



Making Ling 101 accessible for blind students

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0

Collaborator

- Nikki Lyssy
- PhD student in Creative Writing at Texas Tech University
- Blind since birth



1

Terminology

- I'll use "blind" as a shorthand for "blind and/or visually-impaired," except where the distinction is relevant
- Keep in mind that "blind" covers a wide range of experiences

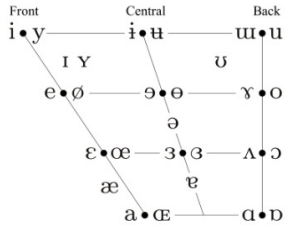
2

The problem

- Ling 101 is chock full of pedagogical tools that rely on vision

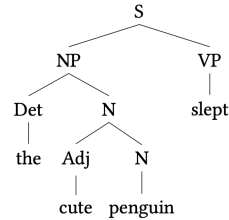
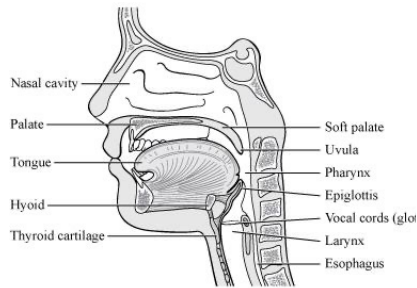
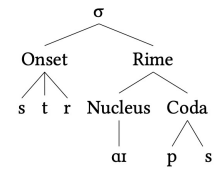
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The problem

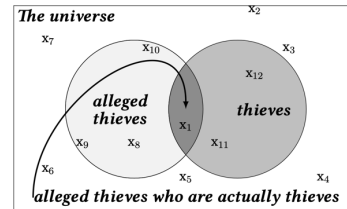


CONSONANTS (PULMONIC) © 2020 IPA

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k ɡ	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill				r						ʁ	
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			



seek	[sik]	sheik	[ʃik]
seat	[sit]	sheet	[ʃit]
cede	[sid]	she'd	[ʃid]



4

The problem

- Accommodations are often one-off, and aren't shared with the broader linguistics community
- Every instructor-student pair is basically starting from scratch

5

Outline

- The problem
- Prior work
- Our context
- Our tools
 - Vocal tract models
 - Representing IPA
 - Handouts
 - Morphological and syntactic trees
- Alternatives and recommendations

6

Prior work

7

Tools for linguistics

- Many resources on Justice, Equity, Diversity, and Inclusion (JEDI) in the field generally (e.g. Charity Hudley et al. 2020), largely focusing on race and gender
- Relatively fewer resources specifically for teaching students with disabilities (though see Zuraw 2022 and the slides that follow)

8

Tools for linguistics

- Tactile magnet IPA (Lillehaugen et al. 2014)
- Braille IPA (see Englebretson 2009)
- Practical tips for for hearing and vision disabilities (McGarrity and Yip 2024)
- Assistive design for English phonetic tools (ADEPT) for L2 English learners (tactile IPA cards + companion website) (Medina González and Hardison 2022)

9

Universal design for learning (UDL)

- *UDL is a framework to guide the design of learning environments that are accessible, inclusive, equitable, and challenging for every learner. Ultimately, the goal of UDL is to support learner agency, the capacity to actively participate in making choices in service of learning goals. (<https://udlguidelines.cast.org/more/udl-goal/>)*

10

UDL guidelines

- Aim for multiple means of:
 - Engagement—cater to learners' variability, interests, and motivations
 - Representation
 - Action and expression
- We focus on *representation*

11

UDL's representation guidelines

- Perception
 - Offer information in multiple modalities
 - Accessible, customizable formats (e.g. easily zoomed, amplified, etc)
- Language and symbols
 - Clarify vocabulary and symbols
 - Provide multiple forms of representation and notation
- Building knowledge
 - Maximize transfer and generalization

12

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13

Our context

14

Texas Tech

- Large regional R1 university
- ~40,000 students (~33,000 undergrad)
- Linguistics teaching is split among various departments
 - English (primary)
 - Classical and Modern Languages and Literatures (applied linguistics)
 - Speech, Language, and Hearing Sciences



15

Our Ling 101 course(s)

- Intro to Language
- How Language Works
- Principles of Language

16

Nikki's background

- Completely blind since birth
- No sense of mental imagery (aphantasia)
- Uses Braille (printed and via refreshable display)
- Uses screen-reading software (JAWS/Voicover)
- Plenty of experience in classes primarily using written materials

17

Screenreaders

JAWS (Windows)

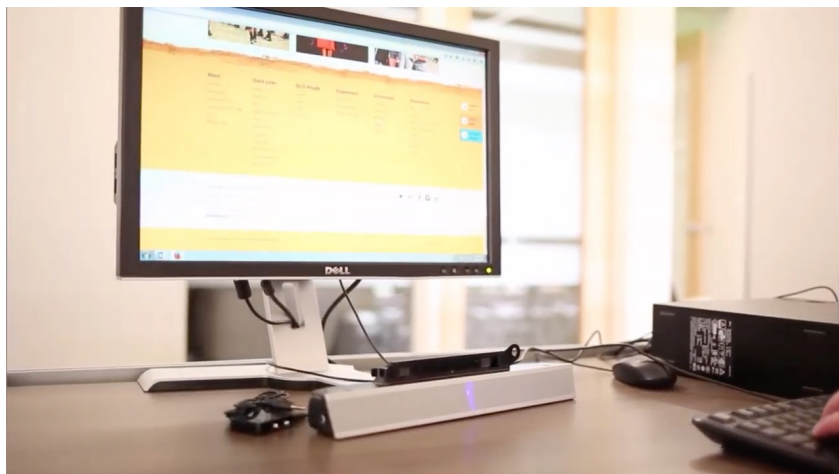


Vocieover (Mac)



