A dynamic approach to the development of lexicon and syntax in a second language
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Chapter 2

Background: A Dynamic Systems and Usage-Based Approach to Writing and Speaking
In this chapter, the two theoretical frameworks that are core to this dissertation are discussed and linked to the research questions that arise from the discussions. It has been shown (Verspoor & Behrens, 2011) that a Usage–Based (UB) approach to Second Language Development (SLD) provides a perspective on language and language learning that is in line with the major tenets of Dynamic Systems Theory (DST). We will discuss the basic ideas behind the UB approach and link it to the DST perspective as a theory for SLD. The most important aspects of a dynamic usage-based (DUB) approach to language use and learning will be presented as well. In the final part of this chapter, we will focus on language acquisition of English in the Taiwanese setting from these two theoretical perspectives.

### 2.1 A usage-based approach to second language development

A fundamental view of language acquisition from a usage-based (UB) perspective is that language, as a part of human cognition, emerges from language use (Ellis & Larsen-Freeman, 2009; Tomasello, 2003) and does not develop according to a largely predetermined innate mechanism. Humans hear or read the language input, sort out the meanings of individual words, and construct sentence structures. Humans also search for the appropriate words to express their meaning during communication and sort out the appropriate patterns of organizing these words. Words are created for the purpose of meaningful communication, whereas sentence structures emerge from using general cognitive processes. In order to achieve the goal of communication with other people, humans use linguistic conventions to describe meanings and then learn how to use these linguistic conventions consistently (Tomasello, 2001). In order to productively use these words systematically, humans categorize, compare (analogy), and choose (distributional analysis) their own patterns of generating language: this process describes their acquisition of grammar (Goldberg, 1995, 2006). In this way, humans gradually build up their own language systems through their contact with the language.

Under the umbrella of the usage-based approach, several models of language processing are built upon the assumption that human language derives from the contact and the use of the language. Cognitive grammar (CG) theory (Langacker, 2008) sees grammar as an apparatus to engage people in the world. Acting as conventionalized form-meaning pairs at different
levels (morpheme, word, phrase, clause, sentence), grammar reflects the means of the process of involvement in language learning: we go beyond the immediate experience to construct our own language where syntax is embedded in lexicon, and lexicon constitutes syntax. In line with the UB approach, there is no principled distinction between lexicon and syntax as both emerge from contact and use of the language.

The process of constructing grammar can be understood with emergent grammar theory (Hopper, 1998). Regular patterns are found through the discourse established over time rather than through a pre-programmed language faculty (Chomsky, 1986). People interact with the massive and complex environment (Ellis, 1998) where different kinds of repetitions, lexical or syntactical, emerge. Grammar can be taken as “the name for certain categories of observed repetitions in discourse” (Hopper, 1998, p.156), and learning grammar is probabilistic in nature. In line with the UB approach, developing one’s language is sensitive to external resources (frequency, contextual contingencies, attention). Thus, the nature of language learning is primarily determined by the learners’ input (Ellis, 2006a, 2006b).

The frequency of language use is a necessary component for language acquisition. Each occurrence of a word or a sentence pattern leaves a memory trace in the learners’ minds and leads to entrenchment. The more frequently learners encounter the word or the sentence pattern, the more likely learners are to memorize the word or the sentence pattern. As the process of shaping the language emerges from the input, language acquisition depends crucially on the type and token frequency of certain words or certain sentence patterns appearing in the input (Tomasello, 2003).

Input has also been the main source of language learning in MacWhinney’s unified model (UM) (2008). Through comparing input and sorting out the similarities and differences, the acquisition of language takes place. However, in addition to only accounting for language processing with frequency, his unified model emphasizes the importance of cue availability, reliability, and validity. How often a cue is present in the input (cue availability) and how often a cue is used consistently (cue reliability) determines cue validity. For instance, the pronouns “we” and “they” are followed by the verb “are” in most of the input consistently. From a probabilistic point of view, we will infer that the cue “we are” or “they are” can be seen to be valid.

