Mapping the Path to Advanced Second Language Literacy in Adults Using Eye-Tracking

An Interdisciplinary Research Grant Proposal
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Abstract

Advanced literacy development in a foreign language (L2) is a key goal of college foreign language study, as well as for the LDS Church's Global Education Initiative. However, the strategies that make one an expert reader in one's native language (L1) do not always transfer to the L2.

This project unites scholars in the fields of linguistics, language acquisition, neuropsychology, digital humanities, and statistics and is aimed at helping learners achieve advanced L2 reading proficiency. By applying machine learning to eye-tracking data, we will...

- identify the characteristics of successful L1 readers in various languages.
- identify differences between L1 and L2 readers.
- identify linguistic features affecting reading.
- develop an efficient diagnostic tool for reading proficiency.
- develop a large, open database of cross-linguistic eye-tracking measures.
- develop a publicly-available tool to determine text difficulty in four different languages for L1 and L2 readers.

Participants in this study will comprise native and non-native speakers of three different non-linguistically-related languages at various levels of proficiency. Using eye-tracking technology we will measure the eye movements of individuals reading in their L1 and their L2. We will employ machine learning to predict reading proficiency on the basis of eye movement behavior. Finally, we will conduct a feature analysis to determine which linguistic factors affect reading comprehension.

Because BYU has more advanced L2 learners than any other university, it is an ideal location for this project. Funds from the university will help us collect baseline data that will facilitate applications for external grants.

Mapping the Path to Advanced Second Language Literacy in Adults Using Eye-Tracking

Little is known about literacy development in a second language

Highly-proficient reading is like breathing; the process is automatic and readers rarely notice what they are doing. But unlike breathing where stethoscopes, x-rays and other instruments can investigate the mechanisms involved, reading research has been limited to using indirect measures (e.g. comprehension questions, reading aloud, etc.) to investigate reading processes. And while the composition of the air that is breathed can be analyzed chemically, the analysis of reading passages themselves is often more subjective. Great inroads have been made in researching the development of native language (L1) reading, especially in children who speak English (National Reading Panel, 2000). Additionally, scholars have developed widely-used text measurement tools for English, including the Flesch-Kincaid and Lexile reading scores.

Despite the body of research available on English literacy development among children and text-analysis tools for English passages, adult literacy and particularly foreign language reading research has lagged woefully behind by comparison (Grabe, 2009). One possible reason for the lack of research may stem from a widespread belief that merely increasing L2 proficiency will result in improved L2 reading ability. Such an assumption would predict that skills learned in one language will automatically transfer to another so long as a reader has a large vocabulary. However, Gorsuch & Taguchi (2008) counter this claim, demonstrating that targeted L2 reading strategies can positively affect reading ability in an L2 even when language proficiency is held constant. This makes sense inasmuch as reading in English must necessarily differ from reading in languages such as Chinese or Russian where script, reading direction, and/or alphabets differ.

The limited available L2 reading research primarily looks at reading strategies or makes inferences about reading behaviors. It rarely explores the developmental processes associated with learning to read in a second language, a second script, a second text direction, a second alphabet, and so forth. Thus much needs to be done to determine if and how adult learners transfer their L1 reading skills or make use of new ones in reading different languages.

Given this background, the problems surrounding adult L2 literacy development are rather pronounced: assessing reading proficiency in L2 is currently difficult because (1) we have no direct measures of the reading process, (2) identifying reading-level-appropriate texts for assessment use is time- and resource-intensive, and (3) little is known about L2 reading development. This is unfortunate since developing advanced L2 literacy ability is increasingly important in a globalized world where adults must read in an L2 for educational, vocational, religious, and general purposes. However, newer technologies are making breakthroughs into reading research. Eye-tracking allows researchers to understand how readers interact with text in real time, and machine learning allows scholars both to systematically analyze texts and to create taxonomies of types of readers. The current research proposal explains how we plan to contribute to this under-researched area by describing a large-scale study of adult L2 literacy development using direct measures of reading behavior to build a model of L2 literacy development and create tools which practitioners and future researchers can use to further the work of global L2 literacy.

Three research questions guide our study

- What are the characteristics of successful L1 readers in Chinese, Russian, Portuguese, and English?
    - How do the characteristics of readers differ across those languages?
    - How do these characteristics differ across various proficiency levels and as readers develop?

- What are the characteristics that distinguish L1 and L2 readers of Chinese, Russian, Portuguese, and English?
- Which linguistic features (e.g., grammatical complexity, word frequency, word complexity) affect reading fluency and development?

Studying reading in a second language presents challenges

Researching second language (L2) reading poses particular challenges. L2 students and learning contexts vary widely. Moreover, L2 students have much wider ranges of language proficiencies, unlike most L1 readers who have considerable implicit linguistic knowledge by the time they begin to read. Many have already learned to read in their L1 more or less successfully. However, L1 reading strategies and processes can either facilitate the transfer of reading skills or become a source of interference. As a basic example, eye tracking research has found that proficient L1 English readers tend to make larger eye movements (*saccades*) than proficient L1 Chinese readers (Liversedge et al., 2016). This change reflects properties of the writing system: Chinese characters are much more informationally and visually dense than English words, so the eyes need to move differently for maximum efficiency in the different languages. An English speaker learning to read in Chinese must make this adjustment. As another example, proficient English readers typically fixate just to the left of word center. However, in languages with complex morphological structure (i.e. lots of informative suffixes on words), readers adjust where they look within the word to ensure that they can clearly see the suffixes (Yan et al., 2014). English speakers who fail to make this adjustment will miss important information. These examples illustrate that habits developed for successful L1 reading may not transfer well to the new language, instead interfering with efficient L2 reading.

