Lexical Sophistication Measurements: Applications in Teaching and Assessment

Ben Naismith
University of Pittsburgh
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Overview

1. What is lexical sophistication?
2. Measuring lexical sophistication
3. Lexical sophistication tools
4. Practical uses for lexical sophistication data
5. Questions
A little math to start...

- How many words are there in English?
  - at least 250,000 distinct English words (OED)

- How many words do you typically teach in a one-hour class?
  - 6-12?

- How many classes would it take to teach them all?
  - $250,000 / 10 = 25,000$! (one class per day for 68 years)

→ Essential to prioritize and select vocab in a principled way
Lexical richness

- Importance of vocabulary widely accepted (Cobb & Horst, 2015)

- Different aspects of ‘lexical richness’:
  - **Lexical depth** – knowledge and accuracy of usage
  - **Lexical diversity** – range of different words used
  - **Lexical sophistication** – range of advanced words used
Lexical sophistication

- Compare: "I am very tired." vs. "I am utterly exhausted."
  - "utterly/exhausted" are more sophisticated words

- Teacher perceptions of proficiency correlate with measures of lexical sophistication (Daller & Phelan, 2007)

- Key descriptor for assessing lexical proficiency, e.g. IELTS band descriptors (British Council, 2018)
Lexical sophistication

- Compare: "I am very tired." vs. "I am utterly exhausted.
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- Teacher perceptions of proficiency correlate with measures of lexical sophistication (Daller & Phelan, 2007)
- Key descriptor for assessing lexical proficiency, e.g., IELTS band descriptors

| 7 | Uses a sufficient range of vocabulary to allow some flexibility and precision |
| 6 | Uses an adequate range of vocabulary for the task |
| 7 | Uses less common lexical items with some awareness of style and collocation |
| 6 | Attempts to use less common vocabulary but with some inaccuracy |
| 7 | May produce occasional errors in word choice, spelling and/or word formation |
| 6 | Makes some errors in spelling and/or word formation, but they do not impede communication |
Measuring Lexical Sophistication

- How to determine ‘advanced words’?
  - Frequency bands compiled from corpora, e.g.

<table>
<thead>
<tr>
<th>BNC/COCA: frequency bands (Davies, 2008-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000: the, and, language, show, study</td>
</tr>
<tr>
<td>2000: accurate, focus, reaction, variable</td>
</tr>
<tr>
<td>3000: compromise, grammar, mask, visual</td>
</tr>
<tr>
<td>5000: inhibitory, retrieve, verb, parallel</td>
</tr>
<tr>
<td>10000: decompose, lexicon, neural, paradigm, prefix</td>
</tr>
<tr>
<td>13-20k: impervious, orthography, neuroscience, connectionist</td>
</tr>
</tbody>
</table>

- 3000–9000 bands considered to be critical for instruction (Schmitt & Schmitt, 2014)
Advanced Guiraud (AG)

- Type-Token Ratio (TTR) based on 'advanced' types only
- Omits high-frequency types below 2000 band (though any list of 'advanced types' can be used)
- Effective in distinguishing between groups/levels, e.g. (Daller & Xue 2007; Juffs 2019)

\[ AG = \frac{\text{Advanced Types}}{\sqrt{\text{Tokens}}} \]
Text 1
I met my friend Nife while I was studying in a middle school. I was happy when I met him because he was a good student in our school. We continued the middle and high school together in the same school. We were studying in the different classes in the middle school; however, in the high school we were studying in the same class. We went to many places in the free time while we were studying in the high school. When we finished from the high school, I went to K.S. University and he went to I.M. University. While we were enjoying in academic life, we made many achievement in these universities. I graduated when Nife was studying in the last semester in the university. After that, I got a job. Fortunately, it was nearby my home. I worked two years then I got scholarship from ministry of high education in my country. When I came here to U.S., my friend Nife arrange some documents to study at grad school in Malaysia.