A usage-based (UB) approach to language learning implies that humans discover the regularities and patterns of the language through contact with the language and that it is not necessary to assume innate grammar that
A dynamic systems and usage-based approach will determine the language developmental path. Each person is exposed to different types of input and experiences with the language in different contexts, which results in different trajectories among individuals. Contrary to what is assumed as language processing in a usage-based perspective, Universal grammar (UG) sees human language learning as a genetic adaptation (Chomsky, 1996). Human beings develop their language faculty over time whilst other species do not. This unique genetic adaptation for language, which distinguishes humans from other species, drives language acquisition. Every person has the same innate language acquisition device, where all languages share the same basic principles. In this dissertation, we take a frequency-based probabilistic point of view of language development, since it has been convincingly demonstrated that language development can be accounted for without assuming an innate language system.

In UB, language development is an experience-situated process: it is the accumulation of the learners’ experiences with the language. Every time we process the input, we reconstruct our language. Every time we encounter a word, we change our way of shaping the word meaning and the habit of using the word. In order to account for the emergence of such complex constructions (Herdina & Jessner, 2002; Larsen-Freeman & Cameron, 2008; Plaza-Pust, 2008), studies focusing on how language is formed and influenced by input over time are necessary. As second language development (SLD) is a complex and dynamic process (De Bot, 2008), it is essential to look at development over time. We need a framework that centers on the process as it changes over time. Dynamic systems theory (DST) is the framework that can offer a good basis for the study of SLD.

2.2 Dynamic system theory as a theory of second language development

DST is essentially a field of mathematics. Researchers have applied it to describe the behavior of complex dynamical systems by employing differential equations where one or several variables are related to the functions of itself and its derivatives of various orders. If there is an analytical solution to the differential equation, the boundary condition (initial condition) is substituted to obtain the exact solution. If there is no analytical solution to the differential equation, we can only use the iteration to obtain the value of the variable. Most of the differential equations are non-linear as some strict conditions must be met in the linear differential equations.
Using DST as a metaphor, many studies have applied these mathematical characteristics of DST to understand SLD (Larsen-Freeman, 1997; Herdina & Jessner, 2002; De Bot, Lowie, & Verspoor, 2007; Larsen-Freeman & Cameron, 2008; Verspoor, Lowie, & Van Dijk, 2008; De Bot & Larsen-Freeman, 2011; Lowie, 2013). Following is a list of characteristics of a dynamic perspective on SLD:

1. Language is sensitive to initial conditions.
2. The current level depends on the previous level: iteration.
3. The change of the language system is a result of internal self-organization and interaction with the input.
4. Language depends on the internal and external resources.
5. The language system is constituted by several embedded subsystems (variables) that interact dynamically.
6. Language emerges from the self-organization of several embedded subsystems (variables).
7. These embedded subsystems (variables) constantly change with chaotic unpredictable variation.
8. Language development is mostly non-linear.

These characteristics of DST will be discussed in detail on how they are related to SLD in the following section.

It is important to explain all the initial conditions which may make a difference to the learning outcomes. Lorenz (1963) demonstrated the sensitive dependence on initial conditions using the butterfly effect metaphor: a very small difference in the initial conditions of a system may bring about massive change later on. Each beginner language learner, who goes through very similar learning experiences to other learners, may develop very different learning outcomes due to small differences in their initial conditions (e.g. a learner’s proficiency level in L1 or a learner’s favorite TV programmes). Identifying all the relevant initial conditions for the learning outcomes is difficult, and it aggravates the difficulty of predicting language development.

Language develops over time: it is iterative in the way that the current state of language development emerges from all previous stages. For instance, the previous capability of the learners’ second language may affect the current sensitivity to the exposure to second language input. The higher the learners’ capability in the second language, the more sensitive they are to the input as they have more internal resources to process the input. Similarly,
previous contact with second language input may affect the current state of the learners’ second language. The more input learners are exposed to, the higher learners’ chances of developing the second language are as they have more external resources to trigger change in the language system.

Language development depends largely on the internal and external resources learners have. Internal resources are the resources within the learners such as their memory capacity, the learning capacity, and motivation; external resources are the sources outside the learners such as linguistic environment and interaction with other people (Van Geert, 2008). However, these resources can act as both a “driving force” and a “delimiting factor” in development (Van Geert, 2003, p.656). There is a maximum “attainable growth level” (Van Geert, 1995, p.316), or “carrying capacity”, based on the resources available to learners.

