Challenging Learners in Their Individual Zone of Proximal Development Using Pedagogic Developmental Benchmarks of Syntactic Complexity

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Complexity

A polysemous and multidimensional construct.

- Task, cognitive, or linguistic complexity (Bulté and Housen, 2012; Vyatkina et al., 2015)
- Linguistic perspective: "the extent to which language produced in performing a task is **elaborate** and **varied**" (Ellis, 2003)
- Sub-constructs: lexical, morphological, **syntactic**, semantic, pragmatic and discoursal (Lu, 2010, 2011; Lu and Ai, 2015; Ortega, 2015; Mazgutova and Kormos, 2015; Jarvis, 2013; Kyle and Crossley, 2015)

Complexity and SLA

- Applications:
  - interlanguage development analysis (Lu, 2011; Lu and Ai, 2015; Mazgutova and Kormos, 2015)
  - performance evaluation (Yang et al., 2015; Taguchi et al., 2013)
  - readability assessment (Vajjala and Meurers, 2012; Nelson et al., 2012)
- Tools:
  - CohMetrix (McNamara et al., 2014)
  - L2 Syntactic Complexity Analyzer (Lu, 2010)
  - Common Text Analysis Platform (Chen and Meurers, 2016)
  - Kristopher Kyle's automatic text analysis tools `http://www.kristopherkyle.com/tools.html`

Syntactic Complexity and Proficiency Development

Advanced learners usually demonstrate the ability to understand and produce more complex language because of

- the expansion of their syntactic repertoire, and
- the increase of their capacity to use a wider range of linguistic resources (Ortega, 2015)

Proficiency development means

- progressively more elaborate language, and
- greater variety of syntactic patterning (Foster and Skehan, 1996)

As a result, syntactic complexity is often used to **determine proficiency** or **assess performance** in the target language (Larsen-Freeman, 1978; Ortega, 2003, 2012; Vyatkina et al., 2015; Wolfe-Quintero et al., 1998; Lu, 2011; Taguchi et al., 2013; Yang et al., 2015; Sotillo, 2000).

Researching Developmental Syntactic Complexity

- Developmental perspective is "...the core of the phenomenon of L2 syntactic complexity" (Ortega, 2015)
- To SLA theory: understanding the developmental trajectories
- To LT practice:
  - Selecting appropriate learning materials
  - Providing reference frame for testing the effectiveness of instructional interventions

Development of Syntactic Complexity in Learner Corpora

Learner corpora have been used to investigate:

- the most informative complexity measures across proficiency levels (Lu, 2011; Ferris, 1994; Ishikawa, 1995)
- the patterns of development for different syntactic measures (Bardovi-Harlig and Bofman, 1989; Henry, 1996; Larsen-Freeman, 1978; Lu, 2011)
- the developmental trajectory of syntactic complexity from the learner production (Ortega, 2000, 2003; Vyatkina, 2013b; Vyatkina et al., 2015).

One thing in common: analyzing syntactic complexity development based on learners' production.

Challenges with Learner Corpora (1)

- Learner corpora vary with
  - learner background
  - production tasks
  - instructional settings
- Inconsistent, contradicting findings, e.g., the correlation between subordination frequency and proficiency level have been found to be
  - positive (Aarts and Granger, 1998; Granger and Rayson, 1998; Grant and Ginther, 2000),
  - negative (Lu, 2011; Reid, 1992), and
  - uncorrelated (Ferris, 1994; Kormos, 2011)

Challenges with Learner Corpora (2)

Limited robustness of NLP tools for analyzing language produced by learners at varied proficiency levels.

- Current NLP tools are reliable for analyzing the writing of learners at upper intermediate proficiency or higher (Lu, 2010, 2011).
- Developmental profiling has rarely been done for learner language below upper-intermediate proficiency levels (Ortega and Sinicrope, 2008).

Challenges with Learner Corpora (3)

Second language proficiency development is systematically affected by individual differences, making complexity research findings from learner data chaotic and hard to generalize.

- "Non-linear waxing and waning" (Vyatkina, 2015)
- Multiple types of morphosyntactic complexity development (Norrby and Håkansson, 2007).
- Important to account for individual variation in modeling L2 development (Murakami, 2013, 2016).

Limited Usability

Developmental benchmarks based on learner corpora are of limited practical use for **proficiency placement** or **performance assessment**.

Pedagogic Corpus

"A large enough and representative sample of the language, spoken and written, a learner has been or is likely to be exposed to via teaching material, either in the classroom or during self study activities" (Meunier and Gouverneur, 2009).

Advantages of TL Corpora

- Linear development of complexity measures (Vyatkina, 2013a), which is desirable for pedagogic purposes.
- Robustness of NLP processing with well-formed language, resulting in a more reliable benchmark.

