LOOK AT THE VIEW

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4 July 2013
Acknowledgement

The author wishes to thank the Lord, Ba, Ma, Alexi, Elizabeth, Thio Pavlo, Dr. Lowie, and Prof. de Bot.
Abstract

This study explores lexical and syntactic variation in writing over time in the development of a second language. The Dynamic Systems approach informs this inquiry. This study forms part of a Second Language Development (SLD) longitudinal study of the corpora of four university students in an English-language program. Selected indexes of time-serial corpora are graphed, correlated, and analyzed for significant behavior. Evidence is found of competition and support between indexes. Precursor behavior is observed, where the movements of one index appeared to predict the subsequent movements of another. Multiple paired correlations also demonstrate competition and support, indicating interaction at a more complex level.
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1 Introduction

The general trends of language development have long been studied. The variations encountered in collected linguistic data have traditionally been viewed as errors or anomalies. A relatively recent approach to language development research applies Dynamic Systems Theory (DST) (Thelen & Smith, 1994) to language learning. To define these terms, “a system is some collection of related parts we perceive as a single entity” (Norton, 1995, p.45). Furthermore, “a dynamic system is one that changes over time; what changes is the state of the system” (Hirsch, 1984, p.3). This approach forms a framework for studying the various systems of the measurable world and their changes over time. Its application to the system of language development means that the variations in language output along the way to higher proficiency may hold new insights into the process of learning. This differentiates DST from other approaches to language research.

One such influential approach proposed by Chomsky includes the concepts of more permanent competence and day-to-day performance. In its focus on the inner workings of language at its most essential elements as it exists in the mind, the unreliable performance of the moment is relegated to the periphery. The DST approach on the other hand, focuses precisely on this performance, but this is not without its challenges. Variability in language output does not necessarily indicate all of the internal development. Thelen and Smith glean a lesson from the Chomskyan distinction between competence and variable day-to-day performance, as in their view, “the well-taken point is that performance is not a perfect window into cognition” (Thelen and Smith, 1994, p.24). Thus a critical eye must be directed both at what comes through the window and the ‘window’ itself, with a view [sic] to constructing a more perfect one.

According to DST, humans, like other entities, are self-organizing, nested systems that are constantly in flux. Self-organizing means that if given input, an individual will internalize and process it and the result of these actions may be a change in the individual as well as the output thereof. Nested systems are systems within systems. The DST view of individuals incorporates their ‘intra-actions’ (within themselves) and their interactions with other humans and the world around them, as these provide constant input and opportunities to reorganize. This nestedness of an individual’s system carries the implication that all systems (nested upward and downward) can and do interplay and affect each other. All this interaction spurs an individual’s continuous reorganization and development. As these changes occur over time, data collection in a study of human development, in this case, language, does well to follow suit. Samples collected at a higher frequency over the course of the study may also provide a clearer picture of any incremental or systematic change. This type of temporally dense sampling of the language produced by a learner taken repeatedly over a period of time may expose markers of internal reorganizational changes, i.e. development of the learner’s language system.

There are various ways someone’s language system can change. Many of the changes may be evident in the language output of the individual. When
the pieces of language, such as words and phrases, become more complex, one could speak of language system development. When fewer mistakes are made in language use, this increased accuracy is another type of development. Both the rate and direction of development of either one of these may change over time, sometimes gradually, and sometimes markedly, forming discernible stages. For example, inconsistent use of a form or feature can be shown to precede stable, correct usage of this feature. Such development might follow a rough pattern, which could be used to predict other trajectories of language development.

The development stages of second language learning are characterized by complex factors that reflect the cultural background, the changing abilities of the learner, and the features of both the native language and the target language. All of these factors are likely to exert a force, positive or negative, on the language learning process, facilitating or impeding it. It is of course difficult to operationalize these into anything more than the most rudimentary of variables. However, the language being learned, whether in a textbook or as it exists in the language system within the learner’s mind, is not an indivisible whole. It has nested systems with interdependent but distinct behaviors which include unique responses to all of those systemic forces. The result is that learning does not progress evenly on all fronts.

There are two such major fronts that form the focus of this study. These are complexity and accuracy in written language production. Each has in turn two subfronts, the lexicon (all of the words in a language system) and the syntax (the phrases, clauses and sentences built from those words). It is expected that language output measured for its complexity and accuracy will fluctuate over time. If these fluctuations are viewed as information, rather than a distraction from the ‘true’ data, they can yield insights into language development.

However, that may not be the extent of the variability, and neither needs it be the extent of the investigation. Multiple changes may be occurring simultaneously in the complexity, accuracy, lexicon, and syntax of the learner’s L2 (second language) output. If they rise or fall together, this can be termed support. On the other hand, one’s rising while the other falls can be called competition. When one predicts the behavior or another, it is called a precursor and the other a dependent. These four aspects are theorized to be nested systems that interact constantly, thus their own measured variations may be investigated in relation to each other.

In this investigation, the central question will be whether and how both competition and support can manifest themselves in the language output of L2 learners. This will be investigated with the use of specific time serial measures of the four aspects of language output. The procedures used for identifying these signatures of competition and support are based on graphical representations of complexity and accuracy indexes. This includes residual and raw data, correlations of linguistic indexes, and in particular cases, multiple correlations between indexes within and across categories. The results will be interpreted and presented in the context of dynamic linguistic theory.
2 Literature

2.1 The Dynamic Framework

Some discussion of dynamic systems theory may elucidate the specifics of how it is actually applied in research. Port and van Gelder attest that “the Dynamical Hypothesis forms a general framework within which detailed theories of particular aspects of cognition can be constructed” (1995, p. 5). Van Geert (2008, p. 185) explains further:

In order to study complex dynamics—of which L2 learning is most likely an example—it is strategically wise to conceptually reduce the complex system to a single dimension or very simple state space, in which the qualitative properties of the system dynamics can be observed. In the given L1–L2 state space, we easily can imagine a single dimension that describes the distance between the “starting point” region and the “end point” region. This simplification does not entail an ontological claim, in the sense that it does not imply that “in reality” L2 learning is a onedimensional process, which clearly would be absurd. Instead, the simplification is a mathematical projection (in the sense of projective geometry), projecting a complex pattern onto a highly reduced state space, which, if done properly, opens the complex pattern for study and description.

Our window into reality is imperfect both because we do not see everything and because what we do see must be simplified in order to be utilized. Graphical representation is a limited but relatively useful visual aid into a reduced state space.

2.2 Variability and Profiles of learning processes

The observable quantities of the dynamic system of L2 learning include variability in the L2 output and language behavior, as well as tests of comprehension, which likewise require response of some kind from the subject. Two main dynamic explanations of variability have been identified by van Dijk (2004, p. 18): “(1) variability as an indicator of a specific moment in development (Ruhland 1998; Wimmers 1996), and (2) variability as a causal factor for development (Bertenthal 1999; de Weerth & van Geert, 1999).”

Variability as a cause of development can be both internal and external. A human being is dynamic, and will not do the same thing the same way every time. In the area of language, the individual will not say, write, hear, or read the same thought, idea, word, phrase, or line of argumentation, the same way every time. This can drive the language to change over time. This can drive development. This is true of every individual, even while every individual varies uniquely. The environment also varies, whether in the amount and kinds of language input available to the individual, the outputs demanded from the individual, or nonlinguistic stresses that also compete with or support the language system, as a whole or in part. As such, environmental variability can
also be a cause or driver of linguistic development. An example would be enrollment in an academic study program taught in one’s second language.

