

# *EMPOWERING THE READER THROUGH THE DYNAMICS OF TEXT-TO-SPEECH: RESEARCH TO PRACTICE*

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## LEARNING OBJECTIVES

**RESEARCH:** Examine research findings and implications for practice relevant to students with dyslexia and other language learning disabilities.

**TECHNOLOGY:** Access potential applications of language-based technology for direct instruction and/or accommodation for students with dyslexia and other language learning disabilities.

# AGENDA

Introductions

Define Assistive Technology and text to speech

Sarah: the current evidence for using text to speech

Jennifer: the research on different text to speech features

Nanci: different text to speech applications for every day use

Questions

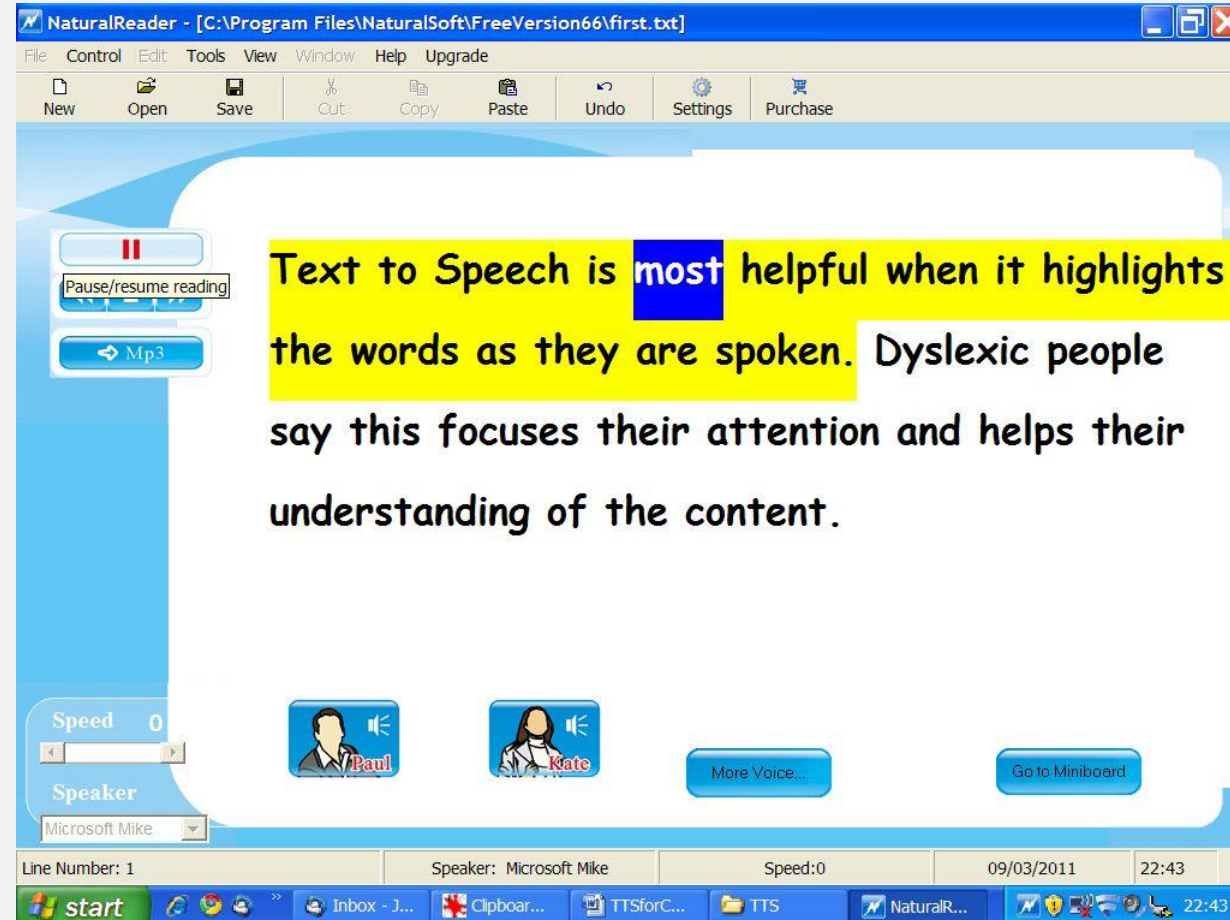
# DEFINITION OF ASSISTIVE TECHNOLOGY

Assistive technology (AT) is any item, piece of equipment, software program, or product system that is used to increase, maintain, or improve the functional capabilities of persons with disabilities.

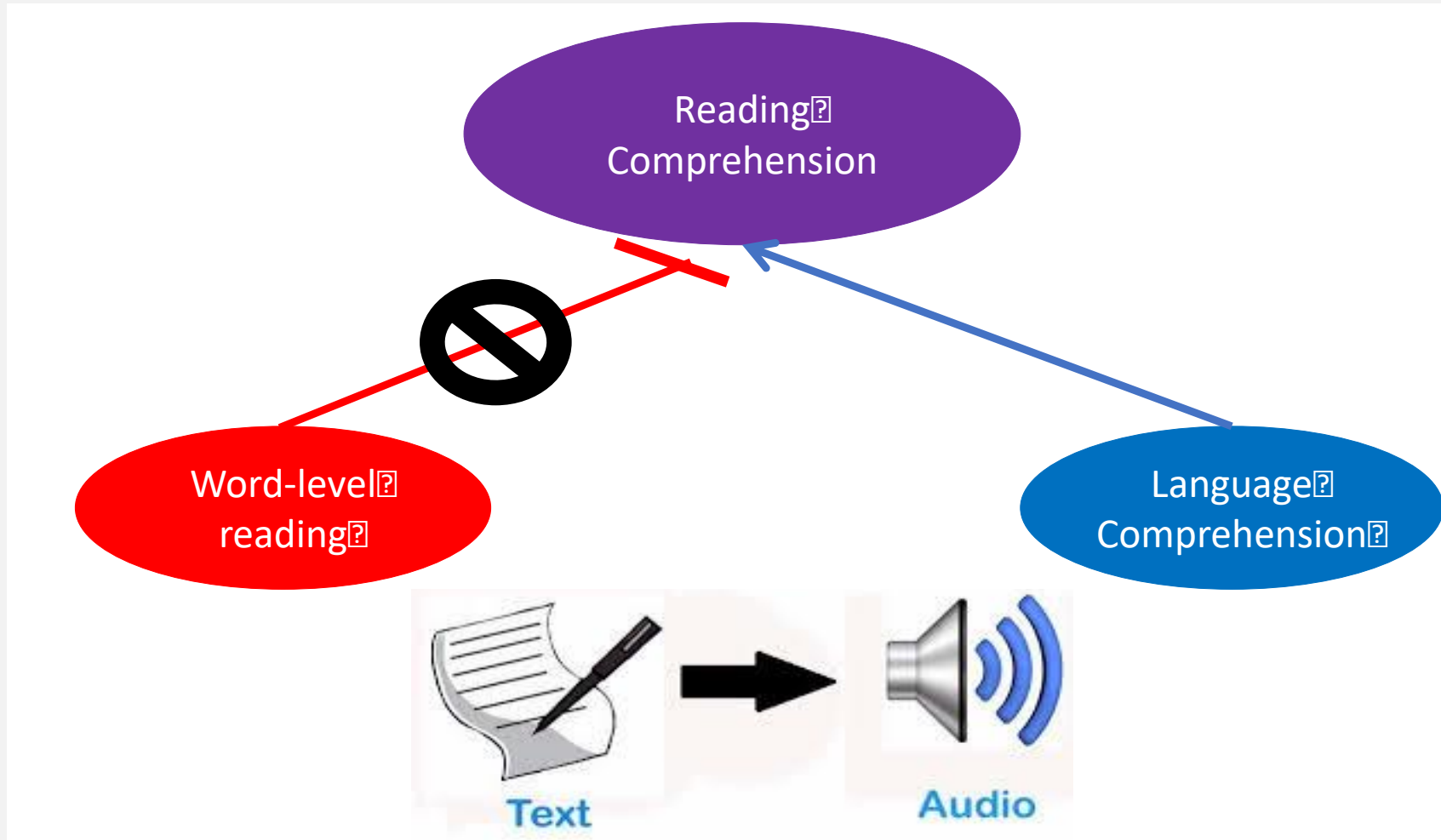
[www.atia.org](http://www.atia.org)