The Syntactic Benchmark System

- Analyzes the syntactic complexity of a text produced by a learner.
- Places and visualizes the text onto a developmental scale constructed from a comprehensive TL corpus.
- Proposes appropriately challenging texts from the TL corpus.

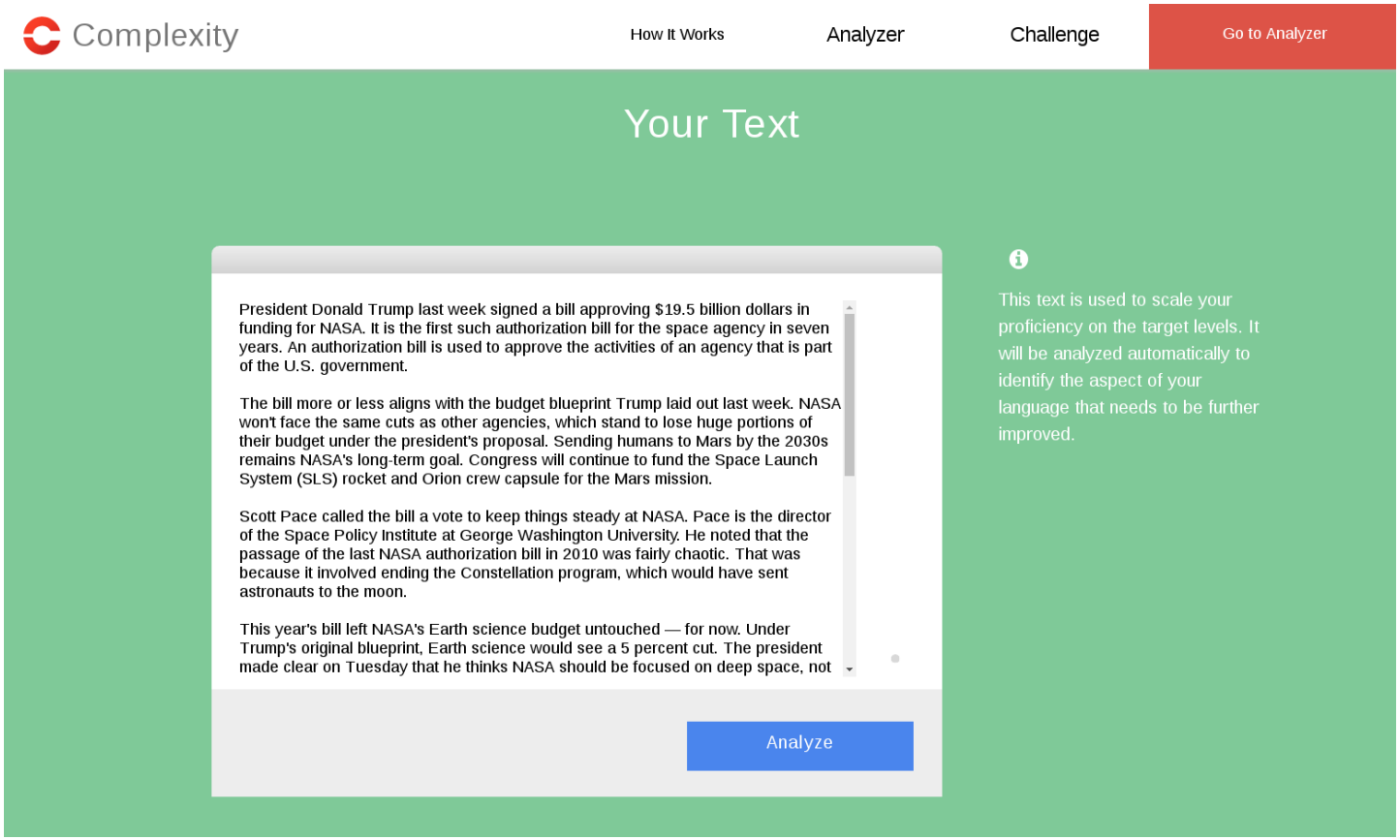
System Details

The TL corpus: Newsela

- 14,581 news articles from Newsela
- five reading levels (human-edited) for each news story

Syntactic complexity measures: exact replicate of the L2 Syntactic Complexity Analyzer (Lu, 2010).