Variability also serves as an *indicator* to the outside observer of the learning process, a symptom, whether observed in the environment or the individual. Some of this may appear directly connected to other factors, such as enrollment, and can be observed with a proverbial naked eye. On the other hand, some of this variability will not be readily explained or attributed to discernible influences. It can occur seemingly on its own. In fact, “simple mathematical dynamic systems models have shown that chaos, seemingly random variation within a certain range, can be the product of the developmental process itself and not something that is added to this process externally” (van Dijk, 2004, p. 16).

Of course, the individual’s creativity or variability is not the sole cause of the change in the individual’s behavior; rather it can also couple with the forces exerted by systemic changes on the individual to produce a new response. Van Dijk states that “dynamic systems theory considers the sensitivity of the developmental grower … to situational factors an important developmental characteristic” (2004, p.22). Thus heightened interaction with the environment stems from (and indicates) higher personal variability, but in turn causes more variability and thus development. In contrast, a high input threshold for interacting with the environment means development and the associated variability in behavior may happen with more difficulty. This is the presumed origin of many insults equating an individual with purportedly limited understanding with an inanimate object of one kind or another.

Since variability itself is not stable over time, changes of variability may serve as an additional parameter for study of the process over time. While observing the acquisition of strategies by children in solving mathematical problems, Alibali (1999) found that there are two idealized profiles of self-reorganization that can occur. If there is high initial variability, then (less effective) strategies are dropped. If there is low initial variability, then strategies multiply. It cannot be ruled out that the subjects in a study such with high initial variability may also have had a period of lower variability in the lead up to the study (environmental considerations such as enrollments aside). This possibility is indeed suggested by the positions both of van Geert (1994, p. 14), that development is an iterative process even in systems that exhibit nonlinear behavior, and Alibali, that “conceptual change is a cyclical process, which results in periods with more variability alternated with periods with less variability” (van Dijk 2004, p. 17). The periods with less variability have been termed attractor states. Once reached, they have a higher threshold of variability needed for departure, not unlike the gravity wells of heavenly bodies. This relative stability can be an indicator to the observer of some stage of development.

Ellis (1994) presents a prime example of “free” (nonsystemic) variability in Cancino, Rosansky and Schumann (1978), “who found that their subjects made use of a variety of forms to express negation at each stage of their development” (Verspoor, van Dijk, and Lowie, In press, p.3). Ellis further asserts
the shared finding of this and other studies, namely that free variability takes place early in development and stabilizes as the second language system arranges itself (p. 137).

Variation can also indicate stages of development even among the first steps of language development. Dromi (1986) shows smooth trends of the language development of Keren, a young learner, because cumulative values are used (van Dijk, 2004, p. 18). In analyzing the data from that study, van Geert (1991) shows that the rate of lexical growth of Keren fluctuates greatly, and slows remarkably after the onset of multiword sentences (van Dijk, p. 18). This can be considered an early evidence of competition between the cognitive demands associated with lexical and syntactical developments. Since different areas of language are nested dynamic systems, any changes they undergo, can be uniform, but also divergent and interactive.

### 2.3 Language as Real-Time Processing

Individuals are variable entities and their ability to digest linguistic input and process and produce output varies from moment to moment and from individual to individual. Unknown phenomena may still hide in the recesses of the human processing apparati, but much can still be observed and measured.

Some linguistic research has indeed focused on the inside of the individual and owes much to Levelt’s landmark processing model (1989, 1993). Some of the studies of intra-individual variability had already focused on the processing demands of linguistic tasks and also addressed the issue of limits on working memory (Hulstijn & Hulstijn 1984). Many of these studies have demonstrated evidence of a limited processing capacity in humans. This is commonly referred to as information processing theory, carrying with it a principle implication that humans “are not able to attend fully to all aspects of a task” (Yuan and Ellis, 2003, p. 1). In fact, “second Language (L2) learners, especially those with limited proficiency, find it difficult to attend to meaning and form at the same time and thus have to make decisions about how to allocate their attentional resources by prioritizing one aspect of language over others” (Yuan and Ellis, p. 1).

Caspi explains why these limits on linguistic input and output are so important to any theoretical approach to linguistic development:

Resource limitations and their curbing effect on growth are not directly addressed by most language acquisition accounts, which may only emphasize capacities and positive growth potential. In contrast, from a dynamic perspective, resource limitations are not only a curbing factor on would otherwise be exponential growth, but a crucial developmental “driving force” (van Geert, 2003, p. 656). This is because resource limitations determine the interactions between the co-developing systemic components that require them. However, this does not imply that these components will only compete for resources: certain skills may eventually support each other, once they reach a threshold value. Thus there may
be seemingly paradoxical interactions of mutual competition and support between co-developing systemic components. (2010, p. 13)

According to Skehan (1998), there are three main areas of language output that can compete: fluency, complexity, and accuracy. Since the data collected in this study are from written samples, fluency is not relevant. On the other hand, complexity and accuracy are themselves the very focus of this study.

Accuracy and complexity could compete and otherwise interact in different ways. For example, an individual may use more complex words and sentences, and subsequently use them with fewer errors. Increased complexity would then be a precursor of accuracy. Another may use the complex words and sentences only correctly and increase usage as long as accuracy can be maintained, e.g. new contexts of accepted usage are learned. To further describe language output, accuracy and complexity can be distinguished into several important types.

2.4 The glossary of indexes

Caspi (2010) has collected language samples and exhaustively indexed each of them for different types of complexity and accuracy. The choice of which of these many indexes to employ in the current study has been guided by the search for evidence of competition or support between complexity and accuracy. As such, this motivation and the explanation thereof form fundamental components of the research framework.

In order to further conceptualize the complementary nature of indexes of the same category, two informal terms are introduced to identify the distinguishing factor in the nature of the index. The term Breadth is used to describe the broad repertoire of forms demonstrated by the subject. The term Depth signifies the presence of especially complex forms rather than variety. An additional term, Shallows applies to more simple or frequently used forms. These terms will be used to identify the nature of the Lexical and Syntactical Measures in the following paragraphs.

General Word Variation is a measure of the ratio of lexical content word types to total content words. This makes it a superior measure of word variation, because non-lexical words such as the and it recur in any text and thus distort the ratio of word types to tokens, especially as the length of a text increases. This is not accounted for in other measures, namely Type-Token Ratio. Each unique word in a text measured this way comprises a type, and each time a unique word. This is because lexical words such as nouns and verbs, tend to vary, thus having less tokens per type, while function words such as pronouns (he, she, it, etc.) and determiners (a, an, the, etc.) are few and tend to repeat in language output. The longer a text is, the more this closed set of words will repeat. Foster (2001) found a correlation of -0.80 between text length and type-token ratio. This demonstrates the distortion that can occur with a simpler measure. While using only lexical words corrects for this, the essay assignments used for this study have also been (generally) constant in length, as already
mentioned. Because General Word Variation measures variety, this index is a Breadth index. General Word Variation in this study is comprised of Noun-, Verb-, and Adjective variation.

Complex Words Ratio measures the ratio of lexical content words longer than three syllables to total lexical content words. This complements General Lexical Word Variation, giving a new dimension to the investigation of lexical analysis. Simply put, it is the Depth to General Word Variation’s Breadth.