# READ-ALOUD TOOLS

## TEXT-TO-SPEECH TECHNOLOGY



# COULD TEXT-TO-SPEECH AND RELATED READ-ALLOUD TOOLS HELP?



# HOW DO WE KNOW IF THIS REALLY WORKS?

Ask the student if technology works

Ask the student's teacher

Look at student's test scores

Conduct objective and unbiased research

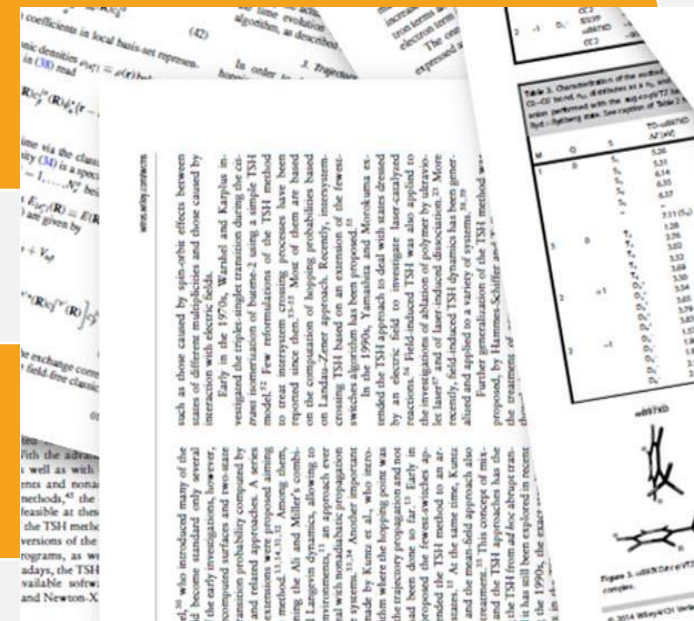
# METHODS FOR EXPLORING PAST RESEARCH

## Literature Reviews

- Qualitative summary of research

## Meta-analysis

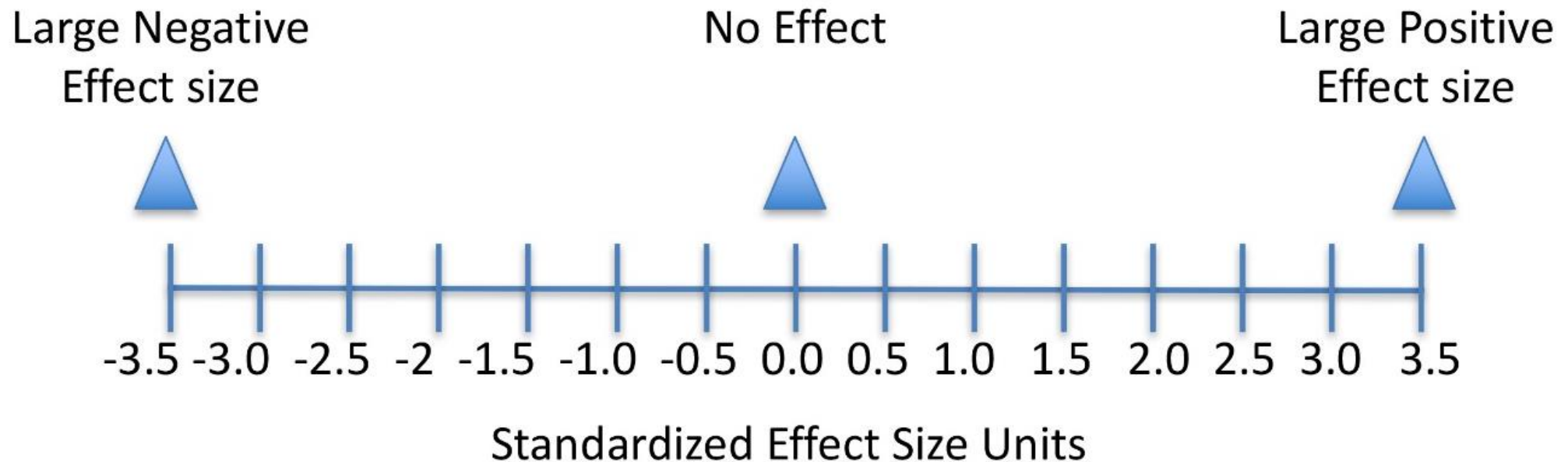
- Quantitative synthesis of literature
- Estimates an effect size for each study
- Uses them to provide an overall effect size





# META-ANALYSIS CALCULATES AN EFFECT SIZE

All effect sizes capture the magnitude and direction of an effect reflecting the difference between two conditions or groups



# PAST LITERATURE REVIEWS AND META-ANALYSIS

- Many older reviews have mixed results for text-to-speech and related read-aloud tools
- Newer Meta-analyses
- Positive effect for students

(Li 2014, Buzick and Stone 2014)

# WHAT DOES THIS MEAN FOR STUDENTS WITH LEARNING DISABILITIES?

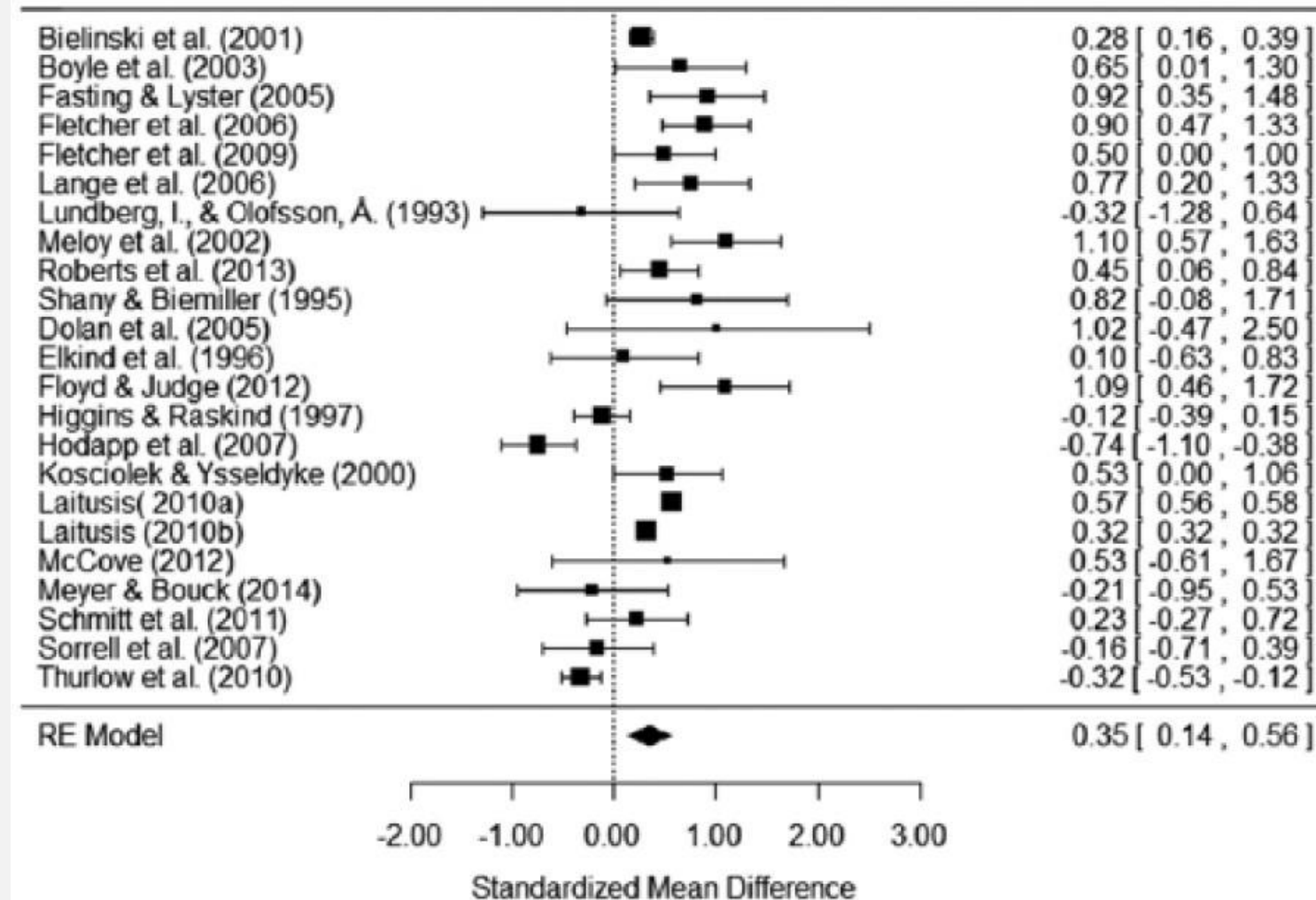


# META-ANALYSIS BY WOOD ET AL. (2018)

- Goal: Synthesize the research literature on the effects of text-to-speech and related tools for oral presentation of material on reading comprehension for students with reading disabilities.