Eye tracking can overcome these challenges better than other assessment methods

In the center of the inside surface of the eye, where light is transformed into a neural signal and sent to the brain, is a region called the *fovea*. This part of the eye sends precise visual information to the brain, resulting in a clear, detailed image. Outside the fovea, our visual acuity is reduced; objects in peripheral vision are lacking in detail. This is why when we read our eyes make a series of movements, called *saccades*, that shift the fovea onto different words; our peripheral vision is too blurry to permit recognition of words. Between these saccades are *fixations*, pauses during which the eyes take in visual information. In proficient readers, the eyes move rapidly from one word to another. Because the eyes must point at an object to acquire high-quality visual information about it, what a person is looking at reliably reflects what they are thinking about. Eye tracking can measure what the reader is doing moment-to-moment, rather than simply measuring the final output of the reading process as most currently-employed reading assessments do. For this reason, eye-tracking has proven to be a superior tool for investigating reading (Rayner, 1998, 2009).

Offline measures of L2 reading proficiency (i.e. comprehension questions) cannot identify these challenges or assess success in overcoming them. Eye tracking can, meaning that it has tremendous potential for assessing L2 reading proficiency. Further, it is already known that L1 reading is affected by language proficiency in children, adolescents and adults (Huestegge et al., 2009; Kuperman & Van Dyke, 2011; Luke, Henderson & Ferreira, 2015). When reading in an L2, readers' eye movements change; Adult bilinguals read less efficiently in their L2 than in their L1 (Cop, Drieghe, et al., 2015; Cop, Keuleers, et al., 2015). These findings suggest that eye tracking can be used to assess L2 proficiency as well. However, no studies to date have used eye movements in this way.

Machine learning can automatically assess reading proficiency

Our eye-tracking data will come from participants whose reading proficiency is known. A machine-learning algorithm can be used to compare each participant's eye-tracking data with their proficiency level and learn to classify new readers into various reading levels based on their eye-tracking

behavior. This technique will reveal what reading habits transfer to their L2 and when intervention might be necessary to mitigate negative transfer.

Machine learning can also identify new assessment materials

When assessing reading proficiency, the reading passage is as important to consider as the readers themselves. Not all reading passages are created equal. Texts can range from simple grocery lists to complex legal contracts. Thus, treating passages as a constant within and between languages is problematic because reading is an interpretive, asynchronous, communicative activity between an author with specific intents and purposes and a reader whose task is to decipher the author's intent.

While some frameworks exist to typologically map different genres of reading, one of the most useful was developed for the federal government by the Interagency Language Roundtable (ILR), which categorizes reading passages into a scale from 0 to 5 using criteria that are aligned by author purpose, reader task, text type, content, etc. While these reading levels have been empirically validated by educated adult readers in a number of different languages (Clifford & Cox, 2013), little research has been done to empirically analyze the characteristics of passages that are inherent to the text itself. Machine learning is ideal for this endeavor as it can automatically group passages with similar reading difficulty together, and we can use these features to see what similarities exist across different languages.

Using computational linguistic techniques, we can automatically identify grammatical properties of any text. A machine-learning algorithm can take a collection of texts whose readability levels are known, and by comparing each text's grammatical properties with its readability level, the algorithm can learn to classify the difficulty of previously unseen texts.

This research requires a unique combination of resources and expertise

Among the resources for this project is, firstly, access to adults who are proficient readers of their L1. This will enable us to control for L1 literacy and can establish a baseline for comparison when examining transfer. Second, we need readers who have high levels of proficiency in an L2. This will allow us to analyze how those readers interact with reading passages of varying levels of difficulty. Additionally, access to languages that are typologically different from one another will improve the generalizability of the findings. For example, languages that use different alphabets, word ordering, inflectional systems, etc, will allow us to know what skills are transferable independent of languages and which are language specific. Access to the reading passages that have already been human-rated will allow machine learning algorithms to mimic the processes needed to sort new passages by difficulty. Finally, this research requires individuals with strengths in L1 and L2 literacy, the proficiency scale, eye tracking and machine learning.

BYU is uniquely positioned to conduct this research

BYU offers a unique combination of resources that will facilitate the current study. The university admission requirements screen for successful readers. Second, BYU teaches the highest number of advanced second language learners in the U.S. Many of the students learn their languages through missionary service opportunities and thus have a wide range of second language reading ability. BYU teaches a wide variety of languages that are linguistically diverse with over 60 languages offered. In terms of reading passages, BYU has been awarded over 1.5 million dollars in government grants to create reading proficiency tests based on the ILR scale, and thus has access to human-graded reading passages in English, Spanish, French, Portuguese, German, Russian, Arabic, Turkish, Chinese, and Japanese.

Moreover, BYU also has the requisite expertise. **Jennifer Bown's** research is focused on how to help students attain high levels of *proficiency in L2 reading*, writing, speaking, and listening. She brings to the research team language expertise and experience in the development and assessment of reading passages. **Troy Cox** researches *language assessment* and has assisted in the development of proficiency tests in a number of languages and will bring that expertise to the project. **Grant Eckstein** researches the

connection between reading and L2 writing. He brings expertise in *L2 reading theory*, competence in utilizing eye-tracking methods, and access to resources for developing, staffing, and mentoring students in an eye-tracking lab. **Steven Luke** uses *eye-tracking* to study reading in native speakers, children, and second language learners. **Robert Reynolds** specializes in natural language processing with applications in computer-assisted language learning. His publications include *machine-learning* approaches to automatic assessment of text readability. **Dennis Eggett** is the Director of Center for Statistical Consultation and Collaborative Research and Associate Research Professor and has co-authored over 200 peer reviewed publications. His role will be to direct the statistical analysis.

How will we do this?

Participants

Participants in this study will comprise 400 native and non-native speakers of Chinese, Russian, Portuguese and English at various proficiency levels. These languages represent critical languages as determined by the National Security Education program and employ different writing systems. Moreover, BYU has developed proficiency tests in each of these four languages. Participants will take these tests in both their native and second languages.

Apparatus

Eye movements will be recorded via an SR Research Eyelink 1000 plus tower mount eye tracker. This eye tracker has a spatial resolution of 0.01°, meaning that it can identify where people are looking on the screen to within a few pixels. It has a sampling rate of 1000 Hz, meaning that it measures eye position every millisecond. Head movements will be minimized with a chin and head rest.

Reading Proficiency Tests

Reading Proficiency Tests (RPT) in each of the four languages have been aligned with national standards for determining language proficiency (Clifford & Cox, 2013). The RPTs in each of the four languages consist of passages at one of three proficiency levels: Intermediate, Advanced, and Superior, followed by one multiple-choice question. The RPT is computer-adaptive.