Text 2
I first met my friend Nife while I was studying in middle school. I recall being delighted when I met him because he was an outstanding student. We then progressed throughout middle and high school together at the same institution. Initially, we were studying in different classes in middle school; however, in high school we were reunited in the same cohort. I remember in our free time, we used to explore the surrounding areas. Upon completing high school, I enrolled in K.S. University, and he opted for I.M. University. While we were enjoying academia, we accomplished many achievements at our respective universities. Eventually, I graduated while Nife was still completing his last semester. Subsequently, I got a job, which fortunately was nearby my home. There, I worked for two years before obtaining a scholarship from the ministry of higher education in my country. When I came here to U.S., my friend Nife completed the necessary arrangements to attend grad school in Malaysia.
Lexical Sophistication

Lexical Diversity

 CVS1

 TTR

Text #1

Text #2
Tools for measuring lexical sophistication

Option 1: Lots of data
- e.g. TAALES (Kyle & Crossley, 2015)
- 400 indices of lexical sophistication
- free downloadable program
- + huge amount of potentially useful data
- - difficult to quickly interpret
Tools for measuring lexical sophistication

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Option 2: Do it yourself

- e.g. Python
- + you can choose which ‘basic’ words to ignore
- - it requires basic coding literacy
- Toolkit for measuring AG to be released soon
Tools for measuring lexical sophistication

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▫ e.g. Python
▫ + you can choose which ‘basic’ words to ignore
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```python
def adv_guiraud(text, freq_list='NGSL', custom_list=None,
                spellcheck=True, supplementary=True):
    
        Calculates advanced guiraud: advanced types / sqrt(number of tokens)
        By default, uses NGSL top 2k words as frequency list
        custom_list is a custom list of common types for frequency list

        Args:
        text: Input string to calculate AG for
        freq_list: string specifying which freq list to use. Must be one
                   of {'NGSL', 'PET', 'PELIC', 'SUPP'}
        custom_list: if not None, used instead of freq_list (can pass own list
                     of strings containing common types to ignore for AG
        spellcheck: Boolean flag to ignore misspelled words (rough spellcheck
                    with wordnet.synsets())
        supplementary: Include NGSL supplementary vocabulary in addition to
                       specified list