# FOREST PLOT OF EFFECT SIZES



## OVERALL EFFECT SIZE FOUND

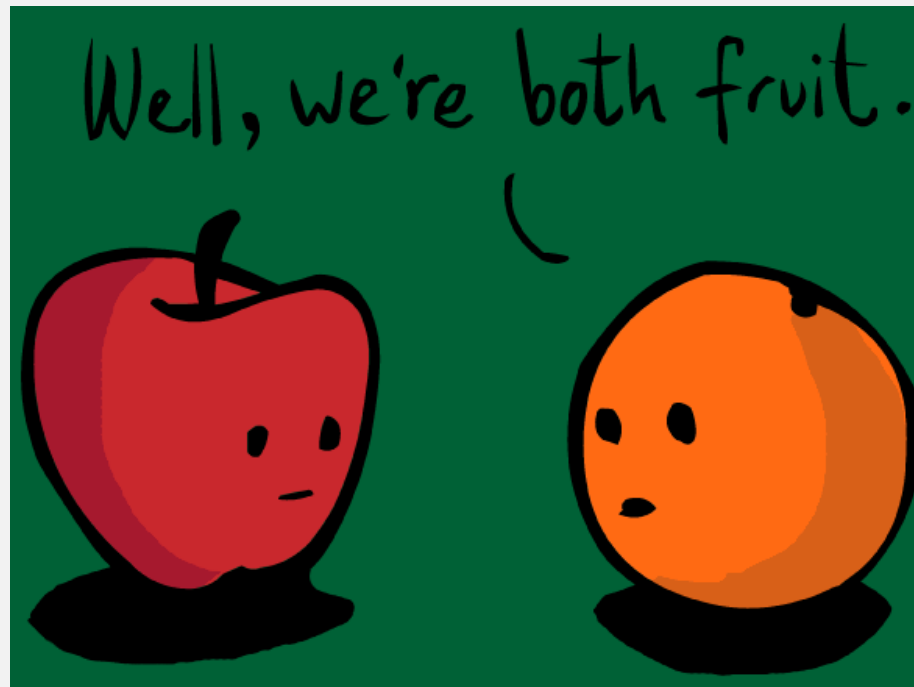
- What is the average weighted effect size of the use of text-to-speech and related tools on reading comprehension?
- $g = .35$  [.14, .56]

# RESULTS SIMILAR TO OTHER META-ANALYSES

	Li et al. 2014	Buzick & Stone 2014	Wood et al. (2018)
Overall effect est. for reading	$g = .13$ [.01, .24], ( $p < .05$ )	$g = .56$ [.42, .70], ( $p < .05$ )	$g = .35$ [.14, .56], ( $p < .01$ )
Academic areas included	Reading and math	Reading and math	Reading (reading comprehension)
Disabilities included	All disabilities	All disabilities	Reading disabilities
Studies & measures included	Published and unpublished	Only studies with standardized measures	Published and unpublished
Grade level included	K-12 <sup>th</sup> grade	3 <sup>rd</sup> -12 <sup>th</sup> grade	3 <sup>rd</sup> - college

# WHAT INFLUENCES THE EFFECT SIZE?

- **There are systematic differences between studies not due to random chance**





# EFFECT SIZE IS REAL BUT...WHAT INFLUENCES THE EFFECT?

Moderators  
influencing the  
effect

```
graph TD; A[Moderators influencing the effect] --> B[Reader Type]; A --> C[Grade-level]; A --> D[Study Design];
```

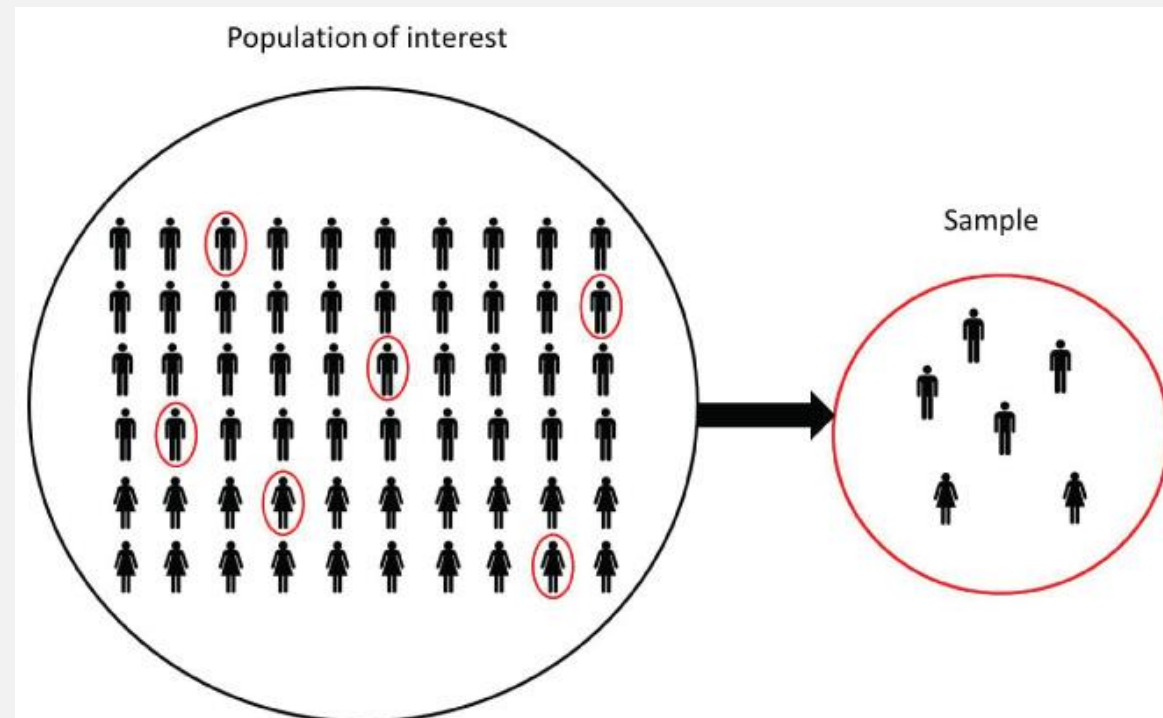
Reader Type

Grade-level

Study Design

# DOES USING DIFFERENT DEFINITIONS OF DYSLEXIA IMPACT THE RESULTS?

- Different definitions of reading disability impact sample selection across studies.
- Single Indicator vs multiple indicator models



# DISSERTATION RESEARCH

- Motivated by findings of Wood et al. (2018)
- Practical Aim
  - To predict for whom text-to-speech will be effective.
- Theoretical Aim
  - To test a model of reading disability by the model's ability to predict differences in the effectiveness of text-to-speech on reading comprehension.

# CONCLUSION OF PART I

Text-to-speech and related read-aloud tools can improve reading test scores for students with reading disabilities.

However, there is wide individual differences in this effect.

Current research is exploring for whom these tools will be most beneficial.

