How Multiple Regression Models Can Be Written to Better Reflect the Complexity of First and Second Language Acquisition Research: An Attempt to Limit Type VI Error

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The purpose of this paper is to show how multiple regression models can be written to investigate and to better reflect the complexity of two major research themes in first and second language acquisition research in order to limit Type VI error. "A Type VI error occurs when an inconsistency exists between the study's research question and the analytic technique and/or research design used in the study" (Newman, Fraas, Newman, & Brown, 2002, p. 138). Newman, Dietchman, Burkholder, Sanders, & Ervin (1976) provide further details about Type VI error.

The two major themes, form focused instruction and the interaction of test-takers and tasks in reading comprehension, were selected because of their importance to their respective fields, their multidimensional nature, and the interdisciplinary research influence on them. These factors make them prime candidates for a paper of this nature. Each theoretical perspective examined in this paper brings with it its own research methodology, and thus the need for a paper that demonstrates how multiple regression models can be written to investigate four of the major foci of first and second language acquisition research to better reflect the complexity of language acquisition research.

While it is the case that such a variety of expertise from a plethora of disciplines enhances the fields of first and second language acquisition, the downside is that each of the different theoretical perspectives naturally brings with it its own research methodology. In addition, many studies consider only one or two variables and then generalize to the whole. Thus, there is the need for conducting research based on first and second language acquisition theories and the

multidimensional variables associated with them. This paper is a theoretical, methodological paper whose purpose is to demonstrate how multiple regression models can be written to investigate some of the major foci of first and second language research and to better reflect the complexity of some of the major findings in order to limit Type VI error.

Two major themes were selected for which multiple linear regression models were developed. The selected topics are amenable for the development of multiple linear regression models, and they illustrate that learning is neither additive nor linear. Research methodology must reflect these realities which multiple linear regression models can capture.

The models presented in this paper were developed for this paper and are not a component of a statistical package. Although the models presented in the paper are related to first and second language examples, the applicability of these models is multidisciplinary, i.e., they could be utilized in psychology and other behavioral sciences, medicine, public health, and in social work and other social sciences.

In the presentation of various multiple regression models in the body of the paper, the authors will refer to testing the Full Model versus the Restricted Model. A Full Model allows a treatment group to have its own achievement mean, which is accomplished through the use of dichotomous predictor variables and least squares weighting coefficients calculated to minimize the sum of the squared values in the error vector (McNeil, Newman, & Fraas, 2012). A Full Model is necessary in order to ascertain whether the data collected by the researcher support a research hypothesis. A research hypothesis always has a corresponding statistical hypothesis, the null hypothesis that states that the condition contained in the research hypothesis is not true. In this paper, the authors refer to a Restricted Model which reflects the condition being tested, i.e., the difference between the Full Model and the Restricted Model is what is tested.

1 Form Focused Instruction

Research on native French-speaking students enrolled in English as a Second Language classes in Canada has shown that although many learners developed good listening comprehension, communicative confidence, and fluency in English, they continued to experience problems with linguistic accuracy and complexity (Day & Shapson, 1991; Ellis, 2001; Lyster, 1994; Lightbown and Spada, 1990, 1994; White, 1991; Williams, 1999). Pedagogical theory suggests that learners will benefit from form-focused instruction which is defined as the instructor's focusing the learners' attention on the forms and structures of the language within the context of communicative interaction by providing metalinguistic information, highlighting the form in question, or providing corrective feedback.

Research has suggested that form-focused instruction and corrective feedback within communicative and content-based second and foreign language classes can assist learners augment their knowledge and use of particular grammatical features (Clyster, 1994). Form-focused instruction may be useful in classroom situations where learners share the same first language, and transfer from that same first language may result in errors that are unlikely to lead to global errors that completely impede communication (Ellis, 2001). In situations such as these, learners are ill equipped to discover/notice errors on their own. Focused instruction, therefore, will help learners to notice targeted features in subsequent input and interaction, although the effects of instruction may not be long-lasting and learners at the lower end of the proficiency continuum may experience difficulty attending to language form (Lightbown & Spada, 2006).

If researchers want to estimate how much the treatment (form-focused instruction) accounts for variance in the dependent score (a test of linguistic and/or communicative

competence), independent of person differences (person vectors), they could use the following model to control for individual differences. Testing Model 1 (the Full Model) versus Model 2 (the Restricted Model) estimates how much the treatment accounts for variance in the dependent score, independent of person differences (person vectors).

Full Model 1: $Y = b_0U + b_1P_1 + b_2P_2 + b_3P_3 + \ldots + b_N\text{-}b_{N-1} + b_N$ (Treatment) + E

Restricted Model 2: $Y = b_0U + b_1P_1 + b_2P_2 + b_3P_3 + \ldots + b_N - b_{N-1} + E$

Where

Y = the stacked dependent variable: Subject 1 at Time 1, Subject 1 at Time 2, etc.

