WORDS AND RULES IN L2 PROCESSING: AN ANALYSIS OF THE DUAL-MECHANISM MODEL

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

BİLAL KIRKICI

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
ENGLISH LANGUAGE TEACHING

MARCH 2005

Approval of the Graduate School of Social Science

_____

Prof. Dr. Sencer Ayata
Director

I certify that this thesis satisfies all requirements as a thesis for the degree of Doctor of Philosophy.

_____

Prof. Dr. Wolf König
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

_____

Prof. Dr. Deniz Zeyrek
Supervisor

Examining Committee Members

Assoc. Prof. Dr. Şükriye Ruhi _____

Prof. Dr. Deniz Zeyrek _____

Prof. Dr. Gürkan Tekman _____

Assoc. Prof. Dr. Ümit Deniz Turan _____

Assist. Prof. Dr. Margaret Sönmez _____

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Last Name, Name : Kırkıcı, Bilal

Signature :

ABSTRACT

WORDS AND RULES IN L2 PROCESSING:
AN ANALYSIS OF THE DUAL-MECHANISM MODEL

Kırkıcı, Bilal
Ph.D., English Language Teaching
Supervisor: Prof. Dr. Deniz Zeyrek

March 2005, 211 pages

The nature of the mental representation and processing of morphologically complex words has constituted one of the major points of controversy in psycholinguistic research over the past two decades. The Dual-Mechanism Model defends the necessity of two separate mechanisms for linguistic processing, an associative memory and a rule-system, which account for the processing of irregular and regular word forms, respectively. The purpose of the present study was to analyse the validity of the claims of the Dual-Mechanism Model for second language (L2) processing in order to contribute to the accumulating but so far equivocal knowledge concerning L2 processing. A second purpose of the study was to find out whether L2 proficiency could be identified as a determining factor in the processing of L2 morphology.

Two experiments (a lexical decision task on the English past tense and a elicited production task on English lexical compounds) were run with 22 low-proficiency and 24 high-proficiency first language (L1) Turkish users of L2 English and with 6 L1 speakers of English. The results showed that the regular-irregular dissociation predicted by the Dual-Mechanism Model

was clearly evident in the production of English lexical compounds for all three subject groups. A comparatively weaker dissociation coupled with intricate response patterns was found in the processing of the English past tense, though possibly because of a number of confounding factors that were not sufficiently controlled. In addition, direct comparisons of the L2 groups displayed a remarkable effect of L2 proficiency on L2 morphological processing.

Keywords: Dual-Mechanism Model, Second Language Morphological Processing, Grammatical Rules, Associative Memory, Regular-Irregular Dissociation

ÖZ

İKİNCİ DİL İŞLEMLENMESİNDE KELİMELER VE KURALLAR:
İKİLİ MEKANİZMA MODELİ'NİN BİR ANALİZİ

Kırkıcı, Bilal
Doktora, İngiliz Dili Eğitimi
Tez Yöneticisi: Prof. Dr. Deniz Zeyrek

Mart 2005, 211 sayfa

Biçimbilimsel açıdan karmaşık kelimelerin zihinsel gösterimi ve işlemlenmesi son yirmi yılda psikodilbilim alanında önemli tartışma noktalarından birini oluşturmuştur. İkili Mekanizma Modeli, biçimbilimsel işlemlemede birbirinden bağımsız iki mekanizmanın gerekliliğini savunmakta. Sözkonusu mekanizmaların biri düzensiz kelimeleri işlemleyen bir çağrışımcı bellek ve diğeri düzenli kelimeleri işlemleyen bir kural mekanizmasıdır. Mevcut çalışmanın amacı, İkili Mekanizma Modeli'nin ikinci dilde biçimbilimsel yapıların işlemlenmeleri için geçerliliğini inceleyerek, bugüne kadar yapılmış çalışmalardan elde edilmiş olan fakat ilgili literatürde genellikle tartışmaya açık oldukları kabul edilen ikinci dilin işlenmesiyle ilgili bilgilere katkıda bulunmaktı. Çalışmanın ikinci bir amacı da ikinci dil seviyesinin o dildeki biçimbilimsel yapıların işlemlenmesinde belirleyici bir rol oynayıp oynamadığını araştırmaktı.

Anadilleri Türkçe, ve İngilizce ikinci dil seviyeleri düşük olan 22 ve İngilizce ikinci dil seviyeleri yüksek olan 24 kişiye ek olarak anadilleri İngilizce olan 6 kişiyle iki psikodilbilimsel deney yürütüldü. Bunların ilki

İngilizce geçmiş zamanla ilgili bir yanıt süresi deneyi, ikincisi ise İngilizce bileşik adlarla ilgili bir yapı üretim deneyiydi. Bileşik ad deneyinden elde edilen sonuçlar her üç denek gurubunun da açık bir şekilde İkili Mekanizma Modeli'nin beklentileri doğrultusunda bir düzenli-düzensiz ad ayrımına gittiklerini göstermiştir. İngilizce geçmiş zamanla ilgili deneyden çıkan sonuçlar ise karmaşık olmakla birlikte göreceli olarak daha zayıf bir düzenli-düzensiz yapı ayrımına işaret etmiştir. Ancak geçmiş zaman deneyinde elde edilen bu kısmen beklenmeyen sonuçların yeterince kontrol edilmeyen bazı faktörlerden kaynaklanmış olabileceği sonucuna varılmıştır. İkinci dil kullanıcı guruplarının doğrudan karşılaştırılmalarından ise ikinci dil seviyesinin o dildeki biçimbilimsel yapılarının işlemlenmeleri üzerinde güçlü bir etkiye sahip olduğu sonucuna varılmıştır.

Anahtar Sözcükler: İkili Mekanizma Modeli, İkinci Dilde Biçimbilimsel Yapıların İşlemlenmesi, Dilbilgisel Kurallar, Çağrışımcı Bellek, Düzenli-Düzensiz Sözcük Ayrımı

To My Family

ACKNOWLEDGMENTS

I would like to express my gratitude to my thesis supervisor, Prof. Dr. Deniz Zeyrek, for her guidance and support both throughout the development of this work and during the entire 12 years I have spent at the department as a student and research assistant. Without her help and intellectual stimulation, I would possibly not have discovered the linguist in me.

I would also like to thank Assoc. Prof. Dr. Şükriye Ruhi, Assoc. Prof. Dr. Ümit Deniz Turan, Assist. Prof. Dr. Margaret Sönmez and Prof. Dr. Gürkan Tekman for providing me with invaluable suggestions and encouragement, and for their careful examination of my dissertation. If there are any errors or shortcomings in this work, they are certainly mine.

In addition, I would like to extend my deepest appreciation to Prof. Dr. Harald Clahsen, who inspired me in many ways and helped me take important steps in my ongoing linguistic journey from “looking” to “seeing”.

This dissertation was partly supported by a Middle East Technical University Scientific Research Grant (ODTÜ Bilimsel Araştırma Projesi no. 2003-05-03-02).

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

This chapter comprises five sections. The first two sections present the theoretical background to the study. The third section discusses the purpose of the present study, while the fourth section shortly introduces the morphological phenomena that will be analysed in pursuit of the research purpose. Finally, the fifth section presents the research questions of the present study and briefly summarises the predicted outcomes in the light of findings of previously conducted research studies.

1.1 Background to the Study: Rules vs. Associations in the Human Language System

A longstanding debate in linguistics and psycholinguistics relates to how linguistic information is processed by the human language faculty and particularly how morphologically complex word forms are mentally represented. At the very heart of this dispute about the functional structure of the human language faculty lie contrasting views concerning the psychological reality of inflectional 'rules' as used in traditional grammars to produce what is conventionally called 'regular' word forms (such as the English plural rule 'add –s to the noun stem'). In other words, it is an issue of hot debate whether these proposed linguistic rules are actually employed in human language processing or whether they are purely descriptive tools that have no mental counterparts. This disagreement concerning the existence of linguistic rules in language

processing, which can be taken as a micro-reflection of larger-scale philosophical arguments concerning the role of symbols and symbolic computations in the overall human cognitive system (see Marcus, 2001), has been acting as the trigger for a great number of empirical studies in psycholinguistics and theoretical linguistics over the past two decades and has led to a serious re-evaluation of many established basics concerning linguistic processing.

Due to the fact that language has long been viewed as a paradigm case of a rule-system, rules have traditionally enjoyed a major role in linguistic theories. As is well known, following the movement from behaviouristic scientific inquiry towards an interest in the inner mechanisms and workings of the mind as a reflection of 'the cognitive revolution' in the 1950s, the field of linguistics, especially with the works of Chomsky and his followers (e.g., Chomsky, 1957, 1965), redirected its focus of attention to the investigation of generative grammar, hypothesised to be an inherent constituent of the human mind. Generative grammar in its early form basically theorised that the language faculty is composed of a finite list of words (the mental lexicon) and a computational component (the mental grammar), which combines these words to form and understand a potentially infinite number of phrases and sentences by means of combinatorial rules[1]. Just as these rules are able to generate sentences from phrases and phrases from words, they are also able to generate complex forms of words (e.g., inflected or derived forms) like in the case of English plural nouns where the rule would, very simplistically speaking, read as *add the suffix –s to the noun stem* [houses$_{PLU}$ → house + [-s]]. In other words, within the framework of generative grammar, linguistic productivity was fundamentally taken to be a product of a system of rules with the help of which it was possible to create an infinite number of

[1] Essentially symbol-manipulation operations.

expressions on the basis of a finite amount of linguistic media (Chomsky, 1965).

With the implementation of connectionist[2] networks in the 1980s[3] (e.g., Rumelhart & McClelland's (1986) pioneering simulation of the acquisition of the English past tense), however, the view that combinatorial rules are an indispensable component of language processing was challenged and associationist explanations of the human language capacity began to become increasingly powerful. Connectionist approaches to linguistic processing reflect the associationist belief that all linguistic (just as non-linguistic) knowledge is learned through, represented in, and computed over a single associative learning mechanism (an associative memory) that is responsive to properties of the stimulus, such as frequency of occurrence and (phonological) similarity. Thus, no distinction is made between a grammar and a lexicon (or other linguistic sub-systems), there is no categorical distinction between noncompositional (morphologically simple) and compositional (complex) forms, and most importantly, there are no mental rules and no distinct system to process rules; rules only serve as convenient descriptive tools without having any explicit representation in the human mind. Instead, the language mechanism gradually learns the entire statistical structure of language, from the arbitrary mappings of noncompositional forms to the rule-like mappings of compositional forms (Ullman, 2001a; Nooteboom, Weerman, and Wijnen, 2002).

---

[2] Henceforth, *associationism* and *connectionism (*and derivations of these terms like *associationist* and *connectionist*) will be used interchangeably.

[3] Connectionist networks are by no means solely products of the last two decades. Networks similar to those designed in the 1980's until today had been implemented in 1950's and 1960's by researchers as Ashby (1952) and Rosenblatt (1962), but were abandoned due to their limited power and the high influence of the symbolic paradigm on cognitive science (Christiansen & Chater, 1999).

The philosophical and empirical conflict resulting from the challenge created by connectionist models and their underlying views of the human language system triggered many counter-arguments speaking for the psychological reality of rules in linguistic processing. Specifically the much-acclaimed connectionist simulation of the acquisition of the English past tense by Rumelhart and McClelland (1986) was severely criticised (e.g., Pinker & Prince, 1988; Lachter & Bever, 1988) and its many shortcomings were taken as clear evidence against the validity of purely associationist theories eschewing linguistic rules. However, as will be further discussed in Chapter 2, it was observed that although the Rumelhart and McClelland model was unsuccessful in accounting for regular English past tense forms, it offered a potentially successful account of the processing of irregular past tense forms. The morphophonological and phonological rules posited in the generative grammar framework (Chomsky & Halle, 1968; Halle & Mohanan, 1985)[4], on the other hand, were found to be insufficient in accounting for many phonological subregularities that irregular forms displayed but appeared to be an accurate account of the processing of regular forms. As a result, a hybrid model (the *Dual-Mechanism Model* or *Words-and-Rules Theory*) was formulated by Pinker and associates (e.g., Pinker, 1991), which incorporates an associationist component and also employs rules. According to the dual-mechanism model, regular forms are basically computed by means of a rule in the mental grammar as had earlier been proposed in the generative grammar framework, and irregular forms are stored in a mental lexicon that bears associative properties similar, but not entirely identical, to those proposed by proponents of connectionist models. This hybrid model was not meant to constitute a model for the representation of the English paste tense alone, but was formulated as a step towards capturing the properties of the entirety of human language.