# RESEARCH AIMS

- To determine whether there is a significant difference between the reading comprehension scores of students with reading difficulties after reading a passage with TTS when compared to without TTS.
- To explore whether there is a significant difference among the reading comprehension scores under the following conditions: *a) silent read b) read aloud c) listen only d) TTS with no highlighting e) TTS with highlighting.*
- To explore the relationship between Dyslexia Only vs Reading and Language Impairment in regard to improved comprehension with TTS.
- To explore the correlations between student scores on behavioral tests and their performance on comprehension questions after the following conditions: *a) silent read b) read aloud c) listen only d) TTS with no highlighting e) TTS with highlighting.*

# METHODS

## Inclusion/Exclusion Test Battery Results

Behavioral Test	<i>M</i>	<i>SD</i>
CTOPP-2 (Elision)	6.24	2.32
TOSREC	88.10	16.23
TOWRE-2 (SWE)	78.13	15.15
TOWRE-2 (PDE)	77.62	9.77
TOWRE-2 (SWE + PDE)	76.55	12.15
WRMT-III (Word ID)	78.82	12.88
WRMT-III (Word Attack)	74.44	8.71
WRMT-III (Pass Comp)	84.17	14.12
TONI-4	105.00	9.98

Note. Comprehensive Test of Phonological Processing-Second Edition (CTOPP-2) Elision; Test of Silent Reading Efficiency and Comprehension (TOSREC); Test of Word Reading Efficiency-Second Edition (TOWRE-2) Sight Word Efficiency (SWE) and Phonemic Decoding Efficiency (PDE); Woodcock Reading Mastery Test-Third Edition (WRMT-III) Word identification (Word ID), Word Attack and Passage Comprehension (Pass Comp); Test of Nonverbal Intelligence-Fourth Edition (TONI-4).

# PROCEDURES

***Testing Session:*** Each child's reading, language, non-verbal intelligence and executive functioning were assessed as well as prior level of exposure to TTS.

***Experimental Session:*** The children read 5 *QRI-5* reading passages at their grade level under each of the five conditions. The children answered 8 multiple choice comprehension questions following each passage.

A randomized block procedure counterbalanced the order of the reading passages and TTS conditions across participants.

# TTS PROGRAM WITH FEATURES

The screenshot displays the Kurzweil 3000 Reader application window. The title bar reads "Kurzweil 3000 Reader". The main window is titled "Sec-OfMiceAndMen (Imported)". The interface includes a toolbar with icons for "Extract Notes & Highlighted Text", "Print", "Thumbnails", "Bookmarks", "Spell Check", "Read the Web", and "Create Audio File". Below the toolbar, there are fields for "Name" and "Period", followed by "Standards Focus: Analyzing Poetry" and "Chapter Two". The main text area contains a paragraph about Robert Burns, with a portion highlighted in blue. A red box highlights this highlighted text, with an arrow pointing to it from a text box below. The text box below the red box contains the text: "As the text is being read, the highlighting moves along with the reader word by word." To the right of the main text area, there is a sidebar with controls. A red box highlights the "Details" section, which includes "Unit" (Sentence), "Mode" (Continuously), and "Voice" (Victoria). Below this, there are radio buttons for "Read Aloud" (selected) and "Read Silently". A red box highlights the "Words per Minute" control, which is set to 173. An arrow points from this box to the text box below it, which contains the text: "Reading unit, mode, voice and speed can be adjusted based on the reader's needs." The main text area also contains a poem by Robert Burns, with the first line highlighted in blue.

Sec-OfMiceAndMen (Imported)

Extract Notes & Highlighted Text Print Thumbnails Bookmarks Spell Check Read the Web Create Audio File

Name \_\_\_\_\_ Period \_\_\_\_\_

Standards Focus: Analyzing Poetry  
Chapter Two

While some students may think that the title *Of Mice and Men* comes from the fact that Lennie likes to pet mice and other soft things, the title is really taken from the poem "To a Mouse" by Robert Burns. Robert Burns (1759 - 1796) is probably the most famous of all the Scottish poets. After accidentally turning up a mouse's nest while he was plowing in 1785, he wrote an ode to this mouse, expressing his sympathy for the mouse and his home.

For the average English speaker, Burn's poetry can be quite archaic and complex. On the left is the original poem by Burns. On the right is a translation of the words into modern English.

Small, sleek, cowardly, nervous little  
Oh, what a panic is in your breast!  
You need not run away so hastily.  
With a quick scurry  
I would hate to run and chase you.

I wad be laith to rin an' chase thee,  
Sae heedless an' sulky like a snail!

As the text is being read, the highlighting moves along with the reader word by word.

Reading unit, mode, voice and speed can be adjusted based on the reader's needs.

Details:

Unit: Sentence  
Mode: Continuously  
Voice: Victoria

☒ Read Aloud  
☐ Read Silently

Words per Minute: 173

(Roberts, Takahashi, Park, Stodden, 2013)



# ANALYSIS - PART I

**First Analysis** examined whether using TTS as a compensatory reading strategy improved the reading comprehension of students.

**Second Analysis** examined the difference in reading performance under the five conditions.

# COMPREHENSION SCORES

Percent Correct, Mean and Standard Deviation for Number of Comprehension Questions Answered Correctly Under Each Condition

Condition	% Correct	<i>M</i>	<i>SD</i>
Silent Read (SR)	60%	4.82	1.60
Read Aloud (RA)	74%	5.93	1.88
Listen Only (LO)	71%	5.68	1.98
TTS-No Highlighting (TTS-NH)	76%	6.10	1.63
TTS-Highlighting (TTS-H)	77%	6.17	1.81
<b>Total: No TTS</b> (SR + RA)	67%	10.75	2.89
<b>Total: TTS</b> (TTS-NH + TTS-H)	77%	12.27	2.99

# FURTHER ANALYSIS - PART I

Further analysis examined the differences in performance of children with different reading profiles

➤ The same analysis was conducted separately for:

- Children with Dyslexia Only
- Children with Reading and Language Impairment
  - Standard score of  $\leq 85$  (1 SD below average) on the *CELF-V*

# RESULTS OF ANALYSES

Results of *t*-tests and Effect Sizes Comparing Comprehension Scores of All Students, Students with Dyslexia Only and Students with Reading and Language Impairment following the Conditions

	All Students n = 29			Dyslexia Only n = 16			Reading & Language Impairment n = 13		
Conditions	<i>t</i>	<i>p</i>	<i>d</i>	<i>t</i>	<i>p</i>	<i>d</i>	<i>t</i>	<i>p</i>	<i>d</i>
SR-TTS-NH	<b>3.79</b>	<b>.00</b>	<b>.704</b>	<b>3.57</b>	<b>.00</b>	<b>.892</b>	1.93	.07	.535
SR-TTS-H	<b>3.94</b>	<b>.00</b>	<b>.732</b>	<b>3.50</b>	<b>.00</b>	<b>.875</b>	<b>2.15</b>	<b>.04</b>	<b>.596</b>
SR-LO	<b>2.37</b>	<b>.02</b>	<b>.440</b>	<b>2.36</b>	<b>.03</b>	<b>.590</b>	1.10	.28	.305
SR-RA	<b>3.01</b>	<b>.00</b>	<b>.559</b>	<b>2.69</b>	<b>.01</b>	<b>.673</b>	1.67	.11	.463
RA-TTS-NH	0.41	.67	.076	0.82	.42	.205	0.10	.91	.028
RA-TTS-H	0.52	.60	.097	0.92	.37	.230	0.00	1.00	.000
RA-LO	0.61	.54	.113	0.33	.74	.083	0.50	.62	.139
LO-TTS-NH	0.95	.34	.176	1.03	.32	.258	0.39	.69	.108
LO-TTS-H	1.11	.27	.206	1.21	.24	.303	0.48	.63	.133
TTS-NH-TTS-H	2.17	.83	.403	0.20	.84	.050	0.12	.90	.033

Note: Boldface indicates significance at  $p < .05$ . SR = Silent Read, RA = Read Aloud, LO = Listen Only, TTS-NH = Text-to-Speech with No Highlighting and TTS-H = Text-to-Speech with Highlighting.

# DISCUSSION - PART I

## Summary of Findings for **All Participants**:

- TTS is a valuable tool to improve reading comprehension scores for children with reading difficulties.
- Children showed significant comprehension gains when using *TTS-NH* and *TTS-H* when compared to *Silent Reading* of the passage on their own without TTS.
- Difference in reading performance was not significant when comparing the two TTS conditions.
- No significant difference between *Listen Only* and either TTS condition, suggests that TTS may change the reading task to a listening comprehension task.