        Returns:
        Calculated AG
```

"""
Tools for measuring lexical sophistication

Option 3: Web-based program

- aihaiyang.com/software/lca/single/ (Ai & Lu, 2010)
- Input text(s), choose indices, get results
- ‘Corrected VS1 (CVS1)’ closest to Advanced Guiraud
- + easy to use and read results
- - visualizations don’t always work, can’t choose the ‘basic words’
Tools for measuring lexical sophistication

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Step 1: Enter text #1

Accurate Measurement of Lexical Sophistication with Reference to ESL Learner Data Ben Naismith University of Pittsburgh Department of Linguistics 4200 Fifth Ave, Pittsburgh, PA 15260 1-412-624-5900 bnaismith@pitt.edu Brianna Hill University of Pittsburgh School of Computing and Information 4200 Fifth Ave, Pittsburgh, PA 15260 1-412-624-5900 blh82@pitt.edu Na-Rae Han University of Pittsburgh Department of Linguistics 4200 Fifth Ave, Pittsburgh, PA 15260 1-412-624-5900 naraehan@pitt.edu Alan Juffs University of Pittsburgh Department of Linguistics 4200 Fifth Ave, Pittsburgh, PA 15260 1-412-624-5900 juffs@pitt.edu Daniel Zheng University of Pittsburgh Department of Electrical and Computer Engineering 4200 Fifth Ave, Pittsburgh, PA 15260 1-412-624-5900 daniel.zheng@pitt.edu ABSTRACT One commonly used measure of lexical sophistication is the Advanced Guiraud (AG; [9]), whose formula requires frequency band counts (e.g., COCA; [13]). However, the accuracy of this measure is affected by the particular 2000-word frequency list selected as the basis for its calculations [27]. For example, possible issues arise when frequency lists that are based solely on native speaker corpora are used as a target for second language (L2) learners (e.g., [8]) because the exposure frequencies for L2 learners may vary from that of native speakers. Such L2 variation from comparable native speakers may be due to first language (L1) culture, home country teaching materials, or the text types which L2 learners commonly encounter. This paper addresses the aforementioned problem through an English as a Second Language (ESL) frequency list
## Step 2: Select indice(s)

<table>
<thead>
<tr>
<th>Indice</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Lexical density (LD)</strong></td>
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<tr>
<td><strong>Lexical Sophistication</strong></td>
<td></td>
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<tr>
<td>Lexical sophistication-I (LS1)</td>
<td></td>
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<tr>
<td>Lexical sophistication-II (LS2)</td>
<td></td>
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<tr>
<td>Verb sophistication-I (VS1)</td>
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<tr>
<td>Verb sophistication-II (VS2)</td>
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<td>Corrected VS1 (CVS1)</td>
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<tr>
<td><strong>Lexical Variation</strong></td>
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<td>NDW</td>
<td>Number of different words (NDW)</td>
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<td>NDW (first 50 words) (NDWZ-50)</td>
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<td>NDW (expected random 50) (NDW-ER50)</td>
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<td>NDW (expected sequence 50) (NDW-ES50)</td>
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<td>Bilogarithmic TTR (logTTR)</td>
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<td>Verb variation-II (VV2)</td>
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<tr>
<td>Noun variation (NV)</td>
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<td>Adjective variation (AdjV)</td>
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<td>Adverb variation (AdvV)</td>
<td></td>
</tr>
<tr>
<td>Modifier variation (ModV)</td>
<td></td>
</tr>
</tbody>
</table>

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**Advanced Guiraud**
Tools for measuring lexical sophistication

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Advanced Guiraud

### Numeric Results

The following tabular results can be copied and pasted into a plain text file, and subsequently imported into spreadsheet or database software for further processing and analysis.

<table>
<thead>
<tr>
<th>Text #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD, LS1, LS2, VS1, VS2, CVS1, NDW, NDWZ, NDWERZ, NDWESZ, TTR, MSTTR, CTTR, RTTR, LOGTTR, UBER, VV1, SVV1, CVV1, LV, VV2, NV, ADJV, ADVV, MODV</td>
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<tr>
<td>0.52, 0.43, 0.43, 0.12, 7.95, <strong>1.99</strong>, 1347, 33, 42.30, 42.10, 0.21, 0.78, 11.92, 16.86, 0.82, 21.43, 0.42, 92.28, 6.79, 0.31, 0.07, 0.27, 0.07, 0.03, 0.09</td>
</tr>
</tbody>
</table>
Lexical Sophistication

Lexical Diversity

Text #1

Text #2
Practical uses – Assessment

- Diagnostically (e.g. program entrance tests)
  - *Lexical proficiency good predictor of overall proficiency* (Crossley et al. 2012)

- Summatively (e.g. end of level)
  - *One measure of achievement tests*
  - *Especially if texts are completed electronically*

