Second Language Acquisition Research
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This book is based on the proceedings of the fifth international symposium on ‘processability theory, second language acquisition and bilingualism’ that was held at Deakin University, Australia in September 2005. Turning the conference papers into a thematic book is a challenging task. Indeed, this volume owes a lot to the support and collaboration of the speakers at the symposium who made their papers available for this volume. I gratefully acknowledge their collegiality and assistance in getting this book ready for publication. In particular I would like to thank all of those who took part in the refereeing process which resulted in significant improvements not only for the individual chapters but also for the book as a whole. The symposium was made possible thanks to the financial and logistical support of the Deakin University’ Institute for Citizenship and Globalisation. Finally I would like to acknowledge the expert input of Kazumi Jushi from the Institute in the final formatting, preparation and type-setting of this manuscript.

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CHAPTER 1
SECOND LANGUAGE ACQUISITION RESEARCH:
FROM THEORY FORMATION
TO THEORY APPLICATION
Fethi Mansouri

This book deals with second language acquisition research as a field of inquiry concerned with the processes underlying the development of second languages among non-native learners. The book’s main focus is on the theoretical attempts at accounting for second language acquisition (SLA) where the focus is more on the mental, cognitive and psychological processes underpinning the learning process. Of course the linguistic structures being acquired will also constitute an integral part of any analyses of SLA as their structural and functional features tend to correlate with certain developmental outcomes. In fact, the key theoretical paradigm employed by most of the chapters in this book, namely Processability Theory (Pienemann, 1998) argues that the learners can produce only those target language linguistic forms, which their language processor (i.e. the learner language) can handle at a given point in time. In other words, the target language structures with their specific level of (grammatical) information marking and exchange are acquired – or in PT’s language developmentally emerge- in an order that reflects their processing complexity. Thus, we increasingly see the interconnectedness of linguistic features and processing capacity among learners. It is because this interconnectedness is so fundamental to explaining SLA that learning theories are more and more inclined to employ formal theories of grammar to describe the target language structures. This is the case with PT which uses Lexical Functional Grammar (LFG) as a linguistic analytical framework.

Historical trends and developments in SLA research

The scope and diversity of research into second language acquisition is so broad that it is well beyond the reach of this thematically defined volume. This
breadth and depth of SLA research touches both theory construction and theory testing or application (Doughty & Long, 2003). The theoretical dimension of SLA research was not always restricted to the developmental and cognitive aspect of the analysis. In fact, SLA theories and models have historically drawn from and relied upon linguistic and grammatical theories, such as Chomsky’s Universal Grammar (cf. Ellis, 1994), and the many approaches to functional linguistics most notably Givon’s (1979a) model and the subsequent research that combined SLA theories with functional linguistic models. The fact that independent linguistic theories could potentially be implemented into a theory of second language acquisition to explain the process of learning meant that the resulting predictions were significantly better formalised and thus easier to test and validate.

Before discussing this book’s key themes and objectives, it would be useful to outline very briefly the type of SLA research that has dominated the field for the past decades. In this context, it is necessary to review two strands of second language acquisition approaches that have greatly influenced the past two decades namely morpheme order studies and developmental studies.

Within the broad terms of morpheme order studies, second language learning was predicted to consist of the acquisition of the rules and structures of the target language in a gradual process over an extended period of time. Research carried out within this tradition attempted to describe the order of acquisition of certain morphemes and structures with the view to establishing a continuum of acquisition which can account for and predict the acquisition order of grammatical morphemes. Researchers within this tradition (e.g., Dulay et al., 1982) claim that learners acquire certain structures almost immediately as is the case with word order, whereas other structures such as grammatical agreement are invariably acquired later. Many studies of this kind were more interested in attempting to determine the order in which learners acquire the target language structures rather than the processes that allow learners to achieve such an acquisition order. The significance of this type of research, however, came to prominence when researchers in the context of first language acquisition (e.g., Brown, 1973; deVilliers & deVilliers, 1973) demonstrated that first language learners of English acquired a number of morphemes invariably in the same order. This suggested that first language acquisition is guided by a universal cognitive mechanism which must be responsible for the invariance of the order of morpheme acquisition as produced by various learners.

The question that followed from the above suggestions was whether there is a common universal order of acquisition for second language structures. Early research within morpheme order studies (Hakuta 1974; Larsen-Freeman 1975, Dulay & Burt 1973) focused on one major hypothesis stating that there is a kind of ‘built-in-syllabus’ in second language learners similar to that observed
in the context of first language acquisition. The findings of these early studies supported this hypothesis and argued for the possibility of the existence of a universal or natural order of acquisition of syntactic and morphological structures irrespective of the learners’ first language background. Thus, the idea that first language acquisition follows the same path as second language acquisition was strongly put forward as the \([L1 = L2]\) hypothesis (c.f., Ellis 1994). Of course, in light of recent advances in SLA research as exemplified with the developmentally moderated transfer hypothesis in Processability Theory, this hypothesis is longer universally accepted as an empirical certainty.

