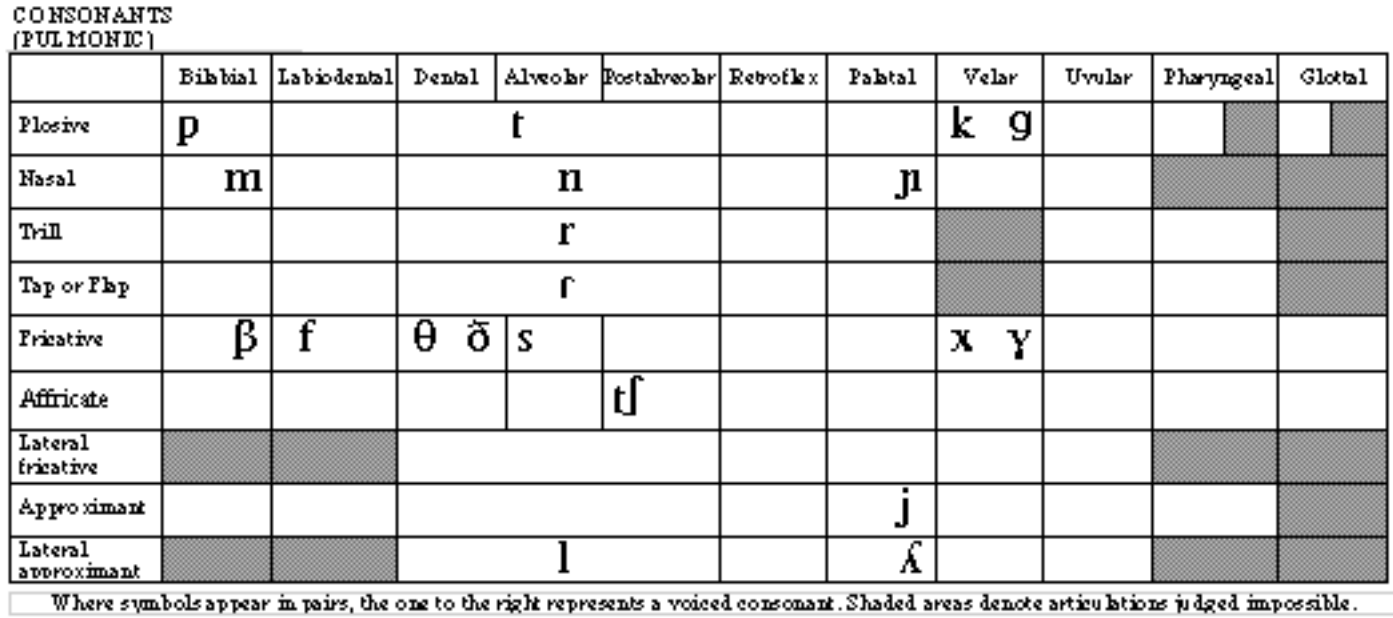


CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d				k g			
Nasal	m			n				ŋ			
Trill											
Tap or Flap											
Fricative		f v	θ ð	s z	ʃ ʒ						h
Affricate					tʃ dʒ						
Lateral fricative											
Approximant				ɹ			j				
Lateral approximant				l							

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Spanish



CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p			t				k g			
Nasal	m			n			ɲ				
Trill				r							
Tap or Flap				ɾ							
Fricative	β	f	θ ð	s				x ɣ			
Affricate					tʃ						
Lateral fricative											
Approximant							j				
Lateral approximant				l			ʎ				

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Variation in Consonant Inventories

English

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d				k g			
Nasal	m			n				ŋ			
Trill											
Tap or Flap											
Fricative		f v	θ ð	s z	ʃ ʒ						h
Affricate					tʃ dʒ						
Lateral fricative											
Approximant				ɹ			j				
Lateral approximant				l							

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Chinese

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p			t				k			
Nasal	m			n				ŋ			
Trill											
Tap or Flap											
Fricative		f		s		ʂ ʐ	ɕ		χ		
Affricate				ts		tʂ	cɕ				
Lateral fricative											
Approximant							j				
Lateral approximant				l							

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Variation in Consonant Inventories

Japanese

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d				k g			
Nasal	m			n				ŋ			
Trill											
Tap or Flap				ɾ							
Fricative	ɸ			s z	ʃ		ç				h
Affricate				ʦ	ʧ ʤ						
Lateral fricative											
Approximant							j				
Lateral approximant											

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Chinese

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p			t				k			
Nasal	m			n				ŋ			
Trill											
Tap or Flap											
Fricative		f		s		ʂ ʐ	ç		χ		
Affricate				ʦ		ʧʂ	ʨ				
Lateral fricative											
Approximant							j				
Lateral approximant				l							

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Variation in Consonant Inventories

Japanese

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d				k g			
Nasal	m			n				ŋ			
Trill											
Tap or Flap				ɾ							
Fricative	ɸ			s z	ʃ		ç				h
Affricate				ʦ	ʧ ʤ						
Lateral fricative											
Approximant							j				
Lateral approximant											

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Korean

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p			t				k			
Nasal	m			n				ŋ			
Trill											
Tap or Flap											
Fricative				s							h
Affricate					ʧ						
Lateral fricative											
Approximant							j				
Lateral approximant				l							

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Variation in Consonant Inventories

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

The human vocal tract can make about 300 different consonants. But most languages only have 20-30 consonants:

Mean: 22.7
Mode: 22
Median: 21
Smallest: 6, (p,t,k,b,d,g), Rotokas, Papua New Guinea
Largest: 122, !Xoo, Botswana

The choice of which 20-30 a language uses is not governed by parameters.

Variation in morphemes (and words)

The specific form that morphemes (and thus words) take in a language is another example of unsystematic variation. The fact that -ed is the form of the past tense and "jump" is the form of the verb for that specific action is completely arbitrary. Languages vary greatly in the form of morphemes. This type of variation is not governed by parameters.

Suffixes

jump

jumped

jumping

jumps

Prefixes and Suffixes

unbelievable

unknowable

denationalize

decriminalize

Prefixes

unlock

retry

invisible

Infixes

hippofuckingpotamus

missifuckingssippi

unfuckingbelievable

Some Conclusions

The code talker paradox shows that languages are simultaneously very similar and very dissimilar. (Thanks Mark Baker!)

Principles and Parameters Theory can resolve this paradox through principles, which govern how all languages work, and parameters, which are a finite number of options/settings that determine how languages can vary.

An example of a principle is that all languages use phrase structure for their syntax. Another example is that all languages use articulatory features for their phonemes.

The Null Subject Parameter can be used to explain differences between English and French on one hand, and Spanish and Italian on the other, when it comes to the presence/absence of subjects in tensed sentences.

The Head Parameter can be used to explain why it is that Japanese word order seems so different from English word order. In fact, once we set aside subjects of IPs, we see that English and Japanese are the mirror image of each other!

P&P is a very powerful theory, easily predicting a large number of language types with very few parameters. However, unsystematic variation, such as the choice of phonemes or morphemes, requires other mechanisms (like memory).