System Demo


Complexity
How It Works
Analyzer
Challenge
Go to Analyzer
Your Text
President Donald Trump last week signed a bill approving $19.5 billion dollars in funding for NASA. It is the first such authorization bill for the space agency in seven years. An authorization bill is used to approve the activities of an agency that is part of the U.S. government.
The bill more or less aligns with the budget blueprint Trump laid out last week. NASA won't face the same cuts as other agencies, which stand to lose huge portions of their budget under the president's proposal. Sending humans to Mars by the 2030s remains NASA's long-term goal. Congress will continue to fund the Space Launch System (SLS) rocket and Orion crew capsule for the Mars mission.
Scott Pace called the bill a vote to keep things steady at NASA. Pace is the director of the Space Policy Institute at George Washington University. He noted that the passage of the last NASA authorization bill in 2010 was fairly chaotic. That was because it involved ending the Constellation program, which would have sent astronauts to the moon.
This year's bill left NASA's Earth science budget untouched — for now. Under Trump's original blueprint, Earth science would see a 5 percent cut. The president made clear on Tuesday that he thinks NASA should be focused on deep space, not
Analyze
This text is used to scale your proficiency on the target levels. It will be analyzed automatically to identify the aspect of your language that needs to be further improved.

Outlook

- Empirically evaluate the system's effectiveness in providing input individually tailored to the i+1 in terms of linguistic complexity as a means to foster learning.
- Which level of challenge for which of the complexity measures at which domain of linguistic modeling is most effective at fostering learning?
- Consider the gap between receptive and productive knowledge, which were found to differ within learners (Zhong, 2016; Schmitt and Redwood, 2011).

Aarts, J. and Granger, S. (1998). Tag sequences in learner corpora: A key to interlanguage grammar and discourse. In Granger, S., editor, *Learner English on Computer*, pages 132–141. Longman, New York.

Bardovi-Harlig, K. and Bofman, T. (1989). Attainment of syntactic and morphological accuracy by advanced language learners. *Studies in Second Language Acquisition*, 11(1):17–34.

Bulté, B. and Housen, A. (2012). Defining and operationalising L2 complexity. In Housen, A., Kuiken, F., and Vedder, I., editors, *Dimensions of L2 Performance and Proficiency*, pages 21–46. John Benjamins.

Chen, X. and Meurers, D. (2016). CTAP: A web-based tool supporting automatic complexity analysis. In *Proceedings of the Workshop on Computational Linguistics for Linguistic Complexity*, Osaka, Japan. The International Committee on Computational Linguistics.

Ellis, R. (2003). *Task-based Language Learning and Teaching*. Oxford University Press.

Ferris, D. R. (1994). Lexical and syntactic features of ESL writing by students at different levels of L2 proficiency. *TESOL Quarterly*, 28(2):414–420.

Foster, P. and Skehan, P. (1996). The influence of planning and task type on second language performance. *Studies in Second Language Acquisition*, 18(3):299–323.

Granger, S. and Rayson, P. (1998). Automatic profiling of learner texts. In Granger, S., editor, *Learner English on Computer*, pages 119–131. Longman, New York.

Grant, L. and Ginther, A. (2000). Using computer-tagged linguistic features to describe L2 writing differences. *Journal of Second Language Writing*, 9(2):123–145.

Henry, K. (1996). Early L2 writing development: A study of autobiographical essays by university-level students of Russian. *The Modern Language Journal*, 80(3):309–326.

Ishikawa, S. (1995). Objective measurement of low-proficiency EFL narrative writing. *Journal of Second Language Writing*, 4(1):51 – 69.

Jarvis, S. (2013). Capturing the diversity in lexical diversity. *Language Learning*, 63:87–106.

Kormos, J. (2011). Task complexity and linguistic and discourse features of narrative writing performance. *Journal of Second Language Writing*, 20(2):148 – 161.

Kyle, K. and Crossley, S. A. (2015). Automatically assessing lexical sophistication: Indices, tools, findings, and application. *TESOL Quarterly*, 49(4):757–786.

Larsen-Freeman, D. (1978). An ESL index of development. *TESOL Quarterly*, 12(4):439–448.

Lu, X. (2010). Automatic analysis of syntactic complexity in second language writing. *International Journal of Corpus Linguistics*, 15(4):474–496.

Lu, X. (2011). A corpus-based evaluation of syntactic complexity measures as indices of college-level ESL writers' language development. *TESOL Quarterly*, 45(1):36–62.

Lu, X. and Ai, H. (2015). Syntactic complexity in college-level English writing: Differences among writers with diverse L1 backgrounds. *Journal of Second Language Writing*, 29:16–27.

Mazgutova, D. and Kormos, J. (2015). Syntactic and lexical development in an intensive English for academic purposes programme. *Journal of Second Language Writing*, 29:3–15.

McNamara, D. A., Graesser, A. C., McCarthy, P. M., and Cai, Z. (2014). *Automated evaluation of text and discourse with Coh-Metrix*. Cambridge University Press, Cambridge, M.A.

