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A case study of lexical development of writing and speaking in identical twins

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Résumé Cette étude analyse les compétences linguistiques de deux élèves débutants en anglais, à l'écrit comme à l'oral. En se basant sur les modèles théoriques de la langue, nous avons trouvé des différences ainsi que des similitudes entre l'écrit et l'oral. Nous avons étudié cent épisodes parlés et écrits de deux jumeaux sous deux aspects: la diversité et la complexité lexicales. Les résultats ont démontré une plus grande diversité lexicale à l'écrit qu'à l'oral. Cependant, les corrélations dynamiques de ces deux dimensions lexicales entre l'écrit et l'oral ne sont pas les mêmes chez les jumeaux.

Abstract This study investigates the lexical performances of two beginner learners of English in writing and speaking tasks. Based on theoretical models of writing and speaking, we find major similarities and differences between writing and speaking. We analyzed 100 writing and 100 speaking samples of two identical twins with respect to two lexical dimensions: lexical diversity and lexical difficulty. The results show a higher degree of lexical diversity in writing than in speaking. However, dynamic correlations of the two lexical dimensions in writing and speaking do not show the same tendencies amongst the identical twins.

Mots-clés : écrit, oral, théorie des systèmes dynamiques, ampleur du vocabulaire, diversité lexicale.

Keywords: Writing, Speaking, Dynamic system theory, Vocabulary size, Lexical diversity.

1. Introduction

In first language acquisition, beginner learners develop basic speaking competence earlier than writing competence (Fradd & McGee, 1994) as they mostly receive writing instructions after attending school at age six. In contrast to first language learners, second language learners do not necessarily develop balanced skills in their writing and speaking. Some L2 learners, who are proficient in speaking, cannot necessarily read or write with any level of competence (Milton & Hopkins, 2006). On the other hand, some L2 learners, who are not fully proficient in speaking, are already able to read and write well (Hudelson, 1984).

This paper begins by exploring the characteristics of writing and speaking as described by theoretical cognitive models, and will look at the relationship between writing and speaking, and at the similarities and differences between them. This paper is written within the tradition of a Dynamic Systems Theory approach to language development (de Bot et al.,

2007). Rather than focusing on the product of development at one moment in time, this approach emphasizes the process of language development and the dynamic interaction of factors that shape the language system. To understand how differences within written and spoken language use emerge over time, a microgenetic longitudinal case study was carried out. Two 15 year-old Taiwanese identical twins, who were beginner learners of English, were followed for eight months. Their writing and speaking were analyzed on two dimensions of lexical complexity: lexical diversity and lexical difficulty. We compared the mean scores of lexical diversity and lexical difficulty in writing and speaking and then analyzed their developmental patterns in terms of three learning stages of development defined by a mathematical model. The main question to be answered in this article is how the differences between writing and speaking emerge over time. We investigated this by observing which language production mode (writing or speaking) shows a higher degree of lexical complexity and by comparing the dynamic correlation in writing and speaking with respect to lexical complexity.

2. Literature Review

2.1 Theoretical models of writing and speaking

A framework aiming at understanding the cognitive processes that play a role in writing was proposed by Hayes and Flower (1981), and is shown in Figure 1. Three main elements of the writing process were distinguished: the task environment, the writer's long-term memory, and the control of a monitor of planning, translating, and revising. In the process of planning, writers generate ideas, organize ideas, set their goals for writing, translate the plans into text, and later edit the text.

