Paul Booth

The variance of lexical diversity profiles and its relationship to learning style

Abstract: Studies in lexical diversity have shown an approximate relationship with learner instruction. Learners with more L2 instruction tend to display less repetition of words and so greater lexical diversity. However, at higher L2 levels of proficiency this relationship does not always occur. This study examines the lexical diversity scores in L2 texts. Lexical diversity scores are examined in relationship to a learning style framework of memory and analysis. The results show that variance in analytic ability scores can account for a proportion of variance in lexical diversity. It was also found that the type of writing task also affects lexical diversity. These results suggest that learners who are more grammatically able may be more likely to restructure their language. The findings illuminate Dynamic Systems Theory; in particular, how lexical diversity is shaped to some extent by differences within individuals and task conditions.

Keywords: lexical diversity, learning style, variance

1 Introduction

Tests for assessing vocabulary knowledge have improved greatly over the last few years with the advent of better software. Two of the main paths to assess vocabulary richness have been to assess the proportions of rare lexis in learner output (Laufer and Nation 1995) or the variety of lexis used (Malvern, Richards, Chipere and Durán 2004). Whilst at higher proficiency levels learners tend to use rarer lexis, there is not always a linear relationship between actual or presumed higher levels of proficiency and lexical diversity (Jarvis 2002). In other words, there tends to be considerable heterogeneity from scores in learners' lexical diversity when higher language proficiency learners are tested (Read 2005). Jarvis's study shows that better quality texts are not always associated with increasingly higher levels of diversity. Jarvis argues that a certain amount of lexical recycling is needed for

Paul Booth: Kingston University, Surrey. E-mail: p.booth@kingston.ac.uk

text coherence. Moreover, Meara and Miralpeix (2007a) highlight lexical recycling is also needed for sentence structure. One way of understanding why high levels of lexical diversity do not reflect increasing levels of proficiency then is that extremely high levels of lexical diversity seem to inhibit text coherence and complex sentence structure.

In order to understand how learners of similar proficiency may differ, Skehan's (1998) learning style framework of memory and analysis is used to help understand the heterogeneity found in L2 language performance. Individual differences in learning style are used as a way of examining diversity profiles to determine whether learners strong in memory or analysis are associated to particular lexical diversity profiles. The written English texts of learners from a wide variety of L1 backgrounds are used to examine whether learners strong in memory or analysis produce similar or different lexis as measured by lexical diversity. The main aim of this study is to understand how differences in lexical diversity are related to learning style. As task topic plays an important role in lexical diversity, a secondary aim of this study is to tease out the relationship between task topic, learning style and diversity. The data will be analysed for variance which is an estimate of average variability in a set of data.

2 Background

2.1 Measures of lexical diversity

Meara and Bell (2001: 6–7) coin the terms "extrinsic measures" of lexical richness versus "intrinsic measures" of lexical variety respectively to highlight the difference between external based criteria based on frequency lists and internal criteria based on the text itself. The Lexical Frequency Profile (LFP) (Laufer and Nation 1995) falls into the category of lexical sophistication because it measures the learner's production of rare and frequent words – rarer words are an indication of sophistication. The problem is where to draw the line between frequent and rare words. A word may be rare in terms of frequency counts but may have a considerable distribution (i.e. range) in a particular text. The other problem, as highlighted by Bogaards (2000: 322–323) is that a word is defined in the program as a base form with its inflected and derived forms. The result is that the program does not pick up wrong derivatives or inflections. A learner who constantly overuses the present tense and is able to communicate the past purely through time markers is not differentiated from a learner who is able to grammaticise her language to communicate meaning. The LFP program is not able to distinguish

whether the learner knows different word types from the same word family. So a learner who simply repeats the same token from the same family e.g. 'technology' is not distinguished from a learner who is able to use the different derived forms rather than 'technical' or 'technique'. A way around this problem is to base the measurement around an intrinsic measure i.e. lexical diversity.