[4] See Chapter 2.2 for details.

Thus, the dual-mechanism model formed a mid-way between exclusively rule-dependent and exclusively associationist models, capturing both properties in one framework that employs two distinct mechanisms.

1.2 The Past Tense Debate

The bulk of empirical and theoretical research surrounding the above stated connectionism-dual mechanism debate, or 'connectionist-symbolist debate' (Clahsen, 1995), has focused on inflectional morphology, and particularly on the representation and (L1) acquisition of English past tense morphology[5]. The reason for this prominence is that the inflectional processes within the English past tense appear to comprise two descriptively distinct systems ('regular' and 'irregular' past) that are matched in complexity (one word), meaning (past), and syntax (tensed), and compute independently of other linguistic subsystems like syntax, semantics, and phonology (Pinker, 1991; Ullman, 1999). The vast majority of English verbs form their past tense by adding the morpheme *–ed* (*talk-talked, look-looked*). This 'regular' pattern is productively applied to a number of different situations like new verbs (e.g., *faxed*) and unknown verbs (Pinker, 1991) and since Berko's (1958) famous "wug-test" it is well-known that even children hearing novel verbs create their past tense by adding –ed (*blick-blicked*)[6]. In contrast, English contains also around 180 exceptional (or *irregular*) verbs whose past forms are formed in idiosyncratic ways (e.g., *sing-sang, bring-brought*). Thus, English past tense formation appears to be served by two distinct systems that seem to act independently from each other and therefore lend themselves particularly well to investigating whether two distinct mechanisms are at work, as predicted by the dual-mechanism theory, or

[5] Often referred to as "the past tense debate" (Pinker & Ullman, 2002; Marslen-Wilson & Tyler, 2003).
[6] See, however, Taylor (2002: 315) for a critique and short reanalysis of Berko's "wug-test".

whether this observed binary distinction can be explained by means of a single mechanism, as proposed by connectionist models.

From a dual-mechanism perspective, English past tense morphology reveals that two psychological processes are at work, one for regular and one for irregular morphology (Marcus, Pinker, Ullman, Hollander, Rosen and Xu, 1992). From this point of view, irregular past tense forms (e.g., *sing-sang*, *teach-taught)* are retrieved already inflected from an associative memory, while regular past tense forms (e.g., *want-wanted*, *talk-talked*) are computed in real time by a distinct rule-processing system (Pinker & Prince, 1988). According to the connectionist view, however, regular as well as irregular past tense forms are learned in, and computed over, an associative memory without a separate system for rule processing, just as is supposedly the case for all language and other cognitive processes (e.g., Elman, Bates, Johnson, Karmiloff-Smith, Parisi, & Plunkett, 1996).

In summary, then, proponents of both associationist and dual-mechanism models have focused extensively on the English past tense to be able to gather convincing evidence for their claims. Interestingly, the descriptive properties of one and the same inflectional system have been presented as strong verification of either of the models. Evidently, the effort invested in establishing a descriptively and explanatorily valid account of the English past tense and other morphological phenomena does not constitute an end in itself, but forms only a micro-level reflection of the overall purpose of explaining language and other cognitive processes.

1.3 Purpose

Attempts to provide scientific evidence for rule-based or associationist theories of the mental representation of language have more recently

also focused on second language (L2) acquisition and processing, though the number of L2 studies (e.g., Clahsen, 1995; Beck, 1997; Zobl, 1998) is rather insufficient when compared to L1 research conducted in the same domain. Just as L2 studies in this domain are rare, their results are also "ambivalent" as put by Birdsong & Flege (2001) in the sense that the findings obtained are often contradictory and hardly provide compelling evidence, as will be further discussed in Chapter 3.

The major aim of the present study is to constitute a contribution to the above-mentioned 'connectionist-symbolist' debate by investigating the validity of the dual-mechanism model for the mental representation of inflectional morphology in L2 English. In other words, the broad purpose of this study is to examine to what extent the processing of inflected word forms in L2 English can be explained with or without rules. In spite of the fact that neither the dual-mechanism model nor associationist models are originally theories of the mental representation of L2 linguistic knowledge, investigating whether their theoretical tenets can be established in L2 processing appears to be a potentially fruitful enterprise for the following reasons.

First of all, establishing the relative roles of rule-based and associative processes in L2 processing constitutes an important overall objective in itself. Considering the connectionism–dual-mechanism debate prevalent in psycholinguistics, it should be of great interest to unravel whether the brains of L2 users provide support for one or the other model of language processing. It must not be disregarded that theories of language developed solely on the basis of findings based on monolingual individuals may not be representative of the entirety of the human species since multicompetence is anything but the exception in the world and the question whether mental processes in a mind that incorporates two or more linguistic systems are different from those in a monolingual

mind is still far from being answered (Bialystok, 2002). Thus, increasing our knowledge of the multicompetent mind and comparing it with observations and findings concerning the monolingual mind carries the potential of taking us a number of steps beyond our current understanding of the human language system.

Of particular interest is the view maintained by some researchers as Zobl (1998) that the use of full listing and/or decomposition by L2 users is by no means static, but shows variation according to their proficiency-levels in the second language.[7] Zobl claims that L2 users initially go through a *listing stage* during which all morphologically simple and complex word forms are listed undecomposed in the lexicon while consequently, with increasing proficiency, a *computational stage* evolves where L2 users gain the ability to make use of productive decompositional rules. This hypothesised developmental dimension in the processing of L2 morphology is a potentially important one since the establishment of such developmental stages may add a new facet to the ongoing debate in psycholinguistics and establish L2 proficiency as a significant variable in the L2 processing of morphologically complex words. Therefore a further broad purpose of the present study will be to analyse whether it will be possible to come across proficiency-related differences in the processing of morphologically complex words in L2 users.

1.4 Morphological Focus

The morphological structures that will be analysed for the pursuit of the above-stated aims are the following:

---

[7] See also Chapter 3.

a) English Past Tense Morphology

b) English Lexical Compounds

The reasons why these grammatical structures, which have also been the foci of previous studies, have been chosen for analysis is that the production of both of these structures involve certain inflectional constraints and processes which may be indicative of *rule-like* vs. *associative* or *regular* vs. *irregular* inflectional processes. The English past tense, for example, involves a high number of 'regularly' inflected verb forms, which are described as involving the attachment of the regular suffix *–ed,* and approximately 180 'irregularly' inflected verb forms, which involve the application of "unpredictable" morphophonological processes (Pinker & Ullman, 2002). Since the English past tense and its implications for models of morphological representation are extensively described throughout this study, no further details will be provided at this point.

Similarly, the formation of English lexical compounds[8] (e.g., *car-washer*) also bears direct relevance to the debate at hand. As is well known, lexical compounds are constrained by the fact that irregular but not regular (-s) plural forms may occur as non-head elements inside lexical compounds (e.g., *mice-killer* vs. **dogs-killer).* From a dual-mechanism perspective, the distribution of plurals-inside-compounds corresponds to the distinction between lexically stored (irregular) and rule-based (regular) inflection proposed. As is known, regular plural nouns are formed through the application of the suffix *–s* (e.g. *table-tables, window-windows*), whereas irregular plural nouns are not produced by the addition of the regular suffix, but are formed in idiosyncratic ways (e.g.,

[8] Although compounding is often taken to be closer to being a derivational rather than an inflectional process, it still falls within the scope of the present study due to its close relevance to the issues under investigation.

ox-oxen, tooth-teeth, fish-fish). From the perspective of the dual-mechanism model, but naturally not from an associationist perspective, regular plural nouns are thus computed 'on-line' by the concatenation of the regular rule (add *–s* to the noun stem), whereas irregular plurals are stored in memory already inflected. Thus, given that lexical compounding concatenates lexical entries, it follows that irregular plurals, which are allegedly lexical entries, can be fed into the compounding process, whereas rule-based forms such as *-s* plurals, which are not lexical entries but computed on-line, cannot be included in the compounding process (Clahsen & Almazan, 2001).

1.5 General Research Questions

On the basis of the findings of previous research into the mental representation of inflectional morphology and the aims of the study summarised above, the following general research questions have been formulated[9]:

1) Do L2 users display asymmetries in the production of complex word forms that are indicative of a distinction between rule-based vs. association-based mental processes and hence lend support for the view that the dual-mechanism model is applicable to L2 processing?

2) Are the relative roles of association-based and rule-based processes comparable in L1 and L2 processing or do L2 users employ these processes to comparatively different degrees?

[9] See the experimental chapters (Chapters 4 and 5) for research questions and predictions specific to the respective experiments.

3) Does the processing of morphologically complex words vary according to the proficiency levels of L2 users?

In the light of previous findings of L2 studies (e.g., Kırkıcı, 2002; Beck, 1997), it is expected that the overall results of the present study will show that the L2 subjects in this study will display asymmetries in the processing of regular and irregular morphologically complex word forms, pointing towards the presence of two distinct linguistic mechanisms as posited by the dual-mechanism model.

However, in contrast to what has been reported for L1 speakers in previous studies, it is expected that the outcomes of the experiments to be conducted will imply that L2 users utilise the associative memory to a higher extent; i.e., that the associative memory plays a much more salient role in the processing of linguistic information when compared to L1 speakers. The reason for this expectation is the fact that L2 learners are known to store an important portion of linguistic information initially unanalysed and only later to go through an affix discovery procedure in which they attempt to match form with meaning, as put by Lowie (1998). Only if the frequency of the affix in the input is high enough will the learner start to recognise a particular affix and start using it productively; i.e., decompose the complex word form and use the rule productively in the case of regular forms.

Considering that the subjects employed for the present study are learners of English as a foreign language with only a limited amount of L2 input, it is conceivable that they have only limited opportunities to discover the whole range of the target language morphology and to implicitly apply rules of the grammar productively. Therefore a considerable part of the morphological knowledge acquired should be stored unanalysed in the memory. Thus, it is expected that this high utilisation of the memory will

increase its productivity for L2 processing, resulting in a tendency to store a subset of morphologically complex word forms as wholes and leading to relatively more undecomposed listings when compared to L1 speakers. However, it is not anticipated that the results of the experiments to be conducted point towards a deficit or a complete lack of the rule-system in L2 processing, but rather that they display an increased productivity of the associative memory *in addition to the rule-system*. In this sense, a refinement of the dual-mechanism model is proposed in which the associative memory takes on a more significant role in L2 processing than in the original theory devised for L1 processing.

It is further expected that this proposed relatively high productivity of and the high reliance on the associative memory will decrease with increasing L2 proficiency. It is assumed that increasing proficiency is a by-product of a higher degree of L2 input, which, as stated above, should lead to the progressively more productive use of implicit morphological rules. However, it is not assumed that L2 learners are initially devoid of the ability to apply rules as proposed by Zobl (1998). It is instead proposed that L2 learners are able to make use of rules *from early stages of interlanguage development on*, though possibly only to a limited degree and probably by making predominant use of partially explicit knowledge. This expectation is largely based on the findings obtained by Kırkıcı (2002), who found clear-cut evidence of a low-proficiency L2 users' ability to employ linguistic rules[10]. This constitutes a modification of the assertion of Zobl (1998), who, as discussed before, argues that L2 learners initially lack a rule-system altogether and build it up only later with increasing proficiency.

[10] See Chapter 3.2.2.3.

CHAPTER 2

SETTING THE SCENE: SINGLE-MECHANISM MODELS OF MORPHOLOGICAL PROCESSING

This chapter consists of three major sections. The first major section introduces the chapter. The second major section presents the main tenets, strengths and shortcomings of two early generative models of linguistic processing (Chomsky's *Standard Theory* and Halle & Mohanan's *Segmental Phonology Model*), which constitute prototypes of rules-only models. Finally, the third major section reviews the general properties of connectionist models, presents early and more recent connectionist models of morphological processing, and discusses their strengths and shortcomings.