18

Screenreaders



https://www.youtube.com/watch?v=q_ATY9gimOM

19

Refreshable Braille display



20

Refreshable Braille display



21

Other courses

- Primarily text-based
- Tactile graphics exist for some more common subjects (e.g. math, chemistry)

22

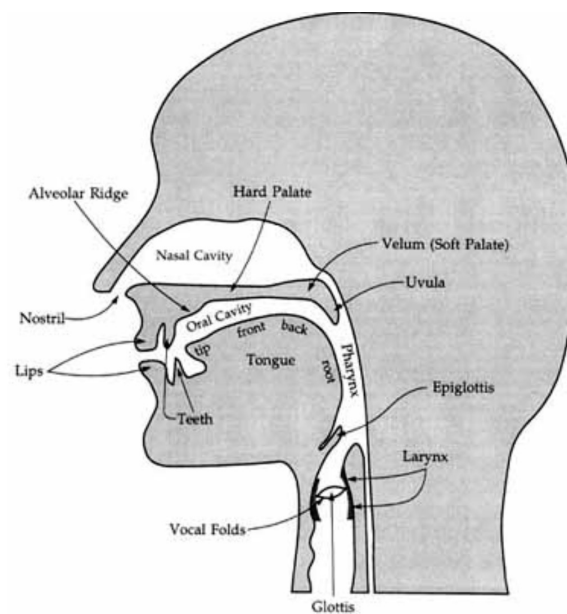
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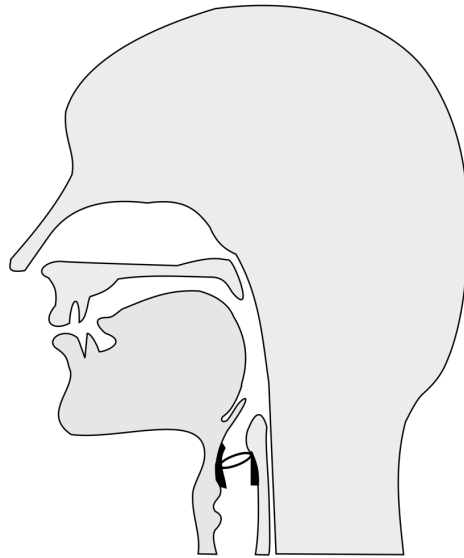
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Vocal tract models

24



25



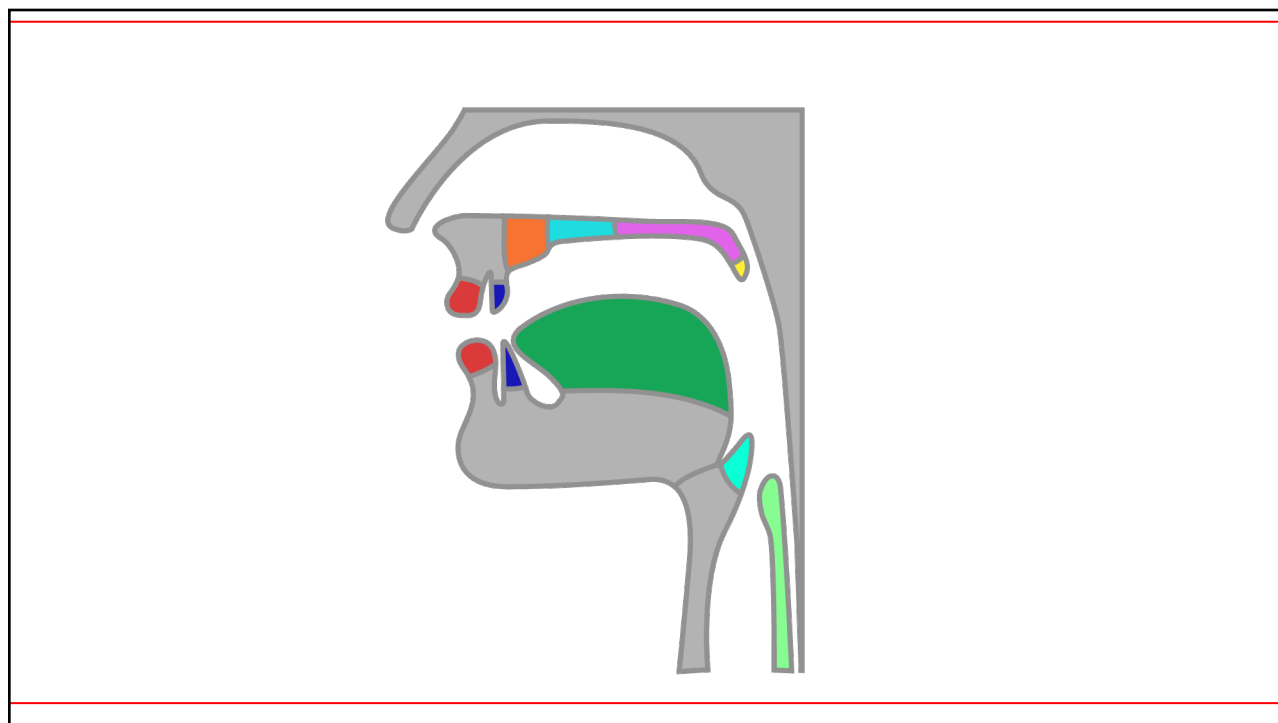
https://commons.wikimedia.org/wiki/Category:Vocal_tract#/media/File:VocalTract.svg