From a purely pedagogic perspective, however, and as Burt & Dulay (1980: 266) argued “the acquisition order studies could also provide practical guidance in the development of the curricula, materials and assessment instruments”. Therefore, and by extension if a universal order is observed then it could potentially be used as the basis upon which curricula and course materials ought to be designed, since the universal order of acquisition reflects at least in part psychological reality. This approach was further developed in what became known as the ‘natural’ approach to second language teaching based on the natural order of the acquisition hierarchy obtained through a number of morpheme order studies such as those carried out by Krashen (1983). The major claim of these studies is the existence of a fixed order of morpheme acquisition that takes place regardless of the variables investigated (e.g., formal vs. informal learning; different L1 backgrounds; written vs. oral data; age). In other words, learners appear to follow a pre-determined universal order of acquisition of grammatical morphemes.

From a theoretical viewpoint, a serious criticism of morpheme order studies is their inadequacy to capture the developmental regularities in second language learners’ output. Wode (1978) points out that morpheme order studies miss important phenomena in SLA such as learners’ learning strategies. Such strategies can include avoidance of difficult L2 structures and forms as well as the influence of the learner’s L1. Because morpheme order studies focus on the learners’ production of target-like forms, they are unable to capture developmental aspects which are an essential part of the process of language acquisition.

Another problem with morpheme order studies was the fact that they are based on cross-sectional data rather than longitudinal data which meant that it was impossible to answer questions about how second languages are actually acquired or how individual variation among learners can be accounted for. This is especially crucial as Andersen (1991) puts it since “attention to individual variation is the key to understanding the process of second language acquisition” (Andersen, 1991:02).
Attempting to prove the inadequacy of morpheme order studies, Huebner (1979) argued that to discover developmental features and sequences of second language acquisition, one must look not only to occurrence of morphemes and forms in an obligatory context, but more importantly in contexts where these morphemes and forms would not be critical for successful communication. Language learning is systematic but also dynamic and undergoes continual and constant change. Variation in the learner language is the main indicator of change and progress from one developmental stage to another. In this regard, Huebner (1979) indicated that grammatical forms are produced by second language learners in one linguistic context, then in other linguistic contexts as these learners test and revise their own hypotheses about the target language. The interpretation of language acquisition as a linear process does not illustrate the roles assigned to different factors such as the formalised linguistic factor and the psychological factor. This task was more prominent in SLA studies carried out under the developmental umbrella.

Developmental studies differed from morpheme order studies in that they focused on the learning process and the learner’s strategies rather than simply on the order of certain morphemes. The view taken by researchers working within the developmental approach is that while still learning the grammar of the target language, second language learners use forms which do not belong to either the second language or the native language. These forms were known as ‘transformational forms’ (Dulay et al., 1982). A number of other researchers employed the term ‘developmental sequences’ to refer to these same transitional constructions and the order in which they occur (Wode 1977, Meisel et al 1981).

The term ‘developmental sequences’ implies that language learners go through a number of implicational steps before moving to higher developmental stages on the acquisition hierarchy. These steps, more importantly, are not random but rather systematic. The changes, or variations, in the learner language are the result of a number of operations such as modification and generalisation which learners apply to linguistic structures as they gradually move forward along the developmental path.

A number of researchers (e.g., Hatch 1978a) found that errors observed in the transitional constructions produced by L2 learners do not always bear any relation to their L1. These errors can be intra-lingual in nature resulting from a developing system, rather than inter-lingual resulting from the learner’s L1 interference. In other words, the learner’s language should be analysed as a linguistic system in its own right rather than a distorted version of the target language system (c.f., Larsen-Freemen & Long 1991). Along the lines of the developmental approach, a number of researchers in the field of SLA research conducted investigations on the acquisition of morpho-syntax in a number of different target languages. Processability Theory, described succinctly by
Pienemann in chapter 2 in this book is such a theory that reflects recent insights into the process of second language learning.

Recent developments in SLA research

There is now a growing interest in second language acquisition (SLA) research that is driven as much by new interdisciplinary approaches to the field as it is by the practical needs of understanding language learning and performance in an increasingly inter-connected world. Intellectually, second language acquisition research is now a recognised independent field of academic inquiry that is concerned with cognitive, psychological, social and pragmatic aspects of second language development. Therefore, SLA research tends to be highly theoretical and experimental and as such lends itself well to the rigour of scientific research. It is in this context that the use of explicit and well articulated theories and concepts is increasingly seen as an essential research and ‘thinking’ tool for understanding and conducting SLA research.