2.1 Introducing Single-Mechanism Models

The aim of this chapter is to present the major tenets of single-mechanism models of morphological storage and processing, which play central roles in the dual-mechanism-connectionism debate. What the models to be discussed in this chapter have in common is that they constitute single-mechanism models in the sense that it is hypothesised that all morphological processes are taken care of by one single mental mechanism – either a rule system or an associative system– in contrary to the dual-mechanism model, which employs two systems as the name suggests. The discussion will, where possible, be tied to the properties of the English past tense due to the fact that the bulk of the discussions in

the connectionism vs. dual-mechanism debate have revolved around the English past tense, as mentioned in Chapter 1.

2.2 Rules-Only: Early Generative Models

Although the present study is basically psycholinguistic in nature, two major theoretical linguistic models of morphology, Chomsky's (1957, 1965) *Standard Theory* and Halle & Mohanan's (1985) *Segmental Phonology Model* will be briefly discussed at this point for various reasons. Firstly, most psycholinguistic theories of morphology are directly or indirectly based on the tenets of the linguistic theories to be discussed below or have taken over some of their basic assumptions. Secondly the linguistic models to be discussed share the common feature that they are classified as coming from the generative grammar framework, which is known for its attempts to establish a direct link between linguistic constructs and mental processes (Miller & Chomsky, 1963) and is therefore indirectly related to many contemporary psycholinguistic efforts. Finally, and most importantly, particularly early generative approaches to morphology (or morpho-syntax) constitute paradigm cases of rules-only theories in which almost all possible patterns in a given language are explained on the basis of rules and are therefore indispensable for the entirety of the present study in that they exemplify the requirement for rules on the one hand, but clearly embody the drawbacks of *exclusively* rule-based systems on the other.

2.2.1 Morphological Processing in Chomsky's *Standard Theory*

The earliest model of generative grammar, the *Standard Theory* (Chomsky, 1957, 1965), postulated a grammar with only a syntactic and a phonological component and did not hypothesise a separate morphological component. While the majority of morphological processes

(inflection, derivation, compounding) were realised through syntactic transformations, allomorphic variations were seen as the result of the operation of phonological rules. The role of the mental lexicon, on the other hand, was merely to provide the items for lexical insertion transformations into the syntax (Spencer, 1991).

This early model would, as it stands, evade a lot of lexical redundancy since in this proposed system only word stems are stored in the lexicon and all inflected word forms are derived by rule. Thus, the mental lexicon only carries the burden of listing word stems and all kinds of productive word formations are carried out by means of the concatenation of phonological material. In terms of the English past tense, for example, this would mean that regular forms are produced by the addition of the phonological material *–d,* which encodes the grammatical feature [+past], to a given verb stem. In this way, the listing of each and every word form together with its stem (e.g., *talk* and *talked*) is circumvented and storage cost is kept at a minimum level. For irregular past tense forms, on the other hand, the conventional explanation was that they are simply listed in the mental lexicon like stems.

However, while the generation of regular past tense forms by means of the concatenation of a phonological entity, i.e. the application of a rule, constitutes an elegant way of overcoming storage cost and, to a certain extent, appears to carry descriptive validity, the view that English irregular verb forms are rote-learned and simply listed in the mental lexicon runs against the characteristics displayed by English irregulars. Firstly, apart from the pairs *be-was/were* and *go-went*, all irregular forms largely maintain the phonological content of the stem in the past tense form (Pinker, 1991) and are thus phonologically related. Under the view that irregular stem-past tense pairs are rote-memorised and stored as arbitrary pairs, it is rather difficult (if not impossible) to account for this

phonological relatedness since rote memorisation is not necessarily driven by phonological constraints. Secondly, it is curious that irregular alternations like vowel-changes are not found in single irregular verbs but in groups or 'gangs' (Stemberger & MacWhinney, 1988) of similar verbs such as *sing-sang, ring-sang, spring-sprang, drink-drank, shrink-shrank, sink-sank, stink-stank, begin-began, swim-swam* (i→a); *grow-grew, throw-threw, blow-blew, know-knew, draw-drew* (o→u). Thus, simple unproductive rote memorisation does not appear to be able to explain this large degree of redundancy either (Pinker & Prince, 1988). In other words, if the view that every idiosyncratic irregular verb form is unproductively rote-listed was correct, it would be incredibly difficult to find a feasible explanation for the existing phonological overlaps between different verb forms, as shown above. In addition, it is also known that children as well as adult speakers occasionally extend certain existing patterns to other existing patterns (e.g., *bring-brang* extended from *sing-sang*), which constitutes counterevidence for the view that irregular pairs are unproductive word-lists (Prasada & Pinker, 1993).

2.2.2 Halle & Mohanan's (1985) Segmental Phonology Account

In a later generative account, which is largely based on Chomsky & Halle (1968), Halle & Mohanan (1985) re-examine and further develop the approach to the segmental phonology of modern English presented in Chomsky & Halle (ibid.). Borrowing concepts from lexical phonology (Pesetsky, 1979; Kiparsky, 1982; Mohanan, 1982), Halle & Mohanan suggest that the lexicon consists of five strata (or levels), at which different morphological affixation processes take place. So, for example, while *-ic, -ion,* and *–ity* are suffixes attached at stratum 1, affixes like *–ness, adjectival –ed, -hood,* and *un-* attach at stratum 2, compound formation takes place at stratum 3, and regular inflections (e.g., *plural –s* and *past –ed*) take place at stratum 4. While the first four strata can thus

be categorized as 'lexical' strata, where mainly affixation and compounding processes are realised, the fifth stratum is a 'postlexical stratum', where words come together to form phrases and larger syntactic entities.

Halle & Mohanan adopt Siegel (1974) and Allen's (1978) idea of level-ordering and suggest that the aforementioned five strata are *ordered* in the sense that while a process 'assigned' to a higher stratum may apply after a lower-stratum or equal-stratum process, a lower-stratum process can not apply once a higher-stratum process has taken place. To exemplify, *guardedness* is a well-formed word in English because the suffix *–ness*, attached at stratum 2, follows *adjectival –ed*, which is again a suffix attached at stratum 2. The word **guardedity*, on the other hand, is ill-formed because the stratum 2 suffix *adjectival –ed* is followed by a stratum 1 suffix (*-ity),* which runs counter to the ordering of the levels.

To account for the phonological variations in English, Halle & Mohanan propose around 30 phonological rules, which interact with the morphological strata listed above by being assigned specific morphological strata domains and apply only at the strata they are assigned to. So, for example, the vowel shortening rule is assigned to stratum 1 and may therefore apply to *divinity* and *serenity* as these are formed with the suffix *–ity*, which is a stratum 1 suffix. The vowel shortening rule can thus not be applied to *maidenhood*, since the suffix *–hood* is a stratum 2 suffix whereas the vowel shortening is only operative at stratum 1 (Halle & Mohanan, 1985).

Of specific relevance to the present study is the way Halle & Mohanan handle the formation of English past tense verb forms, and particular irregular verb forms. For regular verb forms, Halle & Mohanan theorise that the grammar contains a statement that in the past tense the suffix –

ed is attached to the verb stem. For suppletive forms like *go-went*, on the other hand, the grammar is theorised to contain a statement that the past tense of *go* is *went*. In the case of irregular verb forms, the grammar is said not to contain an excessive number of statements stating the past tense form for each and every verb like 'the past tense of *teach* is *taught;* the past tense of *bring* is *brought, etc.*' Instead, a number of morphophonological rules are devised which map verb stems and groups of verb stems to their corresponding past tense forms and which are similar to the general rules stated above. It is important to note that the morphophonological rules deriving irregular past tense forms operate at strata lower than the regular past tense suffixation rule *–ed*, which, as mentioned before, is operative at stratum 4. Consequently, only forms which have not undergone an irregular rule process at one of the lower strata (strata 1-3) are subject to the concatenation of the regular past tense suffix, thus preventing the production of over-generated forms like **sanged* and marking regular suffixation as the 'default' process.[11]

The following two examples demonstrate how the proposed morphophonological rules in Halle & Mohanan (1985) generate irregular past tense forms:

1) *Lowering Ablaut* (stratum 2)

$$V \rightarrow \begin{bmatrix} +\text{low} \\ -\text{high} \end{bmatrix}$$

[11] See also Kiparsky (1982) and Aronoff (1976), where the 'default condition' is analysed as 'the elsewhere condition' and 'the blocking principle', respectively.

Halle & Mohanan state that the above-stated ablaut-lowering rule (operative at stratum 2) accounts for verbs like *sit, spit, bid, drink, begin, ring, shrink, sing, sink, spring, stink,* and *swim*,[12] which change the stem vowel /I/ to /æ/ in the past tense.

2) *Backing Ablaut* (stratum 2)

$$\begin{bmatrix} V \\ \text{<-high>}_a \end{bmatrix} \rightarrow \begin{bmatrix} +back \\ \text{<+round>}_b \end{bmatrix}$$

If a, then b

The ablaut-backing rule presented above (again operative at stratum 2) accounts for verbs like *cling, dig, fling, shrink, sling, slink, spin, stick, sting, string,* etc., which change their stem vowels from /i/ to /ʌ/ as a result of backing. The second part of the rule, on the other hand, accounts for verbs like *break, wake, get, swear, wear* etc., the non-high stem vowels of which are not only backed but also rounded to produce past tense forms like *broke, woke, got, swore* and *wore.*

Halle & Mohanan thus try to account for the subregularities within the whole set of approximately 180 irregular past tense forms in English by proposing 10 morphophonological rules which are operative in three different strata, work in an interactive fashion and are applied to verb stems which are stored in the mental lexicon. Needless to say, the model is as it stands unnecessarily abstract and, in some cases, requires the application of too many rules in interaction as is exemplified by Say (2000):

---

[12] The rule is further claimed to be operative for verbs like *eat, lie,* and *choose*, where the surface vowel is subject to vowel shift (Halle & Mohanan, 1985).

> … to derive *sought* from *seek*, at level 1 affixation of *–t* is followed by /x/ formation, a rule which changes a non-anterior obstruent (for example /k/ or /g/) to /x/ before /t/. The final consonant cluster provides motivation for shortening the vowel (/si:xt/ → /sixt/) which subsequently undergoes Backing Ablaut. Finally, an (independently motivated) rule of /x/ deletion yields the past tense form *sought* (p. 15).

Another drawback the model exhibits is that although it may provide a *descriptively* adequate picture of the irregular patterns in the English past tense, the explanations provided are insufficient in providing a satisfactory *explanatory* account for the phenomena. From the perspective of Halle & Mohanan, the mental grammar appears to contain specific information as to which irregular verb stem undergoes which morphophonological rule(s) to form its past tense form and verb stems that undergo the same rules are grouped together. In other words, a given rule can only be effective on a verb stem that has been marked for the specific rule. However, in reality, it is known that certain irregular patterns are productive in the sense that they can be and are extended to new instances, i.e., to stems that have not been marked for a specific rule, on the basis of phonological similarity. For example, it is a well known fact that a nonce-word like *spling* is likely to be inflected by adults and children as *splang* on the basis of its phonological similarity to verbs like *cling, spring,* and *fling.* This is not necessarily a behaviour predicted by the Halle & Mohanan model since the nonce-word *spling* cannot have been marked by the grammar to undergo a specific vowel alternation rule as it is not contained in the lexicon/grammar. Similarly, children are known to overapply irregular patterns to already existing irregulars as in the case of *bring-*brang* in analogy to *sing-sang,* which, according to Marcus et al. (1992), should not be the case if *bring* is marked in the grammar to undergo a specific rule that has the effect of mapping it to the past tense form *brought*. In this sense, simply equating group-

membership with the standard application of a morphophonological rule, as is done by Halle & Mohanan, disregards the productivity irregular patterns display beyond their 'pre-assigned' group members.