# DISCUSSION - PART I

## Summary of Findings for Children with Dyslexia Only and Children with Reading and Language Impairment:

- **Children with Dyslexia Only** performed different than children with Reading and Language Impairment.
- **Students with Dyslexia Only** appeared to benefit from all TTS conditions as well as auditory-only input.
- **Students with Reading and Language Impairment** appeared to benefit only from *TTS-H*.

# CONSIDERATIONS

For **All Students**, comprehension improved under all auditory input conditions, including *Listen Only*, suggesting that decoding was the primary problem for many of these children.

There was no significant difference between *Listen Only* and *TTS-NH* or *Listen Only* and *TTS-H*. Presence of the text was not significantly helpful and suggests that the task changed to listening comprehension.

For All Students the mean listening comprehension score was in the average range but the mean listening comprehension score fell below average for the children with Reading & Language Impairment.

## DATA ANALYSIS - PART 2

Participant scores on the behavioral tests were correlated with the number of correct comprehension questions under the five conditions.



# TEST BATTERY SCORES

Reading Tests						
CTOPP-2	TOSREC	TOWRE-2	WRMT-III Basic Skills	WRMT-III Read Comp	WRMT-III Total Read	WRMT III Listening Comp
M=6.2 R=2-14 SD=2.3	M=88.1 R=55-110 SD=16.2	M=76.6 R=55-99 SD=12.2	M=75.4 R=55-91 SD=9.7	M=83.3 R=55-108 SD=13.6	M=77.8 R=55-97 SD=11.4	M=92.6 R=60-120 SD=13.5
Language Test						
CELF-V Spoken Paragraphs	CELF-V Core Language	CELF-V Receptive Language	CELF-V Expressive Language	CELF-V Language Concepts	CELF-V Language Memory	
M=7.9 R=3-12 SD=2.3	M=84.0 R=55-109 SD=12.6	M=84.2 R=53-113 SD=13.8	M=85.2 R=65-112 SD=12.1	M=87.9 R=65-116 SD=13.7	M=85.0 R=58-113 SD=12.7	
Cognitive & Executive Function Tests						
TONI-4	Conners-3	BRIEF-2 BRI	BRIEF-2 ERI	BRIEF-2 WM	BRIEF-2 CRI	BRIEF-2 GEC
M=105 R=91-124 SD=10.0	M=76.9 R=50-90 SD=12.9	M=57 R=41-75 SD=9	M=59 R=41-77 SD=11	M=64.4 R=47-79 SD=8.0	M=62.8 R=43-77 SD=9.0	M=62 R=46-74 SD=8.3

# COMPREHENSION SCORES

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# PCA EXTRACTION METHOD FOR TESTING BATTERY VARIABLES

Initial Eigenvalues & Extraction Sums of Squared Loadings			
Component	Total	% of Variance	Cumulative %
1. Language/Reading	7.836	43.534	43.534
2. Executive Function	3.697	20.542	64.076
3.	1.517	8.429	72.505
4.	1.416	7.862	80.372

Note. Components 5-19 had Eigenvalues less than 1.00 and are not included in this table. Components 3 and 4 do not have an obvious interpretation.

# DATA ANALYSIS – PART 2

The researchers then examined the relationship of these two components (**Language/Reading** and **Executive Function**) across the five reading conditions using a **Mixed Models General Linear Regression** approach.

- First, differences were noted among the five conditions.
- **Reading/Language** proficiency was a significant predictor of **student performance** for both *TTS-NH* and *TTS-H*; while **Executive Function** was a significant predictor for *Silent Read* and *Listen Only*.

# CORRELATIONS BETWEEN BEHAVIORAL TESTING & EXPERIMENTAL CONDITIONS

PCA/Mixed Models Linear Regression			
Component	Condition	<i>B</i>	<i>p</i>
Language/Reading	SR	.13	.38
Language/Reading	RA	.27	.24
Language/Reading	LO	.34	.09
Language/Reading	TTS-NH	<b>.41</b>	<b>.05</b>
Language/Reading	TTS-H	<b>.54</b>	<b>.04</b>
Executive Function	SR	<b>.44</b>	<b>.00</b>
Executive Function	RA	.38	.09
Executive Function	LO	<b>.75</b>	<b>.00</b>
Executive Function	TTS-NH	.16	.42
Executive Function	TTS-H	.11	.65

Note. Boldface indicates significance at  $p < .05$ . SR = Silent Read, RA = Read Aloud, LO = Listen Only, TTS-NH = Text-to-Speech with No Highlighting and TTS-H = Text-to-Speech with Highlighting.

# DISCUSSION – PART 2

*Language/Reading* proficiency was highly correlated with the TTS-NH and TTS-H conditions.

Students with stronger language and reading proficiency are more likely to have greater comprehension with TTS.

Children with weaker Executive Function skills may benefit less from TTS

# IN CONCLUSION

TTS helped improve comprehension for All Students.

There was no significant difference between *TTS-NH* and *TTS-H*.

Children with Dyslexia Only appeared to benefit from both TTS conditions and auditory-only input.

Children with Reading and Language Impairment appeared to benefit only from *TTS-H*.

*Language/Reading* was a predictor of success with TTS, while *Executive Function* was not a predictor.