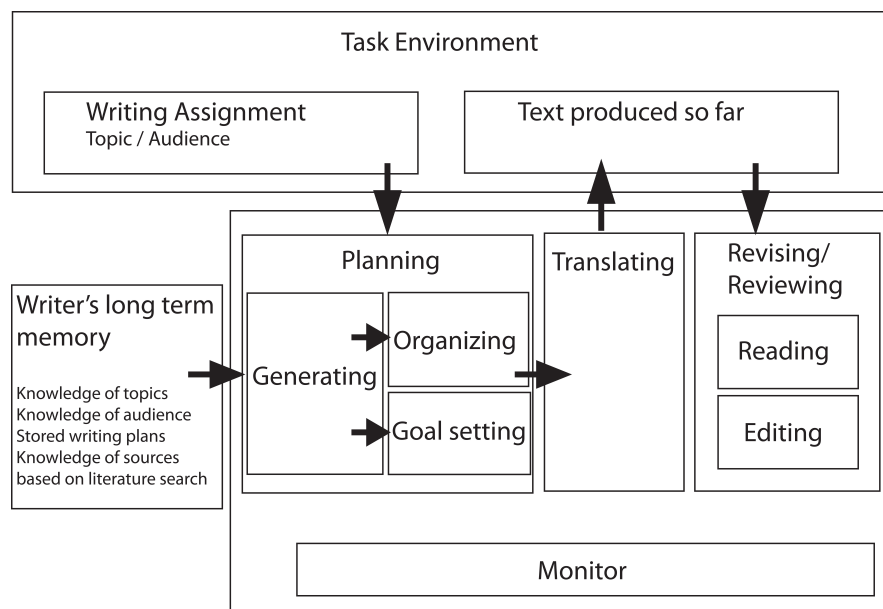


Figure 1: The cognitive process model of the composing process (Hayes & Flowers, 1981)

Levelt's model of speaking (1989) subdivided the process of speaking into three sequential components: a conceptualizer, a formulator, and an articulator. Each component serves as an output of another component. A preverbal message generated in the conceptualizer pro-

cess proceeds to the formulator. In the formulator, the preverbal message is turned into a verbal message, which involves grammatical and phonological encoding in interaction with the mental lexicon. The output of the formulator, the phonetic plan, proceeds to the articulator. In the articulator, the phonetic plan is turned into a speech utterance.

These two widely accepted theoretical models show three similar characteristics of the writing and speaking modalities. Firstly, both types of production have a communicative function that requires the learner to take into consideration not only the topic, but also the receiver. Writers communicate with the (imaginative) reader, while speakers communicate with the audience. Secondly, both speakers and writers formulate their production goals, which determine the mode of production. For instance, formal speech is more organized than a chat with a friend; an assignment is more organized than an email written to parents. Thirdly, both writing and speaking are based on three main processes: preverbal planning (conceptualizer), translating (formulator) and revising (feedback loop).

In addition to these similarities, differences between writing and speaking can also be observed. First, writing and speaking constitute different modes of operation: writers produce the written form whilst speakers produce the spoken form. Second, the time pressure that is higher for speaking than for writing. This implies that speaking is more automatic. Due to lower cognitive load, writing, compared to speaking, generally allows learners to find the more appropriate words to express a certain meaning (Halliday, 1985). Third, the option for revision in writing is basically absent in speaking.

2.2 Characteristics of beginner learners of English in Taiwan

Beginner learners of English in Taiwan do not have a balanced capacity of writing and speaking (Chang, 2006; Wu, 2012). This is caused by a strong focus on the ability to write in the English learning environment in Taiwan. Most beginner learners, from age six to twelve, learn to spell vocabulary by rote learning in order to achieve well on written tests, causing some of them not to be able to pronounce the English at all. Consequently, the development of speaking falls far behind that of writing in Taiwan.

Another characteristic of these Taiwanese learners is that they are not taught to set high standards of writing and speaking goals. In their writing and speaking productions, they do not focus much on which word they should select and whether the grammatical form is accurate. They do not pay much attention to revision: the ideas are not organized, the sentence structures are not entirely accurate, and words are not carefully selected. In short, they are writers write as they speak. This means that they mix registers easily which may lead to a style of writing that may be too informal for the test type used.

The only distinction between writing and speaking in these beginner learners of English in Taiwan is the modality of the presented form (written or spoken) and the degree of automaticity (time allowed to formulate the language). As our target participants, two identical twins, do not have significant difficulty producing spoken or written utterances based on the results of their general English proficiency test (GEPT) where they both passed writing and speaking sections (80/100), the only factor that affects the difference between these modalities is the degree of automaticity, which may lead to the differences in lexical complexity between the two types of production.