In the same vein, positing that only stems are stored in the lexicon and that all subsequent inflections are results of the rule-applications runs counter to a psycholinguistic finding that has been attested in many studies in the past few decades. In speeded production tasks (e.g., Prasada, Pinker & Snyder, 1990), lexical decision tasks (e.g., Stanners, Neiser, Hernon & Hall, 1979), as well as other types of psycholinguistic experiments, it has been found that irregular past tense forms exhibit frequency effects. That is, stem frequency being equal, low frequency irregular forms are produced (or comprehended) slower than high frequency irregular forms, which speaks against the view that irregular past tense forms are produced by means of rules that are applied to stems and, instead, provides evidence for whole-word storage, as is also pointed out by Say (2000). For regular past tense forms, on the other hand, the frequency effects that have been attested for irregular forms have not been found, which is indicative of inflection by rule as is suggested in the Halle & Mohanan model. Furthermore, reported linguistic behaviours like over-regularisation errors as in *teached* and *bringed* (in Marcus et al., 1992) and the concatenation of the 'regular' past tense suffix to nonce-words that bear no similarity to existing irregular and/or regular stem forms as in *ploamph-ploamphed* (in Prasada & Pinker, 1993) also indicate that for regular forms the stem and the suffix are accessed separately and that a rule system for regulars which concatenates a given suffix to the stem must be the case.

In sum, neither the rote-memorisation and rules model of Chomsky (1965) nor the rules-only model of Halle & Mohanan (1985) appear to be entirely successful in accounting for the whole picture in morphological

processing, particularly when analysed in relation to the English past tense. Whereas the proposed rule-models are successful in explaining the representation and processing of regular forms, their suggested mechanisms fail to constitute successful models of irregular processing in the light of the above-mentioned criticisms.

2.3 Associations Only: Connectionist Models

Connectionism can be basically described as a computational architecture that aims at modelling human cognitive processes by using networks of large numbers of interconnected processing units (or *nodes)*, which correspond to concepts or features in the human cognitive machinery. The structure of connectionist models is based on the neuro-anatomical architecture of the human brain, which is known to consist of a large number of interconnected neurons that operate simultaneously and cooperatively to process information. Similarly, connectionist models entail a large number of nodes that operate in a simultaneous and cooperative fashion in a network in which they transmit numerical values. Despite this 'neural inspiration', as Christiansen & Chater (1999) call it, connectionist models are not taken as realistic models of the human brain, neither in terms of the incorporated processing nodes, which fail to represent successfully the properties of human neurons, nor at the level of the overall structure, which displays little similarity to the actual human neural structure (Christiansen & Chater, ibid.).

As mentioned in Chapter 1, connectionism is often taken as a direct challenge to traditional symbolic accounts of cognition, which maintain that human cognitive mechanisms are symbolic, modular, innate and domain specific. Instead, connectionist modelling mostly assumes that cognitive processes are "graded, probabilistic, interactive, context-sensitive and domain-general" (McClelland & Patterson, 2002: p.465),

that the rules and symbols utilised by more traditional accounts of the human cognitive machinery constitute merely descriptive tools which bear little or no psychological realism and that "many phenomena which appear to require explicit rules can be handled by using connection strengths" (Touretzky & Hinton, 1988: p. 423). It should be noted, however, that not all connectionist models make this entirely non-symbolic assumption, but some connectionist models (e.g., Hinton, 1990; Holyoak & Hummel, 2000) concretely incorporate the implementation of a symbol-manipulation system. Connectionist models of the former type are often referred to as *eliminative connectionist models*, while models of the latter type are commonly called *implementational connectionist models* in line with the distinction drawn by Pinker & Prince (1988). In other words, a connectionist view of cognition does not, in general, automatically preclude the belief that the human brain implements symbol manipulation, and vice versa.[13] However, within the context of the present study, connectionism will refer to eliminative single-mechanism connectionist models, since the challenge to symbolic accounts of cognition has been built upon this type of connectionist models.

Although there are many different types of connectionist models, the basic design of most connectionist models shares a common overall structure (Figure 1) and function. Very simplistically speaking, the fundamental task of these models is to learn a mapping from a set of input nodes to a set of output nodes[14] by means of a number of training samples and feedback provided by an external 'teacher'. The input and output nodes have activation values (numbers like 0 and 1) and externally assigned labels, and are connected to each other by means of

---

[13] See Marcus (2001) for an excellent discussion of the integration of symbol-manipulation processes in connectionist models.

[14] Some connectionist models further contain hidden units, which take place between input and output units . These represent neither the input nor the output, but serve as internal representations of the input (Marcus, 1998).

weighted connections, the weights of which are usually adjusted by a learning algorithm. These models are thus described to 'learn' by adjusting the strengths of the connections, usually in a direction that reduces the divergence between an actual output in response to some input and a desired output provided by an independent set of teaching-units. Depending on the weights of the connections, a connectionist network can represent a number of different relations between input and output nodes.

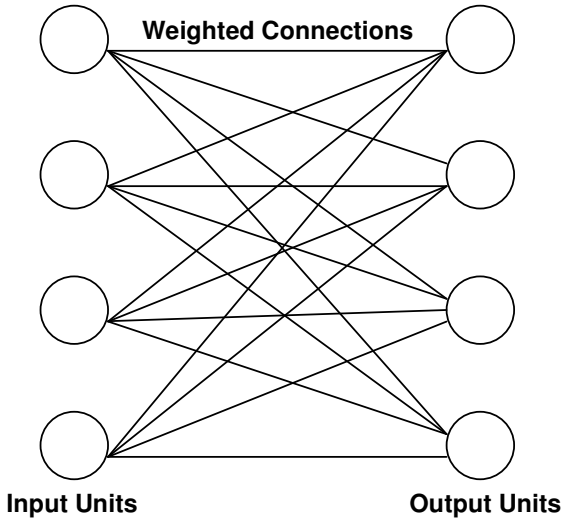


Figure 1: A simplified representation of general connectionist architecture

Probably the most controversial trait of connectionist models is the requirement of the above-mentioned 'teaching-units' or a 'supervisor', i.e. an external supervisory device and/or learning algorithm[15] (Seidenberg &

[15] A typical example of such an error-correction algorithm is the *back-propagation algorithm* (Rumelhart, Hinton & Williams, 1986).

Elman, 1999), which provides the model with feedback on the established input-output mappings and their distance to the target(s) aimed at and, in some models, adjusts the weights between connections to correct the measured error. Many critics of connectionist models question the plausibility of such an external supervisor since real-life human cognitive processes are hardly ever supervised or provided feedback on by any external entity or person. However, not all connectionist models employ such a mechanism and the relevance of such external teaching-mechanisms is still a matter of debate. Needless to say, there are many more and architecturally different types of connectionist models which bear various features and technical details. However, discussing all implemented models and all the intricacies of connectionism would go far beyond the purpose and scope of the present study.

2.3.1 Connectionist Morphological Modelling

What, then, are the implications of connectionist modelling for the processing and representation of language in general and morphology in specific? As mentioned before, from a connectionist perspective the cognitive system taken as a whole- including all linguistic processes, from the acquisition of language to the representation and processing of lexical and syntactic units – is basically served by a domain-general, single mechanism, which makes no distinction between a grammar and a lexicon (or other linguistic sub-systems). Just like other cognitive processes, linguistic processes are computed through the adjustment of connection weights between input and output units in the connectionist system on the basis of statistical contingencies in the environment. Thus, the entirety of linguistic knowledge is learned through, represented in, and computed over the single associative learning mechanism described above. Since the system is roughly built upon the formation of associations, it is responsive to properties of the stimulus, such as

frequency of occurrence and phonological similarity. In other words, more frequent items are accessed easier (or faster) and more accurately than less frequent items, and items that share a lot of common features (e.g., phonological similarity) tend to be stored closer to each other, in 'gangs' or 'families' (Stemberger & MacWhinney, 1988; Alegre & Gordon, 1999). Most importantly, there are no linguistic rules and no distinct system to process rules since 'rules' as posited by more traditional linguistic approaches are regarded as nothing more than descriptive tools that have no explicit representation in the human mind.

On the basis of these general properties, and particularly on account of the fact that morphological rules (and rules in general) are eschewed, connectionist models do not distinguish between noncompositional (morphologically simple) vs. compositional (complex) or regular vs. irregular word forms: "all types of morphological patterns can be acquired by the same process – the storage of items, the creation of connections among them, and the formation of patterns that range over sets of connections" (Bybee, 1991: pp. 86-87). Connectionist models of morphological processing are distinct from all other models of morphology discussed so far since the proposed mechanism is neither a model that employs some kind of morpho(phono)logical rules as in decompositional/parsing models or traditional, generative models, nor is it a prototypical full-listing model proposing the listing of all possible words and word forms as whole units. Instead, connectionist models of morphology propose an associative memory system that works on the basis of a mechanism that establishes associative relations between input and output representations of word-features (mostly sounds), which are strengthened by means of factors like frequency of occurrence and phonological similarity.

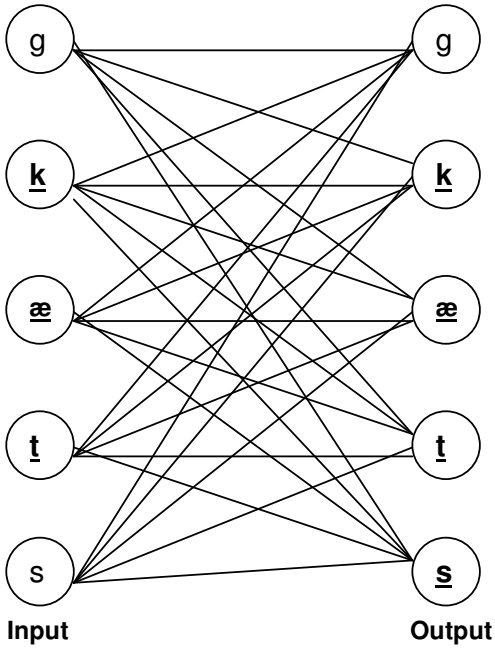


Figure 2: A highly simplified sample two-layer model of the English plural system, representing words as phonetic features.[16]

Put plainly, in a connectionist model of morphological processing a (phonetically)[17] encoded input representation of a word stem provided in the training sample is linked to a (phonetically) encoded output (i.e., the complex word form). So, for example, the learning of the plural form of the noun *cat* can be achieved by presenting the model with a phonetic description of the stem *cat* encoded as the input and establishing associations (or links) to the phonetic description of the plural form *cats* as the output. The simultaneously activated input nodes (sounds) [k], [æ], and [t] would represent the word *cat,* and would be connected to the

[16] Activated nodes are underlined and in boldface.
[17] Depending on the connectionist model implemented, the encoded features may not be phonetic features but can represent a range of different features like a whole word (e.g., Elman, 1990), a semantic unit (e.g., Hinton, 1986), or any other specification assigned by the modeller.

output nodes, which represent the sounds [k], [æ], [t], and [s] (Figure 2). The repeated adjustment of the connection weights between the input representation and the output representation will then lead to the learning of the input/output mapping (in this case, stem/plural form) without having to implement a plural *–s* rule. By means of this single mechanism of association between input and output representations, it is claimed, connectionist models are capable of learning all kinds of morphological forms without making use of symbol-manipulating rules, no matter if the form at hand is regular, irregular, simple, or complex (Marcus, 2001).

2.3.1.1 The Rumelhart & McClelland Model (1986)

One of the most cited and by far most controversial connectionist simulations of linguistic behaviour is Rumelhart & McClelland's (1986) two-layer feed-forward network model of the English past tense. The Rumelhart & McClelland model is accepted as a revolutionary step in linguistic and cognitive science that "irrevocably changed the study of human language" (Pinker, 2001: p. 159) since it presented a significant challenge to the then commonly accepted view that language acquisition is merely a rule-induction process and that linguistic productivity can not be explained without resorting to some kind of rules. Rumelhart & McClelland specifically chose to model the acquisition of the English past tense because following studies like Berko (1958) and Ervin (1964), which reported the (over)-application of the past tense suffix *–ed* to irregular (*goed*) and nonce (*pluncked*) forms in experimental studies, the linguistic behaviours of children using the English past tense were often cited as evidence against rote memorisation accounts and as support for the view that children make use of *rules* of languages – in this case the past tense rule (Pinker & Prince, 1988). Following the inception of the Rumelhart & McClelland model and the publication of subsequent criticisms raised at it (see below), the 'past tense debate' has become

one of the central themes in cognitive science and psycholinguistics, triggering what Marslen-Wilson & Tyler (2003) describe as a philosophical and empirical discussion on the architecture of human cognition and the human language system.