Phrase to Sentence Ratio measures syntactical complexity in a general way. The kinds of phrases that are measured are not distinguished. This is a simple tally of phrases per sentence. This can be seen as the syntactical counterpart to the variety of words in the lexical analysis, that is, the Breadth. Intriguing as it is, the proposition of a General Phrase Variation, an exact analogue to General Word Variation, is of dubious applicability because combinations of words are exponentially less likely to repeat than lexical words.

The Depth index, Subordinate-Phrase Ratio, serves as a measure of subordinating conjunctions per phrase. Subordinating conjunctions are more complex than coordinating conjunctions, as they use the same noun or verb phrase head as their parent phrase (in which they are embedded), rather than their own. This can be contrasted with coordinating conjunctions, which string together phrases or sentences together on the same level. Much like the complex words ratio in the lexical analysis, this measure targets complex forms, and thus complements the general measure of unique forms.

Correct Lexical Word Use is a measure of overall lexical accuracy, that is, error-free use of lexical words. It is an accuracy Breadth measure, and thus a counterpart to General Lexical Word Variation. The second index, Correct General Academic Vocabulary Use, measures error-free use of words on a 1000 word compilation of two well-known word lists, the Academic Word List (Coxhead, 2000) and the University Word List (Xue and Nation, 1984). As expected, it is an accuracy Depth counterpart to Complex Words Ratio. The last index, General K2 Accuracy Ratio, measures the correct use of the 2000 most common lexical words, thus targeting a form of ‘accuracy in simplicity’. Unlike the other two, it does not have a counterpart to the lexical complexity indexes. It could be considered a measure of shallows in lexical accuracy. As such it helps to complete the picture of language development.

The chosen Syntactical accuracy measure was Correct Verb Tense Use. The particular challenge presented by measuring syntactical accuracy lies in its overlap with other areas, such as Lexical Accuracy. A significant portion of verbs is lexical and it is possible that perhaps a verb tense error may affect both Correct Verb Tense use and Correct Lexical Word Use. Care must be taken when examining these potentially overlapping indexes together on the same graph.
2.5 *Time and intervals (measurements)*

Foster and Skehan (1996), Yuan and Ellis (2003), and others have investigated the effects of different types and lengths of planning periods prescribed for a linguistic task on the complexity and accuracy of the language output. This present study on the other hand does not takes the route of manipulating the setting of language production, but rather repeats the same setting many times.

In many studies a given measure of proficiency is measured once, for example to rank subjects for the principal study. If this measure itself is variable, Van Dijk (2004, p.14) argues, then the resulting ranking may not be accurate. For example, mean length of utterance (MLU) has often been used as a gauge of early language development in children. Later in development it becomes less indicative of the level of the child’s language, as the language becomes more sophisticated in ways not reflected in a change in MLU. Chabon, Kent-Udolf, and Egolf (1982) observed that the mean length of utterance (MLU) was not stable from measurement to measurement. This instability has consequences for the researcher. Willet (1994) on the issue of the intervals needed to sample observed behavior (emphasis is my own):

> If the attribute of interest is changing steadily and smoothly over a long period of time, perhaps three or four widely spaced measurements on each person will be sufficient to capture the shape and direction of the change. **But, if the trajectory of individual change is more complex, then many more closely spaced measurements may be required.** (p. 674)

The closeness of these measurements is not quantified. Larsen-Freeman and Cameron (2008) add the argument that variability may be different on different timescales:

> Any longitudinal study must be set up to capture variability at various levels and timescales, from the general shape of the development process over a long period of time to the short-term variability that takes place between data collection intervals, to the within-session variability that inevitably arises (p. 208).

The present study attempts to meet the first two of the three criteria. As for the third, Ruhland (1998) argues that within-session variability may be less useful as an indicator of development than between-session variability. In that study, the within-session variability coincided with a jump in development in only two out of six subjects, while graphs of the between-session trajectories depicted substantial instability in all of the subjects. While two out of six certainly warrants further study, Ruhland suggests that between-session variability may “be considered as a developmental characteristic” (Van Dijk, 2004, p.18). It is this between-session variability, measured across many sessions, that will hopefully point to the connection between short- and long-term variability described by Tarone (1998, p. 137).
2.6 Dynamic Analysis of Language Output

This time dimension is central to analyzing the language output data, but another crucial element is the synchronic comparison of different types of output data. Evolving relationships between measures, including multiple relationships, may point to some pattern in coping mechanisms. By plotting two or three dynamic correlations together, parallel relationships may be demonstrated between two pairs of indexes. Also, one index can be correlated with two other indexes; the plotted correlations can demonstrate the behavior of the one index relative to the other two. For example, index A may behave like index B, in a highly correlated manner, and then break with B and continue instead to correlate with C, and begin competing with B. The result would be that all three indexes represent unique directional continua in a linguistic state space. The resulting plot represents three dimensions – four, including time – in this spatial representation of the linguistic system, albeit on a two dimensional graph.

Thus the aspects of language measured by these indexes can be shown to evolve over time, as well as the relationships between indexed aspects of language, and even the relationships between different relationships. Such multiple correlations might better describe the intricate development of the language system, as predicted by DST.

2.7 Mathematical Expressions of Learning Mechanisms

For protracted investigations of the interaction between a learner and the environment, the reader is referred to Paul van Geert (1994, pp. 242-270), and furthermore, to “the good old theory of development that we find in a variety of forms, ranging from Piaget to Vygotsky, and from information processing to skill theory” (p.14). Nevertheless, the concept of a next step in learning is intuitive and forms a fundament for the development of this thesis. It is insufficient, however. DST mathematical modeling is the answer, according Paul van Geert (1994) and others. It is not meant to replace the various theories of learning, however, as that would involve “the formidable task of rebuilding and reconstructing the whole discipline” (p.14).

Thus van Geert (1994) seeks to properly apply the same iterative basic principles of learning submitted by Piaget and Vygotsky and others, using several elementary concepts, which lend themselves to empirical research in a DST framework. With them the various theories categorizing the learning process can be expressed numerically and quantified for analysis. While actual mathematical modeling lies outside the scope of this study, the basic concepts of logistic growth, connected growth, and the precursor, underpin the graphical analyses that lie within.

With logistical growth, a single learning step serves as input for a subsequent learning step, not unlike funds in a bank account accruing interest, where the output of one month’s calculation becomes the input for that of the next month. In the connected growth model, multiple inputs (variables) can compete with and support each other at the same time. In the precursor model,
one grower prevents another “dependent grower from growing, as long as the precursor threshold [has] not been reached” (van Geert 1994, p. 224). When the first reaches a certain level of development, the second is free to bloom. Caspi (In press) has observed behavior suggesting ‘that recall acts as a precursor to controlled production” of language (p. 5). What is notable about the findings of Caspi is that the precursor does not pass a threshold once and then permanently frees the dependent grower to flourish. Rather, the development of the precursor predicts the development of the dependent grower from week to week, continuing to influence the dependent grower.

There is another example, that of lexicon being a precursor to syntactical development. This is common sense: one must have words before one can have sentences. Paul van Geert (1991, 1994) demonstrates with the data from Dromi (1986) that in terms of complexity, or rather development in general, at the outset of language output, lexical development, necessary for multiword utterances, also slows once the multiword utterance, i.e. syntax, forms a part of output. This shows that interaction can go both ways, even in a precursor situation. Vocabulary growth is slowed by the onset of something it made possible in the first place. For that matter, it is possible that multiword recall or recognition may already be present before multiword production in infants. Of course, the challenge is measuring this.