One of the most common measures of lexical diversity is traditionally conceptualised as the number of different words (word types) used in a text or transcript, or in terms of the relationship between the number of types and text length. This has been calculated by type-token ratio (TTR) i.e. the number of word types divided by the number of word tokens (running words). This measure of lexical richness has been widely criticised (e.g. Laufer and Nation, 1995) because TTR is text length dependent, therefore the longer a text, the smaller the chance that new or different types will be introduced, automatically resulting in a lower TTR for longer texts (van Gijsel, Speelman and Geeraerts 2005). To highlight this problem, a study by Linnarud (1986) did not show any large differences between native speakers of English written texts and Swedish learners of English. More importantly, there were no correlations with evaluations of the texts. Perhaps this shows that high diversity is not a positive factor in text quality.

Tweedie and Baayen (1998) conducted a useful study of various measures of lexical richness based on the number of word types. The measures were analysed by using texts from different authors. They conclude that measures of lexical richness are not independent, or roughly independent, of text length (Tweedie and Baayen 1998). Moreover, the authors argue that when the constants measure real texts i.e. coherent prose the empirical values fall outside the 95% confidence interval established by theoretical models from randomized texts. Tweedie and Baayen argue that discourse structure has an impact on these measures. That is, almost all measures vary substantially in systematic ways with text length. They found that it was necessary to correct for text length or to consider the developmental profiles of the full text. The upshot of their study is that the constants varied as text length increased, which highlights the need to take the full text into account and that the discourse structure of a text has an impact on the mathematical measures. More recently, one common problem of measuring lexical richness via type token ratio has been tackled by Malvern, Richards, Chipere and Durán's (2004) parameter D which measures lexical diversity. Malvern and Richards tackle this problem by producing a method of measuring lexical diversity that is a measurement made over a series of points in order to establish the pattern of fall of the curve rather than any particular value on it (Malvern et al. 2004: 59). Parameter D (for diversity) calculates a mean segmental TTR for a random selection of words from the text. Skehan (2009: 108) describes the D value as "an index of the extent to which the speaker [or writer] avoids the recycling of the

same set of words." The statistic which is calculated is not any particular point on the curve: it is the pattern of fall of the curve which is calculated. The parameter is a mathematical ideal curve which is the closest fitting curve to the actual TTR curve from real language. The program (vocd) "... can read a transcript of the language sample, then plot the TTR verses tokens curve between N = 35 and N = 50, deriving each point from an average of 100 trials on sub-samples of words of the token size for that point" (Malvern et al. 2004: 55).

This measure of lexical diversity has been used in a cross-sectional study (Malvern et al., 2004: 169–70) of nearly one thousand narrative compositions written by English school children of the ages 7, 11, and 14 years. One of the aims was to look at the relationship between lexical diversity and the quality of writing as assessed in accordance with the National Curriculum guidelines. Lexical diversity, as measured by D, was sensitive to writing quality and showed continuous development across levels in writing as defined under the National Curriculum. Levels of writing quality had a larger effect size than Key Stage in relation to lexical diversity (p. 170). A more recent study by Daller and Xue (2007) has shown that Malvern and Richards' measure D discriminates between two different groups of learners: Chinese learners of English who had spent a year in the UK and another group of similar learners who had not. Transcriptions of oral data were analysed using Malvern and Richards' measure D, *P-Lex*, Advanced Guiraud[1], Lexical Frequency Profile (Beyond 2000 frequency level) and Guiraud[2]. A one-way ANOVA for the measures showed that the *p*-values and the Eta[2] indicated that Guiraud and D were the most appropriate measures because they showed clear differences between the two groups.

2.2 Heterogeneity in lexical diversity

When L2 learners' texts are holistically rated in terms of quality, however, the ratings do not always relate to quantitative measures of lexical rarity or diversity. There is not a linear relationship between greater rarity or diversity and quality. This may help us to understand why L2 learners who are classified into groups according to the amount of L2 instruction produce lexical diversity profiles which are highly heterogeneous (Jarvis, 2002). Above a certain level of lexical diversity, Jarvis found a negative correlation between D and holistic quality ratings of the texts. Lexical diversity beyond a certain point may preclude repetition which is

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1 This is calculated by dividing the advanced types by the square root of tokens in a text.
2 This is calculated by dividing the types by the square root of the tokens.

necessary for text coherence (Jarvis, 2002: 82). A high diversity score can be achieved through, for example, lists which tend to destroy the coherence of a text.