2.3 Studies comparing writing and speaking

Two studies have compared the syntactical complexity and lexical complexity of L2 writing and speaking and the relation between writing and speaking. Dykstra-Pruim (2003) observed the writing and speaking relations of learners of German over three semesters. The average number of complex type clauses per subject was found to be lower in writing than in speaking. Additionally, the strength of the correlations between writing and speaking in the different grammatical domains changed over time. For instance, there was no correlation between writing and speaking for the accuracy of verb use in the first two semesters, but a significant positive correlation was found in the third semester. Given the fact that the correlation between writing and speaking did not remain constant over the different learning stages, a changing correlation between two tasks is expected in our longitudinal case study.

Yu (2010) studied the relations between writing and speaking in advanced learners of English with respect to lexical diversity (number of different words used in the text). He compared the measure D (Malvern & Richards, 2002) of twenty-five intermediate learners of English. Contrary to what was expected, the writing tasks, which allowed learners to have more time to plan and organize their production, did not have higher D-scores than the speaking tasks. No significant correlation was found between the values for measure D in writing and speaking.

However, as argued by Yu, lexical diversity only accounts for the number of different words and does not explain how these different words were distributed across different frequency bands. The sentence “I go to school with my dog” has the same lexical diversity as the sentence “A barber had my hair permed stylishly.” However, the second sentence has higher lexical difficulty than the first sentence. That is, the second sentence contains more words belonging to higher frequency bands (less frequent words). So in addition to looking at lexical diversity, lexical difficulty should also be considered in the comparison of writing and speaking.

One tool, the Lexical Frequency Profile (LFP) developed by Laufer and Nation, is a potentially useful instrument to measure the percentage of words in the frequency bands (1 to 1000, 1001 to 2000, 2001 to 3000, 3001 to 4000, and so on). However, this tool was not sensitive enough to trace the differences in terms of percentage of words in the frequency band among groups of closer levels of English proficiency (Meara, 2005), so that it is not likely to be useful in assessing proficiency in individual development. As our study follows the individual development on a weekly basis, LFP could not be used as a suitable tool to measure the lexical difficulty based on frequency bands.

The only alternative possibility to evaluate lexical difficulty based on frequency bands is to use the extrinsic index: V-size. V-size (Meara & Mirapleix, 2004) was originally developed to estimate writers' vocabulary size based on the number of the words used in different frequency bands. The basic assumption of V-size is that the more proficient learners are, the more low frequent words there will be in their writing. V-size generates a score, which can be considered to be either learners' estimated vocabulary size or the level of lexical difficulty of learners' writing. V-size as an index of lexical difficulty based on frequency bands is sufficiently sensitive, and is therefore an appropriate measure to investigate the individual development on a weekly basis.

In the current study, the first question to be answered is whether writing and speaking differ in lexical diversity and lexical difficulty. As writing is less automatic, learners have more time to select the words to use, which potentially increases the level of lexical diversity and lexical difficulty. Therefore, we hypothesize that writing generally shows higher levels of lexical diversity and lexical difficulty than speaking.

Yu's (2010) study did not show a significant correlation between writing and speaking in terms of lexical diversity among advanced learners of English, which was probably due to the limited number of data points. His study did not provide any conclusions about the correlation between lexical characteristics of speaking and writing in beginner learners of English. Therefore, the second research question to be answered is whether there is a correlation between writing and speaking for beginner learners of English in lexical diversity and lexical

difficulty. Finally, as shown by Dykstra-Pruim's study (2003), the strength of the correlation between writing and speaking seems to change over time. We therefore also investigate whether and how the correlations of writing and speaking change over time.

