Measuring the syntactic complexity of Sentence Intelligibility Test sentences

J. McManaman & K. F. Nagle
Seton Hall University, South Orange/Nutley NJ, USA

SCHOOL OF HEALTH AND MEDICAL SCIENCES
SETON HALL UNIVERSITY

SVOlab

Background

- The *Sentence Intelligibility Test* (SIT; Yorkston, Beukelman & Tice, 1996) has been used clinically and in research to elicit dysarthric and dysphonic speech (e.g., Hustad, 2007; Nagle, et al., 2012). Created to measure intelligibility and speech rate, the SIT consists of 1,100 sentences that are
  - low-context, but not designed to meet specific lexical, syntactic or phonetic criteria;
  - grouped by number of words (5-15);
  - created to provide a bottom-up listening task in which acoustic information from the speaker is parsed into phonetic and linguistic units.

- Some sentences from the SIT may be "easier" to understand than others not because the speaker is more intelligible, but because their semantic or syntactic components are more predictable (Beverly et al, 2010).

- Identifying stimuli that are more or less syntactically complex will help researchers and clinicians who wish to know more about the communicative success or comprehensibility of a speaker; and the burden or effort involved in listening to disordered speech or voice.

Lacking an objective measure of syntactic complexity, we compare two measures indexing the syntactic complexity of sentences beyond their length in words or syllables.

Methods

JM identified the components of SIT sentences; KFN reviewed and made final decision.

Sentences
- randomly chosen from SIT lists
- N=220 (20 x 11 word-lengths)

Measures
- The *Flesch-Kincaid Reading Ease* (FKRE) score (Kincaid et al., 1975) determines reading difficulty using the number of words and syllables per word for a given sentence - higher score = writing that is "very easy to read:"
  - strongly related to sentence length, but a gross measure of difficulty;
  - simple algorithm, freely available online.
- The first draft of our *Syntactic Complexity Raw Score* (SCRS) is based on fine-grained analysis of complex writing by researchers in second language acquisition (Biber et al., 2016; Lu, 2017; McNamara et al., 2014).
  - **sum** of absolute number of instances for a raw score of syntactic complexity (Table 2).

Data Analysis
- compare variability of measures using *T*-test for independent samples and Levene's Test for Equality of Variances

Table 1. Components of Draft SCRS

- **t-units** = one main clause + subordinate clause or nonclausal structure attached to or embedded within it (usually a sentence)
- **verbs**
  - finite = act as a verb
  - nonfinite = do not act as a verb; do not change form when number or person of subject changes
  - auxiliary = verb that accompanies a finite verb to express tense, aspect, modality, voice, emphasis, etc.
- **nouns**
- **pronouns**
- **conjunctions**
- **prepositions**
- **modifiers** = adjectives, adverbs
- **articles**
- **negation** = syntactic transformations
  - counted *no, not, neither, nor*
  - did not count *none, nobody, nothing, nowhere*
- **left embeddedness** = number of words before the main verb
- **mean length of utterance (MLU)**
- **mean syllables/word**

Discussion

The **FKRE may provide more sensitivity** to syntactic differences among groups of sentences of the same word length (Table 2) and different lengths (Figure 1).
- FKRE scores are more variable Draft SCR scores (Figure 1).
- FKRE is easily calculable, but designed to evaluate writing.

An evidence-based measure of syntactic complexity would benefit clinicians and researchers wishing to evaluate the amount of effort involved in communicative success for speakers and listeners. **It is not clear that FKRE scores correlate strongly with a speaker's intuition about sentence complexity**.

Limitations & Future Directions

Although the components of the draft SCRS were carefully chosen, it was created with no attempt to weight any of the factors. The next phase of this research is to compare FKRE and Draft SCRS to some type of "ground truth" about syntactic complexity and create a weighted model.