26

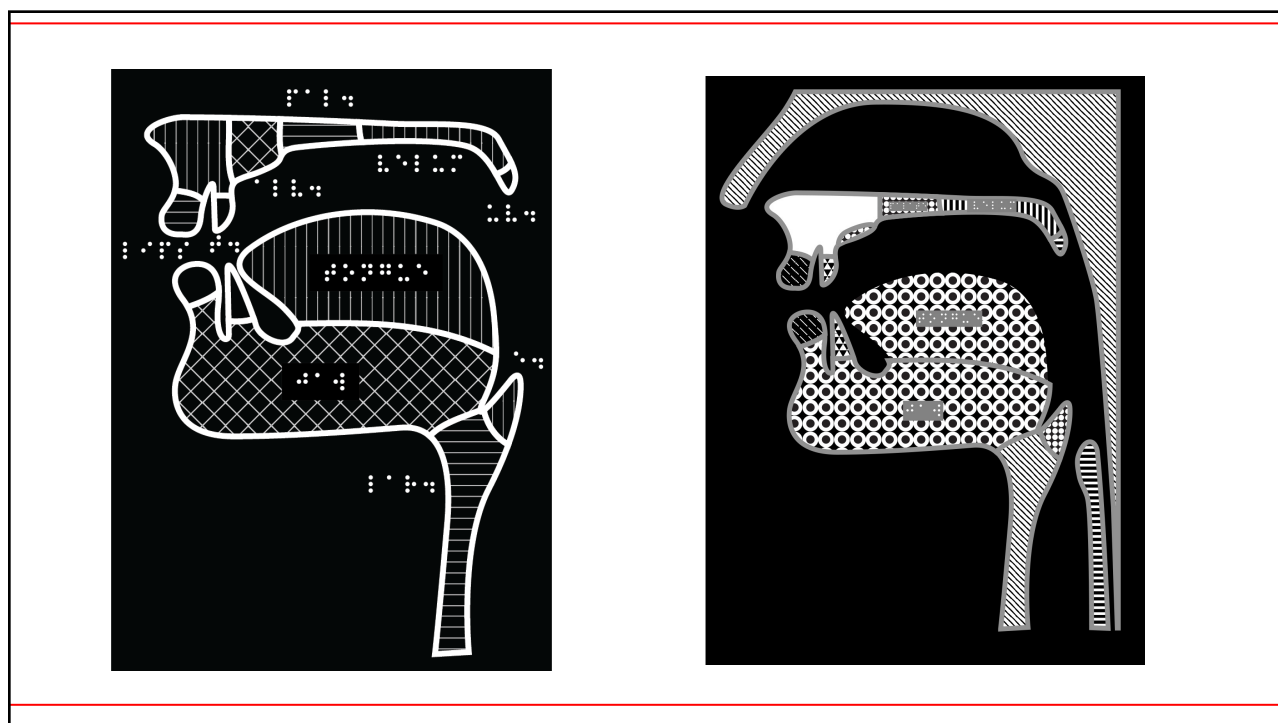
Glowforge laser cutter/engraver



27



28



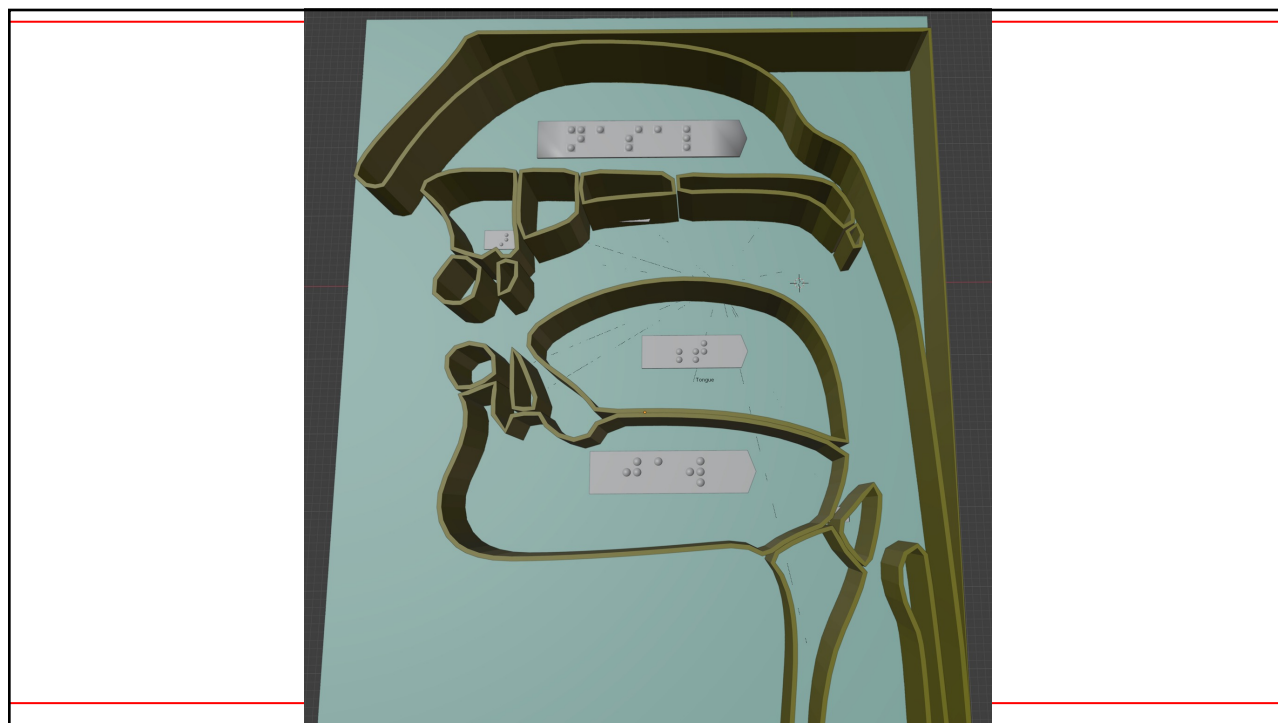
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30