Procedure

After taking the RPT, research participants will read passages at each of the assigned levels: Intermediate, Advanced, and Superior while the research team measures their eye movements using the eye tracking device. The participants will undergo this process twice: first in their native language and then again in their second language. The eye-tracking data from these participants will become input to supervised machine-learning algorithms to produce models for categorizing L2 texts according to difficulty, and categorizing L2 learners according to proficiency level.

Data Analysis

A discriminant analysis will then be used to categorize participants into proficiency levels based on measures from the eye-tracker. The eye tracking measures will also be used to classify text difficulty levels. This analysis will also be used to determine differences in fixation and saccade lengths (i.e., reading behavior) across languages and proficiency levels in order to describe features of L2 literacy development in the four target languages.

Innovations and Deliverables Stemming from this Project

The long-term objective of our proposed research is to help individuals around the globe develop advanced L2 literacy. Important groundwork is needed to accomplish this ambitious goal, which we have outlined above. It includes developing a better understanding of the processes involved in developing adult L2 literacy and the creation of tools which can more quickly and reliably categorize learners and texts into respective proficiency levels. The research we outline here moves in that direction and promises the following innovations and deliverables further to the goal of improving L2 literacy globally.

Our research will produce unique innovations including the following specific outcomes:

- increase knowledge about L2 reading development that complements existing research on L1 reading development
- develop direct measures of L2 reading processes
- determine a less resource-intensive and accurate way to measure the difficulty level of a given text in four different languages.

We expect to develop the following products for public and academic use:

- an efficient diagnostic tool for evaluating reading proficiency
- a large, open database of cross-linguistic eye-tracking measures
- a publicly-available tool to determine text difficulty in four different languages for L1 and L2 readers

Budget

While we have received some internal funding, to gather the amount of data necessary for the large-scale outcomes we desire, more funds are needed. We are requesting $120,000 to jumpstart this project by

1. Creating a mentored research lab in which graduate and undergraduate student employees will assist through experiential learning = ~$40,000
   Graduate student support = ~$24,000
   Undergraduate Research Assistant Compensation
   400 participants X 3-4 hours per participant X $10 per hour = ~$16,000

2. Compensating research participants for their time, =~ $20,000
   Participant Compensation: $50 X 4 languages X 100 participants per language

3. Acquiring additional equipment to expedite data collection =~$42,000
   SR 1000 Eyelink plus Eyetracker
   Data analysis and calibration computers

4. Traveling to professional conferences to network and meet with potential external funders =~$18,000

External Funding Potential and Timeline

The potential for external funding is high and varied. First, the government has different sources for research into languages that are critical to national security available through the Department of Education (including National Security Education Program, Language Resource Centers Program and Education Research) and the Department of Defense (Minerva Institute and Defense Language and National Security Office (DLNSEO)). The research team has a current relationship with DLNSEO having previously been awarded over 1.5 million in grants for language development. Furthermore, the National Science Foundation has programs related to both Linguistics and Development Science for which funding is available. Finally, charitable organizations including the Ray Solem Foundation provides funding for the development for English language learners. Initially, however, we will apply for a funding opportunity (FOA) through the National Institues of Health on **Typical and Atypical Patterns of Language and Literacy in Dual Language Learners (R01)** a descripton of which is found below**.**

> *The purpose of this FOA is to support investigator-initiated R01 applications that will inform our understanding of the typical and atypical patterns of language and literacy development of dual language learners (DLLs) in the United States. Applicants are encouraged to take advantage of advances in the language sciences and related fields to identify and clarify specific cognitive, linguistic, neurobiological, and sociocultural factors associated with normal and impaired language and literacy acquisition in young DLL populations.*
> *https://grants.nih.gov/grants/guide/notice-files/NOT-OD-18-009.html*

The deadline for this FOA is on or after January 25, 2018. Our plan is to start the process to submit it by March 15, 2018.

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Subject: FW: New Letter of Intent Proposal
Date: Friday, December 1, 2017 at 4:11:15 PM Mountain Standard Time
From: Ray Clifford
To: Sarah Dorff
CC: Troy Cox
Priority: High
Attachments: image001.png

I fully support the proposal in this email.
Ray Clifford

Ray Clifford
Associate Dean
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BRIGHAM YOUNG UNIVERSITY
HUMANITIES

From: Research Development
Sent: Friday, December 01, 2017 4:06 PM
To: Ray Clifford <rayc@byu.edu>
Subject: New Letter of Intent Proposal

Name of Principal Investigator

Troy L Cox

Project Title:

Investigating the Path to Advanced Second Language Literacy Through Eye-Tracking and Machine Learning

Abstract (250 word limit):

Advanced literacy development in a foreign language (L2) is a key goal of college foreign language study, as well as for the LDS Church's Global Education Initiative. However, the strategies that make one an expert reader in one's native language (L1) do not always transfer to the L2.
This project unites scholars in the fields of linguistics, language acquisition,

neuropsychology, digital humanities, and statistics and is aimed at helping learners achieve advanced L2 reading proficiency. Using eye-tracking and machine-learning technologies, we will

•identify the characteristics of successful L1 readers in various languages
•identify differences between L1 and L2 readers
•identify linguistic features affecting reading

Participants in this study will comprise native and non-native speakers of three languages at various levels of proficiency. Using eye-tracking technology we will compare the participants' eye movements while reading in their L1 and L2 and to compare the eye movements of native speakers to non-native speakers. We will employ machine learning to predict reading proficiency on the basis of eye movement behavior. Finally, we will conduct a feature analysis to determine which linguistic factors affect reading comprehension.

This study will result in a database of reading-based eye movement data that can be used in development of training materials that include instruction in literacy strategies at BYU and elsewhere.

Because BYU has more advanced L2 learners than any other university, it is an ideal location for this project. Funds from the university will help us collect baseline data that will facilitate applications for external grants.