Meara and Miralpeix's (2004) *D-Tools* program which is based on parameter D was used by Read (2005) to analyse 88 transcriptions of IELTS speaking tests. The mean values for D decreased as the IELTS band scores scale decreased. At the high band levels (i.e. bands seven and eight) the standard deviations showed large dispersions. Read suggests more proficient candidates use a wider range of vocabulary than less proficient ones but that D by itself cannot distinguish between the bands. In this present study, learners with different scores of memory and analysis are compared to see whether low scores in these learning style dimensions can explain the variance in lexical diversity. An extremely high diversity score can be indicative of a telegraphic style because of the lack of function words to code sentence structure. An extremely low diversity score can be indicative of excessive repetition. Either way, a certain amount of repetition is necessary in order to make sentences complex.

In a study of lexical diversity (D) and language aptitude, Kormos and Trebits (2012) found a payoff between lexical diversity and grammatical sensitivity. That is to say, the ability to detect grammatical patterns correlated with greater clause length (p. 459). They hypothesized that grammatical sensitivity is related to clause complexity. However, this relationship was influenced by the type of writing task. Yu (2009) found that when lexical diversity is analysed by Malvern and Richard's measure, task topic can influence the D value. Yu concludes that different writing topics exert an influence on the lexical diversity in L2 texts. This is hardly surprising as different topics may call upon different levels of complexity. For example, picture description can be less cognitively demanding for the writer than a discursive essay in which points need to be argued. It is for this reason that different writing tasks will be given to different sets of participants. Although it is known in the literature that different writing tasks are associated with different levels of lexical diversity, it is not clear how learning style interacts with different L2 writing genres.

2.3 Variability as an important indication of information

The review so far has shown that, broadly speaking, lexical diversity is related to proficiency (Malvern et al. 2004); however, at higher proficiency levels this measure of vocabulary production does not quite fit our expectations (Read 2005). From a Dynamic Systems approach Thelen and Smith (1994: 155) argue that at the macroscopic level that we can see great uniformity and regularity but at the local level the data is messy and there is the emergence of pattern.

Central to Dynamic Systems Theory is the notion of development and that intra-individual variability is an indication of this notion i.e. "differences (in achievement or behavior) between measurement occasions" (van Geert and van Dijk 2003: 341). The work reported in this study is concerned with variance in learners' lexical diversity across different data sets and also within data sets in order to understand how apparently similar learners' lexical production is different. Variance, which is a type of variability, in learners' lexical profiles is an important source of information to not only understand development, but also the processes which drive it forward. Van Geert and van Dijk (2002: 341) argue that "variability is viewed as a potential driving force of development and a potential indicator of ongoing processes". To express complex sentences in English, texts need a certain amount of lexical recycling of grammar words. This is why a lexical diversity is used as it measures the extent to which words are repeated. I intend to explore the question of whether variance in lexical profiles can be associated with learning style. For example, do learners categorized by increasing scores of memory or analysis cluster together in lexical diversity? Conversely, could weak associative memory or language analysis be associated with heterogeneous profiles.

In order to understand the variance in lexical diversity across different sets of data and variance within sets of data, a two-way independent ANOVA and multiple regression analyses are used. From a macro perspective, the ANOVA is intended to show how much variance in lexical diversity (D) is explained by different writing tasks and overall proficiency levels. From a more micro perspective, one data set is analysed to understand to what extent the amount of variance in lexical diversity is explained by the variance in ability to infer grammatical patterns (LAT B) and IELTS scores in writing.

2.4 Internal factors: Learning style

From his work with language aptitude and learner types, Skehan (1998: 250) developed a model of learning style. Skehan's argument is that there is research (Wesche 1981; Skehan 1986) which identifies memory-orientated and analysis-orientated learners. Analysis-orientated learners would favour rule-based representation and processing, whereas memory-orientated learners would favour exemplar-based representation and processing. Skehan's argument is that learners can be high or low in either or both dimensions. In terms of lexis, high analysis foreign language learners would only need a "single representation lexical system ... [l]ow analysis learners, in contrast, would have smaller and less differentiated systems" (Skehan 1998: 250). High memory learners would have a "wide

range of lexicalized exemplars, considerable redundancy in their memory systems, and multiple representations of lexical elements … [which] could be highly accessible, and could be mobilized for communication in real time" (Skehan 1998: 250). However, low memory learners "would not have such a repertoire of lexical elements, and might not have the multiple representations characteristic of high memory learners" (Skehan 1998: 250).