## TEXT TO SPEECH OVERVIEW

Built into the operating  
system

As an extension

Within Microsoft Word

Within Google Docs

Using an outside vendor

Physical Tool



# RULES FOR THE ROAD

Provide ample time to practice

Do not try and learn to use TTS with a looming deadline

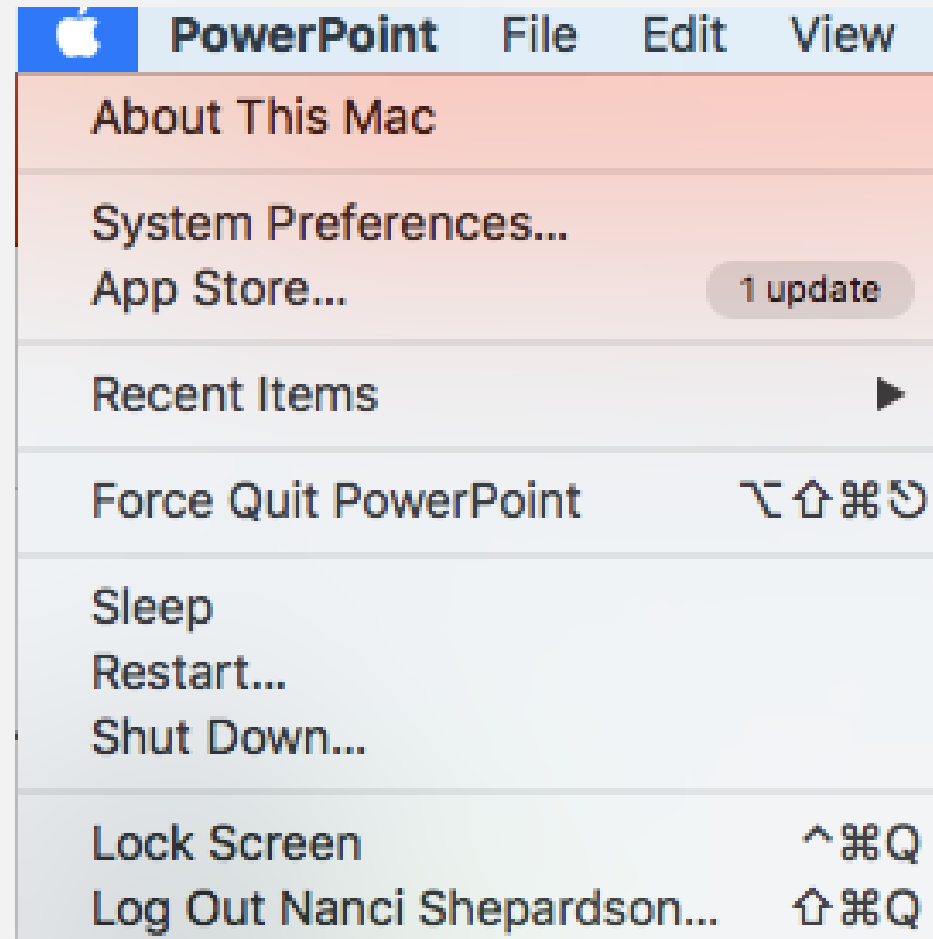
Model, model, model

Change the voice and rate as needed: Charlie Brown effect

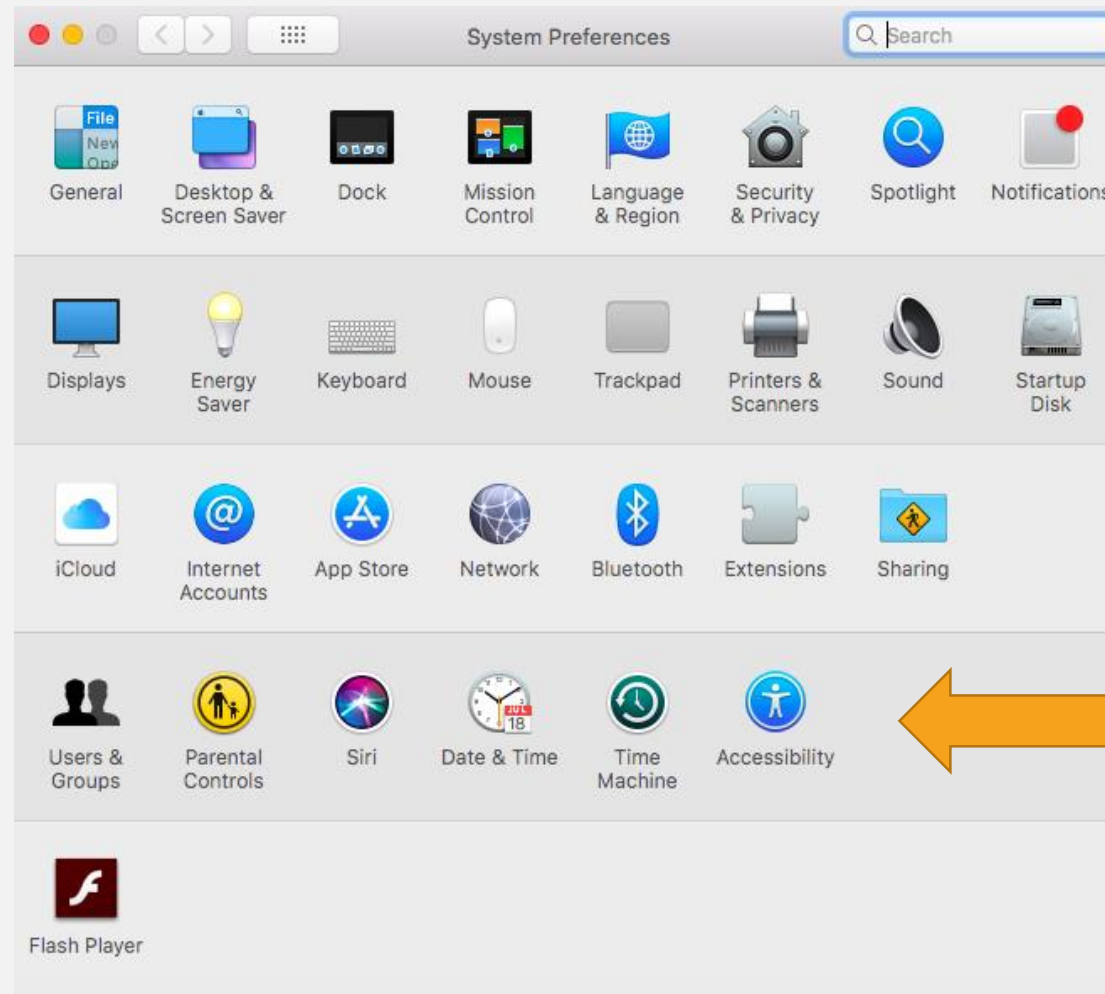
Teach metacognitive skills: what voice is best for history vs. science