These growth functions can be expressed in terms of iterative mathematical equations for which each output is the input for the subsequent iteration. Building on basic logistic growth, the connected growth models can quantify relationships between multiple growers, and the precursor model, by means of a single parameter, can add an additional element of complexity to these relationships. Each of these growth-modeling functions can thus demonstrate a whole range, from simple linear growth to complex nonlinear growth, and are viable tools for simulating natural learning behavior and interactions. It should also be noted that a simpler approach with simpler equations should be considered obsolete, as it cannot possibly describe nonlinear dynamic systems.

The following paragraph is but one example of the variability inherent to human beings described by so many. Elman et al. (1996, p. 362) describe how small developments can lead to major change in a language system:

We have offered many examples in this book of cases in which a single mechanism gives rise to very different overt behaviors at different points in time. The best known example is the well-studied case of the English past tense, where a single learning mechanism operating on a constant or incrementally expanding database goes through dramatic changes at the behavioral level, the kind of change which was ascribed (without further ado) to a switch from rote memory to the application of a rule. A single mechanism, operating incrementally, need not undergo abrupt internal changes in order to produce abrupt external changes in behavior.
While the current study does not operate on the level of iterated equations, it is important to consider logistic growth, connected growth, and the precursor model, as they may be observed with continued study of development trajectories. These types of simple reiterated mechanisms, with seemingly insignificant individual effects, can ultimately result in conspicuous and observable changes on a larger (system-wide) scale, such as measurable language output.

2.8 Statement of Purpose

The hypothesis for this study is that there will be indications of competition or support between complexity and accuracy, and that within each of these categories, competition or support between syntax and lexicon will also be discovered. Certain indexes within syntax or lexicon may also have meaningful relationships. Certain indexes may also have precursor relationships.

Syntactical and lexical development may compete with or support each other in the areas of complexity and accuracy. Syntactical accuracy and complexity may also compete with or support each other. Even specific measures of lexical complexity may compete with or support each other, as may accuracy measures. There may be competition or support at every level: accuracy vs. complexity, syntax vs. lexicon, syntactical breadth vs. depth, lexical breadth vs. depth, and even lexical breadth vs. breadth (noun vs. verb vs. adjective).

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<td>Accuracy</td>
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Table 2.1 Areas to be investigated

The index categories and relationships are best reflected graphically. Table 2.1 suggests that these supportive and competitive relationships happen in the horizontal, vertical, and diagonal (in the four bottom-right boxes). The intra-quadrant relationships may be further divided. Certain indexes are actually subcomponents of other indexes, such as *noun*, *verb*, and *adjective variation*, which make up General Word Variation. It is certainly conceivable that these or other components also reflect meaningful intra-quadrant relations with each other.
3 Method

The data used for this study consists of four longitudinal case studies of second language learners. Collected and processed by Caspi as part of a PhD dissertation, these data have been graciously made available for analysis.

3.1 Subjects

The identity of the four subjects remains unknown, but their native languages may be used for identification purposes. These languages are Mandarin Chinese, Vietnamese, Portuguese, and Indonesian. They all have English as a second language. During the duration of the study they were enrolled in four different English-language Master’s programs.

3.2 Materials

Each case consists of writing samples in the form of 36 weekly essays of roughly 350 words each. The topics of the written assignments were adapted from TOEFL subject lists.

3.3 Procedures

The essays were completed by the four subjects over the course of a year of study in their respective Master’s programs.

3.4 Design and Analyses

The writing samples have been catalogued in terms of accuracy and complexity, each subdivided into measures of syntactical and lexical factors. The complexity measures are all positive; a higher data value number means more complexity. The accuracy measures, being measures of errors, were negative in terms of accuracy: a higher data value means more errors, and lower accuracy. These were inversed to become proportions of correct uses, making the higher data value mean higher accuracy. Thus any given index, such as general word variation, consisted of 36 consecutive values, one from each weekly writing sample. Plotting these indexes in a graph displayed the evolution of the subject’s writing in the aspects measured by the indexes. A number of analyses were employed to discover relationships between different factors, both within and across categories, as indicated by the hypothesis.

3.4.1 Indexing descriptions

Lexical and Syntactical Complexity Measures

General Word Variation and Complex Words Ratio were chosen to represent lexical complexity, while Phrase-Sentence Ratio, Subordination-Phrase Ratio represent Syntactical Complexity.
Lexical Accuracy Measures
Indexes included Correct Lexical Word Use, Correct General Academic Vocabulary Use, and General K2 Accuracy Ratio. All measure the ratio of correct use to total use.

Syntactical Accuracy Measures
The chosen Syntactical accuracy measure was Correct Verb Tense Use.

3.4.2 Methods of analysis

Individual Min-Max graphs
The first investigation involved the plotting of ‘min-max’ graphs to establish levels of fluctuation over time for a given index. These graphs have ‘minimum’ and ‘maximum’ lines instead of the raw data line. The maximum value at a given point is obtained using a running sample for a span of five raw data points. By combining a line from all of the ‘max’ points with a ‘min’ counterpart, the amplitude of fluctuation over time can be determined. Changes in variation levels can indicate stages of development.

Detrending
To clarify the local variations when analyzing indexes, the data was detrended. To accomplish this, a y-intercept and average slope are calculated for the data points of an index. These are used to calculate trend line data points, which are then subtracted from the original data. Thus when indexes are graphed, the upward or downward trends are eliminated, placing data values on the same level, which better displays the local behaviors, aiding comparison of different time frames and different indexes.

Graphing indexes together
For visualization of the data, indexes were plotted together to display any discernible relationships between them.

(Multiple) Dynamic Correlations
Moving correlations were plotted for single and double pairs of indexes using the running averages for each. Like the min and max lines these also use a running sample of five data points, but these are then correlated with the five matching points for the other index in the pair. Plotting a line with these points shows the change in correlation between the indexes over time. It was also possible to use this method to plot pairs of moving correlations together, to see whether or how relationships between pairs of indexes resembled each other, or perhaps were opposites.

SPSS Correlations
The overall significance of relationships between the indexes was determined using the SPSS statistical analysis program.
4 Results and Discussion

4.1 Complexity Measures

General word variation and complex words ratio were chosen to represent lexical complexity, while phrase-sentence ratio and subordination-phrase ratio represent syntactical complexity.

4.1.1 Lexical Complexity Breadth and Syntactical Complexity Breadth

The complexity measures, both of the representative indexes and the dynamic correlations between them, display evidence of competition (Figures 4.1 – 4.3). The residual data are reproduced here for a clearer picture of the temporally local variations of the indexes in relation to each other. It should be stated that the general guidelines employed in discerning competition and support were simply movement in opposite directions or in the same direction from one given week to the next. The slopes of these lines and the oscillations are indicators of rate of change and will be not discussed in this study.

![Figure 4.1](image)

Figure 4.1. Residual General Word Variation and Residual Phrase-Sentence Ratio, Chinese subject. The range for the two y-axes is different in order to superimpose the two traces and to better compare the local movements relative to each other.

As can be seen in Figure 4.1, there are many sections where one index rises while the other falls; a notable instance occurs in weeks 16-18. However, this alternates with support, as can be seen very clearly in weeks 9-16.
Figure 4.2. Dynamic Correlation of General Word Variation and Phrase-Sentence Ratio, Chinese subject. This graph shows the correlation of the two indexes displayed in Figure 4.1. Note that the number of weeks is shorter. This is because the last correlation of the series starts at 32 and ends at 36.