Seeing language as a dynamic system, we see different linguistic variables such as the lexical system and the syntactical system as interconnected subsystems. A change in one variable (seen as the embedded subsystem) will bring about a change in another variable, which in turns leads to change within the entire language system. The interconnected relations between the embedded subsystems can have two directions: either competitive or supportive interaction (Caspi, 2010), which can dynamically change between stages of development. If there is a competing relation between two variables, these two variables develop in opposite directions. When one variable increases, the other variable decreases. When one variable decreases, the other variable increases. There can also be a supporting relation between variables. In the supporting relation between two variables, these two variables develop in the same directions. When one variable increases, the other variable increases or vice versa. A good illustration of the dynamically competing and supporting relations between two variables is how lexical development may hinder syntactic development in some stages of development, while in another stage lexical and syntactic development may be mutually supportive (Caspi, 2010).

As a result of the nonlinear relationships between subsystems (competitive or supportive), a curvilinear (non-linear) development can be highly predictable. One good illustration of understanding the non-linear development pattern is Meara’s study in 2004. He described the vocabulary loss with a simple simulation model (Boolean network model) by studying the effect of switching off one word after another. He finds that when switching off one word after another, there will be an effect on the entire lexical network and that this does not lead to a completely predictable decline of
vocabulary loss.

Through understanding the characteristics of DST, it is evident that DST can be used as a theory of understanding SLD. Research with a DST perspective on SLD should describe how the language system is formed and how the different subsystems (different linguistic variables) are interconnected. This is in line with the UB approach where language is seen to be emergent from experienced-situated processes. Therefore, with a dynamic usage-based approach, we focus on language as a usage-based process rather than a pre-determined product. Instead of only looking at causal relations, we focus on the interconnecting linguistic variables and the dynamic interrelation between developing subsystems.

Most natural phenomena are involved in chemical reactions (e.g. smelting iron, brewing beer, and making cheese) where the reactant and the product are well-known to everybody, but the processes are mostly only known to a small number of people. However, if the processes of these chemical reactions remain unknown, the chances of improving them or applying them to other reactants are small. Language acquisition, a natural phenomenon of human beings, is generally being observed on its reactant (input or innate grammar, cognition) and its product (language proficiency test). Studies investigating what reactant can enhance the product are ubiquitous, but only a limited number of studies focus on observing the processes of language acquisition. However, unveiling the processes of language acquisition is essential as it can improve learners’ language acquisition and can be applied to other domains of research such as artificial intelligence.

Ergodic process, which is an ideal description of the evolution of dynamical systems, has the same behavior averaged over time as averaged over the space of all the system’s states, which are comprised of so-called “phase space”. Spatial averaging describes the average properties of many identical systems within a specific position, which statistically provides the information of how the states of system are distributed. Time averaging describes the average properties of a single system over a period of time, which dynamically illustrates how the state of the system evolves along the trajectory. Once the spatial and time averaging converge, the observation is assumed to be able to depict dynamical systems confidently (Birkhoff, 1931). For instance, to understand the dynamical properties of climate change, one should not only record the temperature of all the cities in the world, but also should observe the temperature fluctuation of a certain city over a long period of time. The combined information could inform us of a better understanding of how climate will change in the future.
Similarly, to understand the dynamical system of the language, one should observe the linguistic capacity of a group of language learners at a certain time; one should also observe the linguistic capacity of a participant over a long period of time. Most of the studies in applied linguistics apply the spatial averaging with a limited number of observations over time (2 or 3). Studies focusing on applying the time averaging as the major observation are few. The studies from two types of observations are supposed to complement each other rather than compete with each other.

2.3 Dynamic system theory approaches to modelling language development

With a UB perspective, language is shaped by in interaction with the input and thus each individual has different trajectories of language development. DST, combined with UB as a theory of language development, can help us understand SLD. To understand the dynamic and complex language development, we cannot only rely on a non-dynamic research approach which only looks at the mean of performances without involving time as a core aspect of development. Neither can we exclusively rely on a descriptive analysis of the language development. We need to develop a dynamic analytical approach that takes into account individuals’ language development over time.