The question that arises is how these two constructs, exemplar-based i.e. memory-orientated or rule-based i.e. analysis-orientated, are related to learners' lexis. Previously the two types of knowledge have mainly been discussed in relation to learners' performance in grammaticality judgment tests (e.g. Robinson 1997). What is lacking is how these two approaches to language learning relate to vocabulary. Vocabulary and grammar are inextricably intertwined because, as Bogaards (1996: 373) argues, "every lexical unit calls up its own grammar". Hence, lexis, as Ellis (2001: 54) argues, "… is at the very centre of syntax … syntax acquisition reduces to vocabulary acquisition – the analysis of the sequence in which words work in chunks". It seems that grammaticisation is a process in which individual words lie at the very centre. One way that learners can grammaticise L2 English is through function words. Meara and Miralpeix (2007a) explain that the repetition of function words and sentence structure are related. Lexical diversity measures are sensitive to word repetition.

3 Method

3.1 Research questions

In light of the above, the research question of this study is concerned with memory and analysis and the relationship with the heterogeneity of learners' diversity profiles: How are memory and analysis related to the variance in lexical production as measured by diversity? It is expected that learners who prize restructuring will have more homogenous lexical diversity profiles whereas those who do not will have more heterogeneous profiles. A secondary question is related to the interaction between writing topic and proficiency: What is the relationship between writing topics, proficiency and lexical diversity?

3.2 Participants

The learners of English comprised undergraduate and postgraduate students from two pre-sessional English courses at a UK university. The mean age of

the learners was 25 years. The learners were categorised into two proficiency groups to understand how variance interacts not only with learning style but also with proficiency. Low proficiency was categorised as learners who score IELTS 5.5 or below ($n = 41$) and high was proficiency IELTS 6.0 or above ($n = 55$). The main L1 backgrounds were Korean, Thai, Mandarin, Japanese and Arabic.

3.3 Memory and analysis

The language ability tests by Meara, Milton and Lorenzo-Duz (2001) were used to determine the learning style of the participants: memory LAT B (visual memory for paired associates) and analysis LAT C (ability to infer grammatical rules). The memory and analysis tests were projected onto a large screen and were demonstrated to the participants how the tests should be used. After the demonstration the learners also had the opportunity to ask any clarification questions. They also had printed instructions to refer to once the demonstration was over. Learners carried out the memory and analysis tests at their own pace. They recorded their scores onto their background data sheet which was then checked to ensure there were no errors in reporting the results.

3.4 Lexical production

To determine whether the type of text is associated with learning style, the learners were given two different types of writing task. The first was a descriptive task and the second was a discursive task.

3.4.1 Group 1: Picture story

The participants in this group ($n = 36$) wrote a descriptive text which was elicited via a cartoon picture story. They were instructed to look at the pictures to understand what happened in the story before they started to write. A time limit of 40 minutes was given to write a story based on the pictures. The students wrote a minimum of 300 words directly on the PCs in Word format. No dictionaries were allowed but they did have access to Word *Tools* i.e. *Spelling* and *Grammar* check which some learners did use. The participants were seated sufficiently apart so that they could not copy from each other. Before writing, the learners were told

that there were no 'wrong' or 'right' ways to write the story but that it was their vocabulary which would be analysed.

3.4.2 Group 2: Discursive essay

The participants in this group ($n = 60$) wrote a single text which was elicited via a discursive type question under timed conditions with no dictionaries or electronic translators. This might have the effect of producing more varied profiles as learners are encouraged to express their ideas rather than describe a series of cartoons. The essay question elicited a situation-problem-solution-evaluation text on the topic of globalisation. All students had a choice of two questions[3] related to this topic of which they were given texts to read beforehand so that they had time to digest the information they were given. The question on cross-cultural communication was twice as popular as the question on English as a world language. All participants were allowed to bring to the writing session one sheet of hand written notes (i.e. not copied out chunks of text) and only three quotations. The hand-written essays were then transcribed so that they could be inputted for lexical diversity. All quotations were discarded but paraphrasing was included. This writing task contrasts sharply with the first in terms of preparation and discourse type which was done so that the effects task conditions could be clearly brought out.