The dynamic correlation of Figure 4.2 shows that the two indexes are negatively correlated for the majority of the duration of the study, yet the support is clearly indicated in points 10-12. Less of the overall stretch of support is visible, only its central area makes up the plateau. This is because the competitive data point pairs interspersed with the stretch of support lower the correlation significantly enough to make the cooperative streak seem shorter. This is a limitation of the dynamic correlation method. Sampling five points means a majority of points need to correlate positively for a positive correlation point. If competition and support alternate too frequently, one, the other, or both may be underrepresented in the dynamic correlation plot.

Figure 4.3. Residual General Word Variation and Residual Phrase-Sentence Ratio, Vietnamese subject.

For the Vietnamese subject, the same indexes produce a different plot in Figure 4.3, with alternating stages of competition and support. The two indexes have a -0.356 correlation, significant at p=0.033. Interestingly, from week 15 to about 30, there are periods where the two indexes seem to be in concert, with instances of opposite motion (weeks 17-18, 21-22, and 27-28). These instances
can be seen as obvious competition. In each of these, general word variation is decreasing while phrase-sentence ratio is increasing. However, in each instance, the phrase-sentence ratio decreases in the subsequent week (19, 23, and 29), while there is an increase prior to each general word variation instance (weeks 16-17, 20-21, 26-27). Weeks 15-24 exhibit a form of precursor behavior for these two connected growers. If one takes the pink line from weeks 15-23 and moves it one week to the right, and upwards, one will likely get a near perfect match of the blue, and certainly a very high, positive correlation. This phenomenon may also be observed in Figure 4.11, where residual complex words ratio and residual subordination-phrase Ratio are plotted for the same Vietnamese subject.

![Figure 4.4. Dynamic Correlation of General Word Variation and Phrase-Sentence Ratio, Vietnamese Subject. This graph shows the correlation of the two indexes displayed in Figure 4.3.](image)

The above dynamic correlation plot for the Vietnamese subject in Figure 4.4 demonstrates that the stages are multiple here, and that the support is much shorter. Alternately, the support can be seen as brief interruptions in competition. There are two striking areas of support, in the second and third week and in weeks 18-20 and 22. Though the proportion to competition is comparable in the Chinese subject (Fig. 4.2), the places of support are different.

### 4.1.2 Lexical Complexity Breadth and Syntactical Complexity Depth

For the Indonesian subject in Figure 4.5, the general word variation vs. subordination-phrase ratio indexes show clear instances of both support and competition. While this is in part because they are residuals and thus essentially superimposed, the two indexes appear to be nearly perfectly synchronized at times, notably in weeks 7-11 and 33-35. Weeks 2-6 and 7-9 display synchronized behavior as well but the indexes are not superimposed. On the other hand, weeks 26-33 exemplify competition, with movement in opposite directions in nearly every week.
The dynamic correlation plot of these indexes in Figure 4.6 suggests that they occur in two stages. Halfway through, support gives way to competition. The change from support to competition is quite rapid and stark. In fact, this curve has a strong negative correlation with time of -0.637, significant at $p=0.000$. It should also be noted that this competitive stage appears to refer to an example of complex behavior given by van Geert and van Dijk (2002), namely that “a developmental variable may be slowly oscillating while gradually growing” (p. 346). While not an index per se, the level of agreement between the two indexes can be considered the description of a “developmental variable”. For another such variable, the reader is directed to Figure 4.27.
The general word variation and subordination-phrase ratio for the Portuguese subject in Figure 4.7 displays many areas of competition. Many of the peaks appear to be mirrored by valleys, such as in weeks 2-5, 6-13, 15-21, 22-24, 25-29, and 30-33. The general brevity of the support in weeks 1-2, 5-6, 14-15, 21-22, 24-25, 29-30, and the exception, 33-36, might tempt one to overlook or them lack to attribute them any significance, yet it combines with the competition to produce an almost perfectly clean relationship of alternating competition and support. Only in 13-14 and perhaps 21-22 is it construably neutral. This demonstrates how strong the ambivalence of two connected growers can be.

The dynamic correlation plot for the Portuguese subject in Figure 4.8 shows clearly that the majority of written language development, as represented by these indexes, is spent in competition. The last few data points mark a rapid ascent into positive correlation. Unsurprisingly, the correlation correlates positively with time at 0.481, and is significant at p=0.005. This demonstrates the differences in behavior from subject to subject for the same indexes when compared with Figure 4.6 for the Indonesian subject.
The brief respite of support clearly do not outweigh the competition in the dynamic correlation. Yet support finally prevails at the end, the correlation growing stronger with each of the last synchronized point pairs added to the sample. Whether this would be part of an extended period of support is a matter of speculation. As far as the reason for the change, it can be surmised that some breakthrough was made, which freed these two from being antagonists.

### 4.1.3 Lexical Complexity Depth and Syntactical Complexity Depth

The residual complex word ratio and the residual subordination-phrase ratio for the Chinese subject in Figure 4.9 displays several simultaneous peaks and valleys such as in weeks 6, 12, 16, 21, 27, and 28. On the other hand, there are synchronized movements such as weeks 3 - 5, 13 - 15, 17 – 20, 29 – 30, and 32 – 35. Not all of these are reflected in the correlation displayed in Figure 4.10. If the correlation is between two moving averages, it is not designed to reflect these week-to-week movements. While the moving correlation has very definite points on a graph, these points are but a reflection of the actual data, one with limited resolution.

![Figure 4.9. Residual Complex Words Ratio and Residual Subordination-Phrase Ratio, Chinese subject.](image)
Figure 4.10. Dynamic Correlation of Complex Words Ratio and Subordination-Phrase Ratio, Chinese subject. This graph shows the correlation of the two indexes displayed in Figure 4.9.

The correlation of these indexes in Figure 4.10 for the Chinese subject also shows a late positive correlation after a (mostly) negative correlation. This correlation behavior resembles the general word variation vs. subordination phrase ratio correlation for the Portuguese subject displayed in Figure 4.8.

Figure 4.11. Residual Complex Words Ratio and Residual Subordination-Phrase Ratio, Vietnamese Subject.

The graph in Figure 4.3, also of the Vietnamese subject, was of lexical complexity breadth and syntactical complexity breadth, while that in Figure 4.11 above is of lexical complexity depth and syntactical complexity depth. This latter pair of indexes, as the former pair, has developed a relationship exceeding the bounds of competition and support. Weeks 10-21 demonstrate a striking example of precursor behavior. Here complex words ratio predicts with accuracy the movements of subordination-phrase ratio from weeks 11-22, in week over week development. This change is much like that observed in Figure 4.3 and in Caspi (In press). Both in breadth and depth, lexical complexity behaves as a precursor to syntactical complexity. This may lend significance to the breadth-depth distinction, as the parallel relationship occurs within the two categories. Furthermore, this also resembles the very young subject in Dromi (1986) in that lexicon still appears to be a precursor to syntax.
This type of behavior is undetected by a moving correlation that samples 5 points (which sacrifices some resolution). However even with correlation of two point pairs at a time many of the week-to-week intervals would simply appear to be competition with smatterings of support (as in Figure 4.9). Gradient correlation using slope rather than relative values might address relative movements of two indexes. Still another analytical method algorithm, such as the nonlinear model used by Caspi (In press), might be more useful to detect delayed mimicry in indexes, but for the current study, the most practical is the naked eye.