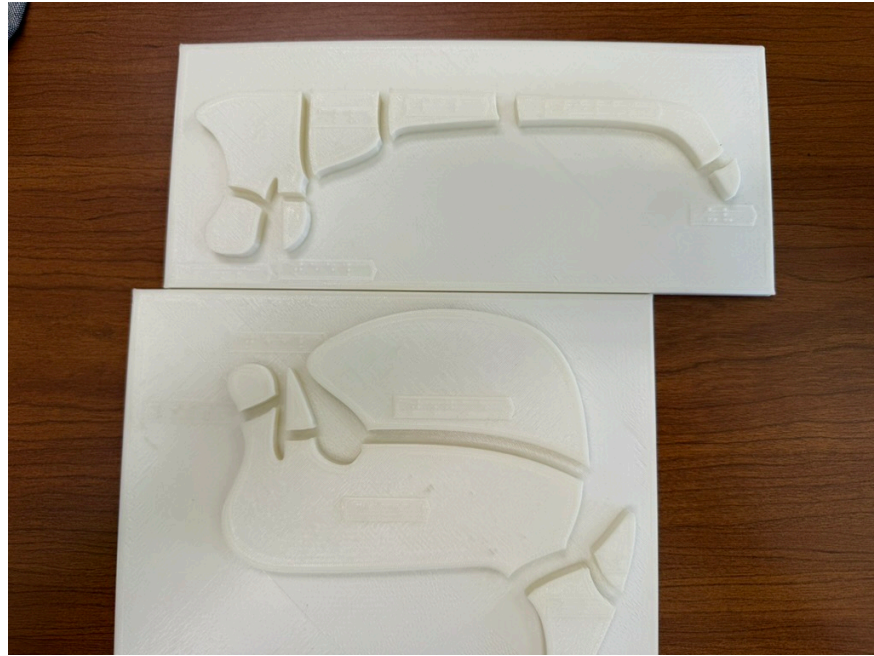
31



32



33




34

Representing IPA

35

Screenreader on IPA

- Inŋwɪstɪks ɪz fʌn 

36

Tactile IPA magnet-board

- Lillehaugen et al. 2014
- Large-print and raised/embossed IPA symbols
- Magnetic board for arranging symbols

37

Tactile IPA magnet-board



FIGURE 2. A tactile magnet: ʃ.

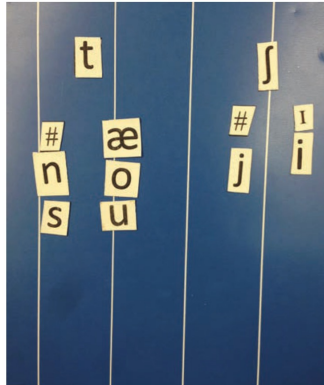


FIGURE 6. Using the boards to work phonology problems: a distribution chart.



FIGURE 4. The organization of the consonants.

Tactile IPA magnet-board

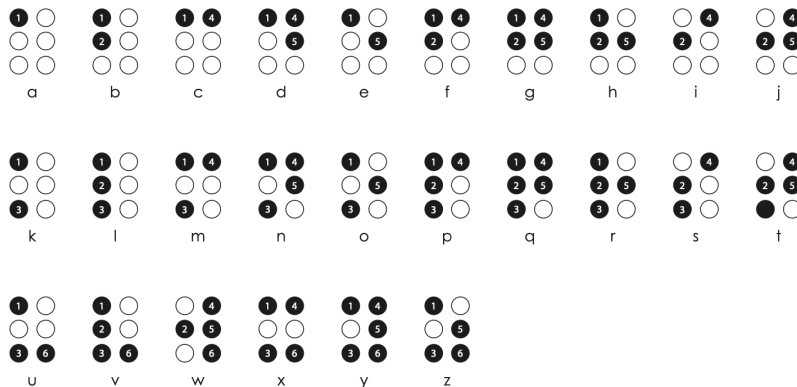
- Use of print allows sighted students to share the same tool
- May be useful for blind students who don't read Braille
- Many blind students are familiar with reading Braille, but not tactile print (especially for new symbols)

Tactile IPA magnet-board

- Nikki has a hard time with tactile print
- Can't prepare large datasets ahead of time
- Must be created by hand (i.e., no way to convert existing digital sources)

40

Standard English Braille



41

Braille IPA

- Originally designed by Merrick and Potthoff (1932)
- Adapted by Englebretson in 2008, accepted by Braille Authority of North America (see Englebretson 2009)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	⠠ ⠡			⠠ ⠡		⠠ ⠡ ⠢	⠠ ⠡ ⠢	⠠ ⠡	⠠ ⠡ ⠢		⠠ ⠡
Nasal	⠠ ⠡	⠠ ⠡ ⠢		⠠ ⠡		⠠ ⠡ ⠢	⠠ ⠡ ⠢	⠠ ⠡	⠠ ⠡ ⠢		
Trill	⠠ ⠡			⠠ ⠡					⠠ ⠡ ⠢		
Tap or Flap		⠠ ⠡ ⠢		⠠ ⠡ ⠢		⠠ ⠡ ⠢					
Fricative	⠠ ⠡ ⠢ ⠣	⠠ ⠡ ⠢	⠠ ⠡ ⠢	⠠ ⠡ ⠢	⠠ ⠡ ⠢	⠠ ⠡ ⠢ ⠣	⠠ ⠡ ⠢ ⠣	⠠ ⠡ ⠢ ⠣	⠠ ⠡ ⠢ ⠣	⠠ ⠡ ⠢ ⠣	⠠ ⠡ ⠢
Lateral fricative				⠠ ⠡ ⠢ ⠣							
Approximant		⠠ ⠡ ⠢		⠠ ⠡		⠠ ⠡ ⠢	⠠ ⠡	⠠ ⠡			
Lateral approximant				⠠ ⠡		⠠ ⠡ ⠢	⠠ ⠡ ⠢	⠠ ⠡			