2.4 A dynamic systems approach to lexical development

The present study starts from the assumption that lexical development in speaking and writing is a dynamic process. Full treatment of the application of Dynamic Systems Theory (DST) to lexical development is beyond the scope of the present article. Discussions of the basics of DST and its application in L2 development can be found in de Bot (2008), Lowie & Verspoor (2011) and de Bot et al. (2013). The basic assumption is that development is an iterative process in which the next state of a system is a modification of the previous stage. In development different aspects may change in different ways and some processes of development may support each other - connected growers in terms of Van Geert (2008) - but they may also compete. For the present study the aim is to see to what extent the development of writing and speaking support each other as reflected in positive correlations over time between the two modalities or rather should be seen as competitive. It is conceivable that in one stage of development all the cognitive resources are spent on writing development, which may go at the expense of speaking, or the other way around. In DST, it is assumed that development is not linear and that the interaction between variables over time can lead to complex patterns. The dense data in the present study allow us to see how the modalities develop and how they interact over time.

3. Methodology

3.1 Participants

Two identical twins, Gloria and Grace (not the participants' real names), participated in the study. They were 15 year-old (ninth grade) Taiwanese beginner learners of English whose L1 was Chinese. They received conventional eight-hour English lessons (per week) at school, where most of the instructions were in Chinese, and the focus was on L1-L2 translation. However, in order to enhance their development in lexical diversity and difficulty over time, they were given extra input outside the classroom by the researcher in different amounts at different moments. In terms of the hours of exposure, roughly three stages can be distinguished. From writing 1 to 20, they received low to intermediate amounts of input; from writing 21 to 56, they received high to intermediate amounts of input; from writing 57 to 100, they received intermediate to low amounts of input.

3.2 Procedure

The two participants produced two to three writings (200 words with no time limit) and monologue recordings (2 to 3 minutes, free to stop) per week. Over a period of eight months, 100 written and oral texts were collected from each participant. The topics for writing and speaking were selected from the list of standard TOEFL¹ tests provided by the researcher at the beginning of the study. The researcher reminded the participants to produce writings and recordings every week. The writings were posted on a Facebook writing club constructed for

¹ The TOEFL writing topics are available on line at the following URL: <http://www.ets.org/Media/Tests/TOEFL/pdf/989563wt.pdf> [last consulted February 19, 2014].

the purpose of the experiment, and recordings were sent to the researcher via Gmail. Participants were able to access each other's writings and could comment on what they read or wrote. They could choose whether or not to respond to each other if they received feedback on their writings.

The choice of topics in writing and speaking are usually assumed to affect production performance; the difficulty of the writing topics was therefore controlled as much as possible. The TOEFL topics can be regarded as a reliable selection of writing topics, as its general topics can potentially elicit the use of as many words from learners as possible. Although the eventual choice of topics may largely depend on learners' personal experience and preferences, of the fact that we have used identical twins with the same background and similar hobbies can be expected to minimize the effect of the topics.

After collecting all the writings samples and monologue recordings, we calculated the values of lexical diversity and lexical difficulty. The most commonly used measure of lexical diversity is the Type-Token Ratio (TTR). However, TTR is strongly affected by the text length. Thus, McKee, Malvern, and Richards (2000) developed one adjusted metric of TTR, the *D*, where the text length has little effect. The higher the value of *D*, the greater the lexical diversity is. As an operationalization of lexical difficulty, we used *V*-size (Meara & Mirapleix, 2004). As previously explained, *V*-size is a reliable measure to express the difficulty of the word use in the texts. To investigate the development of *V*-size over time, we fitted the *V*-size values for each of the frequency bands with a mathematical model. Analogous to *D*, the higher the value of *V*-size is, the higher the level of lexical difficulty the words will be.

After obtaining the values of the lexical measures, we plotted these values to observe the development of lexical diversity and lexical difficulty. We applied an automatic smoothing technique to our data, which is known as spline smoothing (Chambers & Hastie, 1992). This technique reduces the variability locally in a dynamic way, while preserving the most important information in the data sets. With the smoothed data, we were better able to focus on the general trend without being distracted by the variability.

However, the general trajectories found could not answer our research questions, as the descriptive analysis is only based on visual observation. We therefore applied a mathematical model, the hidden Markov model, to quantify lexical development and the relations between writing and speaking at three learning stages.