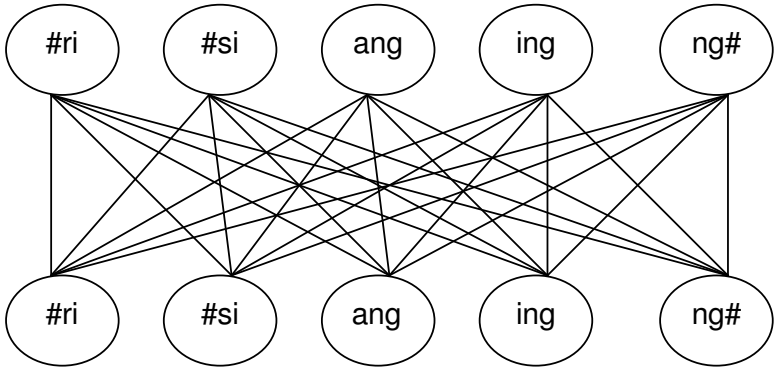


Figure 3: A simplified version of the Rumelhart & McClelland (1986) Model[18] (based on Marcus, 2001)

The Rumelhart & McClelland model basically consists of an input layer and an output layer, which contain a total of 920 input and output nodes that encode Wickelfeatures (sequences of three phonetic features) like *liquid, unvoiced, voiced,* etc. to represent words. The word *bring*, for example, would be represented by the simultaneous activation of the triplets[19] *#br, bri, rin, ing*, and *ng#*[20] (see Figure 3 for a very simplified sketch of the model). The model is initially 'trained' by feeding in a

[18] Note that the actual model contained 460 input nodes, each connected to each of 460 output nodes.
[19] Throughout the present discussion Wickelphones (sequences of three phonemes) are used instead of Wickelfeatures for simplification.
[20] The marker # specifies word boundaries.

number of input and output forms (phonetic features of stems and past tense forms, respectively), comparing the actual output computed by the connections with the correct past tense forms intended, and adjusting connection weights accordingly. This feeding, comparing and adjusting process is repeated until the model is able to produce the correct past tense forms of all samples in the training set.

A by-product of this process is that the activation of given nodes during the training of a specific stem-past tense pair like the activation of the *ing-ang* nodes for the pair *sing-sang* strengthens the *ing-ang* connection for all words that contain either/both of these nodes (e.g., *spring-sprang, ring-rang*) and, thereby, forms strong associations between these words and enables the model to generalise to phonetically similar words that have not been encountered before. In this way, the model does not need a separate system for regulars since, similarly, training the model on a regular pair like *walk-walked* strengthens the connections between the *alk* input nodes and the *alked* output nodes, thereby enabling the network to generalise to similar pairs like *talk-talked* (Marcus, 2000). In the same vein, over-regularisation errors like *thinked*, which are often taken as proof for the existence of morphological rules, are also handled by the same mechanism. The production of *thinked*, for example, may occur as a result of an analogy formed with *blinked,* with which it shares a lot of phonetic material (Marcus, 1995a).

The training of the Rumelhart & McClelland Model was implemented in two stages, which comprised the feeding-in of 420 stem-past tense form pairs, in approximately 200 training cycles, and about 80.000 trials. In Stage 1, the network was trained on 10 high frequency verbs (8 irregulars and 2 regulars)[21], after which it performed perfectly and produced the

[21] These verbs were the 10 highest frequency verbs in English, excluding *do* and *be*.

correct past tense forms of the regular and irregular verbs it had been trained on when presented with the stem forms. In Stage 2, the network was presented with an additional 410 of the next-most-frequent verbs (76 irregulars and 334 regulars). In the beginning phase of this second stage, the network tended to over-regularise irregular verbs (e.g., *bring-bringed*, *teach-teached*) but correctly produced past forms of regular verbs, only to gain almost perfect performance towards the end of the training procedure and accurately produce both regular and irregular forms.

This overall learning-pattern displayed by the model in the training stages (the accurate production of regular and irregular forms– followed by over-regularisations and the later regaining of accuracy on regulars and irregulars) is argued to mirror the sequence children go through in acquiring the English past tense. It is well known that children acquiring the English past tense begin by correctly producing a small number of both regular and irregular forms, followed by a later stage in which they produce typically 'over-regularised' forms (like *eated* or *holded*) for a small amount of their verb forms[22]. They then appear to re-learn the correct forms (or unlearn the over-regularized forms), producing the classic 'U-shaped developmental profile reported in earlier studies (e.g., Berko, 1958; Marcus et al., 1992). In other words, the model appears to model successfully the U-shaped developmental pattern observed with children acquiring the English past tense system.

However, later reanalyses of the Rumelhart & McClelland model (e.g., Pinker & Prince, 1988; Marcus et al., 1992) made it obvious that the U-shaped developmental pattern reproduced by the model was in reality an artefact of the training procedure. As mentioned above, Rumelhart & McClelland presented the model in the first training stage with only a

[22] Marcus et al. (1992) report this rate of over-regularization as 4.2% of opportunities.

small number of very high frequency items (10), the overwhelmingly majority of which happened to be irregular verbs (8/10), and trained the model until it learned all the correct stem-past tense mappings. In Stage 2, the model was suddenly presented with a very high number of additional items (410), the majority of which were regular verb forms (334/410). Thus, this sudden incursion of a regular-dominated input apparently caused the abrupt strengthening of many connections between stem features and features defining the regular ending (*ed*) in output (past tense) forms, which in turn overwhelmed the few already existing stem-irregular past connections and thus led to over-regularisations. Subsequently, with increased feedback and adjustments, the stem-irregular links were strengthened again and correct irregular forms reappeared, as pointed out by Marcus et al. (1992), thus creating a 'manufactured' U-shaped developmental pattern obtained by feeding in carefully chosen input.

Rumelhart & McClelland defend their training regime, claiming that it successfully captures children's experience in the acquisition of the English past tense:

> *Our conception of the nature of this experience is simply that the child learns first about the present and past tenses of the highest frequency verbs; later on, learning occurs for a much larger ensemble of words, including a much larger proportion of regular forms* (1987: p.222).

In other words, Rumelhart and McClelland base their modelling assumptions on the view that children's over-regularisations concur with the 'vocabulary spurt' attested for children during which a rapid increase in the quantity of vocabulary is said to occur (Brown, 1973) and on the belief that children initially are exposed to/produce mostly irregular verbs but subsequently produce/are exposed to regular verbs in the majority. However, detailed statistical analyses conducted by Marcus et al. (1992)

on the properties of children's speech and the input provided by their parents in the course of the acquisition of the English past tense have shown that the modelling assumptions of Rumelhart & McClelland are merely misconceptions and, therefore, that the training regime provided is in fact very unrealistic:

> *Our estimates of children's types, adults' types and children's tokens provide virtually no support for the hypothesis that overregularisation is triggered by increases in the number of proportion of regular verbs available to the child. Regular verbs remain a roughly constant proportion of adults' and children's conversational tokens, and never dominate. Regular types … necessarily increase with development, both absolutely and as a proportion of total verb vocabulary, but the sizes of these increases do not correlate positively with children's tendency to overregularise.* (Marcus et al., 1992: p.99).

Thus what Marcus et al. have found as a result of their detailed analyses is that, in fact, the quantity of regular verbs in the linguistic input to and output of children, before and during the over-regularisation stage, is found to be rather low and stable and, additionally, that there appears to be a striking negative correlation between growth in regular vocabulary and rate of over-regularisation, contrary to the assumptions of Rumelhart & McClelland.

A further problem that the Rumelhart & McClelland model has been criticised for is its rather poor performance in generalising to verbs that it has not been trained on. After the completion of the training stages of the model, Rumelhart & McClelland presented the system with 72 regular and 14 irregular novel verb stems (i.e., stems which had not been members of the training set). Considering the fact that the model had been successful in producing the correct past tense forms of the items in the training set, it should now have learned how to inflect for past tense. It

should therefore be able to extend this capacity to new forms in a manner comparable to the way humans behave when they encounter new forms.

However, as was also underscored by Pinker & Prince (1988), the model had serious generalisation problems with regulars since in 33% of the instances (24/72) the response provided as output was incorrect. For 6 verb stems (*jump, pump, soak, warm, trail, glare*), the model provided no response at all, indicating that the system had not learned to generalise for these forms. Incorrect responses included bizarrely inflected forms (*squat-squakt, mail-membled, tour-toureder, mate-maded*), no change at all (*hug-hug, smoke-smoke*), double markings (*type-typeded, step-steppeded, snap-snappeded, map-mappeded, drip-drippeded*), and incorrect vowel/consonant-changes (*shape-shipt, sip-sept, slip-slept, brown-brawned*). As Pinker & Prince (1988) note, these production behaviours are quite remote from the confusions people would be expected to make and certainly do not reflect the production patterns of humans who encounter new forms. From this perspective, the model can definitely not be regarded as a realistic model of the use of regular English past tense forms because it simply fails to generalise successfully the regular pattern. This failure appears particularly significant when it is considered that not even children at the age of four are reported to produce such deviant forms as those produced by the Rumelhart and McClelland model, but are easily able to inflect novel forms like *to rick* as *ricked* (Berko, 1958) when confronted with a verb form they do not have in their lexical repertoire.

With regard to its performance on novel irregular forms, however, the Rumelhart & McClelland model displayed a considerably different picture. Prasada & Pinker (1993) note that despite the fact that the model had been trained on as few as 84 irregular forms (compared to 336 regular forms), it was able to produce the past tense forms of phonologically

diverse verbs like *weep, bid,* and *cling* (*wept, bid* and *clung,* respectively), thus displaying its potential to make highly complex generalisations on the basis of phonological similarity to items already stored in the associative system. In addition, the model showed that it was sensitive to the sub-regularity that all no-change verbs (verbs whose stem and past tense forms are identical like *bid-bid*, *cut-cut*, *set-set*, etc.) end in either *t* or *d*, and tended to treat both regular and irregular stems ending in *t* or *d* as no-change verbs, again demonstrating its capability of making powerful generalisations. Thus, despite the limited amount of training samples, the Rumelhart & McClelland model did not produce highly deviant irregular structures as was the case with regular forms, but proved to be quite successful in discovering and applying some of the sub-regularities and similarities that irregular verb forms displayed.

2.3.1.2 Later Connectionist Models

Ever since the Rumelhart & McClelland model and the subsequent sharp criticisms raised against it, researchers in the 'connectionist camp' have tried to come up with improved connectionist models of the acquisition of the English past tense which incorporated a number of architectural updates such as the addition of further layers of connections and various learning algorithms. However, none of the successors of the Rumelhart & McClelland model has been able to constitute a satisfactory model of the acquisition and representation of the English past tense.

Similar to the Rumelhart & McClelland model, one of the fundamental problems of early (e.g., MacWhinney & Leinbach, 1991, Plunkett & Marchman, 1991, 1993; Egedi & Sproat, 1991) as well as later models (e.g., Plunkett & Juola, 1999) of the post-Rumelhart & McClelland-period has been the difficulty, or impossibility, of modelling the U-shaped developmental pattern without having to manipulate the input. Egedi &

Sproat (1991), for example, compared two training regimes in a multilayer connectionist model that incorporated a back-propagation algorithm, which can be defined as an error-correction algorithm that adjusts connection weights in multilayer models. It was found that the U-shaped developmental pattern was only displayed by their model when the input was presented in distinct stages as in the Rumelhart & McClelland model. Their model failed to display the U-shaped developmental pattern when the input was not manipulated. Similar results have been reported by Marcus (1995a) for MacWhinney & Leinbach (1991) and Plunkett & Marchman (1991), who did not train their models by using abrupt changes in the training regime, but failed to imitate the initial stage of the U-shaped developmental pattern in which the model is supposed to exhibit correct performance on regular and irregular verb forms.

Plunkett & Marchman (1993) succeeded in creating a U-shaped sequence with a multilayer connectionist network using a different, *incremental*, training regime, which involved the gradual increase of the vocabulary size from 20 to 500 verbs. Thus, in the beginning stage the model was trained on only 20 verbs until 100% accuracy was reached. After that, the vocabulary size was expanded gradually and when the vocabulary size was around 100 words, the model's performance on irregular verbs began to decline and over-regularisations started. Subsequently, the model improved at vocabulary size 200 and regained perfect performance at around size 300, thus displaying a seemingly faultless U-shaped pattern.