The chapters included in this book report on the various technical and theoretical aspects of experimental SLA research across a number of typologically different languages. The book includes a detailed introduction and a general chapter outlining the key theoretical claims and methodological requirements underpinning this kind of SLA research. It will also relate Processability theory-related studies to the wider field of SLA research. Though the emphasis is on cross-linguistic experimental research undertaken within the parameters of Processability Theory, the book will nevertheless shed light on the nexus between bilingualism and theory-driven second language acquisition research.

Processability Theory (Pienemann 1998) is one such a theory that has been applied across a number of second languages. It is based on a universal hierarchy of processing procedures derived from the general architecture of the language processor. Processability theory has been tested against an array of data from the target languages English, Swedish, German, Chinese, Arabic and Japanese. As this book shows, the first step in any cross-linguistic testing is to relate a set of linguistic structures of the target language to the general hierarchy of processability and more specifically to the exchange of grammatical information involved in producing these structures. This exercise should yield a set of language-specific predictions for the sequence in which these structures will emerge in the learner language. In a second step this hypothesised sequence can be tested against empirical data from the acquisition of the chosen language.

The logic underlying processability theory is the following: at any stage of development the learner can produce and comprehend only those target language linguistic forms which the current state of the language processor (i.e.
the learner language) can handle. It is therefore crucial to understand the architecture of the language processor and the way in which it handles a second language. This enables one to predict the course of development of the target language linguistic forms in language production and comprehension across different languages.

The book’s key themes and structure

The book’s key objective is to present a snapshot of empirical studies in the second language acquisition research where both theory formation and theory application are integral elements. This has not always been a straightforward task as it is rather difficult to construct testable research methodologies for application for example in teaching intervention studies.

The book is still focussed on theory formation which is certainly important. The chapter by Pienemann in particular is a good case in point. However, and as the application of SLA research and its key theories becomes more appealing, it would be naïve to dismiss application studies as non-relevant within a book focussed on SLA research. The fact that SLA researchers have tended to be rather defensive about the potential of their research formulations and findings to teaching should not mean that there is no potential in SLA theory application. We can see advantages of PT-based optimal input that is developmentally ordered. Given these two interconnected agendas, this book is organised around two general sections: (a) theory construction and testing and (b) theoretical research on speech processing and bilingualism.

Theory construction and testing

Despite the emergence of clear theoretical paradigms in SLA research, as Pienemann argues in chapter two, we are still a long away from having a coherent comprehensive theory of SLA. This is despite the many attempts that are being made to tackle various aspects of such a theory. Pienemann’s point is that to articulate a comprehensive theory of SLA is an enormously complex task that is beyond individual researchers. It was for this reason that Pienemann’s processability theory was designed as a modular approach aimed specifically at explaining developmental schedules. In his chapter, Pienemann shows how processability theory can interface with other modules that are jointly capable of explaining a wider array of phenomena in SLA. Pienemann’s chapter explores second language development within an LFG framework that exhibits psychological and typological plausibility. As with the his seminal 1998 book, Pienmann’s aim is to demonstrate that the interplay between constraints on processability, the re-ranking of Optimality Theory constraints that have to be
assumed for SLA and the L2 initial state cause some of the attested L1-L2 differences.

Along similar theoretical lines, Kawaguchi’s chapter aims to explain the development of argument-function mapping at the interface of discourse-syntax in learning a second language, based on the Unmarked Alignment Hypothesis and the Lexical Mapping Hypothesis. These hypotheses are posited in the current extension of Processability Theory. The Unmarked Alignment Hypothesis is based on the most harmonious mapping between thematic role, grammatical function and syntactic position. The Lexical Mapping Hypothesis is based on non-default mapping of thematic argument roles onto grammatical structure. Kawaguchi argues that the learning of new lexical features is necessary in order to perform higher-stage language-specific operations which are morpho-lexical in nature. As Kawaguchi shows, such this allows the speaker to make choices with respect to which argument will receive which degree of prominence in production. The successful performance of such morpho-lexical operations contributes to the characterization of the higher stages of learners’ development. Kawaguchi’s chapter reports on empirical research where these two hypotheses are applied to Japanese L2, and the structural outcomes at different developmental stages are predicted with LFG formalism. The analysis of a three-year longitudinal study shows that the results validate these hypotheses.