42

Braille IPA

“Since Braille characters are larger than corresponding print characters, they cannot be lined up by place and manner as is usually done. A page large enough to hold eleven columns for place of articulation would have to be approximately two and a half feet across.”

(Wells-Jensen 2005:226)

43

Braille IPA

- Challenging for sighted classmates to use
- May not be useful for blind students who don't read Braille
- Nikki found the system unintuitive
- Not easy to make compatible with screen reader and braille display simultaneously
- Few tools for converting

44

SAMPA

- SAMPA (Speech Assessment Methods Phonetic Alphabet) was developed in the late 1980s to encode 6 European languages with standard ASCII characters
- Uses IPA symbols where available on standard keyboard
- Other symbols have less transparent origins
 - ə = @
 - æ = {
 - ø = 2 (cf. French *deux* [dø])
 - œ = 9 (cf. French *neuf* [nœf])

45

X-SAMPA

- Extended SAMPA (X-SAMPA) developed in 1995 by John C. Wells to cover the whole IPA
- Some regular patterns:
 - Implosives: $\text{b} = \text{b}_<$, $\text{d} = \text{d}_<$, $\text{g} = \text{g}_<$
 - backtick and slash as modifiers:
 - $\text{r} = \text{r}^{\backslash}$, $\text{s} = \text{s}^{\backslash}$
 - $\text{r} = \text{r}^{\backslash}$, $\text{s} = \text{s}^{\backslash}$
 - $\text{r} = \text{r}^{\backslash}$
 - Diacritics mostly start with underscore
 - voiceless = $_0$, nasalized = $_~$, aspirated = $_h$

46

X-SAMPA

- Each component already has a Braille equivalent
- Works easily with Braille display
- Online IPA↔X-SAMPA converters exist; I provide an R script
- Classmates can read it—could be used instead of IPA

47

X-SAMPA

- Screenreaders do ok with it
 - Read the character name, rather than the sound (e.g. $\text{b} = \text{b}_< =$ “bee underscore less than”)
 - Settings in screenreader software may determine whether and how punctuation is read out
- We put spaces between each X-SAMPA character:
 - Screenreader more likely to read character name
 - Easier to tell where one phone ends and the next begins, especially when composed of multiple glyphs

48

X-SAMPA

- Let us (relatively) easily modify existing tools

Interactive IPA Chart

TYPE AUDIO AUDIO + VIDEO

Type IPA

Consonants (Pulmonics)

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

Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.

Interactive IPA Chart

TYPE AUDIO AUDIO + VIDEO

Click around to hear the sounds of the International Phonetic Alphabet. Press a symbol to hear it spoken.

Consonants (Pulmonics)

Consonants (Pulmonics)

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

Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.

49

Online chart with sounds

Consonants (Pulmonics)

Consonants (Pulmonics)																							
	Bilabial		Labiodental		Dental		Alveolar		Postalveolar		Retroflex		Palatal		Velar		Uvular		Pharyngeal		Glottal		
Stop	p	b					t	d			t̪	d̪	c	ɟ	k	g	q	ʁ				ʔ	
Nasal		m		f				n				n̪		j		ŋ	ɴ						
Trill		ʙ						r									ʀ						
Tap								ɾ				r̠											
Fricative	p̪	β	f	v	θ	ð	s	z	ʃ	ʒ	s̠	z̠	ç	ʝ	x	ɣ	χ	ʁ	ħ	ʕ	ʕ̰	h	h̰
Lateral fricative								ɬ	ɮ														
Approximant				ʋ				ɹ				r̠		j		ɰ							
Lateral approximant								l				ɭ		ʎ		ʟ							
Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.																							

Modified from <https://int-ipa.winstondurand.com>

50

Handouts

51

Handouts

- Previous handouts were in LaTeX, which not very screenreader-friendly
- Converted these to Word format, using an R script to convert IPA to X-SAMPA

52

Another source of accent differences is differences in sound inventories. This leads to *sound substitutions*:

- French doesn't have the sounds [D] or [T]
 - *this* >> [z I s]
 - *thin* >> [s I n]
- English doesn't have [x], which is found in German
 - *Bach* [b A x] >> [b A k]
 - *Lebkuchen* [l e b k u x @ n] 'Christmas cookie' >> [l e I b k u k @ n] or [l e I b k u h e n]

Another source of accent differences is differences in sound inventories. This leads to *sound substitutions*:

- French doesn't have the sounds [ð] or [θ]
 - *this* → [zɪs]
 - *thin* → [sm]
- English doesn't have [x], which is found in German
 - *Bach* [bax] → [bæk]
 - *Lebkuchen* [lebkuxən] 'Christmas cookie' → [leɪbkukən] or [leɪbkuhen]

53

Japanese also uses both [s] and [ʃ]:

Japanese 'know'	
[ʃiranai]	'not know'
[ʃirimasu]	'know (polite present)'
[ʃiru]	'know (present)'
[ʃireba]	'know (conditional)'
[ʃiroo]	'let's know'