However, a later analysis of the model by Marcus (1995a) made clear that this apparent success in producing the U-shaped developmental pattern was in fact the result of a "non-linear change" (p. 275) in the training regime. While Plunkett & Marchman initially trained the model by adding a new verb to the system every 5 training epochs until vocabulary

size was about 100, the training regime was then suddenly changed from one verb every 5 training epochs to one verb every epoch thereafter. As Marcus (1995a) points out, the model's first over-regularisation appears exactly at the point when the sudden alteration in the training regime is initiated, thus artificially creating a U-shape in the performance on irregular verbs:

> *For the first 100 words, the model is given 5 epochs per verb, apparently allowing the model ample time to learn each new stem-past pair without overgeneralisation. Then the training regime suddenly switches, forcing the model to assimilate new verbs five times more rapidly, and the model, apparently lacking time to completely learn each verb, starts to overgeneralise – thus the dip in the U-shaped curve appears to be caused not by an internal reorganisation triggered by a constant increase in vocabulary size, but rather by an externally imposed discontinuity* (Marcus, 1995a: p. 276).

Similar problems related to the manipulation of the input resulting in the desired output pattern have been found in later connectionist models of English morphology. Plunkett & Juola (1999), for example, modelled the acquisition of English past tense and plural morphology and were successful in displaying a U-shaped learning pattern for both nouns and verbs. Plunkett & Juola trained their model on a minimal subset of the total vocabulary (20%), again consisting of irregular verb forms in the majority, for 5 training epochs until perfect performance was obtained. Thereafter, the vocabulary size was increased *exponentially* by 5 percent of current word types at every 5^{th} training epoch, which created U-shaped learning in the short period in which the model moved from 20% to 100% of its total vocabulary size. It is thus clear that the Plunkett & Juola (1999) model, just like other models of the acquisition of the English past tense, relied very much on the structure and careful preparation of the input and was only able to display the desired output behaviour as a result of these input manipulations employed, which are not representative of the input

children receive and which MacWhinney & Leinbach (1991: p. 130) describe as “an illegitimate way of deriving the desired phenomenon.”

Two further criticisms, among others, raised at connectionist models of morphological processing are their heavy reliance on feedback and their being limited to either the *production* or the *recognition* of word forms, but not both together (Pinker, 2001; Taatgen, 2001). As has been mentioned above, connectionist models constantly receive feedback on their actual output so as to be able to adjust their connection weights and proximate the intended output. This, however, is far from being a realistic reflection of the actual acquisitional behaviours of children since children hardly ever receive feedback concerning their own output (Pinker, 1984). Plunkett & Juola (1999) defend the validity of feedback provided to connectionist models by making the controversial assumption that children’s morphological processing system employs a *hypothesis generator* that constantly compares word forms in the input with the word forms (e.g., past tense forms) that the hypothesis generator is expected to produce as inflected forms of given stems. If the hypothesised word form of a given stem (e.g., *goed*) differs from the word form the child hears in the input (*went*), the child infers that the current hypothesis is wrong and needs modification. In other words, under this view the child appears not to learn during production but during comprehension only, which Taatgen (2001) describes as an assumption that runs counter to the general observations on skill acquisition in general and is far from having scientific backup.

The latter problematic aspect, the models’ difficulty in handling production and comprehension at once, constitutes another serious flaw in the networks’ success in constituting realistic models of linguistic processing since, according to Pinker (2001), children do not acquire the ability to produce and comprehend word forms separately but are able to access

learned information in both ways. With connectionist networks to date, however, the convergence of production and comprehension processes in a single mechanism has not been the case. Pinker notes that it is, in fact, possible to design a system that comprehends and produces at once, but only by combining two separate networks – one that produces and one that comprehends linguistic forms.

In conclusion, connectionist models of the English past tense, which have been devised to constitute the most powerful evidence for arguments against symbolic accounts of morphology, bear striking insufficiencies and fail in constituting realistic models of human processing. The strong argument of proponents of connectionist models, that a single mechanism that does not employ any symbolic processes is able successfully to model the processing and representation of human language and other cognitive traits, can thus be rejected on the basis of current models of the English past tense. This, however, does not mean that the connectionist modelling of morphological processing as a whole is 'useless', but rather that, for now, their explanatory and architectural shortcomings are too significant to be overlooked (Kırkıcı, 2002). As has been mentioned in previous parts of the present discussion, connectionist models definitely appear to be successful in accounting for the complex patterns found in 'irregular' cases because of their strength in generalising. However, it would be hard to say the same thing for their performance on 'regular' cases, where the associative processes employed bear unrealistic results that *may* be overcome by the addition of a (sub-)system that employs rule-like processes, as has also been emphasised by Pinker (2001):

> *I am sometimes asked if I would deny that any connectionist model could ever handle inflection. Of course not! I am sceptical only of the claim that the current favoured style – a single pattern associator – can handle it in a psychologically*

> *realistic way. A neural network consisting of an associative memory (for words, including irregulars) and a hierarchical concatenator (for combinatorial grammar, including regulars) could (if the details were done correctly) handle all the phenomena … and I would have no problem with it. My objections are aimed not at connectionism, but at the current fashion for denying compositional structure and shoehorning phenomena into a single uniform net* (p. 175).

In this sense, the question "whether a single connectionist mechanism can simultaneously deal with both regular and the irregular cases, or whether the regular cases can only be generated by a distinct route involving symbolic rules" (Christiansen & Chater, 1999: p. 425), can *under the current state of affairs* clearly not be answered in favour of connectionist models.

CHAPTER 3

THE DUAL-MECHANISM MODEL

This chapter consists of two main sections. The first major section presents the main theoretical arguments of the dual-mechanism model, and discusses to what extent the model's predictions have been born out in L1 acquisition studies, L1 psycholinguistic studies, and L1 neurolinguistic and neuropsychological studies.The second section first presents the reasons for investigating the validity of the dual-mechanism model and rival theories for second language (L2) processing. Subsequently, the results of previously conducted L2 studies that have obtained results speaking largely against the soundness of the dual-mechanism model in accounting for the mental representation of L2 inflectional morphology (3.2.1) and L2 studies that have arrived at results essentially supportive of the tenets of the dual-mechanism model (3.2.2) are reviewed.

3.1 Exploiting Rules and Associations

With the exception of early generative linguistic theories, a common property of all models discussed in the previous chapter is that they are essentially single-mechanism models in the sense that word forms are accessed during production and/or recognition by means of a uniform mechanism that is supposedly able to account for all potential word forms in a given language (i.e., so-called 'regular', 'irregular', 'complex' and 'simplex' word forms). This proposed single mechanism happens to be a rule-system in the case of decompositional models and later generative

models of morphology, and an associative memory in the case of connectionist models[23]. Early generative models (e.g., Chomsky, 1965), on the other hand, are not quintessential single-mechanism models since they posit two mechanisms for the processing of words, a rote memory and a computational component; hence, they are also often termed *traditional dual-mechanism models.*

As has been pointed out at various places throughout the preceding discussion, each of the reviewed models bears its own descriptive and/or explanatory deficiencies in accounting for the entirety of morphological processes, at least when analysed in terms of their performance on English past tense morphology. While some appear to be potentially useful in explaining the processing of regulars (e.g., generative theories, decompositional models), others (e.g., full-listing models, connectionist models) seem to constitute suitable models of the processing of irregular forms. Steven Pinker and his collaborators (Pinker & Prince, 1988, 1991; Pinker, 1991, 1999; Marcus et al. 1992; Marcus, Brinkmann, Clahsen, Wiese & Pinker, 1995; Pinker & Ullman, 2002) have therefore devised a theory of language, the *Dual-Mechanism Model* or *Words and Rules Theory*, which constitutes a compromise position in that it exploits full-listing, decomposition, rules, and associative processes that function in a complementary and co-operative fashion to capture the entirety of the human language.

The Dual-Mechanism Model is, on the one hand, similar to generative theories of language in that it maintains the view that the human language faculty depends on a 'mental lexicon', a subdivision of memory that contains arbitrary sound-meaning mappings that form the basis of morphemes and simple words, and a 'mental grammar', which is a

[23] See preceding discussions for further details of the mentioned models and theories.

system of productive, combinatorial operations, i.e. 'rules', that form complex word forms, phrases and sentences out of morphemes and simple words (Pinker & Ullman, 2002). These two systems work in parallel when a word, a word form or any other linguistic unit needs to be accessed. On the other hand, however, the Dual-Mechanism Model departs from the basic tenets of generative models of language in that the proposed mental lexicon is not simply a rote-memory, but an associative memory that works on the basis of analogy similar to the way connectionist models function.

Although the exact nature of the proposed associative memory has to date not been made explicit by proponents of the Dual-Mechanism Model, it is often described as a 'productive' memory (e.g., Ullman, 2001a) in the sense that it can learn the mappings of individual word-pairs (e.g., *grow-grew*), discover common patterns in different word-pairs (e.g., *grow-grew*, *throw-threw, blow-blew, know-knew, draw-drew*), and then generalise these patterns to new forms (e.g., *frow-frew) similar to the way connectionist models are able to generalise on the basis of the phonological properties of training-samples. However, Pinker (1999) specifically points out that, different from connectionist models, it is not only phonetic features that are connected to each other, but rather whole words are connected to whole words (e.g., *sing-sang*), and constituents of words (like stems, onsets, rimes, consonants and vowels) are connected to constituents of words. In addition, similar nodes of different words that share a number of the afore-mentioned properties (e.g., *sing, spring, ring*) overlap, thus displaying the associative effects found in connectionist models. As such, the suggested lexical memory may be said to make use of an associative full-listing structure, which links both whole words and their individual semantic, morphological, syntactic and phonological features.

The other component of the Dual-Mechanism Model, the mental grammar or the rule system, is “a system of productive, combinatorial operations that assemble morphemes and simple words into complex words, phrases and sentences” (Pinker & Ullman, 2002: p. 456). It is theorised that the rule-system is basically a symbol-manipulator that applies a mental rule in real time to all members of a given class of words or other constituents that the rule is assigned to, without having to access their phonological or semantic features in memory. So, a given rule *X* (e.g., the past tense rule) that results in the application of the linguistic material *Y* (e.g., the past tense suffix *-ed*) to linguistic units of the syntactic type *Z* (e.g., verb stems) can by default be applied to all members of type Z (e.g., all verb stems) without taking into consideration any further features (e.g., semantic or phonological features) of the members of the group it is applied to.

In terms of morphological processing, proponents of the Dual-Mechanism Model posit that the distinction between the associative memory and the rule-system corresponds to the difference between the processing and storage of irregular forms and regular forms, respectively. Thus, while irregular forms (e.g., *children, oxen, sang, brought*) are supposedly listed in the associative memory just as any other morphologically simplex word (with the difference that irregular word forms embody certain additional features like *tense, number,* etc., which is not normally the case for simplex word forms), regular forms (e.g., *tables, glasses, talked, played*) are not stored as wholes, but are products of the concatenation of the plural or past-tense affix, i.e., the rule, to the verb or noun stem, which is stored in memory. In other words, the storage and processing of irregulars is employed like any other word in a undecomposed fashion (hence, *words)*, whereas regulars are rule-products that emerge as the result of the productive implementation of a rule that can be applied to any member of the word category that it has been assigned to (hence,

rules), no matter if familiar or unfamiliar, similar or not to memorised regular forms (Marcus et al., 1995).