3.3 Hidden Markov Model (HMM)

Through the HMM, we are able to determine mathematically the most likely learning stages given the time-series data of several variables at the same time – the hidden stages are inferred on the basis of the observed data. In our study, the learning stages are inferred by four linguistic measures: lexical diversity and difficulty in both writing and speaking. However, to reach the ideal estimation of the learning stages, it is important to select the number of stages, revealing the differences in each stage. On the basis of the amount of input received in three different periods as indicated in section 3.1 (i.e. from low to intermediate level of input, from intermediate to high level of input, and from intermediate to low level of input), we assumed that defining three stages in HMM should give us enough information to reveal the overall developmental pattern of the learner. Finally, the stages of lexical development could be determined from the model, including the information on how the stages coincided with data points, the means of the variables at each stage, and the covariances between variables at each stage.

4. Results

4.1 Comparison of the means and correlations of variables in writing and speaking

The means of the lexical measures in writing and speaking of the two participants are presented in Table 1. The means of vocabulary size of Gloria’s writing and speaking did not show any difference, but the means of vocabulary size of Grace’s writing were found to be significantly lower than that of her speaking. However, the means of vocabulary diversity of Gloria’s and Grace’s writings were both significantly higher than that of Gloria’s and Grace’s speaking.

Gloria- Writing (Vocabulary Size)	Gloria-Speaking (Vocabulary Size)	Significance
Mean=3492, SD=989	Mean=3306, SD=1390	
Grace- Writing (Vocabulary Size)	Grace- Speaking (Vocabulary Size)	
Mean=3008, SD=1195	Mean=3648, SD=1894	**
Gloria- Writing (D)	Gloria- Speaking (D)	
Mean=60.92, SD=12.09	Mean=42.63, SD=9.08	**
Grace- Writing (D)	Grace- Speaking (D)	
Mean=53.88, SD=12.13	Mean=38.58, SD=9.06	**

** p < 0.01

Table 1: Significance between writing and speaking in V-size and D

As shown in Tables 2 and 3, there does not seem to be any relationship between the overall means of writing and speaking in vocabulary size and vocabulary diversity in Gloria and Grace’s data, as none of the correlations are statistically significant.

Writing	V-size	D
Speaking		
V-size	-0.15 (p=0.14)	
D		0.15 (p=0.13)

Table 2: Correlations of two variables in writing and speaking: Gloria

Writing	V-size	D
Speaking		
V-size	-0.12 (p=0.25)	—
D	—	-0.17 (p=0.10)

Table 3: Correlations of two variables in writing and speaking: Grace

4.2 Modeling development of speaking and writing

Figure 2 shows the general trends of lexical difficulty and lexical diversity of the two subjects in writing and speaking over time. Over time, Gloria’s vocabulary size in writing was gener-

ally higher than in speaking; in contrast, Grace’s vocabulary size in speaking was generally higher than that in writing over time. Both Gloria’s and Grace’s vocabulary diversity in writing were higher than in speaking.