Team Members/ Departments:

Troy Cox, Center for Language Studies; Jennifer Bown, Department of German and Russian; Robert Reynolds, Office of Digital Humanities; Grant Eckstein, Department of Linguistics and English Language; Steven Luke, Department of Psychology; and Dennis Eggett, Department of Statistics

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Budget Estimate: (Total may not exceed $60,000/yr)

$60,000/yr

Send To: (Email of Principal Investigator's Department Chair)

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Note to PI Department Chair: Please forward this proposal to sarahdorff@byu.edu with a statement of approval to complete submission.

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PUBLISHED BOOKS:

Brown, N.A., & Bown, J. (Eds.) (2015). *Developing professional levels of language proficiency: Theory and methods.* Washington, DC: Georgetown University Press.

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Brown, N.A., Batyshina, T.M., Talalakina, E.V., Bown, J., & Kurilenko, V.B. (2014). *Mastering Russian through global debate.* Washington, DC: Georgetown University Press.

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Journal Articles

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Evans, N., Hartshorn, K. J., Cox, T. & Martin, T. (2014) Measures of written linguistic accuracy: Questions of reliability, validity, and practicality. *Journal of Second Language Writing*, *24*, 33-50

Eggington, W. & Cox, T. (2013). Using elicited oral response testing to measure speaking and listening proficiency in order to determine the need for an interpreter. *Harvard Latino Law Review.* In Press

Clifford, R. & Cox, T. (2013). Empirical validation of reading proficiency guidelines. *Foreign Language Annals*, *40*(1), 45-61.

Cox, T. & Davies, R. (2012) Using automatic speech recognition technology with elicited oral response testing. *CALICO Journal*, *29*(4), 601-618

Book Chapters

Cox, T. L., & Davies, R. S. (2016). From Standards to Rubrics: Comparing Full-Range to At-Level Applications of an Item-Level Scoring Rubric on an Oral Proficiency Assessment. In *Pacific Rim Objective Measurement Symposium (PROMS) 2015 Conference Proceedings* (pp. 215-238). Springer Singapore.

Dewey, D., Clifford, R & Cox, T. (2015) L1, L2, and Cognitive Development: Exploring Relationships. In T. Brown and J. Bown (Eds.) *To Advanced Proficiency and Beyond: Theory and Methods for Developing Superior Second-Language Ability,* Georgetown University Press.

Cox, T., McMurry, B. & McCollum, R. (2010) iDeas for iPods, in B. Baurain & P. Ha (Eds.) *TESOL Classroom Practice Series on Multilevel/Mixed-Ability Settings* (pp. 93-100). TESOL Classroom Practice Series.

Cox, T. (1995) Internet movie database, In M. Warschauer (Ed.) *Virtual Connections: Online Activities and Projects for Networking* (pp. 283–285), Second Language Teaching & Curriculum Center, University of Hawaii Press.

B. Scholarly Work Accepted for Publication

Journal Articles

Cox, T., Malone, M., & Winke, P. ((accepted for publication in Spring 2018) Future Directions in Assessment: Influences of Standards and Implications for Language Learning. *Foreign Language Annals.*

Ma, J., Henrichsen, L., Tanner, M. & Cox, T. (accepted for publication in Fall 2018) Pronunciation's Role in English Speaking Test Ratings. *Journal of Second Language Pronunciation*.

Encyclopedia Entries

Cox, T. (forthcoming, 2018) Standardized Testing in Reading. *TESOL Encyclopedia for English Language Teaching*

Book Chapters

Cox, T., Bown, J., Bell, T & Evans, J. (forthcoming, 2018) Does the question language in advanced L2 reading proficiency assessments make a difference? In S. Gass & P. Winke (Eds.) *Foreign Language Proficiency in Higher Education* (working title). Springer Publishing, New York.

C. Scholarly Work Submitted for Publication

Barrows, J. & Cox, T. (under review) The Effect of Prompt Accent on Elicited Imitation Assessments in English as a Second Language. *Language Testing.*

Decker, L., Cox, T. & Wilcox M. (in progress) The Impact of Changing TOEFL Cut Scores on University Admissions. *Journal of Studies in International Education.*

Summers, M., Cox, T., McMurry, B. & Dewey, D. (under review) *Using self-assessment of language ability as a measure of proficiency.*

Zhao, K., Cox, T, Dewey, D & Eckstein G. (under review) *Investigating the effect of rater's second language learning background and familiarity with examinee's native language on speaking test scores.*

D. Education

Ph.D., Instructional Psychology and Technology, Brigham Young University, April 2013
Concentrations: Item Response Theory, Language Assessment, Technology in Teaching, Technology in Assessment, Teacher Education, Research and Evaluation
Dissertation: Investigating prompt difficulty in an automatically scored speaking performance assessment

M.A., Teaching English as a Second Language, Brigham Young University, 1996
Thesis: The effect of prequestions, proficiency level and passage length on listening comprehension test scores

Certificate Teaching English as a Second Language, Brigham Young University, 1995

B.A., Linguistics, Brigham Young University, 1994
Class standing: Cum Laude

Grant Eckstein

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Education

Ph.D. Linguistics, University of California, Davis, November 2014
Designated emphases: Second Language Acquisition; Writing, Rhetoric, and Composition
Dissertation: *Response to Multilingual Writing in Writing Center Tutorials: Student Expectations and Experiences*
M.A. Linguistics, University of California, Davis, May 2013
Thesis: *One-on-one Conferences for L2 Writing and Language Development: Student Preferences and Teacher Practices*
M.A. TESOL, Brigham Young University, Provo, UT, August 2007
Emphases: Pronunciation, Curriculum Development, and Program Administration
Thesis: *A Correlation of Pronunciation Learning Strategies with Spontaneous English Pronunciation of Adult ESL Learners*
Graduate Teaching Certificate in TESOL, Brigham Young University, Provo, UT, April 2006
B.A. Linguistics, Minor TESOL, Brigham Young University, Provo, UT, April 2005

Scholarship, Published (*peer reviewed)

Books

Childers, J., & **Eckstein, G.** (2003). *Ilokano Language Objectives*. MTC Publications.
Eckstein, G. (2002). *Ilokano Grammar Guide.* MTC Publications.