3.5 *D-Tools*

The learners' texts were then analysed by Meara and Miralpeix's *D-Tools* (2007b) which is based on Malvern and Richard's *vocd* program but is more user-friendly in that texts can be transcribed on Microsoft Notepad instead of the rather more complex CHILDES system (MacWinney 2000). All spelling mistakes were corrected so that they did not increase the lexical diversity. Phrasal verbs and hyphenated words were counted as one word because they can be seen as retrieved as one item, and grammar mistakes were left uncorrected. Lexical production in this study was given a value of parameter D. The learners then completed two

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3 1) The process of globalisation has given rise to a number of cross-cultural problems. Identify one of those problems, explain the situation which gives rise to the problems and offer some solutions. You should also evaluate your solutions.
2) There are a number of problems associated with the rise of English as a world language. Outline some of these problems, explain how they arose, offer some solutions and evaluate your proposed solutions.

learning style tests: LAT B which is a visual memory test of paired associates and LAT C scores which is a test of grammatical sensitivity.

4 Results

4.1 What is the relationship between writing tasks, proficiency and lexical diversity?

The written texts comprised of two different samples. One was based on a cartoon story and the other was a discursive essay. Proficiency was measured by the IELTS score for overall performance. Table 1 below highlights the means (D) of the groups when categorized by proficiency and writing task.

A two-way independent ANOVA was conducted to determine the interaction between writing tasks, proficiency and lexical diversity. There was a significant main effect of task type on lexical diversity, $F(1) = 10.786$, $p < .001$. However, there was no significant interaction between task and proficiency, $F(1) = .002$, $p > .05$. Figure 1 shows the interaction between task, proficiency and lexical diversity.

The differences in lexical diversity from two different writing tasks are hardly surprising given the fact that for the discursive essay task, learners were encouraged to bring notes to the task and had read relevant literature beforehand. This would have encouraged a wider range of vocabulary and so less repetition of words. Moreover, it shows that the task type can influence the lexical diversity produced. Overall, a discursive type essay task encourages greater diversity than a simple picture story. It shows that learners are competent in understanding the different task requirements in terms of argument and discussion to produce more varied lexis. Giving learners time to prepare and allowing the use of notes helped

Table 1: Writing task and proficiency

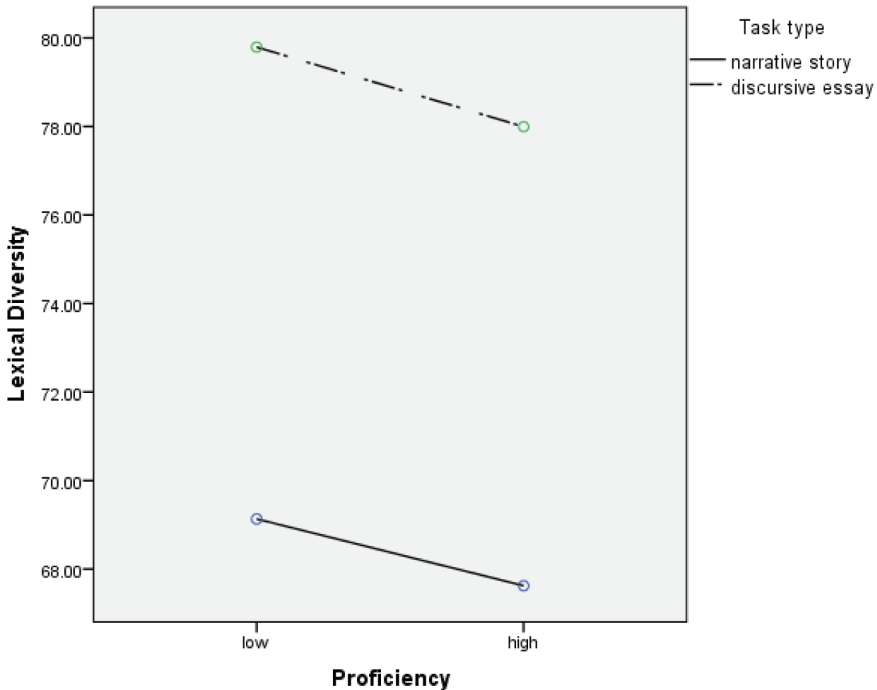| Task type | Proficiency | Mean | Std. Error | 95% Confidence Interval | |
				Lower Bound	Upper Bound
Narrative Story	Low	69.132	3.763	61.659	76.605
	High	67.623	3.365	60.939	74.306
Discursive Essay	Low	79.792	3.010	73.814	85.770
	High	77.995	2.544	72.943	83.048

Dependent Variable: Diversity

Fig. 1: The interaction between task, proficiency and lexical diversity

to raise the lexical diversity. In contrast, the learners who wrote a short story had to produce lexis more spontaneously and so lowered the lexical bar.