Theory construction as outlined above in particular by Pienemann in chapter two is often followed by theory-testing research that in some cases it contributes to the advancement of the theoretical approach being tested. Håkansson and Norrbys’s study reported in chapter four is such a case as they apply PT to written and oral Swedish L2 data. Håkansson and Norrbys hypothesis is that the hierarchy of processability predicted by PT guides both written and spoken learner production. The results reported in this book show that both learner groups developed the target structures as predicted by PT though some structures occurred more frequently in writing than in speaking. In Håkansson and Norrbys view, the results demonstrate that the planning time that is used in writing does not influence grammatical processability, though the lack of contexts for certain structures in speech suggests that time has an influence on language complexity.

Mansouri’s study described in chapter five discusses the feasibility of accounting for intra-stage developmental sequences in second language development and their conceptual potential as additional explanatory tools in second language acquisition research. Mansouri discusses this phenomenon in the context of Arabic as a second language (ASL), focussing on the phenomenon of zero (null) and reduced making of definiteness within noun-phrase agreement structures. Based on the analysis and findings reported in this
study, it is argued that zero and reduced marking can be accounted for in terms of processing requirements and typological features (form-function mappings). Using PT as a conceptual framework, the study proposes a conceptual basis for extending Hypothesis Space as an additional explanatory module. This extension could be useful for dealing with intra-stage sequences where multiple structures with differing patterns of processing complexity and form-function mappings exist.

Still within the broad PT paradigm, Zhang’s research on the acquisition of Chinese syntax incorporates discourse-pragmatic principles into the developmental approach to second language acquisition research. This has led to the formulation of the Topic Hypothesis which predicts the successive acquisition of L2 syntactic structures from a canonical order to a non-canonical. The key feature here is that the latter order deviates from the linearity principle of mapping between argument, functional and constituent structures. Zhang’s findings support the Topic Hypothesis, showing an orderly developmental sequence as predicted by the hypothesis.

Dealing with a more applied matter within the PT paradigm, Keßler’s chapter reports on a feasibility study of Rapid Profile as a tool for online-assessment of EFL learner language development. The study was motivated by the claim that Rapid Profile provides a valid and quick means of diagnosing EFL-development in formal settings. Keßler’s study reveals an inter-rater-reliability of 85.7 per cent, and thus proves Rapid Profile to be both a valid and a feasible diagnostic tool for online-assessment. Additionally, the results imply important SLA-based implications for the EFL classroom.

The significance of studies such as Keßler’s is that it shows that it practically feasible to turn findings from second language acquisition research into a basis for language teaching and assessment. This is a theme that is bound to become more prominent within SLA circles as the pressure to link research to practice mounts on theorists and applied researchers alike. The following section of this chapter deals with two aspects of second language acquisition that are not too dissimilar from the chapters described thus far but nevertheless focus on two interconnected notions: bilingualism and speech processing.

**Bilingualism and speech processing**

Itani-Adams’ chapter investigates the relationship between the development of lexicon and grammar in Japanese and English in a bilingual child (age 1;11 to 4;10). The research focuses on the relationship between verbs and the suffixation of morphemes, and the relationship between verbs and the semantic function of the arguments of the two languages. Itani-Adams’ study found that regardless of the different input languages, the noun bootstrapped the bilingual
child into both languages. Overall, the findings from this study support the prediction of Processability Theory that the initial word order used by a language learner is the canonical order of the language. The results suggest that, for this bilingual child, Japanese and English each developed in a separate but a parallel manner.

Staying within bilingual research, Suarez and Goh’s study investigated codification in short-term memory in bilinguals with different levels of English/Chinese dominance. The experiments manipulated phonological and visual features of words and examined their influence on the degree of semantic proactive interference (PI) in a short-term cued recall task. The results suggest that bilinguals process their two languages according to their language dominance. Particularly, Mixed and English dominant bilinguals showed evidence of phonological influence on PI, implicating phonological codification. There was also evidence of visual influences on PI for English dominant bilinguals, implicating visual codification. Chinese dominant bilinguals did not show any evidence of phonological and visual influences on semantic PI, which may suggest that they have a very integrated phonological, visual and semantic memory system.

Leaving bilingualism and ESL issues aside, Van den Noort, Bosch and Hugdahl’s chapter discuss the processing of relative clauses in L1 research where subject relatives are reported to be easier to comprehend than object relatives. In this study, Van den Noort, Bosch and Hugdahl test the hypothesis that object relatives cause a greater working memory load on twenty multilinguals, who were all native Dutch speakers (L1) and fluent in German (L2). Ten subjects started their free acquisition of Norwegian (L3) in the last 6 months, whereas ten others started their acquisition of Norwegian more than 3 years ago. Participants conducted a relative clause task in all languages, a reading span task in Norwegian (L3), and a number ordering task. The results show that differences in subject- and object relatives can only be found for participants, who are in an advanced stage of third language acquisition. Moreover, no significant correlations were found between the number ordering task, the reading span task (in L3), and the total comprehension score on the relative clause task in Dutch, German, and Norwegian. Van den Noort, Bosch and Hugdahl’s findings are in line with the SSIR theory of (foreign) language comprehension.