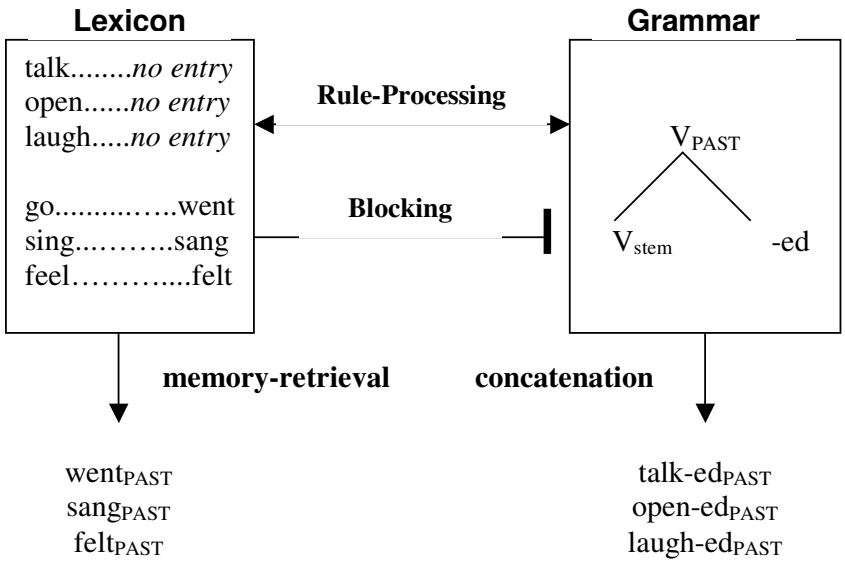


Figure 4: A simplified representation of the Dual-Mechanism model (based on Pinker & Ullman, 2002 and Pinker, 1999)

This does not mean, however, that regular forms can not be memorised at all, but rather that they do not have to, as Pinker and collaborators have pointed out at various places (e.g., Pinker & Ullman, 2002). Since the associative memory bears no constraints as to the quality and quantity of the items it can store and may even store linguistic units larger than words and affixes, from idioms to songs and poems, it is also possible for a regular form (e.g., *books, talked*) to be stored as a whole in memory under certain circumstances. Whether or not a regular form is stored in memory undecomposedly is determined by a number of factors like the frequency of a regular form and the availability of an irregular alternative. It has been found that the likelihood of a regular form's storage in associative memory increases with increasing frequency; that

is, the more frequently a regular form is computed, the easier it gets for the associative memory to store it as a whole. In fact, Gordon & Alegre (1999) have found that regular English word forms that are more frequent than 6 per million, which they have calculated to be the frequency threshold, tend to be stored as whole words rather than being decomposed, whereas regular forms that have a frequency below the threshold level are more likely to be computed on-line by a rule. Similarly, for regular forms that have alternative irregular forms like *dive-dived/dove* and *dream-dreamed/dreamt,* the likelihood of storage in memory is also seen as potentially high since, otherwise, it is predicted that they would be continuously suppressed by the *blocking mechanism* described below.

Given the fact that the regular rule can, in theory, apply to all members of a given word category and thus emerges as the *default rule*, a question that arises is how the over-application of the regular-rule to irregular forms, and hence the production of over-regularised forms like *childs, seed,* and *singed*, is prevented. This is accounted for by means of a *blocking mechanism*, which is a procedure similar to Kiparsky's (1982) *Elsewhere Condition* and Aronoff's (1976) *Blocking Principle*[24], and which blocks the application of the default regular-rule if an irregular form can be identified in and is likely to be retrieved from the associative memory by the linguistic processor. Whenever a word must be inflected, for example, the associative memory and the rule-system are activated in a parallel fashion. While the rule-system tries to implement the application of the necessary rule, the associative memory tries to access the word form as a whole. Whenever there is the likelihood of a successful retrieval of an irregular form (e.g., *went*) or a stored regular form from the associative memory, this is said to result in the sending of a continuous

[24] Note that the strategies described by Kiparsky and Aronoff were not related to an associative memory, but to what Aronoff describes as a simple list of existing items in the language; i.e., basically all suppletive forms.

signal to the rule-system, which in turn holds back the computation of the general rule and thus prevents the occurrence of over-regularised forms like *goed* (see Figure 4). However, if a memorised form can not be retrieved because of various factors like the non-existence of an irregular form in memory[25] as in the case of nonce-forms (e.g., *ploamph)* or the weakness of the memory traces of an irregular form as in the case of a newly acquired form or a very low-frequency form (see below), the regular rule applies, which according to Pinker and collaborators clearly captures the regular rule as the *default* process.

Marcus et al. (1995) provide an exhaustive list of 21 circumstances in which access to a form in memory is prevented, which constantly results in speakers' applying the default regular-rule rather than in the production of an uninflected form or an alternative form constructed on the basis of similarity to already existing forms in memory.[26] Among these, Marcus et al. list instances in which

- *the memory contains no entry or no similar entries for the word in question* like in the case of novel words (e.g. **snarfed, *wugs*)[27], low-frequency words (e.g., *stinted, eked*) and unusual-sounding words (e.g., **ploamphed, *krilged*),

[25] For details of the proposed memory, see the following discussions on the declarative/procedural model.

[26] Note that related instances are subsumed under single titles. In the original list, items like *onomatopoeia, surnames, unassimilated borrowings* and *acronyms,* which are here collectively listed under a single title, each constitute individual instances. However, since an in-depth review of all listed circumstances would be much beyond the scope of the present study, only a few of the listed situations will be reviewed at this point without giving all details. Interested readers are directly referred to Marcus et al. (1995) or Pinker (1999).

[27] All examples are from Marcus et al. (1995), unless otherwise indicated.

- *the memory entry is not a canonical root*[28] as in the case of onomatopoeia (e.g., *peeped, dinged*), surnames (e.g., *the Childs*), unassimilated borrowings (e.g., *latkes, cappucinos*) and acronyms (e.g., *TVs, PCs)*,

- *the root can not be marked for the inflectional feature because it is of a different grammatical category* like denominal verbs (e.g., *'The commander ringed/*rang the city'* cf. 'form a ring around'), deadjectival verbs (e.g., *righted*) and nominalisations (e.g., *ifs and buts*),

- *the derivation via a name blocks the percolation of information from the root entry* like in eponyms (e.g., *Mickey Mouses, Batmans*), product names (e.g., *Renault Elfs*), team names (e.g. *Toronto Maple Leafs*), pseudo-English forms (e.g., *walkmans*) and nominalised verb phrases (e.g., *bag-a-leafs, shear-a-sheeps)*,

- *the memory fails* like in over-regularisations (e.g., *comed, breaked*) by children, healthy adults (basically slips of the tongue), and individuals with genetic or acquired mental diseases (e.g., Alzheimer, Williams Syndrome, Aphasia)

The Dual-Mechanism Model has recently been extended by Ullman and his collaborators into a theory of the neural bases of the theorised lexicon and grammar, the *Declarative/Procedural Model* (Ullman, Corkin, Coppola, Hickok, Growdon, Koroshetz & Pinker, 1997; Ullman, 2001a, 2001b, 2001c, 2004). Ullman (2004) describes the core assumption of the Declarative/Procedural Model as the premise that aspects of the

[28] Marcus et al. describe a 'canonical root' as a standard word format in a language that includes, among other types of information, a phonological representation that must conform to a canonical template for words in the language.

associative memory/rule-system (or lexicon/grammar) distinction are based on the distinction between two largely independent brain memory systems, the declarative memory system and the procedural memory system, which are hypothesised to subserve the associative memory and the rule-system, respectively, and which are largely informationally encapsulated from each other.

The declarative memory system is hypothesised to be rooted in medial temporal lobe structures, in particular the hippocampus, which are connected with temporal and parietal neocortical regions. It is known that medial temporal lobe structures are required for the consolidation of new memories, which in the long run become independent of the medial temporal lobe structures and become dependent on temporal neocortical regions (Ullman, 2001b). The declarative memory system is known to be effective in the learning, representation and use of knowledge about facts and events, and in the learning of arbitrary-related information (Ullman, 2004). According to the declarative/procedural model, the same brain structures that underlie the declarative memory also serve the mental lexicon. It thus undertakes the storage of the arbitrary semantic, phonological, syntactic and other memorised information related to words, representations of simplex words (e.g., *book*), bound morphemes (e.g., the plural suffix *–s*), irregular word forms, stored regular forms and idioms, and supports a productive associative memory that allows for the generalisation of stored knowledge to representations (Ullman, ibid.).

The procedural memory system, which is often called a ‘skill’ or ‘habit’ system, is said to be rooted in the frontal/basal-ganglia structures, which are connected with frontal cortex, and has been associated with the learning of new and the control of previously established motor and cognitive habits or skills (Ullman, 2001a). According to the declarative/procedural model, the brain system that underlies the

procedural memory also serves the mental grammar in that it "underlies the learning of new, and the computation of already-learned, rule-based procedures that govern the regularities of language – particularly those procedures related to combining items into complex structures" (Ullman, 2004: p. 245), including the computation of regular word forms.

In sum, the dual-mechanism model as well as the declarative/procedural model make specific assumptions concerning the distinct natures of regular and irregular forms, which can be overtly tested and, if confirmed, can provide strong support for the overall theory. In what follows, the explicit claims of the overall theory will be summarised in the form of empirical predictions that should be possible to be substantiated by means of experimental studies and, subsequently, the results of psycholinguistic and neurolinguistic studies that have taken up this specific issue and have tested subjects from different backgrounds by means of various instruments and techniques will be presented.

3.1.1 Empirical Predictions of the Dual-Mechanism Model

As mentioned above, if the theoretical tenets of the dual-mechanism model and, relatedly, of the declarative/procedural model concerning the distinct mental representation and processing of regular and irregular word forms are correct, it should be possible to obtain certain empirically confirmable dissociations in the surface behaviours of these forms.

For example, if irregular (but not regular) forms are indeed retrieved as whole words from an associative memory, they are expected to exhibit markers of the associative memory like *frequency effects* and *phonological neighbourhood effects* (Ullman, 2001a). Thus, irregular word forms are expected to display *frequency-sensitivity*; i.e., high frequency irregular forms should be better and faster retrieved than low

frequency irregular forms since the frequency of retrieval brings about the strengthening of connections and therefore ease of subsequent re-retrieval. Regular word forms, on the other hand, should show no such frequency effect once access to their stems is controlled for regular forms are supposedly products of one and the same computation, which should always take the same duration to apply.

Similarly, irregular word forms are expected to exhibit *phonological neighbourhood effects*; i.e., they should be sensitive to their phonological similarity with other word forms since, as has been mentioned above, the proposed associative memory is a productive memory in which the activation of a word form simultaneously activates all word forms that share one or more of the properties of the word. So, for example, the activation of *sing-sang* should at the same time strengthen the memory traces of neighbouring irregulars like *ring-rang* or *spring-sprang*. This, however, should not be the case for regular forms if they are indeed rule-products as hypothesised.

Finally, particularly in line with the tenets of the declarative/procedural model, it should be possible to capture selective impairments to either of the proposed rule-system and associative memory if they are indeed served by distinct memory systems and brain structures. In other words, depending on the affected brain region in the subjects under investigation in a given neurolinguistic study, Ullman (2001a) makes the explicit prediction that it should be possible to find subjects who have retained the ability to process irregular forms but are impaired in their ability to perfectly process regular forms (e.g., an impairment in generalising the general rule to novel forms) if the neural substrate for grammatical combination has been damaged, and vice versa, there should be a greater impairment of irregular forms and a problem in the productive

generalisation of existing stored patterns to novel forms if the neural substrate for the associative memory has been damaged.

Therefore, the following sections will present empirical evidence from psycholinguistic and neurolinguistic studies in support of the dual-mechanism model and the declarative/procedural model. Since the bulk of relevant research studies has revolved around the processing of the English past tense, the discussion to follow will predominantly focus on the English past tense but will also include results from studies on English noun plurals and cross-linguistic evidence from languages like Spanish and German.

3.1.2 Findings from Child Language Acquisition Studies

If the basic premise of the dual-mechanism model that regular and irregular past tense forms are served by and computed over distinct mental mechanisms is indeed correct, it should be possible to locate manifestations of these two mental mechanisms (or at least traces of them) in the production patterns of children acquiring a morphological system that contains regular and irregular forms. A morphological system that includes regular and irregular forms and has been extensively studied within the framework of the discussion at hand is, as has been mentioned at various places, the English past tense.