Japanese 'lend'	
[kasanai]	'not lend'
[kaʃimasu]	'lend (polite present)'
[kasu]	'lend (present)'
[kaseba]	
[kasoo]	

Japanese also uses both [s] and [S] :

SAMPA	meaning	ipa
S i r a n a i	'not know'	ʃiranai
S i r i m a s u	'know (polite present)'	ʃirimasu
S i r u	'know (present)'	ʃiru
S i r e b a	'know (conditional)'	ʃireba
S i r o o	'let's know'	ʃiroo
k a s a n a i	'not lend'	kasanai
k a S i m a s u	'lend (polite present)'	kaʃimasu
k a s u	'lend (present)'	kasu
k a s e b a	'lend (conditional)'	kaseba
k a s o o	'let's lend'	kasoo

Handouts

- Datasets on handouts are often in tabular format—but not always accessible
- Excel is fairly accessible out of the box

Handouts

- Tabs for each separate dataset
- Columns for item number, X-SAMPA, gloss, and standard IPA

	A	B	C	D
1	1	ki:ba	'soon'	ki:ba
2	2	ki:i^a	'you'	ki:ja
3	3	ko d_Zi:u^	'he tries'	ko dʒi:u
4	4	ma sk i s i n	'shoe'	maskisin
5	5	ma sk u^ a k	'bears'	maskuak
6	6	ma:ga	'but'	ma:ga
7	7	ke:ga:t_S	'almost'	ke:ga:tʃ
8	8	t_Si:ga h i g a n	'axe'	tʃi:ga h i g a n
9	9	ki:si ga:u^	'day'	ki:si ga:u
10	10	o sp u^ a: g a n	'pipe'	ospu a: g a n
11				
12				
13				
14				
15				

3 Cree t_S and d_Z 5 Cree k and g +

56

Trees

57

Goals for trees

- Represent hierarchical structure
- Be readable by both blind and sighted people

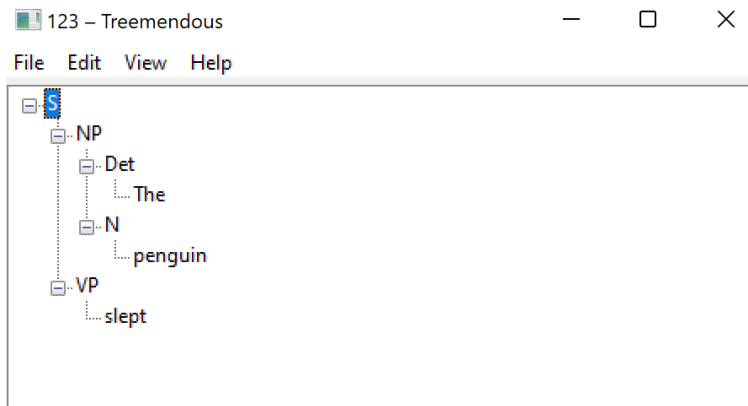
58

Trees: First thoughts

- Bracket structure
- Software solutions

59

Treemendous

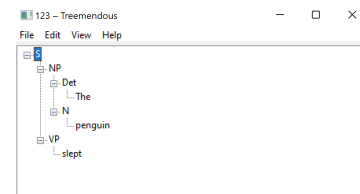


<https://github.com/codeofdusk/treemendous>

60

Treemendous

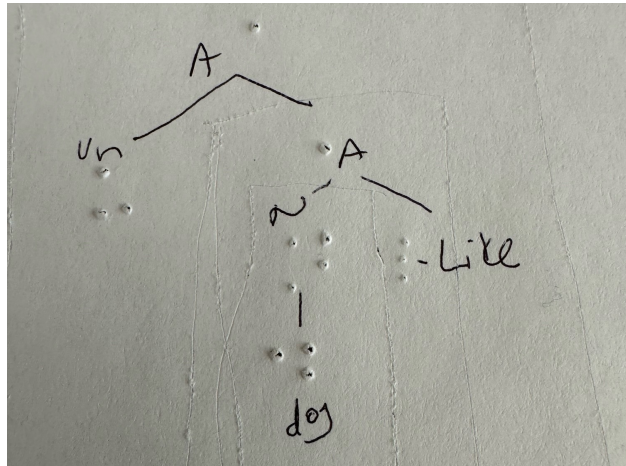
- Works well with screenreaders
- Windows-only
- Up/down vs. left/right navigation
- Hard to perceive relationships between units
- No easy conversion to/from other formats (e.g. brackets)



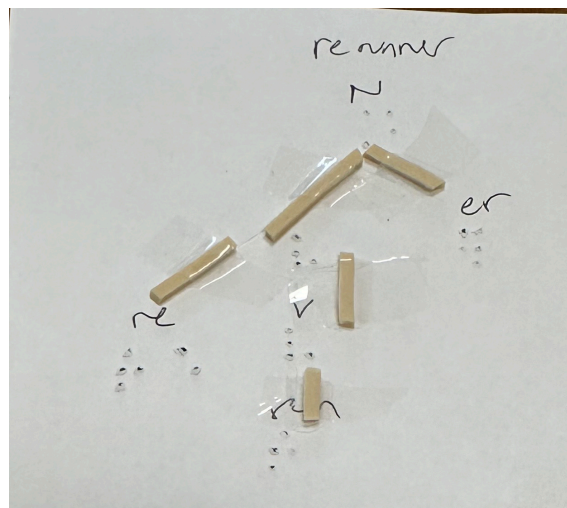
<https://github.com/codeofdusk/treemendous>