These learners' scores for memory and analysis are used to determine whether variance in lexical diversity is explained by this model of learning style. However, as we will see, the IELTS overall score needs to be reconsidered because the focus of this study is on writing. Proficiency measured simply by categorising learners to high or low is an oversimplification therefore the IELTS writing scores (IELTSW) are used from the group of participants who wrote the discursive essay and their scores for memory and analysis. As all of these measures use different scales, the data was standardised so that all results could be easily compared.

4.2 How are memory and analysis related to the variance in lexical diversity?

Table 2 shows whether the regression model was a significant fit to the data.

Table 2: ANOVA[a] for the independent variables: memory, analysis and IELTS

	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.521	3	1.507	1.532	.211[b]
Residual	90.479	92	.983		
Total	95.000	95			

a. Dependent Variable: Diversity
b. Predictors: (Constant), Memory, IELTS, Analysis

Table 3: Coefficients: analysis, IELTS and memory

	Standardized Coefficients	
	Beta	Std. Error
(Constant)	5.228	101
Analysis	−.211*	102
IELTS	−.042	102
Memory	−.006	102

Note: $R^2 = .048$ $p < .05$

The first regression model was not significant, $F(3, 92) = 1.532$, $p > .05$. When the model is broken down in Table 3, analysis (LAT C) significantly contributes to the model. However, IELTS and memory (LAT B) do not contribute significantly to the model ($p > .05$).

In light of the above results, memory was deleted from the model and only IELTS writing was included from participants who wrote the discursive essay. Table 4 shows whether the second model is a better fit to the data.

The second regression model was significant, $F(2, 54) = 3.320$, $p < .05$. In Table 5, the coefficient for analysis significantly contributes to the model.

Table 4: ANOVA[a] for the independent variables: analysis and IELTS Writing

	Sum of Squares	df	Mean Square	F	Sig.
Regression	6.133	2	3.066	3.320	.044[b]
Residual	49.867	54	.923		
Total	56.000	56			

a. Dependent Variable: Diversity
b. Predictors: (Constant), IELTS(W), Analysis

Table 5: Coefficients: analysis and IELTS writing scores

	Standardized Coefficients	
	Beta	**Std. Error**
(Constant)	1.153	127
Analysis	−.331*	127
IELTS(W)	.002	127

Note: $R^2 = .110$ $p < .05$

Although analytic ability (LAT C) significantly contributes to the model, the IELTS writing scores do not significantly contribute ($p > .05$).

5 Discussion

5.1 Lexical diversity and its relationship to learning style

The main finding is that analytical ability rather than memory can explain a proportion of the variance in lexical diversity. The inclusion of analysis in the model can be explained because of the relatively strong relationship between lexical diversity and sentence structure. The repetition of grammar words is necessary for sentence structure which lowers the lexical diversity measure. It could explain why learners who are strong in language analysis do not have extreme lexical diversity scores because a certain amount of recycling is necessary to grammaticise language, whereas learners who tend to be weaker in analysis can have more unpredictable diversity scores which may stem from a more random use of grammar words. Learners who are grammatically sensitive could be learners who structure their L2 to a greater extent which in turn affects lexical diversity.

The evidence presented in this empirical work shows that high proficiency learners' lexical diversity scores tend to be lower than less proficient learners. It is possible that the higher levels prize complexity and systematically strive for it through the regular use of function words and repetition of words for coherence. This may help to explain why their texts show relatively lower lexical diversity. A learning style which relies heavily on memory as categorised by LAT B seems to not explain variance in lexical diversity.