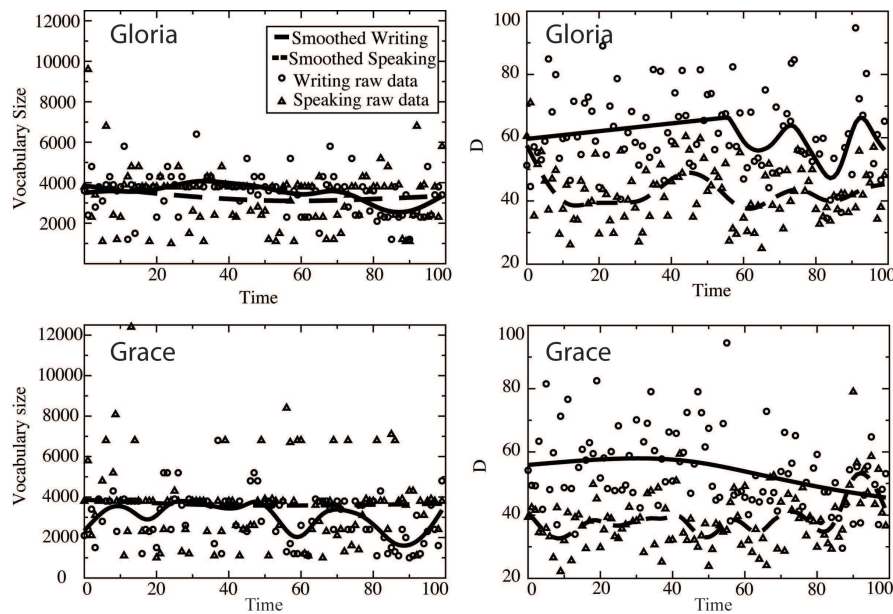


Figure 2: Development of V_size and D of Gloria and Grace

Tables 4 and 5 depict the means of vocabulary size and vocabulary diversity in each stage and the data points falling in each stage. For instance, Table 4 shows that Gloria’s first stage was from data point 1 to 27, which had a mean of V-size value in writing of 3598, a mean of V-size value in speaking of 3690, a mean of vocabulary diversity (D-value) in writing of 61.8, and a mean of vocabulary diversity (D-value) in speaking of 42.9.

There are two interesting points worth noting before we present the differences in the lexical measurements over the three stages. Firstly, even though the twins have different values of lexical measures, they seem to show very similar trained hidden stages. For instance, Gloria’s first stage runs from writing sample 1 to 27, and Grace’s first stage runs from writing sample 1 to 32. Secondly, the learning stages in the mathematical model seem to go hand in hand with the input stages defined by the amount of input hours (writing 1 to 20, writing 21 to 56, and writing 57 to 100). Therefore, the selection of the number of the stages appears to be an accurate reflection of the data set.

Observing the changes in lexical measurements over three stages, we found that Gloria’s vocabulary size in writing was almost equal to that in speaking at stage 1, and higher than that in speaking at stage 2, but became lower than that in speaking at stage 3. There seemed to be a shift of a larger vocabulary size from writing to speaking in Gloria’s development. Grace had a smaller vocabulary size in writing than in speaking in all three stages. As far as vocabulary diversity was concerned, the twins had higher vocabulary diversity in writing than in speaking at every stage.

Gloria	Mean of Vsize in writing	Mean of Vsize in speaking	Mean of Vocd in writing	Mean of Vocd in speaking
Stage 1 (1-27)	3598	3690	61.8	42.9
Stage 2 (28-75)	3797	3001	62.7	42.5
Stage 3 (76-100)	2780	3469	57.5	42.6

Table 4: Means of V-size and D in writing and speaking in three stages: Gloria

Grace	Mean of Vsize in writing	Mean of Vsize in speaking	Mean of Vocd in writing	Mean of Vocd in speaking
Stage 1 (1-32)	3310	3759	56.31	36.47
Stage 2 (33-67)	3146	3515	57.07	36.46
Stage 3 (68-100)	2576	3681	48.22	42.80

Table 5: Means of Vsize and Vocd in writing and speaking in three stages: Grace

Table 4 depicts the correlation of each variable in writing and speaking at all three stages. Due to the small number of the data points in each stage (approximately 33 data points) compared to the whole time series of development (100 data points), the correlations between writing and speaking would have to be relatively high before significance can be reached (at $p < 0.05$). Only two of the correlations are found to be statistically significant in three stages.

The first question addressed in this study was whether there is a difference between writing and speaking in lexical diversity and lexical difficulty. Based on the comparison of the means of the lexical diversity and difficulty in writing and speaking, lexical diversity proves to be significantly higher in writing than in speaking, but lexical difficulty in writing is either equal to or lower than lexical difficulty in speaking. Similar findings are found with the trajectory and the three learning stages. The trajectories of lexical diversity in writing are mostly higher than those in speaking and the values of lexical diversity in writing are always higher than those in speaking at three learning stages.

The second question concerned correlations of writing and speaking between the two learners. The results show that no statistically significant correlations were found in writing and speaking for lexical diversity or for lexical difficulty among beginner learners.

The third question extends our understanding of the second question. It attempted to find out whether the correlations between writing and speaking change over time. The two identical twins did not show similar results: the correlations between Gloria's V-size values for writing and speaking did not change over time while those of Grace's change from no correlation to a negative correlation. For lexical diversity (D), the correlations between Gloria's writing and speaking changed from no correlation to positive correlation at the second stage while those of Grace did not change over time.