Figure 4.12. Dynamic Correlation of Complex Words Ratio and Subordination-Phrase Ratio, Vietnamese subject.

The correlation of these indexes for the Vietnamese subject in Figure 4.12 shows that the support occurs in similar sections for the same subject in the general word variation vs. phrase-sentence ratio diagram in Figure 4.4, once in the beginning and again after the midpoint, though the second support period lasts longer here.

All of these pairings demonstrate competition between syntactical and lexical complexity over time. However, there are also areas in the plots with clear support. There are also plots that display a kind of precursor relationship, where one index’s movement closely follows another in the following week, for many weeks at a time.

4.1.4 Syntactical Complexity Depth

The min-max graphs for subordination-phrase ratio for the Chinese and Vietnamese subjects have been displayed in Figures 4.13 and 4.14. Both feature a narrowing at or soon after the beginning, and a temporary widening of amplitude at the minimum while the maximum dips slightly. This is followed by a raising of the maximum (earlier for the Chinese subject), and a temporary narrowing before the end. While this effect has not been found for the Portuguese and Indonesian subjects, it is notable that such similarity can be observed at all.
The peak levels for the different subjects varied however. This could be studied in itself but is, as are many other features, well beyond the scope of this study. The peak levels are highest for the Portuguese subject, followed by the Indonesian, Chinese, and Vietnamese.

![Figure 4.13. Min-max graph of Subordination-Phrase Ratio, Chinese Subject.](image)

![Figure 4.14. Min-max graph of Subordination-Phrase Ratio, Vietnamese subject.](image)

### 4.1.5 Lexical Complexity: Breadth and Depth

Lexical complexity in breadth and depth has been displayed for the Vietnamese subject using general word variation and complex words ratio in Figure 4.15 to 4.17. The raw data is displayed in Figure 4.15 and shows quite frequent oscillations, only at some points turning into multi-week up or down trajectories. The residuals of these indexes are displayed in Figure 4.16 and clearly show synchronized oscillations at the end of the period. Both the raw and the residual data set pairs correlate strongly at 0.451, significant at p=0.006, and 0.445, significant at p=0.007, respectively. The dynamic correlation plotted in 4.17 also correlates very strongly with time at 0.704, significant at p=0.000, presumably because it starts mostly low and ends on a consistently high note.

The correlation plot of the same indexes in Figure 4.17 demonstrates the final stage of exceptionally high correlation after previous periods of alternation.
competition and support. It is notable that during the period of greatest relative amplitude, the correlation is steadily high and positive. The two indexes may be fluctuating together in response to extra- or suprasystemic stresses or as part of their own developmental processes. Figure 4.15 shows how raw data retains the gradual slope (see complex words ratio). The residual emphasizes local fluctuations and permits closer comparison.

Figure 4.15. Raw General Word Variation and Complex Words Ratio, Vietnamese subject.

Figure 4.16. Residual General Word Variation and Complex Words Ratio, Vietnamese subject.
4.2 Multiple Complexity Measures – Depth and Breadth

4.2.1 Lexical Complexity Depth and Breadth versus Lexical Complexity Depth and Syntactical Complexity Breadth

Residual complex words ratio and general word variation and complex words and phrase-sentence ratio have been presented for the Chinese and Vietnamese subjects in Figures 4.18 and 4.19. These graphs step beyond the sections above by adding a second dynamic correlation.

In each correlation there is an alternation between competition and support, yet these behaviors are also alternating across the correlations. The members of each index pair do not correlate significantly with each other, perhaps because of the even distribution of positive and negative points in each dynamic correlation. However, complex words ratio and phrase-sentence ratio do correlate strongly with time at 0.494, significant at p=0.004, which is
unsurprising, given that they start low and end high. Of course, the two correlations plotted above also correlate strongly with each other at -0.772, significant at \( p=0.000 \). The alternating competition and support of complex words ratio with the other two complexity indexes is quite compelling. Also noteworthy is that complex words ratio competes with and supports its lexical cohort general word variation, yet displays a nearly perfectly coordinated mirror image of competition and support with phrase-sentence ratio. This evidence of competition and support occurs both within lexical complexity and between lexical and syntactical complexity, and these two interactions themselves appear to interact with each other. The relation between indexes is displayed in the following table:

<table>
<thead>
<tr>
<th>Correlation 1 (Blue)</th>
<th>Correlation 2 (Red)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexical Complexity Depth</td>
<td>Lexical Complexity Depth</td>
</tr>
<tr>
<td>Lexical Complexity Breadth</td>
<td>Syntactical Complexity Breadth</td>
</tr>
</tbody>
</table>

Complex words correlates for the most part with one or the other index. One might be given to surmise that there is only enough cognitive capital for proficiency in two of the three indexed areas at a given time; however these are not levels of performance but of correlation. What this does demonstrate is that lexical development is not monolithic, and it interacts just as much within itself as with syntax.

This adds another dimension to the interactive behavior of a mere pair. One index moves in synchronicity with second index, and subsequently into the same with a third index, whose motion is nearly perfectly opposed to the second index. If one adapts the dynamic systems concept of a state space, the second and third indexes can be considered axes along which the first index moves, but only in a very limited sense, as none of these indexes are static over time.

![Figure 4.19. Two dynamic correlations of Residual General Words Variation and Complex Words Ratio (Blue) and Complex and Phrase Sentence Ratio (Red), Vietnamese subject.](image-url)
A different, yet similar interaction involving competition and support is observed when the same correlations are plotted above for the Vietnamese subject. Again each correlation depicts a volatile relationship, and the two plotted together show overwhelming proportions of anticorrelation. The correlation of complex words ratio with general word variation correlates significantly with time at 0.704, significant at p=0.000. Unsurprisingly, it also correlates with the correlation of complex words ratio with phrase-sentence ratio at -0.495, significant at p=0.004.

The two are on occasion both positive and negative (note however that this is on a residual scale). There are also occasions where the two correlations move together, such as from 13 to 17 and 18 to 22. This is despite one being positive and the other negative in position on the graph. This synchronized movement may indicate a force being exerted on them from outside the particular nested system they comprise or at least represent. Still, needless to say, the immediate impression here is of mutual exclusivity.

This type of analysis serves as a poignant illustration of the need to move away from a one- or two-variable paradigm, daunting as it may be. It is daunting, because reality will still be only simulated. Nevertheless, one step in this direction reaps ready insights; still deeper forays may provide theirs.

4.2.2 Lexical Complexity Depth and Syntactical Complexity Depth versus Lexical Complexity Depth and Breadth

The graph presented in Figure 4.20 for the Vietnamese subject is slightly different from the two graphs presented in the previous section. The difference is that phrase-sentence ratio has been replaced with subordination-phrase ratio. This constitutes a change from breadth to depth for the second index in correlation 1 as given in the following table:

<table>
<thead>
<tr>
<th>Correlation 1 (Blue)</th>
<th>Correlation 2 (Red)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexical Complexity Depth</td>
<td>Lexical Complexity Depth</td>
</tr>
<tr>
<td>Syntactical Complexity Depth</td>
<td>Lexical Complexity Breadth</td>
</tr>
</tbody>
</table>
Figure 4.20. Dynamic correlation of Complex Words Ratio and Subordination Phrase Ratio (Blue) and General Words Variation and Complex Words Ratio (Red), Vietnamese subject. The red curve is the same as the blue curve in Figure 4.19.