One possible reason is that lexical diversity could have close association with grammar. As function words are the most common form of repetition (Meara and

Miralpeix, 2007a), so D is heavily influenced by sentence structure. Lexical diversity does not necessarily correlate with high levels of language proficiency because complex language is not linearly related to the recycling of words. Kormos and Trebits (2012: 457) found that language complexity as measured by clause length correlated with grammatical sensitivity. One feature of complex language is the repetition of function words and prepositional phrases. Lexical diversity is sensitive to the repetition of words and so more sensitive to the repetition necessary to code complexity. Texts which contain lexis of this nature would not be overly repetitive or overly 'telegraphic' (i.e. lack of function words). The most common first language backgrounds in this study were of languages non-cognate with English. Learners with this type of L1 background may only have vague semantic knowledge of opaque lexis and so use semantically opaque lexis erratically which could in turn make the diversity scores more heterogenic and so prone to greater variance than learners who have a more precise conceptual understanding of semantically opaque lexis. A reliance on paired associate learning would make semantically opaque lexis difficult to acquire in part because of the lack of L1 to L2 mapping. Unlike the more linear relationship between lexical rarity and lexical sophistication, a higher D statistic does not indicate more sophisticated language. The upshot of an analytical learning style is a ceiling effect in D (diversity) but more heterogeneity in D scores from learners who are less grammatically sensitive.

5.2 Lexical diversity and the relationship to proficiency and memory

Different patterns of diversity are shown when learners are separated by proficiency. The difference between the levels was not that great i.e. 0.5 IELTS. In some cases, learners who were classified as low proficiency actually had a higher IELTS writing score than some learners classified as high. Therefore, the second model used the full range of IELTS writing scores for the second group of participants. However, the writing scores did not predict variance in lexical diversity. One reason might be related to the type of typical writing task learners can expect for the IELTS exam. Hickey (2013) explains that the main part of the IELTS writing task requires learners to give their opinions based on their past experience. University writing assessments normally require students to synthesise sources in order to construct logical arguments. This mismatch in the process and product of writing may be a factor why there is no relationship between the participants IELTS writing proficiency score and lexical diversity from texts which incorporated sources and learners' notes.

Memory did not contribute to predicting variance in lexical diversity either. Forging an association between two words is less cognitively demanding than the restructuring involved in "the mapping of two lexical and conceptual systems onto each other" (Ijaz 1986: 405). The cost, though, for learners who are weak in analysis and who are more predisposed to a memory-based approach to vocabulary processing may be that those learners are less likely to restructure and most likely to fossilise in an L2.

This relationship between diversity scores and learners who are particularly able to analyse language has some parallels with Dynamic Systems Theory (Thelen and Smith 1994). One aspect of this theory which is particularly relevant is that dynamic systems interact in complex ways. As interaction is a fundamental aspect of DST, variance matters and it is not simply classified as 'noise' in the data which can be the case when using probabilistic statistical measures.

5.3 A dynamic perspective on words and analysis

In order to illustrate the importance of heterogeneity, a dynamic metaphor is presented based on Conrad Hal Waddington's epigenetic landscape (van Geert, 2003: 648–650). Waddington's landscape featured a marble on the cusp of a hill with valleys which irreversibly shape the route the marble actually takes. The metaphor comes from Waddington's own biological work on genes and embryogenesis. Instead of genes carrying the full description of the organism's form, Waddington showed that genes are the starting point for development and that it is the process of embryogenesis which determines how the body is actually constructed. The analogy with the landscape is that when the marble rolls down the hill its destination is not fully predetermined before the journey but is shaped as it travels.

Figure 2 borrows from Waddington's landscape idea. As we have seen from the previous empirical work, there is a ceiling effect in lexical profiles from learners who are particularly perceptive of the grammatical relationships that are encoded in words, whereas learners who do not have this approach to learning and are perhaps more concerned with the memorisation of words tend to produce lexical profiles which are more unpredictable.