Dealing with speech processing and procedural features within an integrated theoretical framework, Kim and Kwon’s study is inspired by three L2 developmental modules in procedural development, syntactic development, and morphological development. By integrating three separate modules into one, Kim and Kwon’s study proposes a model called the Parallel Developmental Sequence (PDS) Model. The three modules from which the PDS Model is
derived are the English Developmental Sequence (Pienemann and Johnston, 1987), the Minimal Tree Hypothesis (Vainikka and Young-Scholten, 1998), and the PT (Pienemann, 1988). In essence, the PDS Model proposes that L2 development follows a series of parallel developmental stages sequentially. Each of these stages incorporates three different dimensions of sequential development: the procedural developmental sequence, the syntactic developmental sequence, and the unificational (morphological) developmental sequence. Each stage is operative through parallel activation, parallel connection, parallel strength, and synchronization by the logic of 'parallel connection' of the Parallel Distributed Processing Model. Therefore, the assumption of the PDS is that an L2 learner at a stage will activate the parallel mechanism and synchronize the three parallel systems to process rules in order to understand and produce language in that stage. The question then is whether or not the theoretically built sequence of parallel developmental stages does reflect the actual developmental stages of the L2 learner.

**Conclusion**

While this book has deliberately focussed on the process of language learning in its right, there is little doubt now that a more direct interaction with language teaching and assessment can pursued more confidently. In fact, as is shown by the Pieneman’s teachability hypothesis, the establishment of referential developmental points can have real purchase for grammar instruction and potentially language testing. This book coincides with a gradual shift in language teaching towards employing second language acquisition research as a relevant knowledge source for teaching practice and curriculum design (Lightbown, 1985, 2000; Long & Robinson, 1998). This is clearly evident in the growing number of empirical studies that attempt to test the educational benefits of specific design features in the curriculum, or certain teaching strategies inspired by and based on theoretical claims articulated within second language acquisition research (Mitchell, 2000; Macroy, 2000; Doughty & Williams, 1998). There is also a growing interaction between theoretical research in SLA and other relevant areas of academic inquiry, such as applied linguistics and foreign language assessment (c.f. Kramsch, 2000; Lightbown 1985; 2000; Long & Robinson, 1998).

**Notes**

1 The edited volume is based on papers delivered at the 5th International Symposium on Processability, Bilingualism and Second Language Acquisition. The Symposium was held at Deakin University’s Melbourne Campus, 26-28 September 2005.
References


CHAPTER 2
AN INTRODUCTION TO PROCESSABILITY THEORY
Manfred Pienemann

Basic outline of the theory

Processability Theory (Pienemann 1998) is a theory of second language development. The logic underlying Processability Theory (PT) (Pienemann 1998; 2005) is the following: at any stage of development the learner can produce and comprehend only those L2 linguistic forms which the current state of the language processor can handle. It is therefore crucial to understand the architecture of the language processor and the way in which it handles a second language. This enables one to predict the course of development of L2 linguistic forms in language production and comprehension across languages.

The architecture of the language processor accounts for language processing in real time and within human psychological constraints such as word access and human memory. The incorporation of the language processor in the study of second language acquisition therefore brings to bear a set of human psychological constraints that are crucial for the processing of languages. The view on language production followed in PT is largely that described by Levelt (1989), which overlaps to some extent with the computational model of Kempen and Hoenkamp (1987) which emulates much of Merrill Garrett's work (e.g. Garrett 1976, 1980, 1982) and on which the corresponding section of Levelt's model is based. The basic premises of that view are the following:

- Processing components operate largely automatically and are generally not consciously controlled;
- Processing is incremental;
- The output of the processor is linear, while it may not be mapped onto the underlying meaning in a linear way;
- Grammatical processing has access to a temporary memory store that can hold grammatical information. (cf. Pienemann 1998 for detail)
The core of PT is formed by a universal processability hierarchy that is based on Levelt’s (1989) approach to language production. PT is formally modelled using Lexical Functional Grammar (LFG) (Bresnan 2001). PT is a universal framework that has the capacity to predict developmental trajectories for any second language. The notion ‘developmental trajectory’ implies a developmental dimension known as ‘staged development’ as well as a variational dimension accounting for individual differences between developmental trajectories as illustrated in Figure 1.