The two correlations presented here display less mutual exclusivity. The pairing of indexes is not parallel in this case. By replacing the phrase-sentence ratio with subordination-phrase ratio the relationships between each correlation pair no longer has any embedded commonality. In the previous case, while presence of syntax distinguished correlation 2, there was still a constant in the form of depth-breadth being compared with depth-breadth; here, depth-depth was compared with depth-breadth, which is a change great enough to severely mitigate the constancy factor that might have been supplied by complex words.

4.2.3 Syntactical Complexity Depth and Breadth versus Lexical Complexity Depth and Breadth

The dynamic correlation presented in Figure 4.21 for the Vietnamese subject represents an evolution of the two previous dynamic correlations, in the sense that complex words ratio is no longer a reference index for the others. Subordination-phrase ratio and phrase-sentence ratio correlate with time at 0.569, significant at p=0.001, and with complex words and general word variation at 0.611, significant at p=0.000.
In this correlation the internal agreements within lexical and syntactical complexity are presented by using a depth-breadth correlation for each, as displayed in the following table:

<table>
<thead>
<tr>
<th>Correlation 1 (Blue)</th>
<th>Correlation 2 (Red)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntactical Complexity</td>
<td>Lexical Complexity Depth</td>
</tr>
<tr>
<td>Depth</td>
<td>Depth</td>
</tr>
<tr>
<td>Syntactical Complexity</td>
<td>Lexical Complexity Breadth</td>
</tr>
<tr>
<td>Breadth</td>
<td>Breadth</td>
</tr>
</tbody>
</table>

After the initial divergent period, at point 10 the two correlations start to trace each other, and generally continue this for the duration. The similarity of their internal correlations points to a parallel relationship between lexical pair and the syntactical pair. This parallel relationship is of course already described by the parameters of breadth and depth. The overall correlation between the two is very strong at 0.611, significant at p=0.000.

Together the current and previous correlations provide a detailed view of the internal variation within and across the categories. It further shows that considering depth and breadth parameters is helpful in bringing out those details. It may be helpful to rearrange these indexes and discover whether and where they continue following each other.
4.2.4 Lexical Complexity Depth and Syntactical Complexity Breadth versus Lexical Complexity Breadth and Syntactical Complexity Depth

This dynamic correlation presents a second of three variations using four independent indexes. In this case the depth-breadth correlation across the lexical-syntactical boundary is compared with the breadth-depth correlation across the same. The indexes used are displayed in the following table:

<table>
<thead>
<tr>
<th>Correlation 1 (Blue)</th>
<th>Correlation 2 (Red)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexical Complexity Depth</td>
<td>Lexical Complexity Breadth</td>
</tr>
<tr>
<td>Syntactical Complexity Breadth</td>
<td>Syntactical Complexity Depth</td>
</tr>
</tbody>
</table>

The resulting dynamic correlation of these cross-categorical correlations is presented in Figure 4.22 and shows a general lack of correlation. The two correlations are not within lexical complexity, nor syntactical complexity, nor breadth, nor depth. There are no parallels in these pairings and the lack of parallel behavior is reflected in the diagram. There is another possibility, that like Figures 4.3 and 4.11, also of the Vietnamese subject, there may be some form of high complexity precursor behavior.
4.2.5 Lexical Complexity Depth and Syntactical Complexity Depth versus Lexical Complexity Breadth and Syntactical Complexity Breadth

The dynamic correlation presented here is a direct variant of the correlation presented in the previous section 4.2.4. Here the depth-depth variation across the boundary is compared with the breadth-breadth variation across that boundary. The relation between indexes is displayed in the following table:

<table>
<thead>
<tr>
<th>Correlation 1 (Blue)</th>
<th>Correlation 2 (Red)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexical Complexity Depth</td>
<td>Lexical Complexity Breadth</td>
</tr>
<tr>
<td>Syntactical Complexity Depth</td>
<td>Syntactical Complexity Breadth</td>
</tr>
</tbody>
</table>

The dynamic correlation presented in Figure 4.23 shows that the two correlations clearly follow each other across most of the length of the experiment, but not quite as closely together as the combination presented in Figure 4.21. Accordingly, their correlation with each other, 0.580, significant at p=0.000, is lower than but certainly in the range of that of Figure 4.21. Depth and breadth can be seen as two constants measured across two variable domains, lexical and syntactical, behaving similarly to the arrangement in Figure 4.21, where syntax and lexicon were the constants and depth and breadth were the variables.

These results also support the use of depth and breadth as parameters for index description and correlation analysis. It is shown that when there is one constant category (element) in each pair, a correlation can be found. These constants were absent in Figure 4.18 and 4.19 (section 4.2.1) where an anti-correlation was found.
4.2.6 Within Lexical Complexity Breadth

General word variation has already been shown to interact with other indexes, yet it is itself a synthesis of separately indexed components. In Figure 4.24, the noun variation, verb variation, and adjective variation have been correlated with each other. Coupled with the previous plots involving general word variation, these can be seen as evidence of multilevel or nested dynamic behavior. The points 18 to 25 are a striking example of the dynamism in this microcosm. Here the correlation between noun variation and verb variation becomes positive when the other two become strongly negative, roughly mirroring noun and verb variation. Close perusal reveals this divergence to recur.

In virtually every week, one or more of the correlations is moderate if not strong. While the interactions are not as prolonged as those in other plots, the many spurts of synchronicity make it easy to surmise that the indexes are reacting to each other. While adding three more interactions, the inclusion of adverbs into future measurements might be a useful comparison to the above behaviors. More frequent measurements might also tease out the true motives of these furtive indexes.

4.3 Accuracy Measures

Correct lexical use, correct academic use, and K2 correct use measured lexical accuracy, while correct tense use per verb measured syntactical accuracy.

4.3.1 Lexical Accuracy and Syntactical Accuracy

The results for the Chinese subject are presented in Figure 4.25, followed by their dynamic correlation in Figure 4.26.
4.3.2 Lexical Accuracy Depth, Lexical Accuracy Shallows

A notable interaction was found within lexical accuracy. Correct academic word use, using one thousand academic words, is a depth measure, while K2 correct use, where K2 represents the most common two thousand...
lexical words, is a shallows measure. Their dynamic correlation appears in Figure 4.27.

![Figure 4.27. Dynamic Correlation of Correct Academic Word Use and the K2 Correct Use, Portuguese subject.](image)

This correlation correlates with time at 0.409, significant at p=0.020. To use overt DST terms, there is evidence of alternating competition and support, yet it can be clearly seen that the range of variation diminishes and the two converge ever closer to a +1 correlation. Though the actual levels of accuracy may be fluctuating, the closer the correlation is to 1, the more these two bodies of words change together (support each other) in terms of accuracy. The output strongly suggests the convergence of these two vocabularies, namely their correct use, in the language system of the Portuguese subject. The weaker oscillations toward the end also suggest that this convergence is, in DST terms, an attractor state. This is plausible, considering first the fact that English is a second language for the subject, and that the one thousand academic English words at the outset of this study, that is, upon enrollment in the English-taught Master’s, may have been less active than the two thousand most common lexical words, but were probably accessed regularly over thirty six weeks of study, with special attention to their correct form. This is a striking instance, even more than Figure 4.6, of van Geert and van Dijk’s (2002) suggestion that “a developmental variable may be slowly oscillating while gradually growing” (p. 346). It also may lend credence to the use of the categories of depth and shallows in the greater category of accuracy.
5 Conclusions

This study set out to show the presence of competition and support within second language development in the realms of complexity and accuracy, and within them, syntax and lexicon. Competition and support have been observed in the language output of L2 learners from a variety of cultural and linguistic backgrounds. Two instances of precursor type behavior were also observed in the Vietnamese subject. Furthermore, a new category pair, depth and breadth, as well as the category shallows, were introduced for organizational purposes, and proved useful as conceptual tool in identifying trends of competition and support. Only a fraction of the results were included in this study in order to most favorably support the hypotheses and for considerations of space.