Van Geert, Caspi, and Lowie (Van Geert & Van Dijk, 2002; Van Geert, 2004; Caspi, 2010; Lowie, Caspi, van Geert, & Steenbeek, 2011; Caspi & Lowie, 2013) have developed dynamic analysis tools (mathematical modelling) to quantify the observations of language development. There are two types of observations on modeling language development in their studies. The first type is the observation of the developmental pattern of the variables over time; the second type concerns the way the variables interact over time. They looked at language development as an iterative process using logistic equations to model language development, starting with a single variable and adding other variables to simulate real human learning as much as possible. Although it is more meaningful to include more variables to see how they interact over time for a description of development, observing the microscopic development of one variable can be a good and simple start to discover and to describe the bigger picture of language processing. In a DST approach, development is the result of interaction with the input. As an illustration, we will now look at how different types...
of input (incidental and intentional) may affect the vocabulary learning in relation to different types of vocabulary knowledge.

2.4 Incidental and intentional vocabulary learning and vocabulary knowledge

Language learning is largely dependent on input, but input does not necessarily lead to intake. A requirement for input to become intake seems to be that input is “noticed” by the language learner (Krashen, 1981; Schmidt, 1990). As argued by Gass (1997), many factors may influence whether input is noticed, such as the learners’ prior knowledge of the language, the frequency of the input, and time pressure. The noticed input may be comprehended by the learners to different extents: some can comprehend the noticed input at the meaning level whilst some can comprehend it at the grammar level. The comprehended input may become intake, but how input is turned into intake seems to depend on noticing something in the input that is relevant for a given developmental phase. Therefore, if a learner’s prior knowledge of the language is not sufficient, the chances for this learner to notice and to comprehend the input are smaller, which leads to less intake in the end.

As the occurrence of intake depends on the noticing of input of the learners, it is crucial to investigate what approaches may lead to the noticing of input during the process of comprehension. There are two major approaches to presenting the input for the purpose of vocabulary learning, namely incidental (implicit) and intentional (explicit) learning. The major difference between these two approaches is the degree to which the words are presented in a context. With an incidental learning approach, students are provided with reading or listening as a source of input and focus on comprehending the meaning of the input by guessing the word meaning from the input and deducing the content of the input. But there may also be incidental learning from less formal input (e.g. when watching a movie in the target language). With an intentional learning approach, students are provided with explicit knowledge of each lexical item and focus on learning the words per se rather than in the context.

These two approaches to presenting input deal with two major aspects of vocabulary learning: vocabulary size and vocabulary knowledge. Learners need a certain number of words in order to operate in a second language.
For instance, learners need around 8000 to 9000 word families (English) in order to read a wide range of texts (Nation, 2006). However, merely recognizing the words is not enough to productively use the language. There is a need to know each word in more detail. A very detailed description of what should be known for each lexical item is provided by Nation (2001, p.27): word form (what it looks or sounds like), word meaning (what it means), and word use (how it can be used in combination with other words). For instance, the knowledge of the word form (cat [kat]) is constructed when the written form and the spoken form of the word are established. The knowledge of word meaning (stupid) becomes more complete when the link of word form and word meaning is established and when the synonym (foolish) or the antonym (smart) can be called upon. The knowledge of word use is more or less complete when learners know how to use the word in different contexts, but also with other words as collocations (“commit suicide” instead of “do suicide”).

A large number of studies have focused on the effect of incidental and intentional vocabulary learning on different types of vocabulary knowledge (Hill & Laufer, 2003; Hulstijn, 1992; Hulstijn & Hollander, 1996; Hulstijn & Laufer, 2001; Laufer, 2005; Laufer & Rozovski-Roitblat, 2011; Schmitt, 1997; Schmitt, 2008). Incidental learning in a rich linguistic environment seems to help students in increasing their opportunities of encountering the same word (the number of repetitions of the same word) and providing the various contexts of the same word. It thus supports students in learning the contextual knowledge of the vocabulary where learners are able to associate the words and to use the words in the context. In contrast, intentional learning seems to effectively strengthen the students’ link between the word form and word meaning where learners are able to expand their vocabulary in size. It is suggested by Schmitt (2008) that learners will typically expand their lexical skills through a combination of incidental and intentional learning.