Figure 1 shows two different developmental trajectories, T1 and T2, which are based on the same set of developmental stages (indicated by the dotted horizontal lines). The two developmental trajectories differ with respect to the interlanguage varieties that are developed at each stage (indicated by vertical lines). As can be seen in Figure 1, there are many possible developmental trajectories based on the same stages of development.

![Figure 1: Different developmental trajectories](image)

In this paradigm, each stage represents a set of grammatical rules that share certain processing routines, and each interlanguage variety represents a specific variant of the grammatical rules. For instance, in ESL question formation the following developmental sequence has been found (e.g. Pienemann, 1998):

<table>
<thead>
<tr>
<th>Stage</th>
<th>Structure</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>SVO question</td>
<td>He live here?</td>
</tr>
<tr>
<td>Stage 2</td>
<td>WH+SVO</td>
<td>Where he is?</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Copula inversion</td>
<td>Where is he?</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Aux-second</td>
<td>Where has he been?</td>
</tr>
</tbody>
</table>
Learners attempting to produce ‘Aux-second’ at stage 3 (i.e. before they are ready for this structure) have been found to produce the following interlanguage variants:

A Where he been?
B Where has been?
C Where he has been?
D He has been where?

Variants A to D have in common that they get around placing the auxiliary in second position after an initial WH-word. In other words, they constitute different solutions to the same learning problem. In Figure 1 each of the different solutions is represented by a vertical line. It is important to bear in mind that for each structural learning process there is a limited set of variable solutions. In the course of L2 development, the learner accumulates grammatical rules and their variants, allowing her or him to develop an individual developmental trajectory while adhering to the overall developmental schedule. In this way, PT defines a two-dimensional space for the formation of processable hypotheses. Both dimensions of this space (i.e. ‘Hypothesis Space’) are constrained by the processability hierarchy which can be applied to any L2 using Lexical Functional Grammar, a theory of language to be described later in this chapter.

The original version of PT (Pienemann 1998) focused solely on what is known as the ‘developmental problem’ (that is, ‘why do learners follow universal stages of acquisition?’). The extended version of PT (Pienemann, Di Biase and Kawaguchi 2005) also starts to address the so-called ‘logical problem’ (that is, ‘what is the origin of linguistic knowledge?’). For instance, how do learners know that there are such things as nouns and verbs?). The developmental and the logical problem are the key issues of any theory of language acquisition, and PT addresses these issues in a modular fashion. One module deals with the developmental problem, a separate, but connected module deals with the logical problem. Both modules are based on LFG because LFG is designed to account for linguistic knowledge in a way that is compatible with the architecture of the language processor, and both these components are needed for PT to address the developmental and the logical problem. The developmental problem is addressed by describing the constraints the language processor places on development, and the logical problem is addressed using specific components of LFG that are summarized below.

The commitment of LFG to the interface between linguistic knowledge and language processing is illustrated very clearly in the following quotation:
[Children] acquire knowledge and skills that enable them to produce and comprehend an infinite number of novel utterances... The major goal of psycholinguistic research is to devise an explanatory account of the mental operations that underlie these linguistic abilities.
—Kaplan and Bresnan (1982:177)

As Kaplan and Bresnan (1982) point out, the various components of a theory of language acquisition can be studied separately as long as they ultimately fit together in a coherent model. In the PT framework the language processor is seen as the computational routines that operate on, but are separate from, linguistic knowledge (cf. Kaplan and Bresnan 1982).

The basic claim of the original version of PT is that language development is constrained by processability. This affects first and second language development (albeit in different ways). It also affects interlanguage variation and L1 transfer. The extended version of PT adds to this the claim that the initial form of grammar in SLA is determined by the default relationship between what is known as ‘argument structure’, that is, the ideas expressed in a sentence, and the way they are expressed by grammatical forms.

**Key constructs and mechanisms underlying PT**

**The processability hierarchy**

In Pienemann (1998) the processability hierarchy is based on the notion of transfer of grammatical information within and between the phrases of a sentence. For instance, in the sentence ‘Little Peter goes home’ the grammatical information ‘third person singular’ is present in the phrase ‘Little Peter’ and in ‘goes’. This is commonly referred to as ‘subject-verb agreement’. In LFG and in Levelt’s model of language generation it is assumed that the language processor checks if the two parts of the sentence, ‘Little Peter’ and ‘goes’, contain the same grammatical information. To be able to carry out this checking operation, the procedures that build phrases in language generation need to have developed in the second language processing system. In our example learners need to have developed a procedure for building noun phrases such as ‘Little Peter’ and verb phrases such as ‘goes home’. They also need to have developed a procedure for putting these two phrases together to form a sentence. In Levelt’s (1989) model of language generation, it is assumed that the grammatical information ‘third person singular’ needs to be stored in the procedures that build the phrases in which this information is used, and that the two lots of information are compared within the procedure that puts the two phrases together to form a sentence. The learner of a language needs to develop procedures that can handle the job of storing and comparing grammatical
information. This way, speakers can learn to decide which sentences are grammatically acceptable and which aren’t. For instance, in the sentence ‘*Little Peter go home’ the phrase ‘little Peter’ is marked for ‘third person singular’, but the verb isn’t. This would be detected by a competent speaker when the noun phrase and the verb phrase are assembled to form a sentence. However, if the learner has not yet developed a fully functioning sentence procedure the mismatch will not be detected.