The valleys in Figure 2 represent what Pinker (1999: 174) describes as "... an abstract mental scaffolding around words". Learners who are strong in analysis are thought to make semantic and grammatical connections, whereas learners who are not strong in analysis tend to make more random or weak connections. The marbles in the valleys represent the emergence of some type of equilibrium
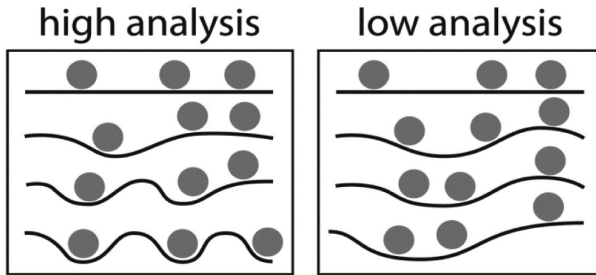
Fig. 2: The landscape of analysis on words

which is found with words that are analysed. The marbles in the under-defined landscape represent the lack of connection found between words that are under-analysed. This dynamic metaphor chimes with Dynamic Systems Theory which, according to de Bot, Lowie and Verspoor (2007: 14), emphasises the way change is visualised rather than measured through the more traditional ways based on probability and variation.

5.4 Task topic and lexical diversity

The secondary finding was that different types of writing tasks have specialised effects on lexical diversity. Description results in lower lexical diversity than discussion. One reason why this may be the case is that repetition of certain story features or characters can lower the lexical bar. In the sequence of cartoons the same character appeared throughout. The learners' texts showed that, overall, they interpreted the cartoon sequence in a literal manner despite a clear moral to the story which they were free to interpret and discuss. On a more pragmatic level, the learners were under considerable pressure to produce a minimum of 300 words in a relatively short space of time. The other task, a discussion of issues relating to globalisation, could call upon a greater variety of lexis. Moreover the complexity of ideas and the use of notes would certainly be influential in making a text less repetitious. This result contrasts with Kormos and Trebits (2012) who found that a more complex narration task resulted in a lower D value than a less complex description task. They argue that there is a cost in more complex tasks which require more attention resources which results in repetition. However, a task which is less cognitively demanding means that L2 learners can devote more time to lexical variation. The use of notes in the present study seems to have over-ridden any cost in terms of attention resources.

6 Conclusions

From the empirical work done we can see how learners who are grammatically sensitive recycle words in a more systematic manner than those who are not particularly grammatically aware. Grammatically sensitive learners are more likely to complexify their L2 because they are by definition able to detect the patterns in language. The ability to recognise grammatical patterns could dispose learners to use lexis in a more systematic manner in terms of function and semantically opaque words. Texts which have extremely low or high diversity typically have either excessive repetition or limited use of semantically transparent words which are needed to give a text precision. I have argued that from a vocabulary perspective, the use of semantically transparent function words and word phrases help to give a text its precision and complexity.

It should be noted that a certain amount of lexical recycling is necessary in order to drive forward complexity. The results suggest that there may be a ceiling effect of lexical diversity in relation to complexity. In other words, greater scores in diversity do not seem to be related to greater complexity. This highlights the need to complement any measures of lexical diversity with more qualitative, holistic ratings of quality in order to get a richer idea of lexical production. How words are used in relation to other words cannot simply be examined numerically.

The task topic and conditions had an effect on the diversity value (D). Even after controlling for the effects of different proficiency levels, there were significant differences between texts which described a cartoon sequence and texts which discussed globalisation issues. At both proficiency levels these differences could be seen. Discursive texts stimulate greater diversity than descriptive texts. These findings chime with others studies which have also looked at the effects task topic has on learners' lexical production (Reid 1990, Yu 2009). The stimulus for lexical production can have specialised effects for learners at different proficiency levels.

Lexical production is dynamic in the sense that task conditions, proficiency, and learning strengths are all factors which interact on vocabulary production. More recent research in L2 vocabulary shows that a learner's production changes over time (Bell 2009, Booth 2009, Caspi and Lowie 2010, Fitzpatrick 2012). This study has shown from a cross-sectional, rather than a longitudinal, perspective that sub-groups of seemingly similar learners differ and that these differences could be the by-product of learning characteristics. In fact, this study complements the findings from longitudinal studies of individual learners in that it is a static snapshot of learners' diversity production at a particular moment in time. From a teaching perspective, it is worth bearing in mind that the writing task which L2 learners do has an effect on their lexical production. Moreover, the

learning strengths of an individual can determine to some extent how the individual's lexical diversity is susceptible to wide fluctuations or whether there is an ingrained consistency which is not open to wild fluctuations.

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