Journal Articles

***Eckstein, G.,** Evans, K., Moglen, D., & Whitener, W. (2017). Graduate writing groups: An interdisciplinary approach to writing productivity. *Journal of Teaching English for Specific and Academic Purposes, 5*(1), pps. 1-11. DOI: 10.22190/JTESAP1701001E.

Gilliland, B. & **Eckstein, G.** (2017). Editorial introduction. *Journal of Response to Writing, 3*(2), 1-5.

***** Ferris, D., **Eckstein, G.**, DeHonde, G. (2017). Self-directed language development: A study of first-year college writers. *Research in the Teaching of English, 51*(4), 418-440.

Eckstein, G. & Gilliland, B. (2017). Editorial introduction. *Journal of Response to Writing, 3*(1), 1-5.

*** Eckstein, G.** (2016). Grammar correction in the writing center: Expectations and experiences of monolingual and multilingual writers. *Canadian Modern Language Review, 72*(3), 360-382.

***Eckstein, G.** (2013). Implementing and evaluating a writing conference program for international L2 writers across language proficiency levels. *Journal of Second Language Writing, 22*(3), 231-239.

Eckstein, G. (2013). The interaction of theory, philosophy, and practice in ESL writing conferences. *CATESOL Journal, 24*(1), 174-186.

Eckstein, G. (2013). Perspectives on plagiarism. *Writing on the Edge, 24*(2), 94-100.

***Eckstein, G.,** McCollum, R., & Chariton, J. (2011). Multi-draft composing: An iterative model for academic argument writing. *Journal of English for Academic Purposes*, *10*(3), 162-172.

Encyclopedia Entries

Eckstein, G. (2017). Introduction to Deirdre McCloskey. *Teachers on the Edge: The WOE Interviews with Composition and Rhetoric Scholars 1989-2017*. Routledge: NY. Page 399.

Eckstein, G. (2017). Introduction to Claude Hurlbert. *Teachers on the Edge: The WOE Interviews with Composition and Rhetoric Scholars 1989-2017*. Routledge: NY. Page 368.

Scholarship, Accepted for Publication (*peer reviewed)

Articles

*** Eckstein, G.,** & Ferris, D. (in press). Comparing L1 and L2 texts and writers in first-year composition. *TESOL Quarterly.* DOI: 10.1002/tesq.376. 26 pages.

*** Eckstein, G.** (in press). What students want in a tutorial: mainstream, international, and immigrant writers. *Writing Lab Newsletter.*

Eckstein, G. & Gilliland, B. (in press). Editorial introduction. *Journal of Response to Writing.*

Scholarship, In Progress (*peer reviewed)

Books

Eckstein, G., Evans, N., Hartshorn, J., & McMurry, B. *Curriculum development for English language programs.* Book under review. (University of Michigan Press)

Articles

*Ferris, D. & **Eckstein, G.** *Language matters: Understanding the writers enrolled in first-year composition.* Research article under review. (College Composition and Communication).

***Eckstein, G.** *Re-examining the tutor informant role for L1, L2, and immigrant writers.* Research article under review. (The Peer Review). 26 pages.

***Eckstein, G.,** Casper, R., Chan, J., & Blackwell, L. *Assessment of L2 Student Writing: Does Teacher Disciplinary Background Matter?* Research article under review. (Journal of Writing Research). 29 pages.

***Eckstein, G.,** Schramm, W., Noxon, M., & Snyder, J. *Difference when rating L1 and L2 writing: An eye-tracking pilot study.* Research article under review. (Journal of Writing Assessment). 30 pages.

***Eckstein, G.** *Expecting and Experiencing Tutorial Directiveness: L1, L2, and Generation 1.5 Writers.* Research article under review. (Writing Center Journal). 31 pages.

***Eckstein, G.**, & Stock, D. *Usability of a writing center: Native, non-native, and generation 1.5 writers.* Research article under review. (Praxis).

*Merrill, M., Cox, T., **Eckstein, G.**, & Hartshorn, J. *Rubric Rating with MFRM vs. Randomly Distributed Comparative Judgment: A Comparison of Two Approaches to Second-Language Writing Assessment.* Research article under review. (Assessing Writing). 37 pages.

*Zhao, K., Cox, T., Dewey, D., & **Eckstein, G.**. *Investigating the Effects of Rater's Second Language Learning Background and Teaching Experience on Speaking Test Scores.* Research article under review. (Language Testing). 35 pages.

*Krauel, M.K., Evans, N.W., **Eckstein, G.T.,** & McMurry, B.L. *Designing and developing an online self-regulated learning course*. Research article under review. (International Journal of Designs for Learning). 17 pages.

*Jackson, K., Evans, N., **Eckstein, G.,** & Hartshorn, J. *Developing and evaluating online curriculum for volunteer ESL teachers*. Research article under review. (International Journal of Designs for Learning). 27 pages.

Relevant Professional Presentations

Escalante, J., & **Eckstein, G.** (2018). *Interacting with multiple choice distractors in reading comprehension tests: An eye-tracking study.* To be presented at AAAL, Chicago, IL, March 2018

Briney, R., & **Eckstein, G.** (2017). *Not seeing eye-to-eye: How compositionists and applied linguists view and assess student texts differently.* Presented at CCCC, Portland, Oregon, March 16, 2017.

Briney, R., & **Eckstein, G.** (2017). *Exploring the effect of linguistic training on teacher processing and assessment of L1 and L2 student writing: An eye-tracking study.* Presented at AAAL, Portland, Oregon, March 20, 2017.

Eckstein, G. (2016). *How Composition and TESOL Writing Teachers Differ when Reading L1 and L2 Student Texts.* Presented at SSLW, Phoenix, AZ, October 22, 2016.

Chan, J., Dalton, N., Blackwell, L. Mitchell, K., **Eckstein, G.** (2016). *How to read L2 student writing effectively: Tips from an eye-tracking study*. Presented at Intermountain TESOL, Provo, UT, October 8, 2016.

Snyder, J., Noxon, M., Schramm, W., **Eckstein, G.** (2016). *How ESL teachers read L1 and L2 student writing: Similarities, differences, and important implications for feedback and grading*. Presented at Intermountain TESOL, Provo, UT, October 7, 2016.