2.5 Second language development in writing and speaking

With a Dynamic Usage-Based (DUB) approach, language development emerges from language use and self-organization. Writing and speaking are essentially two forms of language use which can be utilized to observe L2 development and to observe the self-organization of the language sys-
In this section, we will compare these two forms of language use in naturally occurring processes, then compare them in the development in L1 and in L2, and finally discuss how these two forms of language use can act in self-organization.

Writing and speaking are similar in several aspects. Firstly, they are both means of communication: one to the reader/writer; the other to the listener/speaker. Secondly, the processes of writing and speaking share similar features: from the pre-verbal stage to construct an idea, to translating the idea into a text, and to formulating or revising the text for final production. Thirdly, they are both highly influenced by the L1, especially in the beginning stages of learning. The evidence of cross-linguistic influence can be easily found in their productions. However, the time allowed for producing the final products in writing and speaking significantly differs. Writing allows more time to think and to revise, while speaking allows little time. The automaticity of speaking seems to make the speaking task itself more difficult than writing (if the goals of the two tasks are the same, for instance, an essay and a speech, or a mail and a conversation). Another difference between writing and speaking is the degree of interaction involved in the production. Writing involves interaction with the writer and the potential readers whilst speaking involves a more direct interaction with the speakers. Research on priming and conversational alignment (Garrod & Pickering, 2004) suggests that in interaction, speakers make use of what has been said before, thereby making the speaking task relatively easy. Therefore, we could argue that interactive speaking is relatively easier than writing. But this only applies in interactional settings, not in monologues. Bourdin and Fayol (1994, 1996, 2002) carried out a series of empirical studies investigating the ability to recall the written and the spoken form of the L1 in children. These children heard a word/sentence list with increasing numbers of words and were asked to recall the word/sentence list in the same order of the words presented. It was found that children were able to recall more words in the spoken condition than the written condition at the word level and at the sentence level. Children begin to practice their spoken form in L1 when they are born and only begin to practice their written form in L1 after entering school. On top of that, writing is involved with handwriting and spelling. These two factors make writing more difficult than speaking in L1 for children.

In contrast to the L1, writing and speaking in L2 do not necessarily develop in parallel. Young L2 English learners who are not fully proficient in speaking are already able to read in English (Hudelson, 1984). On the other
hand, Milton and Hopkins (2006) found that some L2 learners, who are proficient in speaking, cannot necessarily read or write. They also found that the relationship of writing and speaking differed in different levels of English proficiency. Lower proficiency learners tend to have a greater capacity for phonological vocabulary knowledge (speaking) whilst higher proficiency learners tend to have greater orthographic vocabulary knowledge (writing). These findings also depend on the learning context. Naturalistic learning may be more closely associated with the spoken modality, whilst formal learning can be expected to lead to greater proficiency in writing.

As both writing and speaking are means of communication, they can act as support for each other. Writing helps L2 learners to rehearse the process of speaking when they are not proficient enough to fluently produce the oral language (e.g. a manuscript for a prepared speech). On the other hand, speaking can also help learners to rehearse the process of writing. However, these two tasks may also interfere with each other. This occurs when L2 learners write like they speak and speak like they write. From a dynamic perspective, the embedded subsystems (variables) may have to compete for the limited resources (working memory). Writing and speaking can on the one hand support each other in rehearsing the language, but on the other hand compete for the limited resources. This supportive and competitive relation between writing and speaking can be seen as part of the dynamic language system.

### 2.6 English language in Taiwan

English Language Teaching (ELT) in Taiwan typically focuses on the ability to translate L1 to L2 or L2 to L1 (Chang, 2006); the learners are hardly exposed to any authentic English input in English class, especially in the spoken form. As the input of ELT in Taiwan is mostly based on translation skills, the meaning of the L2 words is constructed via the L1; and the sentence structure of the L2 is constructed via the memorization of grammatical rules in L1. From a UB perspective, such in-class language learning does not assist learners to shape their L2 as the language that emerges is directly formed from the contact with the input. Moreover, the input provided by the Taiwanese context is mainly the written form of English. From a UB perspective, practicing the written language mostly helps learners in developing their writing, but not their speaking. Therefore, it is very common to find Taiwanese learners of English who write with a
lot of interference from the L1 or who show completely unbalanced performances in writing and speaking due to their unbalanced sources of input (Wu, 2012).