Rate for a cold read vs. rereadingview

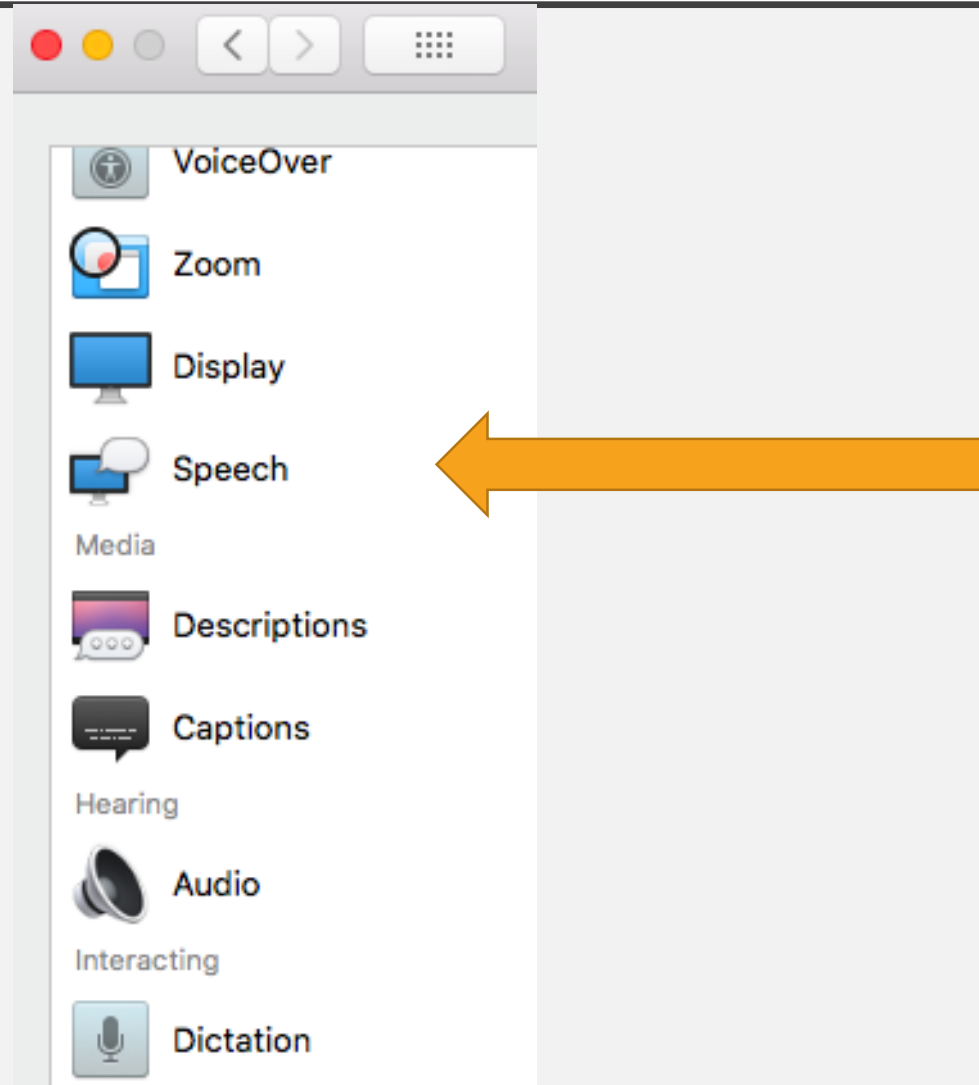
# TEXT TO SPEECH ON A MAC



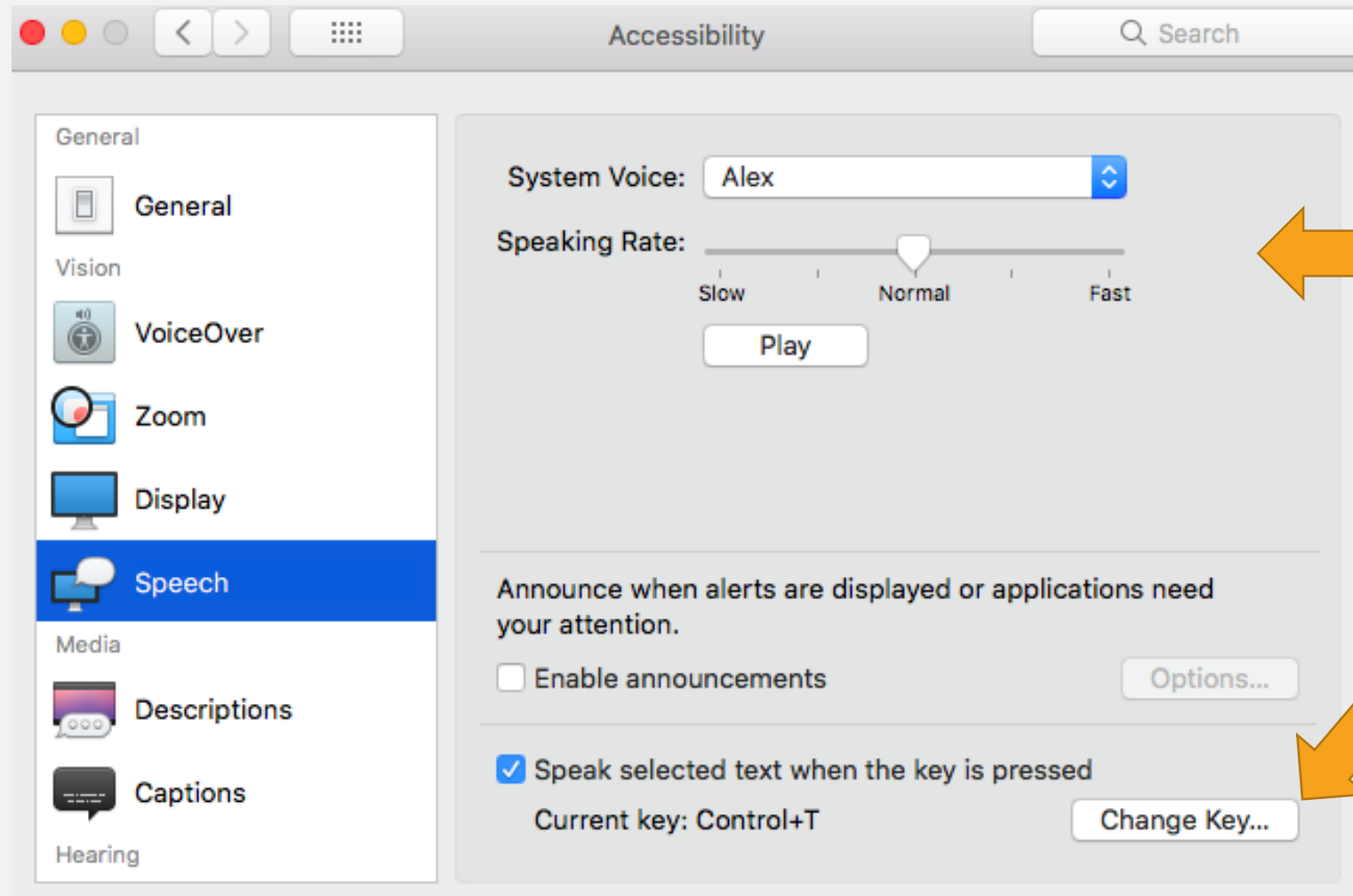
# TEXT TO SPEECH ON A MAC



# TEXT TO SPEECH ON A MAC



# TEXT TO SPEECH ON A MAC



# TEXT TO SPEECH ON A PC

Go to the Control Panel

Click on Speech Recognition



# TEXT TO SPEECH ON A PC

Click on Text to Speech

Control Panel Home

Advanced speech options

[Text to Speech](#)

## Configure your Speech Recognition experience



[Start Speech Recognition](#)

Start using your voice to control your computer.



[Set up microphone](#)

Set up your computer to work properly with Speech Recognition.



[Take Speech Tutorial](#)

Learn to use your computer with speech. Learn basic commands and dictation.



[Train your computer to better understand you](#)

Read text to your computer to improve your computer's ability to understand your voice. Doing this isn't necessary, but can help improve dictation accuracy.

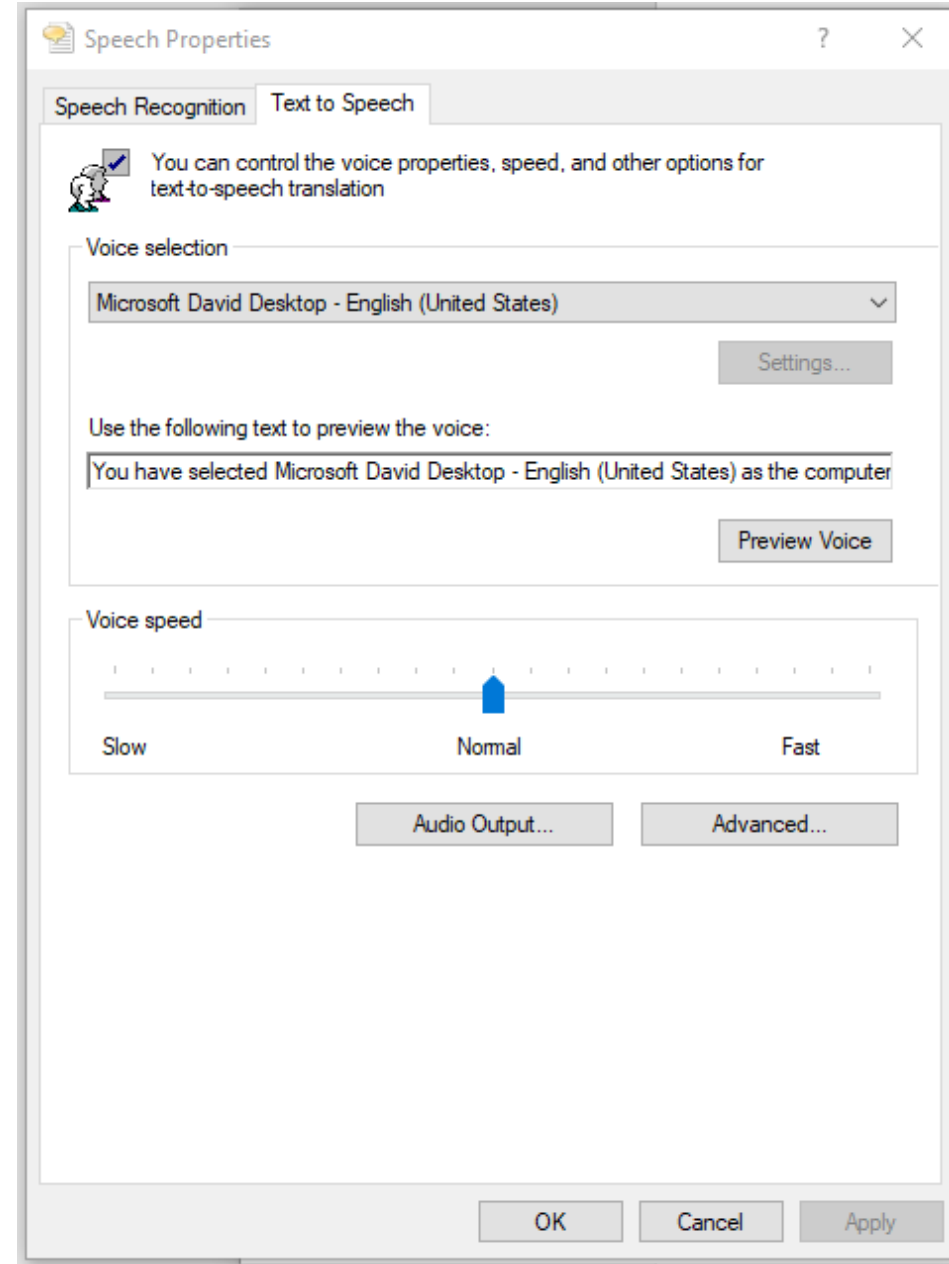


[Open the Speech Reference Card](#)

View and print a list of common commands to keep with you so you always know what to say.

# TEXT TO SPEECH ON A PC

Choose the voice and  
the speed and then  
click “apply”





# TEXT TO SPEECH EXTENSIONS

## 01

Click on

- When in the Google Chrome browser, click on the Apps icon in the upper left hand corner

## 02

Click on

- the Web Store, which can be in different locations on your screen. It depends on the computer.

## 03

Text

- In the search box type in Text to Speech and click on Extensions

# TEXT TO SPEECH EXTENSIONS

Make sure to look at  
how many stars it gets  
and how many people  
have reviewed it.