MA Theses, Projects, & Grant Advisement

In Progress

Escalante, J. *Eye-tracking study to perform a distractor analysis on multiple choice reading*. (MA thesis **Chair**).

Hansen, J. *Fluent ESL reading of narrative texts*. (MA thesis **Chair**).

Katz, A. *Motivation in L2 writing instruction.* (MA thesis committee member)

Miner, S. *Reading Idioms: An Eye-Tracking Study of Non-native Speakers of English.* (MA thesis **Chair**).

Nettgen, K. *Re-reading for fluency of expository texts.* (MA thesis **Chair**).

Schramm, W. *Investigating rater bias in types of grammatical errors: An eye-tracking study.*(MA thesis **Chair**).

Faculty Advisor for Student Grant Awards

Miner, S. (2017). *Reading Idioms: An Eye-Tracking Study of Non-native Speakers of English*. BYU Graduate Studies Grant, $10,000.

Briney, R. (2017). *An Eye Tracking Study: Composition Teachers Assessment of Native and Non-Native Texts.* BYU ORCA Grant, $1500.

Snyder, J. (2017). *How Teachers Grade Native and Non-Native Writing: Exposing Biases and Grading Discrepancies.* BYU ORCA Grant, $1500.

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EXPERIENCE

Director of Center for Statistical Consultation and Collaborative Research and Associate Research Professor, Brigham Young University, Provo, Utah, 1997-Present

Senior Research Scientist, Pacific Northwest National Laboratory, Richland, Washington, 1987-1997

- Statistical consultant to scientific and engineering groups at DOE sponsored Pacific Northwest National Laboratory (PNNL).
- Technical leader for the analysis of satellite data for non-proliferation and treaty verification.
- Design and analysis of Round-Robin studies conducted by the Materials Characterization Center (MCC).
- Characterization of hazardous waste forms such as glass and grout wastes.
- Technical Group Leader of National Security Statistics Group.
- Member of the National Satellite Systems Review Panel.

SAS Institute, Inc., Cary, North Carolina, 1985-1987

- In charge of testing and verifying the Time Series products of SAS Institute.
- Used SAS-IML extensively in the testing of these products.

Graduate Teaching and Research Assistant, North Carolina State University, Raleigh, North Carolina, 1983-1986

- Assistant in grading and teaching various undergraduate and graduate level statistics courses.
- Programmed statistical functions for current research projects. This was done primarily in FORTRAN.

Research Assistant, Brigham Young University, Provo, Utah, 1979-1983

- Student director of the Center for Statistical Research. Supervised student involvement in consulting projects.

- Statistical consultant in the Center for Statistical Research. This included consulting on student, faculty, independent and federally funded research projects. Programmed in SAS, MINITAB, SPSS, and FORTRAN.

R.E. Wilcox Co. Consulting Actuaries, Alpine, Utah, 1978-1979

- Office assistant and programmer. Programmed computer simulations in APL and FORTRAN.

EDUCATION

Ph.D., North Carolina State University, Statistics, 1987

- Dissertation: A Comparative Evaluation of Statistics for Determining the Limits of Applicability of a Linear Regression Model.

M.S., Brigham Young University, Statistics, 1983

- Thesis: Ranking of Teams Competing in Pairwise Comparisons.

B.S., Brigham Young University, Statistics, 1981.

Attended courses at American Statistical Association Annual Meetings on topics such as Statistical Process control, Identification of outliers and influential observations, Designs for observational studies, Multivariate Quality Control, and Analysis of Spatial Data.

Member of the American Statistical Association and the National Satellite Systems Review Panel.

Co-Author on over 200 peer reviewed publications.

SKILLS

- Multivariate Statistics, Classification, Clustering, and Pattern Recognition.
- Design of Experiments, Modeling, ANOVA/MANOVA, and Regression.
- Statistical Process Control and Quality Control.
- Time Series.
- Robust Parameter Estimation.
- Project Management.
- Technical Writing, Editing, Reviewing, and Speaking.
- Group Leadership.
- SAS, S-Plus, SPSS, Minitab, Fortran, APL, Word Perfect, FrameMaker.

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Curriculum Vitae

Assistant Professor
Department of Psychology & Neuroscience Center
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ACADEMIC POSITIONS

2013 to Present	**Assistant Professor** *Department of Psychology & Neuroscience Center, Brigham Young University*
2011 to 2013	**Postdoctoral Research Fellow,** Visual Cognition Lab *Institute for Mind and Brain and Department of Psychology,* *University of South Carolina*
2005 to 2011	**Doctoral Researcher,** Educational Psychology Psycholinguistics Lab *Beckman Institute for Advanced Science and Technology* *And Department of Educational Psychology* *University of Illinois at Urbana-Champaign*
2004 to 2010	**Instructor** *Department of Psychology, University of Illinois at Urbana-Champaign*

EDUCATION

2011	**Ph.D.**, *University of Illinois at Urbana-Champaign, Urbana, Illinois* Educational Psychology with minors in Quantitative Methodologies and Second Language Processing Dissertation: Using Transposed-Letter Effects to Investigate Morphological Processing in L1 and L2. Advisor: Kiel Christianson, Ph.D.
2008	**M.S.**, *University of Illinois at Urbana-Champaign, Urbana, Illinois* Educational Psychology Thesis: The Interaction of Surface and Base Frequency with Each Other and with Sentence Context. Advisor: Kiel Christianson, Ph.D.
2003	**B.A.**, *Brigham Young University, Provo, Utah* Psychology and Russian

PEER-REVIEWED JOURNAL ARTICLES

Carter, B.T. & **Luke, S.G.** (in press). Individuals' eye movements in reading are highly consistent across time and trial. *Journal of Experimental Psychology: Human Perception and Performance*.

Luke, S.G. & Christianson, K. (in press). The Provo Corpus: A Large Eye-Tracking Corpus with Predictability Ratings. *Behavior Research Methods.*

Luke, S.G., Darowski, E. & Gale, S. (in press). Predicting eye movement characteristics across multiple tasks from working memory and executive control. *Memory & Cognition.*

Henderson, J.M., Choi, W., **Luke, S.G.** & Schmidt, J. (2018). Neural correlates of individual differences in fixation duration during natural reading. *Quarterly Journal of Experimental Psychology, 71*, 314-323.