The group of English learners in this study not only has very limited English input from in-class learning where most of the teaching instructions are in Chinese and they hardly speak any English. These Taiwanese English learners also have very little English input outside the classroom. Most of the TV programmes or advertisements in Taiwan are dubbed in Chinese; these learners, though they have easy access to Internet, never pay attention to these chances for English exposure. For research purposes, this provides an excellent opportunity to manipulate the input given to Taiwanese learners of English. Among other goals, this study aims to investigate the effect of authentic input on learning English. Depending on the outcome of these investigations, recommendations will be made to improve the learning of English in this context.

2.7 Main research questions

As the overview of the literature on L2 writing and speaking has shown, there are a number of issues that call for further research. This includes investigating what factors may play a role in DST by observing whether enhanced input (natural exposure to English input) can enhance the learning of contextual vocabulary knowledge, especially associations and collocations that have not been explored yet. We also investigated how the language system and its interrelated components are shaped over time by observing how L2 beginner learners of English develop their lexicon and syntax in the writing and speaking over time.

Firstly, we investigate the effects of enhanced input on beginner learners’ contextual vocabulary knowledge. As learners shape their language from their input, we may assume that these beginner learners naturally exposed to extra input will be able to better develop their contextual vocabulary knowledge. Accordingly, the main question addressed in the first study is whether the enhanced input leads to the development of contextual vocabulary knowledge. We set up an experiment where the experimental group serves as its own control group. In this type of experiment, the sequence of the treatment (with extra natural exposure to English input) becomes an important factor. Therefore, an additional question addressed in this study is whether the sequence of the input conditions may affect the development
of contextual vocabulary knowledge.

Secondly, we investigate the effects of enhanced input on beginners’ use of vocabulary in writing. We may assume that more exposure to input will increase the chances of encountering the same words in different contexts, which will lead to enhanced use of vocabulary in writing. Therefore, the main questions addressed in the second study concern whether beginning learners of English use more difficult words (i.e., less frequent words) in their writings when they have more input and whether they use less difficult words in their writings when they have less input. The study uses a dynamic modelling tool to quantify the developmental trajectory of vocabulary use. In addition, we address the question of whether or not this dynamic modelling tool (logistic equations) can meaningfully describe the developmental pattern of vocabulary use.

Thirdly, learners of English in Taiwan practice writing earlier than speaking; most of their input is from reading— the written form. Therefore, we may assume that the development of writing is more advanced than that of speaking in lexical performance. Accordingly, the first question addressed in the third study is whether the development of writing is more advanced than that of speaking in terms of lexical performance. However, the dynamic relation between writing and speaking can be two-sided. Writing and speaking can either support each other or compete with each other. From a dynamic usage-based perspective, the development of each of the variables may compete for the limited internal and external resources. Therefore, another question addressed in this study is how the correlations between the lexical performance of writing and speaking change over time. This study uses another dynamic modelling tool (the hidden Markov model) to quantify our observations of the development of writing and speaking in terms of the lexical performances of the learners.

Finally, we investigate the development of syntactical complexity in writing and speaking. Though it could be argued that syntax and lexicon are not really separable in a dynamic perspective on language learning and processing, we decided to follow the more traditional distinction between the two components mainly because the tools to study the development of syntax and lexicon intertwined are not yet available. Different from the previous study, this study assumes that the development of speaking is more advanced than that of writing based on Dykstra-Pruim’s study (2013) despite our knowledge that our learners had been mostly exposed more to written language than to spoken language and that writing gives more time for online planning. Two major questions addressed in the fourth
study are whether speaking development is more advanced than writing
development in terms of syntactical performance and whether two identical
twins showed similar developmental patterns. This study uses the same
dynamic modelling tool (hidden Markov model) as in the third study to
quantify our observations of writing and speaking development in terms of
the syntactical performances.
A dynamic systems and usage-based approach