61

62



63

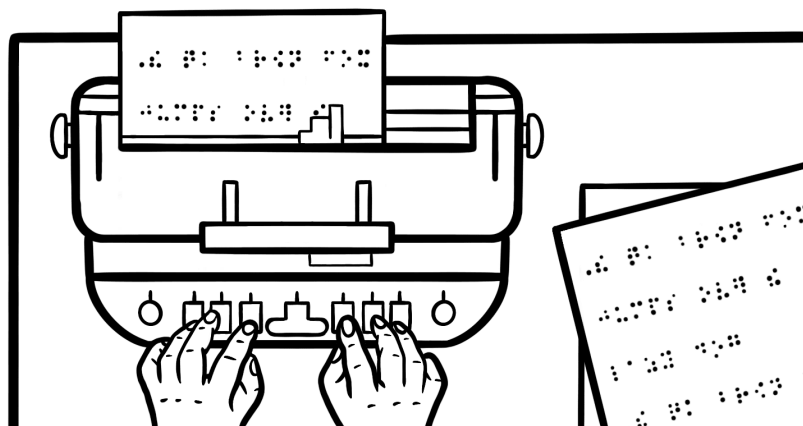


Perkins Brailler



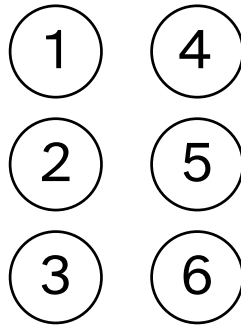
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Perkins Brailler



65

Perkins Braille

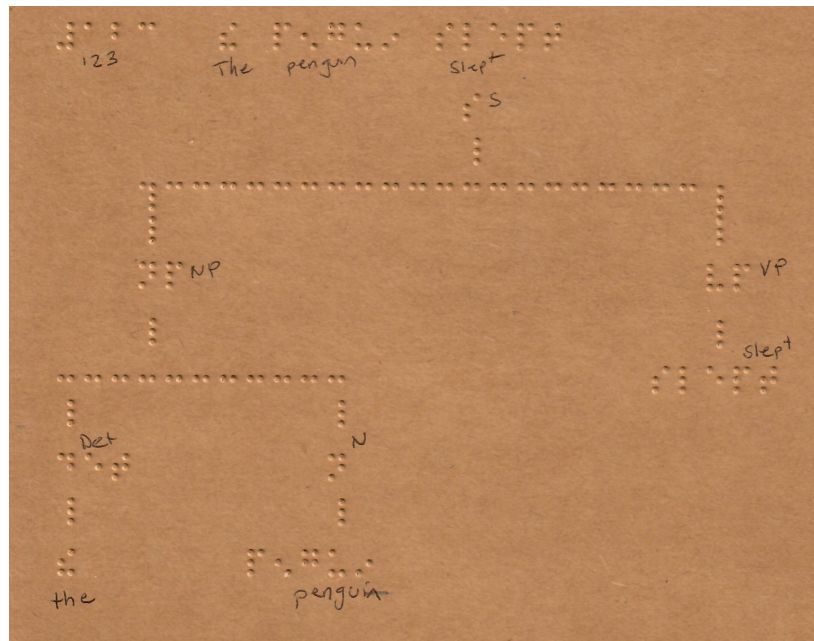


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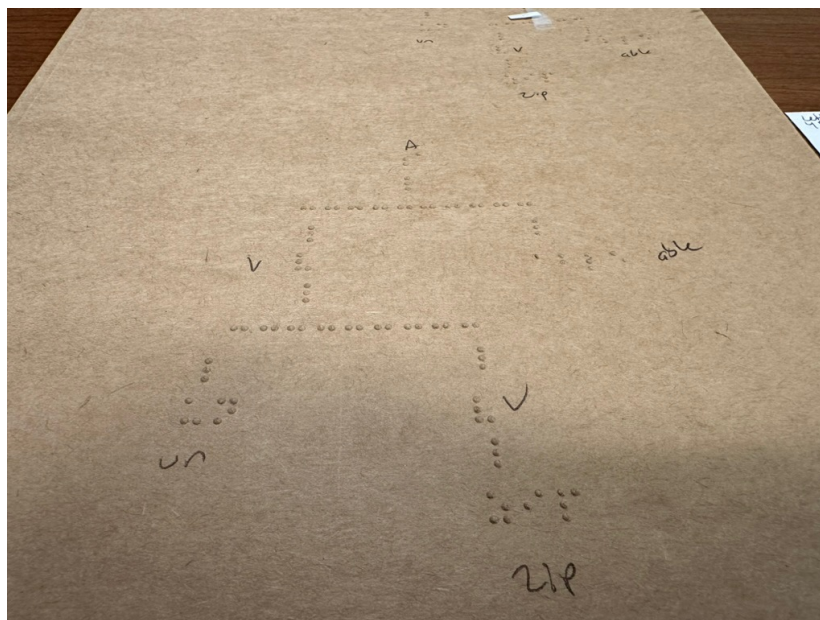
Perkins Braille



67



68



69

Braille trees: Challenges

- Alignment
- Space on the page
- Hard to work bottom-up since—bottom of page is hidden, and there is no easy way to go *up* a row at a time