Better ecological validity for the SCRS may be obtained using:
- reaction-time measures to spoken sentences presented in noise or using a dual-task paradigm;
- subjective ratings of the grammatical complexity of spoken or written sentences, using a sort and rank paradigm;
- measures of autonomic system responses or EEG activity in response to spoken sentences;
- addition of lexical factors to the index.

Results

Descriptive Statistics*
- **FKRE:** *M* 83.41 (*SD* 20.16), range 107.87 (min. 19.03, max. 126.90)
- **SCR:** *M* 25.87 (*SD* 7.65), range 32 (min. 12, max. 44)

Variability in FKRE scores and SCR scores differed significantly, based on Levene's Test for Equality of Variances, $F_{(10,210)} = 120.29) = 120.29$, $p < .001$ (Table 2).

*scores are unitless

We seek input on these and other options!

Table 2. Ten-word sentences (n=20) and components of SCRS, and SCR and FKRE scores.

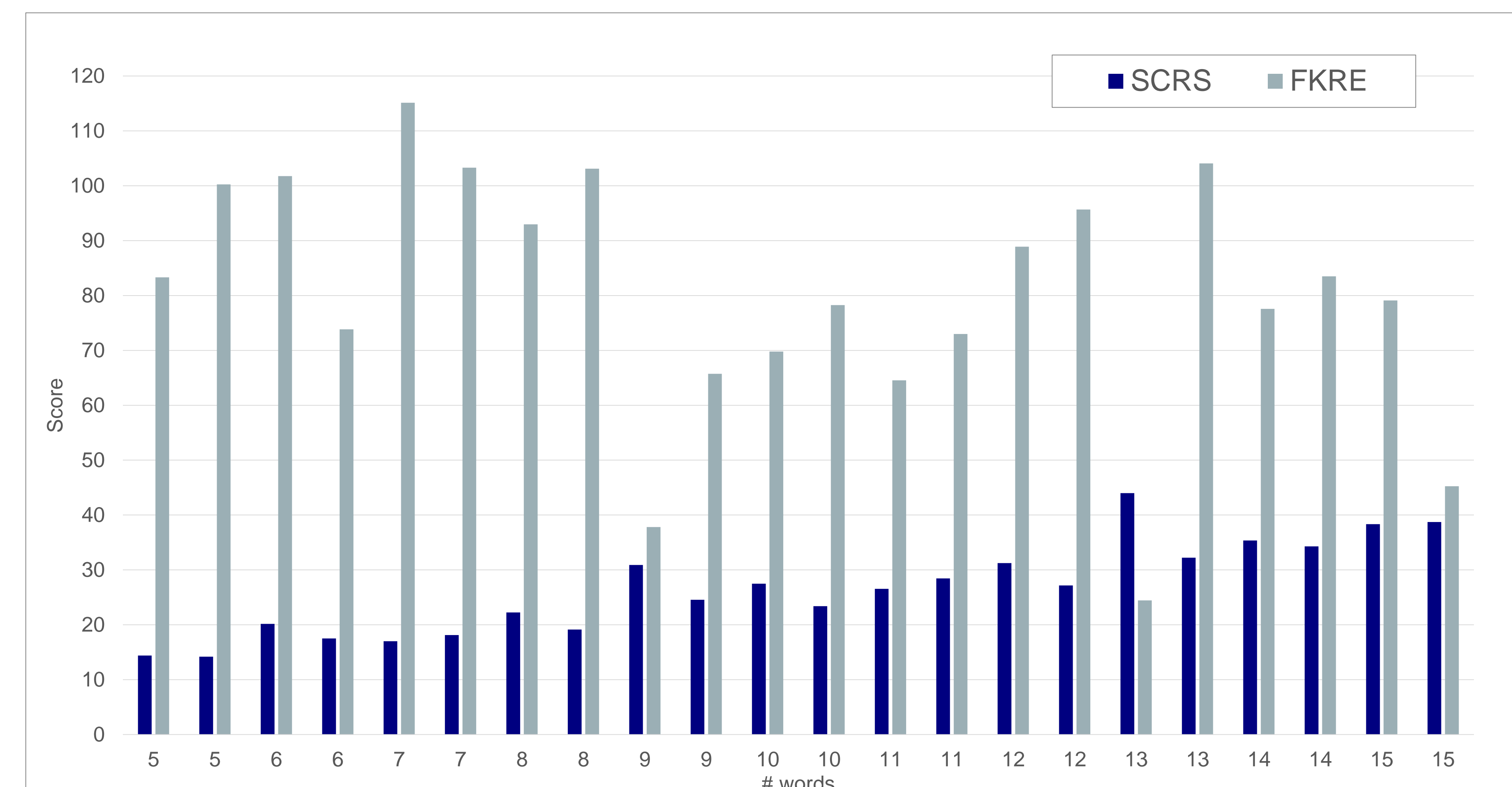| 10-Word Sentence (T-Unit)	Finite Verb	Nonfinite Verb	Aux Verb	Noun	Pronoun	Conjunc.	Prep.	Article	Modifier	Negation	Left embed.	MLU	Mean Syll/Word	SCRS	FKRE
Giving away tickets to women attracted them to the games.	1	1	0	3	1	0	2	1	1	0	0	16	1.5	27.5	69.79
Gold is heavier than anything else in a stream bed.	1	0	0	2	1	0	1	3	0	1	3	12	1.4	23.4	78.25
He was attempting to capture his second consecutive tennis championship.	1	1	1	1	2	0	0	0	3	0	2	13	2.1	26.1	19.03
He was in no way prepared for what might happen.	1	1	1	2	1	0	2	0	1	1	5	11	1.2	27.2	95.17
He will work at it as no man has before.	1	1	1	2	0	1	1	0	1	1	2	11	1.1	23.1	103.63