Christianson, K., **Luke, S.G.**, Hussey, E.K., & Wochna, K. (2017). Why reread? Evidence from garden-path and local coherence structures. *Quarterly Journal of Experimental Psychology, 70*, 1380-1405.

Luke, S.G. (2017). Evaluating significance in linear mixed-effects models in R. *Behavior Research Methods, 49*, 1494-1502.

Luke, S.G. & Christianson, K. (2016). Limits on Lexical Prediction during Reading. *Cognitive Psychology, 88*, 22-60.

Luke, S. G., & Henderson, J. M. (2016). The Influence of Content Meaningfulness on Eye Movements across Tasks: Evidence from Scene Viewing and Reading. *Frontiers in psychology*, *7*.

Henderson, J.M., Choi, W., **Luke, S.G.**, & Desai, R. (2015). Neural correlates of fixation duration in natural reading: Evidence from fixation-related fMRI. *NeuroImage, 119*, 390-397.

Luke, S.G. & Christianson, K. (2015). Predicting inflectional morphology from context. *Language, Cognition & Neuroscience*, *30,* 735-748.

Luke, S.G., Henderson, J.M. & Ferreira, F. (2015). Children's eye-movements during reading reflect the quality of lexical representations: An individual differences approach. *Journal of Experimental Psychology: Learning, Memory & Cognition, 41*, 1675-1683.

Henderson, J.M., Choi, W., & **Luke, S.G.** (2014). Morphology of Primary Visual Cortex Predicts Individual Differences in Fixation Duration during Text Reading. *Journal of Cognitive Neuroscience, 26*, 2880-2888.

Henderson, J.M. & **Luke, S.G.** (2014). Stable individual differences in saccadic eye movements during reading, pseudo-reading, scene viewing, and scene search. *Journal of Experimental Psychology: Human Perception and Performance, 40*, 1390-1400.

Henderson, J.M, Olejarszyk, J., **Luke, S.G.**, & Schmidt, J. (2014). Eye movement control during scene viewing: Immediate degradation and enhancement effects of spatial frequency filtering. *Visual Cognition, 22*, 486-502.

Luke, S. G., Smith, T. J., Schmidt, J., & Henderson, J. M. (2014). Dissociating temporal inhibition of return and saccadic momentum across multiple eye-movement tasks. *Journal of Vision*, *14*(14), 9.

Olejarczyk, J.H., **Luke, S.G.** & Henderson, J.M. (2014). Incidental memory for parts of scenes from eye movements. *Visual Cognition, 22*, 975-995.

Stoops, A., **Luke, S.G.**, Christianson, K. (2014). Animacy information outweighs morphological cues in Russian. *Language, Cognition and Neuroscience, 29*, 584-604.

Henderson, J.M., **Luke, S.G.**, Schmidt, J., & Richards, J.E. (2013). Co-registration of Eye Movements and Event-Related Potentials in Connected-Text Paragraph Reading. *Frontiers in Systems Neuroscience 7:28*. doi: 10.3389/fnsys.2013.00028

Henderson, J.M., Nuthmann, A. & **Luke, S.G.** (2013). Eye movement control during scene viewing: Immediate effects of scene luminance on fixation durations. *Journal of Experimental Psychology: Human Perception and Performance, 39*, 318-22.

Henderson, J.M., Shinkareva, S.V., Wang, J., **Luke, S.G.**, & Olejarczyk, J. (2013). Predicting Cognitive State from Eye Movements. *PLoS ONE 8(5)*: e64937.

Luke, S.G. & Christianson, K. (2013). SPaM: A combined self-paced reading and masked-priming paradigm. *Behavior Research Methods, 45,* 143-150.

Luke, S.G. & Christianson, K. (2013). The influence of frequency across the time-course of morphological processing. *Journal of Cognitive Psychology, 25*, 781-799.

Luke, S.G. & Henderson, J.M. (2013). Oculomotor and cognitive control of eye movements during reading: Evidence from mindless reading. *Attention, Perception and Psychophysics, 75*, 1230-1245.

Luke, S.G., Nuthmann, A. & Henderson, J.M. (2013). Eye movement control in scene viewing and in reading: Evidence from a stimulus onset delay paradigm. *Journal of Experimental Psychology: Human Perception and Performance, 39(1)*, 10-15.

Luke, S. G., Schmidt, J., & Henderson, J. M. (2013). Temporal oculomotor inhibition of return and spatial facilitation of return in a visual encoding task. *Frontiers in Psychology, 4*.

Stites, M., **Luke, S.G.**, & Christianson, K. (2013). The Psychologist said quickly, "Dialogue descriptions modulate reading speed!" *Memory and Cognition, 41(1),* 137-151.

Christianson, K., Mestre, J., & **Luke, S. G.** (2012). Practice Makes (Nearly) Perfect: Solving 'Students-and-Professors'-Type Algebra Word Problems. *Applied Cognitive Psychology, 26,* 810-822.

Henderson, J. M., & **Luke, S.G.** (2012). Oculomotor inhibition of return in normal and mindless reading. *Psychonomic Bulletin & Review, 19*, 1101-1107.

Luke, S.G., & Christianson, K. (2012). Semantic predictability eliminates the transposed-letter effect. *Memory & Cognition, 40(4)*, 628–641.

Christianson, K. & **Luke, S. G.** (2011). Context strengthens initial misinterpretations of text. *Scientific Studies of Reading, 15,* 136-166.

Luke, S. G. & Christianson, K. (2011). Stem and whole-word frequency effects in the processing of inflected verbs in and out of a sentence context. *Language and Cognitive Processes*, *26*, 1173-1192.

Christianson, K., **Luke, S. G.**, & Ferreira, F. (2010). Effects of plausibility on structural priming. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 36,* 538-544.