Gloria's lexicon	Correlation of Vsize in writing and speaking	Correlation of Vocd in writing and speaking
Stage 1 (1-27)	-0.25 (p=0.18)	-0.20 (p=0.28)
Stage 2 (28-75)	-0.03 (p=0.86)	0.43 (p=0.002 **)
Stage 3 (76-100)	-0.01 (p=0.95)	0.15 (p=0.45)
Grace's lexicon	—	—
Stage 1 (1-32)	0.13 (p=0.47)	-0.007 (p=0.97)
Stage 2 (33-67)	-0.12 (p=0.27)	-0.17 (p=0.33)
Stage 3 (68-100)	-0.37 (p=0.02*)	-0.11 (p=0.52)

Table 6: Correlations of V-size and Vocd in writing and speaking in three stages

5. Discussion

Our study compared the lexical development in writing and speaking with a focus on lexical diversity and lexical difficulty. The lexical diversity was significantly higher in writing than

in speaking, which deviates from Yu's (2010) study in which no difference in lexical diversity in the writing and speaking of intermediate learners of English was found. This may be due to the fact that beginner learners, compared to intermediate learners, do not show similar lexical diversity in writing and speaking. The limited time available in speaking and the relatively high automaticity in speaking restricted ranges of word use of beginner learners, but not that of intermediate learners.

In contrast to our expectations, the values found for lexical difficulty were not higher in writing than in speaking. Apparently, more time allowance to monitor writing production did not lead to increased lexical difficulty in use. The results focusing on the three learning stages show that Gloria, like many learners of English in Taiwan, first developed the difficulty of word use in writing and in speaking while Grace first developed the difficulty of word use in speaking. What may play a more important role than the time allowance in the lexical difficulty is the individual language learning strategies: Gloria preferred to first try out less frequent words in her writing and to use her writing as a support for developing her speaking skills. Grace preferred to first try out less frequent words in her speaking and used speaking to support the development of her writing skills. Since writing and speaking are both means of communication, the choice of rehearsing the language depends on learners' preferred way of communicating with their receivers (readers or listeners).

Since this study was done within the framework of a Dynamic Systems Theory approach to language learning, our empirical study especially focused on the changing correlations of writing and speaking over time. Similar to what was found in Dykstra-Pruim's study (2003), the correlations of writing and speaking changed in strength over time either from no correlation to negative correlation or from no correlation to positive correlation in either lexical diversity or lexical difficulty, which led to average correlation values very close to zero. We therefore confirmed the necessity of investigating when and why the correlations changed over time. However, the results of our study show that no definite conclusions can be drawn with regard to the direction of the changing correlation between writing and speaking over time, as the identical twins diametrically opposed relations between writing and speaking in different lexical measures. This finding corroborates the observation that language development is a highly individual process (Lowie, 2013) and that the result of dynamic iterations cannot be predicted for different individuals.

In our study, we compared the lexical performance in writing and speaking. We have not yet investigated the difference between writing and speaking in syntactical dimensions. A future study could compare writing and speaking in terms of syntax or could further focus on exploring how these variables (lexical and syntactical) interact with each other over time. This may shed light on multi-dimensional comparisons of writing and speaking and the interrelationships of the variables in speaking and writing.

6. Conclusions

The aim of this study was to explore lexical development over time in speaking and writing. A set of dense data has been analyzed using both visual inspection of patterns of development and mathematical modeling. This study demonstrated the impact of modality on the variety of words used in writing. From a DST perspective, the findings are highly relevant in that they show that even when initial conditions seem to be the same, since we tested identical twins who have the same family background and language environment but also the same language input, the patterns of development of the two individuals show remarkable differences. It is not clear what causes these differences. It may be due to different preference of rehearsing the language. Therefore understanding individual performance of writing and speaking is as important as understanding group performances of writing and speaking. There are no real indications that the processes of development in speaking and writing are causally related: correlations over time were low and not significant.

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