The same principle applies to grammatical information contained within phrases. For instance, in the noun phrase ‘two kids’ the grammatical information ‘plural’ is contained in the numeral ‘two’ and in the noun ‘kids’. In language generation these two bits of information are compared when the noun phrase is assembled by the noun phrase-procedure. In the case of ‘two’ and ‘kids’ the two bits of grammatical information do match.

We can now see that in both examples grammatical information has to be matched between parts of the sentence. In Lexical Functional Grammar this process is called ‘feature unification’. In non-technical language we might describe this process as information matching. LFG uses formal means to account for such processes. The fact that LFG has this capacity is one of the key reasons why PT uses LFG to model these psycholinguistic processes.

The two examples we used also serve to illustrate the processability hierarchy. It is easy to see that in the ‘Little Peter’ example grammatical information has to be matched between a noun phrase and the verb phrase and that this occurs when the two pieces are assembled to form a sentence. In contrast, in the second example the information matching occurs in the noun phrase procedure — before the sentence is assembled. In other words, there is a time sequence involved in the matching of grammatical information which forms the basis of the original processability hierarchy. Noun phrases are assembled before verb phrases which are assembled before the sentence. In addition, individual words belong to categories such as ‘noun’ and ‘verb’, and category procedures are the memory stores that hold grammatical information such as ‘singular’ or ‘past’. Therefore category procedures appear before noun phrase procedures.

The following is an overview of the original processability hierarchy, following Pienemann (1998):

1. no procedure
2. category procedure
3. noun phrase procedure
4. verb phrase procedure
5. sentence procedure
6. subordinate clause procedure.
The basic hypothesis underlying PT is that learners develop their grammatical inventory following this hierarchy for two reasons: (1) because the hierarchy is implicationally ordered, i.e. every procedure is a necessary prerequisite for the next procedure; and (2) because the hierarchy mirrors the time-course in language generation. Therefore the learner has no choice other than to develop along this hierarchy. Phrases cannot be assembled without words being assigned to categories such as ‘noun’ and ‘verb’, and sentences cannot be assembled without the phrases they contain and so forth. The fact that learners have no choice in the path they take in the development of processing procedures follows from the time-course of language generation and the design of processing procedures. This is how the architecture of language generation constrains language development.

As mentioned above, the original version of the processability hierarchy focuses on information transfer within phrase structure. In the extended version of PT (Pienemann, Di Biase and Kawaguchi 2005) the processability hierarchy is extended to include further aspects of language generation, in particular the relationship between what is known as ‘conceptual structure’ and grammatical structure. Argument structure refers to the basic ideas conveyed in a sentence, i.e. who does what to whom. In other words, the extended version of PT also includes the relationship between what is intended to be said and the way this is expressed using grammatical forms. This extension is also modeled using Lexical-Functional Grammar. Details will be summarized later on.

Figure 2 illustrates the basic points of the processability hierarchy. Three examples of phrase structures are listed in the left-hand column. The second column specifies the type of information transfer possible at each stage. ESL morphological structures are given in the next column to exemplify the types of structures possible at each stage, and the information transfer involved in the generation of these structures is illustrated in the column on the right-hand side.
### Hypothesis Space

The processability hierarchy has been described as the sequence in which the fundamental design of the language processor develops in L2 acquisition, and it has been added that the learner is constrained to follow this sequence. At the same time, the processing procedures developed at every stage of the hierarchy do allow for some degree of leeway for the shape of the L2 grammar. Hypothesis Space is created by the interplay between the processability hierarchy and the leeway it generates at every level.

The constraining effect of the processability hierarchy is illustrated in Figure 2. As can be seen in Figure 2, at the stage ‘phrase’ grammatical information can be exchanged only within phrases, not beyond the phrasal boundary. Therefore grammatical structures requiring information exchange beyond the phrase boundary, such as subject verb-agreement cannot be processed at this stage. To recoup, learners have no choice other than to follow the processability hierarchy
in their development of the L2 grammatical inventory because of the internal architecture of the language processor. At any given point in the hierarchy any grammatical operation requiring processing procedures that are beyond the current point of development are out of reach for the learners. In other words, processing procedures constrain the range of possible production grammars for every level.