Meunier, F. and Gouverneur, C. (2009). New types of corpora for new educational challenges: Collecting, annotating and exploiting a corpus of textbook material. In Aijmer, K., editor, *Corpora and Language Teaching*, pages 179–201. John Benjamins, Amsterdam.

Murakami, A. (2013). *Individual Variation and the Role of L1 in the L2 Development of English Grammatical Morphemes: Insights From Learner Corpora*. PhD thesis, University of Cambridge.

Murakami, A. (2016). Modeling systematicity and individuality in nonlinear second language development: The case of english grammatical morphemes. *Language Learning*, 6(4):834–871.

Nelson, J., Perfetti, C., Liben, D., and Liben, M. (2012). Measures of text difficulty: Testing their predictive value for grade levels and student performance. Technical report, The Council of Chief State School Officers.

Norrby, C. and Håkansson, G. (2007). The interaction of complexity and grammatical processability: The case of Swedish as a foreign language. *International Review of Applied Linguistics in Language Teaching*, 45:45–68.

Ortega, L. (2000). *Understanding syntactic complexity: The measurement of change in the syntax of instructed L2 Spanish learners*. Unpublished doctoral dissertation, University of Hawaii, Manoa, HI.

Ortega, L. (2003). Syntactic complexity measures and their relationship to L2 proficiency: A research synthesis of college level L2 writing. *Applied Linguistics*, 24(4):492–518.

Ortega, L. (2012). A construct in search of theoretical renewal. In Szmrecsanyi, B. and Kortmann, B., editors, *Linguistic complexity: Second language acquisition, indigenization, contact*, pages 127–155. de Gruyter, Berlin.

Ortega, L. (2015). Syntactic complexity in L2 writing: Progress and expansion. *Journal of Second Language Writing*, 29:82–94.

Ortega, L. and Sinicrope, C. (2008). Novice proficiency in a foreign language: A study of task-based performance profiling on the STAMP test. Technical report, Center for Applied Second Language Studies, University of Oregon.

Reid, J. (1992). A computer text analysis of four cohesion devices in english discourse by native and nonnative writers. *Journal of Second Language Writing*, 1(2):79–107.

Schmitt, N. and Redwood, S. (2011). Learner knowledge of phrasal verbs: A corpus-informed study. In Meunier, F., De Cock, S., Gilquin, G., and Paquot, M., editors, *A Taste for Corpora. In Honour of Sylviane Granger*, pages 173–207. John Benjamins Publishing Company, Amsterdam.

Sotillo, S. M. (2000). Discourse functions and syntactic complexity in synchronous and asynchronous communication. *Language Learning & Technology*, 4(1):82–119.

Taguchi, N., Crawford, W., and Wetzel, D. Z. (2013). What linguistic features are indicative of writing quality? a case of argumentative essays in a college composition program. *TESOL Quarterly*, 47(2):420–430.

Vajjala, S. and Meurers, D. (2012). On improving the accuracy of readability classification using insights from second language acquisition. In *Proceedings of the Seventh Workshop on Building Educational Applications Using NLP*, Montreal, Canada. Association of Computational Linguistics.

Vyatkina, N. (2013a). Analyzing part-of-speech variability in a longitudinal learner corpus and a pedagogic corpus. In Granger, S., Gilquin, G., and Meunier, F., editors, *Twenty years of learner corpus research: Looking back, moving ahead. Corpora and Language in Use - Proceedings 1*, pages 479–491. Presses universitaires de Louvain, Louvain-la-Neuve, Belgium.

Vyatkina, N. (2013b). Specific syntactic complexity: Developmental profiling of individuals based on an annotated learner corpus. *The Modern Language Journal*, 97(S1):11–30.

Vyatkina, N. (2015). New developments in the study of L2 writing complexity: An editorial. *Journal of Second Language Writing*, 29:1 – 2.

Vyatkina, N., Hirschmann, H., and Golcher, F. (2015). Syntactic modification at early stages of L2 German writing development: A longitudinal learner corpus study. *Journal of Second Language Writing*, 29:28–50.

Wolfe-Quintero, K., Inagaki, S., and Kim, H.-Y. (1998). Second language development in writing: Measures of fluency, accuracy, & complexity. Technical report, Second Language Teaching & Curriculum Center, University of Hawaii at Manoa.

Yang, W., Lu, X., and Weigle, S. C. (2015). Different topics, different discourse: Relationships among writing topic, measures of syntactic complexity, and judgments of writing quality. *Journal of Second Language Writing*, 28:53–67.

Zhong, H. F. (2016). The relationship between receptive and productive vocabulary knowledge: a perspective from vocabulary use in sentence writing. *The Language Learning Journal*, Advanced Access.