70

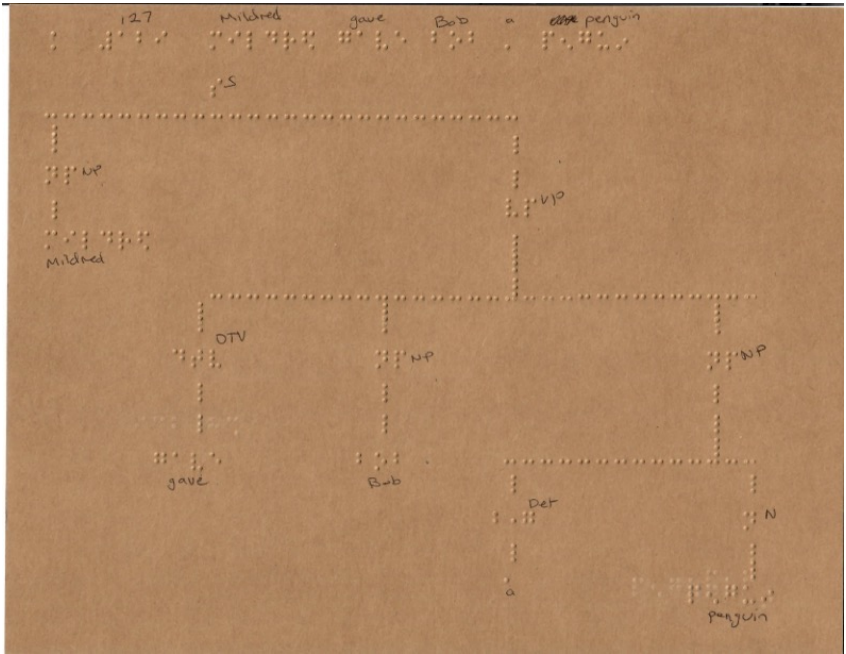
The diagram illustrates the hierarchical structure of the sentence "The duck quacked at the goose" using a grid. The grid has 26 columns (A-Z) and 25 rows (1-25). The sentence is written in row 1. The hierarchical structure is shown in subsequent rows:

- Row 2: S
- Row 3: NP, VP
- Row 4: |
- Row 5: - - - - -
- Row 6: Det N VP PP
- Row 7: |
- Row 8: - - - - -
- Row 9: the duck quacked at the goose
- Row 10: |
- Row 11: P NP
- Row 12: |
- Row 13: - - - - -
- Row 14: at |
- Row 15: Det N
- Row 16: |
- Row 17: the goose

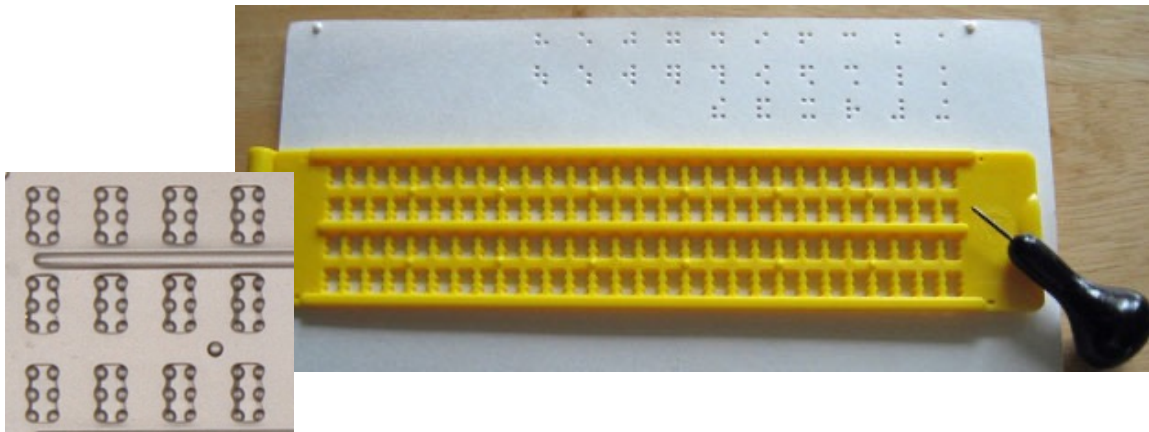
71

Braille contractions ("Grade 2")

ALPHABETIC wordsigns			
⠁ a	⠵ j (just)	⠎ s (so)	
⠃ b (but)	⠽ k (knowledge)	⠞ t (that)	
⠉ c (can)	⠇ l (like)	⠥ u (us)	
⠙ d (do)	⠍ m (more)	⠺ v (very)	
⠑ e (every)	⠝ n (not)	⠺ w (will)	
⠋ f (from)	⠽ o	⠭ x (it)	
⠒ g (go)	⠏ p (people)	⠽ y (you)	
⠈ h (have)	⠑ q (quite)	⠵ z (as)	
⠊ i	⠞ r (rather)		
		Contractions	Wordsigns
		⠠ and	⠠ child
		⠠ for	⠠ shall
		⠠ of	⠠ this
		⠠ the	⠠ which
		⠠ with	⠠ out
			⠠ still
		Groupsigns	
		⠠ ch	⠠ ar
		⠠ sh	⠠ ed
		⠠ th	⠠ er
		⠠ wh	⠠ gh
		⠠ ou	⠠ ow
		⠠ st	⠠ ing



Slate and stylus



74

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75

An expensive alternative

- Embossing devices
 - Braille-only embosser
 - PIAF
 - Braille and image embosser



76

Universal Design for Learning

- We focused on *representation*
- How can we improve engagement and expression?

77

Recommendations: Time

- Start thinking about accessibility *before* you have a student who needs accommodations
- Check out campus resources *now*—and not just the disabilities office

78

Recommendations: Tools

- Create a repository with freely-available tools (e.g. 3D modeling files)
- Approach design of tools as a collaboration

79

Recommendations: For everyone

- Multiple forms of representation can be useful for all students

80

Thank you

Special thanks to Nikki Lyssy for providing her insights and her willingness to try about 5,000 versions of every tool.

81

References

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