At the same time, these constraints leave sufficient leeway for learners to find different solutions to structural learning problems. I illustrated this above with the example of the position of auxiliaries in English WH-questions. This position requires processing procedures at the sentence level in the hierarchy. L2 learners can nevertheless produce WH-questions. When they attempt to do this, learners have four structural options that avoid the placement of the auxiliary in second position. The options available are all processable using the resources available at the previous stage, and the number of options is limited because of the limited resources that are available. The fact that learners need to circumnavigate a structural problem (here Aux-second) is caused by the constraints inherent in the hierarchy. In this way, possible developmental trajectories are constrained by the processability hierarchy.

**Developmental dynamics**

Developmental trajectories within Hypothesis Space have their own dynamics that are a key component of language development. These dynamics are particularly visible in a comparison of first and second language development as shown in Table 2 which lists two sets of processing procedures and the differential developmental trajectories found in the acquisition of German as a first and as a second language (cf. Pienemann 1998b).
An Introduction to Processability Theory

Processing procedures

<table>
<thead>
<tr>
<th>Constituent structure</th>
<th>Mapping</th>
<th>L2 German</th>
<th>L1 German</th>
</tr>
</thead>
<tbody>
<tr>
<td>subordinate clause procedure</td>
<td>comp SOV</td>
<td>comp SOV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[comp \textit{S V O}]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>use of S-procedure for storage across</td>
<td>topicalisation of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constituents in S</td>
<td>core arguments</td>
<td>X \textit{V f S O V i}</td>
<td>X \textit{V f S O V i}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ (X) \textit{S V O} ]</td>
<td></td>
</tr>
<tr>
<td>use of VP-procedure for storage across</td>
<td></td>
<td>X \textit{S V f O V i}</td>
<td>---</td>
</tr>
<tr>
<td>constituents in VP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>use of saliency principle to relax</td>
<td>XP-adjunction</td>
<td>X \textit{S V O}</td>
<td>---</td>
</tr>
<tr>
<td>canonical order constraint</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>category procedure unmarked alignment</td>
<td></td>
<td>\textit{S V O}</td>
<td>\textit{S O V}</td>
</tr>
<tr>
<td>(both result in canonical order)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Developmental dynamics

To appreciate the developmental dynamics shown in Table 2, the reader needs to bear in mind the following descriptive facts about German word order.

- Affirmative main clauses follow a SVO pattern (as in English) except for sentences with a non-subject in initial position (e.g. ‘Gestern ging er weg’. / ‘Yesterday went he away’).
- In sentences containing more than one verb the non-finite verb appears in final position (e.g. ‘Er hat ihn gesehen’ / ‘He has him seen’).
- In main clauses the inflected verb is always in second position.
- In embedded clauses the verb is in final position.

As can be seen in Table 2, L1 and L2 learners follow different developmental trajectories that both reach the same target containing all word order regularities listed above, and both trajectories are placed within the constraints defined by Hypothesis Space. Nevertheless, the two developmental trajectories are fundamentally different, mainly because they start with a different initial hypothesis, and the structure entailed in the initial hypothesis propagates through the entire developmental process (cf. Pienemann 1998b). L1 learners preserve the initial SOV order and modify it to fit the target language,
whereas L2 learners preserve the SVO order and make adjustments on this basis that also leads to a close match of the target pattern. I will show below that these dynamics can be modeled using a formal approach to developmental dynamics called ‘Generative Entrenchment’ (Wimsatt 1986).

**Empirical evidence in PT-based research**

Given the focus of PT on developmental dynamics, the most suitable research design is a longitudinal or cross-sectional study with a large set of data relevant for the phenomena under scrutiny. ‘Relevant data’ does not equal a large data set. The data need to be relevant to the point to be studied. For instance, the study of subject-verb agreement marking requires a large set of contexts for subject-verb agreement marking. This will allow the researcher to decide if the verbal marker is supplied or not. If no context appears, no conclusion can be drawn. However, even the presence of a number of morphological markers is no guarantee that these are based on productive interlanguage rules. In order to exclude the use of formulae and chunks the researcher needs to check lexical and morphological variation (i.e. same morpheme on different words and same word with different morphemes). These descriptive methods are described in more detail in Pienemann (1998a).

![Figure 3: Accuracy and development](image_url)

The interpretation of corpus data depends on the acquisition criterion that is used. In Pienemann (1998a) I make a case for the use of the emergence criterion. The basic point is this: accuracy criteria (e.g. 80% suppliance) are arbitrary. This is illustrated in Figure 3 which shows three different routes for the