« Home

- ☐ Extensions
- ☐ Themes

## Features

- ☐ Runs Offline
- ☐ By Google
- ☐ Free
- ☐ Available for Android
- ☐ Works with Google Drive

## Ratings

- ☐ ★★★★★
- ☐ ★★★★★ & up
- ☐ ★★★★★ & up
- ☐ ★★★★★ & up

[Privacy Policy](#)

[Terms of Service](#)

[About Chrome Web Store](#)

## Extensions



### Select and Speak - Text to Speech

Offered by: [www.ispeech.org](http://www.ispeech.org)

Select and Speak uses iSpeech's human-qu

★★★★★ 3,032 Productivity



### Read Aloud: A Text to Speech Vo

Offered by: [lsdsoftware.com](http://lsdsoftware.com)

Read out loud the current web-page article v

★★★★★ 1,222 Accessibility



### Text To Speech

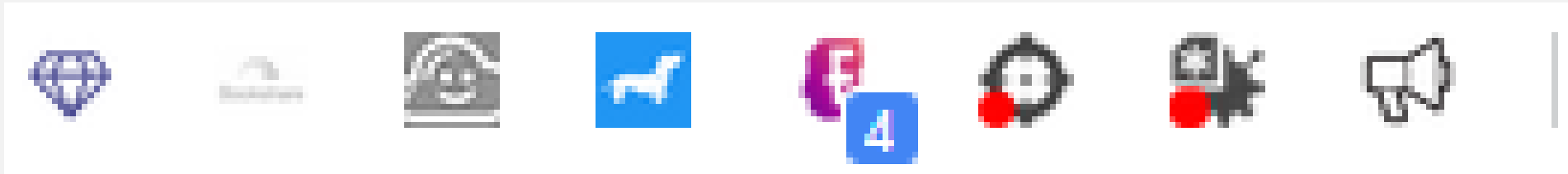
Offered by: [www.texttopspeech.info](http://www.texttopspeech.info)

Free text to speech online app with natural v

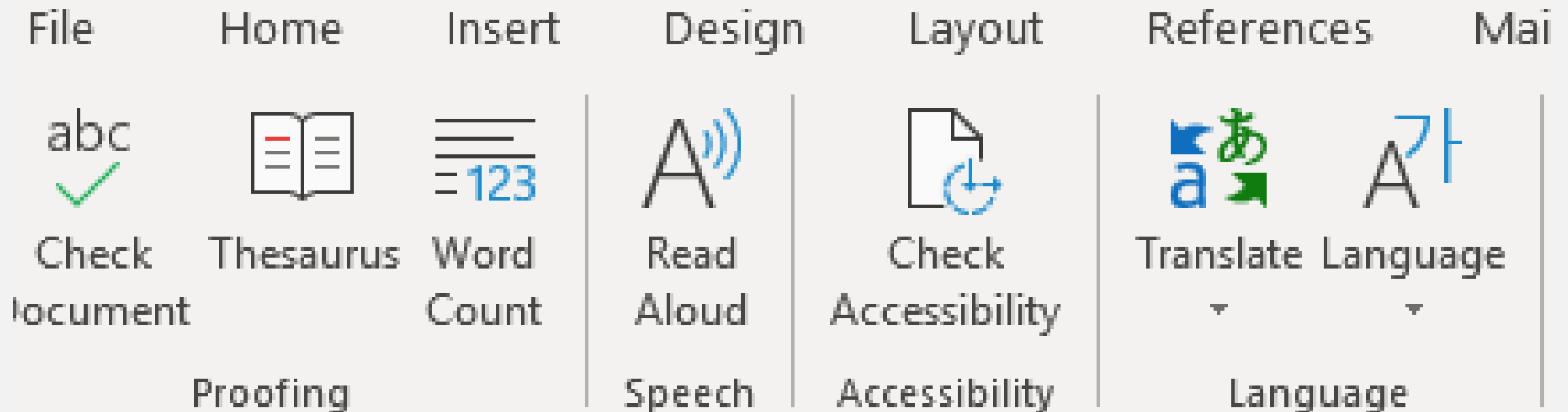
★★★★★ 55 Accessibility

## INSTALLED TEXT TO SPEECH EXTENSION

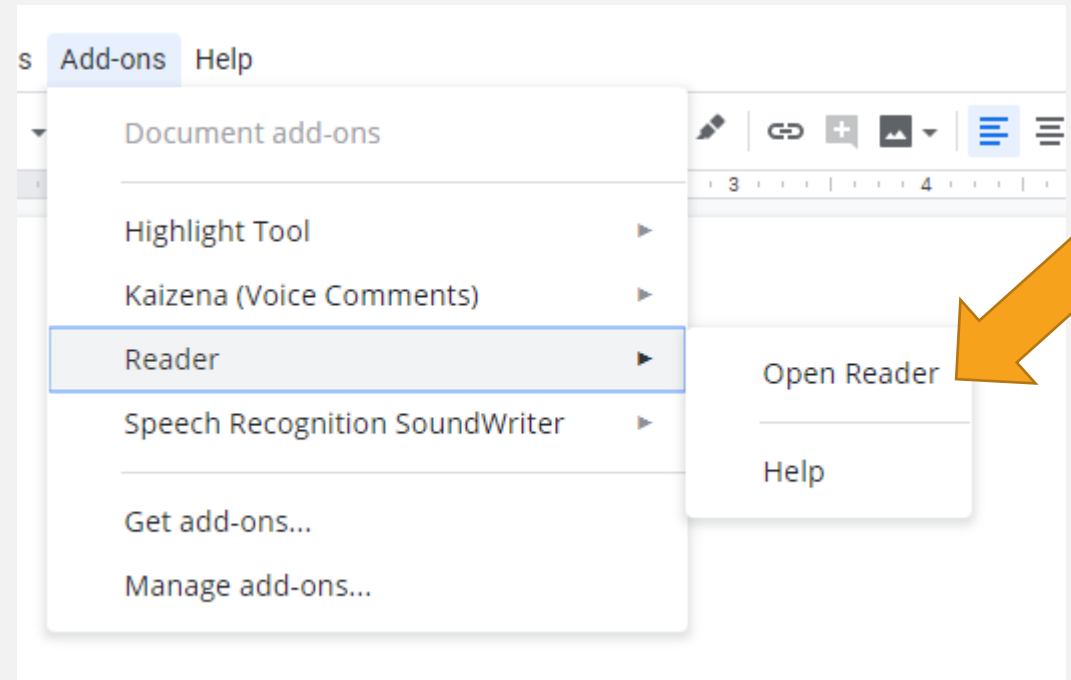
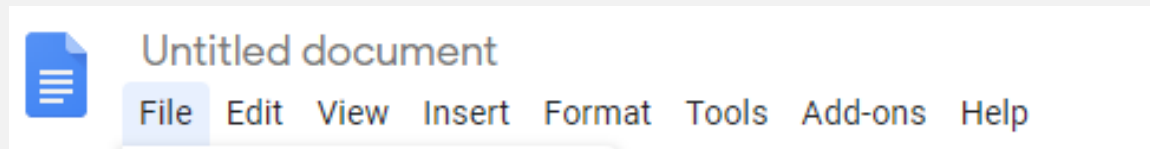
The icon will now be in your tool bar at the top of  
your screen



# TEXT TO SPEECH WITHIN MICROSOFT



# TEXT TO SPEECH WITHIN GOOGLE DOCS



## Reader

 Microsoft Zira Desktop - Engli ▾



☐ Delay blank lines



## TEXT TO SPEECH IN GOOGLE DOCS; FAR RIGHT SIDE OF THE SCREEN

You can change the volume, the rate, the pitch

You can also have it repeat the section

Click the red icon to turn it on

# TEXT TO SPEECH OUTSIDE VENDORS

- Bookshare: <https://www.bookshare.org>



- Learning Ally: <https://learningally.org>



- Project Gutenberg: <https://www.gutenberg.org>



# HAND HELD TOOLS

<https://cpen.com>





## REFERENCES

- Brown, L., Sherbenou, R. J., & Johnsen, S. K. (2000). *Test of non-verbal intelligence fourth edition (TONI-4)*. Austin, Texas: Pro-Ed.
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