- Objective (automated) measure in addition to other subjective measures
Practical uses – Assessment benchmarks

- Based on Naismith et al. (2018) data, AG could be a useful metric for measuring intermediate to advanced gains as students prepare for academic or professional study, e.g.
  - Low intermediate < .30
  - Intermediate < .50
  - Academically ‘ready’? > 1.0

- Vocabulary size and speed have been shown to correlate with measures of academic writing and GPA, i.e. they are predictors of academic achievement. (Roche & Harrington 2013)
Practical uses – Tracking development

- **Formative assessment**
  - *From the start to the end of the semester or year*
  - *As part of ongoing learning portfolios (quantitative/tangible measure of progress)*

- **Student-led**
  - *Students check own work (1st draft, 2nd draft, etc.)*
  - *As part of in-class activities*
Practical uses – Tracking development

Students at the University of Pittsburgh ELI

Average AG on PELIC

- Level 3
- Level 4
- Level 5

Languages:
- Arabic
- Chinese
- Japanese
- Korean
- Spanish
Practical uses - Vocabulary lists

(Principled) vocabulary lists can be used to...

▪ standardize what learners should know upon reaching a certain level / entering a program
  → e.g. PET list at B1 on CEFR

▪ push learners to use more sophisticated lexis
  → lexis in next 1000 frequency band (leetutor.ca)

▪ calculate AG scores sensitive to learners’ context
  → e.g. PSL-3 for Pittsburgh IEPs
Practical uses – Selecting lexis

- Selecting from specific frequency bands
  - E.g. COCA 100k:
    (https://corpus.byu.edu/coca/files/100k_samples.txt)

- Checking lexis in texts to use in class (whether from coursebook or authentic material)
  - Lex tutor VP Compleat – word family frequencies
    (https://lextutor.ca/cgi-bin/vp/comp/)
  - English profile – CEFR bands
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</table>
Practical uses

- Selecting lexis
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Once when I was six years old I saw a magnificent picture in a book called True Stories from Nature about the primeval forest. It was a picture of a boa constrictor in the act of swallowing an animal. Here is a copy of the drawing:

In the book it said boa constrictors swallow their prey whole without chewing it after that they are not able to move and they sleep through the six months that they need for digestion. I pondered deeply then over the adventures of the jungle and after some work with a colored pencil I succeeded in making my first drawing. My drawing number one it looked something like this:

I showed my masterpiece to the grown-ups and asked them whether the drawing frightened them but they answered frighten why should any one be frightened by a hat my drawing was not a picture of a hat it was a picture of a boa constrictor digesting an elephant but since the grown-ups were not able to understand it I made another drawing. I drew the inside of a boa constrictor so that the grown-ups could see it clearly. They always need to have things explained. My drawing number two looked like this:

Elephant inside the boa constrictor.
Practical uses

- Selecting lexis
  - Selecting from specific frequency bands
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<table>
<thead>
<tr>
<th>Level</th>
<th>Types</th>
<th>Tokens</th>
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<td>333</td>
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<td>70.70%</td>
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<tr>
<td>A2</td>
<td>50</td>
<td>67</td>
<td>23.04%</td>
<td>14.23%</td>
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<td>8.76%</td>
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<td>15</td>
<td>28</td>
<td>6.91%</td>
<td>5.94%</td>
</tr>
</tbody>
</table>

- **A1**
  - 112 types / 333 tokens
  - 51.61% / 70.70%

- **A2**
  - 50 types / 67 tokens
  - 23.04% / 14.23%

- **B1**
  - 19 types / 22 tokens
  - 8.76% / 4.67%

- **B2**
  - 15 types / 15 tokens
  - 6.91% / 3.18%

- **C1**
  - 2 types / 2 tokens
  - 0.92% / 0.42%

- **C2**
  - 4 types / 4 tokens
  - 1.84% / 0.85%

- **Unlisted**
  - 15 types / 28 tokens
  - 6.91% / 5.94%
Wish list / Future research

- A more transparent, easy-to-use tool for measuring the AG of texts
- AG benchmarks used by different programs
- Effects of using different ‘basic words’ lists for calculating AG
Resources

- **Lexical sophistication tools**
  - TAALES (Kyle & Crossley, 2015)
    https://www.linguisticanalysistools.org/taales.html
  - Lexical Complexity Analyzer (Ai & Lu, 2010)
    https://aihaiyang.com/software/lca/
  - Pitt Lexical Toolkit (forthcoming)
    https://github.com/ELI-Data-Mining-Group/Pitt-ELI-Corpus

- **Public lists**
  - NGSL (Browne, 2014) http://www.newgeneralservicelist.org
  - PET (Cambridge English, 2012)

- **Frequency bands**
  - Lex tutor (Cobb, N.D.) www.lextutor.ca/vp/comp
  - COCA 100k (Davies, 2008–)
    https://www.wordfrequency.info/purchase.asp
References


Questions or comments?
Thank you for attending.

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