$b_0 - b_{n-1}$ = partial regression weights

U = a unit vector and has a 1 for each subject in the sample

P_1 = 1 if the score came from Person 1; otherwise, 0

P_2 = 1 if the score came from Person 2; otherwise, 0

P_n = 1 if the score came from Person $_n$; otherwise, 0

Treatment = 1 if the person was in Treatment; otherwise, 0

E = Error Vector (residuals)

2 The interaction of test-takers and tasks in reading comprehension

Research in second language reading comprehension research has shown that factors within the reader and factors associated with the text being read affect the nature of second language reading (Alderson, 2000). A few example factors are listed below:

Reader variables

- Content background knowledge
- Knowledge of the language
- Knowledge of the genre/text type

- Metalinguistic knowledge and metacognition
- Knowledge of the world
- Cultural knowledge
- Reader skills and abilities
- Reader purpose
- Reader motivation/interest
- Reader affect

Text variables

- Text topic and content
- Text type and genre
- Text organization
- Text readability

Both first and second language reading comprehension researchers can expect changes in person ability and in item difficulty as readers advance across the attained reading comprehension proficiency continuum for the following reasons. Reading tasks vary in their difficulty according to the text, the test-tasks, the reader, and the interaction of text, test-tasks, and the reader. Texts vary by content (level of abstraction, information/propositional density, theme, text form or type, contextualization, and cultural conventions) and by the writer's style (use of vocabulary and structures, cohesion and coherence, and use of redundancy) (Alderson, 2000).

The multiple components involved in reading comprehension interact in different ways according to the proficiency of the reader and the characteristics of the text (Paris & Hamilton, 2009). Interaction can also involve the integration of meaning across words, sentences, and

passages, in addition to the reader and text variables presented above. There are demands of working memory at the word level (recall and retention of semantic meaning), at the sentence-level (merging of the syntactic and semantic cues to create a proposition), and at the text level (synthesizing propositions into a coherent idea) (Paris & Hamilton, 2009). Over time, there may be changes in the reader's cognitive load processing ability, and all of these factors lead to the need to identify who changed and what changed as readers progress across the attained reading comprehension proficiency continuum.

The following regression models can help researchers to identify who changed and what changed as readers become more proficient. Testing Model 3 versus Model 4 allows one to determine if the text accounts for a significant amount of unique variance in predicting the dependent variable when controlling for task and individual differences (person vectors), which controls for the effects of each person having more than one score on the dependent variable. Testing Model 3 versus Model 5 allows one to determine if the task accounts for a significant amount of unique variance in predicting the dependent variable when controlling for text and individual differences (person vectors). Testing Model 6 versus Model 3 provides a test for interaction to determine if there is an interaction between task and text when the model controls for individual differences.

Model 3: $Y = b_0U + b_1Text_1 + b_2Text_2 + b_3Task_1 + b_4Task_2 + b_5P_1 + b_6P_2 + \ldots + b_nP_n + E$

Model 4: $Y = b_0U + b_{n+1}Task_1 + b_{n+2}Task_2 + b_{n+n}P_1 + b_{n+n+1}P_2 + \ldots + b_{n+n+n+2}P_n + E$

Model 5: $Y = b_0U + b_{n+n+1}Text_1 + b_{n+n+2} + Text_2 + b_{n+n+n+1}P_1 + b_{n+n+n+2}P_2 + \ldots + b_{n+n+n+3}P_n + E$

Model 6: $Y = b_0U + b_1(Task_1*Text_1) + b_2(Task_1*Text_2) + b_3(Task_2*Text_1) + b_5$

$(P_1 + \ldots + b_{N+1}(P_n) + E$

Where:

U = a unit vector and has a 1 for each subject in the sample

$b_0 - b_{n-1}$ = partial regression weights

Text = 1 if narrative; 0 otherwise Task = 1 if literal comprehension; 0 otherwise

Text = 1 if expository; 0 otherwise Task = 1 if inferential comprehension; 0 otherwise

E = Error Vector (Residuals)

	Task 1	**Task 2**
Text 1	Cell A $Task_1*Text_1$	Cell B $Task_2*Text_1$
Text 2	Cell C $Task_1*Text_2$	Cell D $Task_2*Text_2$

A + C = Task 1

B + D = Task 2

A + B = Text 1

C + D = Text 2

Y = A + B + C + D

Model 3 presents each text and its corresponding regression weight, and each task and its corresponding regression weight. Model 6 presents three of the cells, A: $b_1(Task_1*Text_1)$; B:

$b_3(Task_2*Text_1)$; and C: $b_2(Task_1*Text_2)$. The fourth cell, D, is dropped because it is linearly dependent with the univector and the other three variables. The Restricted Model, a subset of the Full Model, looks at the main effect of text and task. The Full Model contains all that information, plus the multiplicative; therefore, Models 3 and 6 are hierarchical.

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