Curriculum Vitae

Robert J. Reynolds
Assistant Research Professor
Brigham Young University
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Education:

PhD, Russian Language Technology, Universitetet i Tromsø, Aug 2016
MA, Russian Linguistics, Ohio State University, 2011
BS Psychology and Russian majors, Philosophy minor, Brigham Young University, 2008

Research:

Peer-reviewed journal articles:

Endresen, Anna, Laura Janda, Robert Reynolds, and Francis Tyers. "Who needs particles? A challenge to the classification of particles as a part of speech in Russian." *Russian Linguistics* 40 (2). 2016.

Peer-reviewed collection articles:

Parker, Jeff, Robert Reynolds, and Andrea D. Sims. "Network properties of inflection class systems: Why some classes contribute more complexity than others". Committed to volume on morphological typology and linguistic cognition, to be submitted to Cambridge University Press, eds. Andrea D Sims, Adam Ussishkin, Jeff Parker and Samantha Wray.

Peer-reviewed proceedings articles:

Parker, Jeff, Robert Reynolds, and Andrea D. Sims. "A Bayesian Investigation of Factors Shaping the Network Structure of Inflection Class Systems." *Proceedings of the Society for Computation in Linguistics* 1, no. 1 (2018): 223-224.

Reynolds, Robert. "Insights from Russian second language readability classification: complexity-dependent training requirements, and feature evaluation of multiple categories." In *Proceedings of the 11th Workshop on Innovative Use of NLP for Building Educational Applications*, pp. 289–300. 2016. San Diego, California.

Reynolds, Robert and Francis Tyers. "Automatic word stress annotation of Russian unrestricted text." In *Nordic Conference of Computational Linguistics NODALIDA 2015*, p. 173. 2015.

Tyers, Francis and Robert Reynolds. 2015. "A preliminary constraint grammar for Russian." In *Proceedings of the Workshop on "Constraint Grammar – methods, tools, applications" at NODALIDA 2015*. Vilnius, Lithuania.

Reynolds, Robert, Eduard Schaf and Detmar Meurers. 2014. "A VIEW of Russian: Visual Input Enhancement for a Morphologically Rich Language." In *Proceedings of 3rd workshop on NLP for computer-assisted language learning*. Uppsala, Sweden.

Reynolds, Robert. 2014. "Automatic Evaluation of Potential Targets for Textual Enhancement: Identifying Optimal Sentences for Learner Uptake." In *Research Challenges in CALL. Proceedings of the Sixteenth International CALL Conference*, edited by Jozef Colpaert, Ann Aerts, and Margret Oberhofer, 365. Antwerp: University of Antwerp.

Reynolds, Robert. 2013. "Are Russian prefixes out of order?: Complexity-Based Ordering and template morphology." *University of Pennsylvania Working Papers in Linguistics* 19 (1). ISSN 1524-9549.s 158 - 168.

Presentations:

Parker, Jeff, Robert Reynolds and Andrea D. Sims. "A Bayesian investigation of factors shaping the network structure of inflection class systems". Poster at the *1st Meeting of the Society for Computation in Linguistics*, Salt Lake City, January 4-7, 2018.

Parker, Jeff, Robert Reynolds and Andrea D. Sims. "Network properties of inflection class systems: why some classes contribute more complexity than others". Presentation at the *Morphological Typology and Linguistic Cognition Workshop* at the Linguistic Institute, University of Kentucky, July 22-23, 2017.

Reynolds, Robert. 2016. "Russian computer-assisted language learning and artificial intelligence: automatic morphological analysis and disambiguation." presented at *The 11th Slavic Linguistics Society Annual Meeting*. Sept 23-25, Toronto, Canada.

Reynolds, Robert. 2016. "Computer Assisted Language Learning and Artificial Intelligence: A Case Study With Russian Morphology" presented at *Language Acquisition Research Colloquium*. Sept 21, Provo,UT.

Janda, Laura, Hanne Eckhoff, Olga Lyashevskaya, Robert Reynolds. 2016. "How learnable is Russian aspect?" presented at *Time and Language, organized by the Linguistic Association of Finland.* August 25-26, Turku, Finland.

Reynolds, Robert. 2016. "Insights from Russian second language readability classification: complexity-dependent training requirements, and feature evaluation of multiple categories." presented at *The 11th Workshop on Innovative Use of NLP for Building Educational Applications.* June 16, San Diego, California.

Tyers, Francis, Anna Endresen, Robert Reynolds and Laura Janda. 2015. "Do "particles" deserve to be classified as a part of speech? A view from Russian." presented at *The 5th Conference of the Scandinavian Association for Language and Cognition*. Trondheim, Norway.

Reynolds, Robert and Francis Tyers. 2015. "Automatic word stress annotation of Russian unrestricted text." presented at the *Nordic Conference of Computational Linguistics NODALIDA 2015*. Vilnius, Lithuania.

Tyers, Francis and Robert Reynolds. 2015. "A preliminary constraint grammar for Russian." presented at the *Workshop on "Constraint Grammar – methods, tools, applications" at NODALIDA 2015*. Vilnius, Lithuania.

Reynolds, Robert, Eduard Schaf and Detmar Meurers. 2014. "A VIEW of Russian: Visual Input Enhancement for a Morphologically Rich Language." presented at the *3rd workshop on NLP for computer-assisted language learning*. Uppsala, Sweden, November 13.

Reynolds, Robert. 2014. "Automatic evaluation of potential targets for textual enhancement: identifying optimal sentences for learner uptake." presented at *Antwerp CALL 2014, the XVIth International CALL Research Conference*, July 7-9, Antwerp, Belgium.

Reynolds, Robert. 2014. "Automatisk vurdering og rangering av setninger i tekstberikelse." presented at *NORKOG: Kognitivt sommerseminar* June 20-21, Tromsø, Norway.

Reynolds, Robert. 2013. "Intelligent computer-assisted language learning applications for Russian." *Novemberseminaret*, Nov 22, Tromsø, Norway.

Phelan, Michael, Jeffrey Parker, Robert Reynolds, Lauren Ressue. 2012. "Breaking command-ments and friend-ships: effects of relative frequency and affix parsability in lexical processing." presented at the *American International Morphology Meeting*, Sept 22, Amherst, MA.