He's in a position where he's go to keep improving.	1	2	1	1	2	0	1	1	1	0	1	13	1.4	25.4	78.25
I had all the usual tests, and everything was fine.	1	1	0	1	2	1	0	1	3	0	1	12	1.4	24.4	78.25
I had to stop before I hit the soft sand.	1	1	1	1	2	0	1	1	1	0	3	11	1.1	24.1	103.63
I hate to hide it, because I have young children.	1	2	0	1	3	1	0	0	1	0	1	12	1.2	23.2	95.17
I have no reason to believe he is a candidate.	1	2	0	2	2	0	0	1	0	1	1	10	1.4	21.4	78.25
I looked for a roommate to help with the bills.	1	1	0	2	1	0	2	2	0	0	1	13	1.1	24.1	103.63
I miss having you with me when I'm clearing the table.	1	3	0	1	3	0	1	1	1	0	1	14	1.4	27.4	78.25
It is a safe and effective drug, when properly used.	1	1	0	1	1	1	0	1	4	0	0	13	1.4	24.4	78.25
It is wise to consider this right from the start.	1	1	0	1	2	0	1	1	2	0	1	11	1.2	22.2	95.17
It was fun, once we got up to the house.	1	1	0	1	2	0	2	1	2	0	1	10	1	22	112.09
It was the start of a close and enduring friendship.	1	0	0	2	1	1	2	2	0	1	1	12	1.3	24.3	109.98
Just as often, it's the businessman who is considered right.	1	1	0	1	1	0	0	1	5	0	4	13	1.5	24.5	126.90
Male and female stay together until one of them dies.	1	0	0	2	2	1	1	0	2	0	3	12	1.4	25.4	78.25
Many myths of ancient times still exist to this day.	1	0	0	3	0	0	2	0	4	0	6	12	1.3	29.3	109.98
Most overweight people need to learn to be more assertive.	1	2	0	1	0	0	0	0	4	0	3	12	1.5	24.5	126.90

Figure 1. FKRE and SCR scores for two sentences at each word count (n=20). Note: higher FKRE = easier to read; higher SCR = more syntactically complex.