Lexical Complexity and Syntactical Complexity – The focus of this study has been on complexity, and to a lesser extent accuracy. The initial investigations delved into simple interactions of lexical complexity with syntactical complexity (sections 4.1.1 to 4.1.3). Each of these pairs yielded evidence of competition and support, which were especially apparent in their dynamic correlation plots. In addition, precursor-type behavior was also observed, but not in the form of a single cataclysmic occurrence of one index rising and allowing another to increase. Instead, in two plots of the Vietnamese subject (sections 4.1.1 and 4.1.3), evidence was found for week-to-week precursor behavior, where movement in one index precedes nearly identical movement in another index the following week. In each case the lexical complexity measure was precursor and the syntactical complexity measure was the dependent grower. In addition, the first case consisted of breadth measures, the second of depth measures.

Multiple Dynamic Correlations – The interaction between lexical and syntactical complexity measures was studied further by introducing a second index pair to the dynamic correlation plots (sections 4.2.1 to 4.2.5). Both the Chinese and the Vietnamese subject showed distinct but similarly strong anti-correlations, where complex words ratio correlated positively with general word variation while it correlated negatively with phrase-to-sentence ratio, and vice versa (section 4.2.1). When the subordinate-phrase ratio replaced the phrase-sentence ratio in the Vietnamese correlations (section 4.2.2), the correlations did not demonstrate as strong a relationship. The breadth constancy of the general word variation and phrase-to-sentence ratio was broken by introduction of subordination-phrase ratio. However, upon replacing complex words ratio with phrase sentence ratio, the correlation became strong again (section 4.2.3). The two correlations, one of syntax measures and the other of lexical measures, appeared to move together for most of the study period. Constancy was reintroduced by putting kind with kind, in this case syntax and lexicon. A different pairing of the same indexes, of syntactical breadth with lexical depth and syntactical depth with lexical breadth, only showed a weak and possibly delayed correlation (section 4.2.4). On the other hand, when pairing syntactical breadth with lexical breadth and syntactical depth with lexical depth, the correlation became very strong (section 4.2.5). The two correlations moved together during the whole study period. Having a depth pair and a breadth pair made the
correlations behave much like in the case of pairing of syntactical measures and lexical measures (as described in section 4.2.3). This suggests that the descriptors breadth and depth may – like syntax, lexicon, complexity, and accuracy – be useful, not just to organize a list of measurement techniques, but also as experimental parameters.

**Lexical complexity** – In section 4.2.6 the three components of lexical word variation: noun, verb, and adjective were correlated with each other, and demonstrated dynamic relationships of competition and support. This dynamic relationship among more highly related indexes complements the analysis of the more ‘distant neighbors’ of syntax and lexicon. This nesting is more proximate than that of general word variation with complex words ratio and demonstrates another among the recursive scales of observation possible.

**Lexical Accuracy and Syntactical Accuracy** – Section 4.3.1 demonstrated the limitations of dynamic correlations, as correct lexical use and correct tense use per verb displayed competition and support, which was not reflected adequately in their dynamic correlation.

**Lexical accuracy** – Changes in the situational context can elicit a response of output variability in the language of a learner. Section 4.3.2 demonstrated how continual exposure and elicitation of academic language over an academic year of study can produce an oscillating trend toward merging output accuracy of academic words with the most common lexical words. This remarkable correlation recommends further analysis of accuracy measures.

An index can appear to affect many others, and influences how many of those affect each other. The competition and support between two indexes can compete with or support the competition or support of another two indexes. Language output is variable across several dimensions as much as it is over time. Interactions involving competition and support in language processing are not merely one-to-one, and have been shown to operate on the one-to-two and two-to-two levels (see sections 4.2 and 4.4). These relationships also occur on a smaller scale, among the relative variation levels of ‘close neighbors’ such as nouns, verbs, and adjectives (Figure 4.24). If single indexes can be employed as a viable (if simple) representation of a greater subsystem in the language of an individual, then combinations of correlations can as well. Further study is recommended within and across these and other demonstrably interactive areas of language processing.

With regard to the hypotheses, this study affords evidence of competition and support for the following categories: (1) between lexicon and syntax, (2) within lexical complexity, (3) within syntactical complexity, (4) between lexical and syntactical accuracy, and (5) within lexical accuracy. Competition and support between complexity and accuracy have not been presented and are relegated to further study. There is repeated evidence that lexical complexity can behave as a precursor to syntactical complexity. In addition, breadth, depth, and shallows appear to further describe measures in a manner that complements the categories of syntax, lexicon, complexity, and accuracy.
Recommendations for Further Study

Further study could include additional an additional distinction among types of general conjunctions. In this study, correlative conjunctions were subsumed into coordinating conjunctions, which is justifiable. They could be reclassified as a special subtype of coordinative conjunctions, as they coordinate phrases but are restricted to two. To coordinate the two phrases they use pairs of words, such as *either* and *or*, which indicates a higher level of complexity than that of coordinative conjunctions. However, many of these are themselves also used as normal coordinative conjunctions, such as *or*. Correlatives could thus be considered more similar in complexity to coordinating conjunctions than subordinating conjunctions. The current distinction more than suffices for the purposes of this study, yet a future study could operationalize correlative conjunctions into a separate, intermediate level of complexity. This intermediacy could form part of an expanded descriptive system, along with *breadth, depth, shallows*, and the other categories. Adverbs may also be incorporated in future measurements of general word variation. This may elucidate the rapidly changing relationships between nouns, verbs, and adjectives.

One possible technique for studying precursor interactions could involve an additional test algorithm which shifts the points of one index forward or back one or more weeks, and then correlates the two indexes across the time shift. In addition, it became apparent in sections 4.1.3 and 4.3.1 that it may be the numerical values, rather than rate of change, that is used in the calculation of the dynamic correlations. Further study could also account for the slope ($\Delta y$) in addition to the $y$-value. After all, amplitude of change is no less an example of variability than frequency of oscillation. This technique, along with the proposed point-shifting for studying precursor behavior, may prove useful in study of the dynamic system of SLA.

When one arrives at a tentative conclusion about two or more indexes, one still may take additional indexes into account, not just on the same categorical level but also at higher (and lower) structural levels, since a given relationship can be clarified in the face of others. However, a more complete picture of index interactions would require plots with even more correlations than used in this study. Perhaps three-dimensional traditional plots or scatter plots could be used. Present circumstances afford a mere rapid succession of plots. It is obvious yet still may bear mention that there is some tension between the need to plot more relevant indexes together, and keeping out the clutter to render a few curves reasonably discernible.

As in this study, so in the burgeoning dynamic systems approach to SLA, and undoubtedly, beyond, the limitations for research lie not in the data, but rather our ability to collect and process them. Pushing back against these limitations, may allow us to more effectively observe, describe, and explain the dynamics of SLA. This study was undertaken as an exercise in certain analytical techniques. It has yielded not only significant results, but also future possibilities for description and measurement. Applied and refined further, these may expand the borders of our collecting and processing abilities, or rather, improve the view.
References