3.1.2.1 Marcus et al. (1992)

As is by now well known, children acquiring the English past tense start the acquisitional process by producing a small number of both regular and irregular correct (but unmarked) forms, then produce typically 'over-regularised' forms (like *breaked* or *bringed*) and later regain the ability to produce regular as well as irregular past tense forms correctly, thus

displaying the classic 'U-shaped developmental pattern'. From a dual-mechanism perspective, the U-shaped developmental pattern and particularly the occurrence of over-regularised forms can be explained elegantly within the basic tenets of the theory (in Marcus et al., 1992): A child acquiring the English past tense initially memorises all past tense forms in her inventory in an unanalysed fashion and thus produces all forms correctly. As the acquisitional process continues, the child learns the past tense rule (add *–ed* to stem) and starts to apply it productively. At this point, the child starts to produce over-regularised forms due to the fact that she is not able to retrieve the correct past tense form of each and every irregular form and therefore simply applies the default past tense rule. Irregular past tense forms which can not be successfully retrieved from memory are those whose memory traces are weak due to the verb's being very infrequent or even completely non-existent because that form of the verb has not been encountered yet. Later, as exposure to irregular forms increases and their memory traces get increasingly stronger, failures in retrieving irregulars and occurrences of over-regularisations become increasingly rare and eventually disappear altogether.

On the basis of this account, proponents of the dual-mechanism model have formed five testable predictions, the confirmation of which would lend strong support to the dual-mechanist explanation of the acquisitional pattern of the English past tense (summarised in Marcus,2000: p.156):

1. Since over-regularisation errors are hypothesised to be results of retrieval failures, the rate of over-regularisation should be low,

2. If over-regularisation errors are indeed consequences of memory failure, then they should occur more often with low frequency verbs than with high frequency verbs since the memory traces of high

frequency verbs should be stronger (because they are encountered more often) and thus the memory should fail less frequently with high frequency verbs,

3. If irregular forms are indeed stored in an associative memory, then 'gangs' of similar-sounding irregulars (e.g., *sing-sang, ring-rang, drink-drank*) should be more resistant to over-regularisation since they are expected to reinforce each other,

4. Over-regularisations should disappear eventually as exposure to correct forms increases and memory retrieval improves,

5. Over-regularisations should only occur once the child has correctly analysed regular past tense forms and started to use the past tense rule in appropriate contexts (i.e., while talking about past tense events); before that, retrieval failures should result in unmarked forms (e.g., *Yesterday I draw*) because the productive application of the past tense rule to novel instances should only be possible after it has been correctly abstracted.

These predictions have been empirically tested by Marcus et al. (1992), who analysed 11.521 past tense utterances from the spontaneous speech data of 83 children (age-range: 1;3 – 6;6) acquiring the English past tense. In relation to prediction 1, Marcus et al. found that children indeed go through an error-free stage prior to the over-regularisation stage, in which they tend to over-regularise irregular forms. Crucially, however, it was found that children at no stage of the acquisitional process *completely* replace correct irregular forms with over-regularisations. Rather, children seem to over-regularise the past tense in only 4.2% of their opportunities and do not seem to persist in over-regularisation errors. Thus, as put by Xu & Pinker (1995), children do not

ignore the exceptional nature of irregular verbs by simply applying the default rule indiscriminately, but appear to implement over-regularisations only as a result of retrieval problems in very few instances, which shows that the hypothesised blocking-mechanism becomes active once the child has received evidence for two means of inflection. If it were the case that children over-regularised all or most of the irregulars in this stage of the acquisitional process, as has often been mistakenly reported in various sources (see Xu & Pinker, 1995), this would call the blocking principle into question.

As a test of the second prediction, that low-frequency irregulars should be more prone to be over-regularised due to the weaker memory traces they possess, Marcus et al. calculated the correlation between the rate of children's over-regularisation errors and the frequency at which the over-regularised irregulars had been (correctly) used by their parents. The average correlation across children was found to be a statistically significant negative one ($r = -.34$, $p<.001$), showing that the rate of over-regularisation increased as the frequency of irregulars decreased (Marcus, 2000) and thus "underscoring the important role of the memory strength of the irregular past tense form in the overregularisation process" (Marcus et al., 1992: p.128).

The third prediction, that families of similar irregulars are less likely to be over-regularised when compared to more isolated irregulars, was tested by Marcus et al. (1992) by calculating scores for each irregular verb on the basis of the number and frequency of similar irregular verbs. It was found that phonological similarity (weighted by frequency) to other verbs displaying the same irregular pattern is an important means of protection from over-regularisation. The obtained correlation coefficient between family strength and over-regularisation rate was negative in all instances and ranged between $r=-.07$ and $r=-.11$ (p value significant in all

instances). Thus, the relative strength of a family of similar irregulars in the associative memory like *sing-sang, drink-drank, ring-rang* makes the retrieval of irregulars in such gangs easier and makes them less prone to over-regularisations (e.g., *drinked*), as predicted by the dual-mechanism model.

In relation to the fourth prediction, that over-regularisation errors should disappear gradually with increased exposure to correct forms and eventually disappear altogether, Marcus et al. provide statistics from other studies that have measured comparatively older children. As mentioned before, the subjects in Marcus et al. (1992), who are preschoolers at an age-range of 1;3 – 6;6, over-regularise at an average rate of 4.2%. Marcus et al. mention that there is no sign of a cessation in over-regularisation with their subjects, but a slow overall improvement, and report the results of two studies that have focused on the over-regularisation errors of older children in order to track potential further developments. Moe, Hopkins & Rush (1982) have analysed 10,530 irregular past tense utterances from 329 first-graders and report an over-regularisation rate of 2.8%, whereas Carlton (1947) reports approximately 1% over-regularisations for fourth-graders. In other words, with increasing age and, relatedly, increasing exposure to correct irregular forms, the rate of over-regularisation seems to decrease (from 4.2% with pre-schoolers to 2.8% with first-graders to less than 1% with fourth-graders). Thus, it seems to be correct that the gradual strengthening of memory traces for irregulars leads to a decline in over-regularisation errors, which supports the view of the dual-mechanism model.

In relation to the fifth hypothesis, the prediction that over-regularisations should not occur before the regular rule has been correctly internalised, Marcus et al. (1992) present data which clearly display that the first over-regularisations coincide with the onset of the reliable and constant use of

regular past tense marking, defined as the "attainment of high absolute rates of marking the past tense on regular verbs in obligatory past tense contexts" (p. 101). Thus, over-regularisation appears to be a by-product of the acquisition of the past-tense rule and does not seem to have anything do with the generalisation of regular patterns in the associative memory to irregular words (e.g., the over-regularisation of *grow* to *growed* on the basis of the pattern instantiated by *glow-glowed*, in Marcus, 2000) as has been put forward by connectionist models.

Thus, on the basis of an in-depth analysis of the statistical and qualitative properties of children's over-regularisation errors, Marcus et al. (1992) present evidence for the dual-mechanist position that irregular forms are stored in memory and regulars can be (but do not have to be) computed via a default rule which is applied every time the retrieval of a memorised form from memory fails.

3.1.2.2 Marcus (1995b)

To examine whether the same proposed mechanisms can also account for the over-regularisation of English nouns (e.g., *foots, mans, tooths*), Marcus (1995b) replicated Marcus et al.'s (1992) study, this time analysing children's behaviours on noun plurals. The predictions made within the framework of the dual-mechanism model for the past tense are essentially the same for noun plurals. Irregular plural nouns (e.g., *children, teeth, feet*) are hypothesised to be stored in the associative memory, regular plurals (e.g., *tables, books,* pens) are computed by the default rule (add *–s* to the noun stem), and over-regularisations are produced by the concatenation of the default suffix to irregular noun stems whenever the appropriate irregular form can not be retrieved from memory. Similarly, children acquiring noun plurals are expected to go through a U-shaped developmental pattern and display behaviours

similar to those captured for children acquiring the English past tense (Marcus, 1995b).

To be able to draw direct comparisons to the findings of Marcus et al. (1992), Marcus (1995b) analysed the conversational transcripts of 10 children who had also been members of the subject-group in Marcus et al. (ibid.). It was found that children acquiring plural nouns also exhibit a U-shaped developmental pattern, marked by an initial period in which they correctly produce regular as well as irregular plural forms. This is followed by a stage in which irregular plural nouns are over-regularised at a mean rate of 8.5%. Gradually, however, performance on irregular nouns recovers, just as was the case for irregular past tense forms (Marcus et al., 1992). Although the mean over-regularisation rate of 8.5% may at first appear high when compared to the 4.2% mean over-regularisation rate with past tense forms, it should be noted that the rate reported in Marcus et al. (1992) is the mean over-regularisation rate of 83 children, only 10 of whom have been later re-analysed in Marcus (1995b). The comparison of the mean over-regularisation rates on past tense forms and noun plurals *for the same 10 children* proved to be essentially the same (7.3% vs. 8.5%[29], respectively). In other words, just like in the case of the English past tense, children appear to over-regularise nouns only when they fail to retrieve the correct irregular noun form, which is not a frequent circumstance.

So, Marcus (1995b) has shown that the acquisition of the English noun plural system displays almost identical properties to the acquisition of the English past tense system in terms of the rates of over-regularisations. What is of specific significance in this study is that regular English nouns have much higher type and token frequency when compared to irregular

[29] Marcus reports no statistically significant differences between these two mean rates.

nouns (in contrast to the English past tense system, in which irregular types and token are more frequent)[30]. From a connectionist perspective, this should have led to a very high degree of noun plural over-regularisations since the connections of regular patterns should be very strong and therefore constantly generalise to novel instances. In spite of this fact, however, children acquiring English plural nouns have not been found to over-regularise to a significantly higher extent, which clearly shows that over-regularisations do not depend on pattern associations as put forward by proponents of connectionist models but on the application of a default rule. This can be taken as further, and even stronger, evidence for the dual-mechanism model.

3.1.2.3 Xu & Pinker (1995)

Another important piece of evidence in support of the dual-mechanism model comes from the *irregularisation* errors of children acquiring the English past tense. It is documented that, in addition to over-regularisation errors, children also produce *irregularisation* errors, where irregular inflectional patterns are over-applied not only to regular verbs (e.g., *wipe-wope* in reference to *write-wrote*) but also to irregular verbs (e.g., *bring-brang* in reference to *sing-sang, ring-rang;* Xu & Pinker, 1995). Such irregularisations have also been reported to occur in certain connectionist simulations at rates between 3.2% and 23.5% (Rumelhart & McClelland, 1986; Plunkett & Marchman, 1991; Sproat, 1992) and often as frequently as, or even more frequently than, over-regularisations (Plunkett & Marchman, 1993). Connectionist models take these irregularisations as evidence for their single-mechanism hypotheses because such over-applications on the basis of phonological similarity apparently point to the presence of a lexicon and rule-free, associative

[30] Marcus notes that irregular plural nouns make up 2% of noun types and 3% of noun tokens, whereas irregular past tense verbs make up 14% of verb types and 60% of verb tokens (p. 449).

model which does not differentiate between regular and irregular forms, but picks up simultaneously on patterns of various degrees of similarity.

Xu & Pinker (1995), however, analysed 20.000 past tense and participle forms produced by 9 children (age range: 0;7 – 8;0) and found that irregularisations are, in reality, rather rare in children's outputs. In fact, they discovered that the children in their study on average only irregularised 0.1% of regulars (e.g., *trick-truck*) and 0.23% of irregulars (e.g., *bring-brang*), (mean total: 0.19%, compared to 4.2% over-regularisations reported in Marcus et al., 1992), thus displaying a pattern in strong contrast to the high irregularisation rates manifested in connectionist models of the English past tense. Furthermore, the irregularisations produced by children were found to be almost always dependent on phonological similarity, in contrast to regularisations, where the over-application of the regular rule has been found to function independently of phonological features, as has been discussed before. In contrast to some connectionist models (e.g., Rumelhart & McClelland, 1986), the children in Xu & Pinker's study were not found to produce forms which involved the wild distortion of stems such as *mail-membled, tour-toureder,* or *smairf-spruric*. In this sense, the results were taken as further evidence both for the psychological difference of regulars and irregulars and for the view that irregular forms are stored as memorised linked pairs in an associative memory.

3.1.2.4 Cross-Linguistic Evidence: German and Spanish

Dissociations in the treatment of regulars and irregulars have also been documented in the first language acquisition of languages other than English. Clahsen, Aveledo & Roca (2002) analysed 64 samples of spontaneous speech and narratives from 15 children (age range: 1;7 – 4;7) acquiring Spanish as their first language. Clahsen et al.'s analysis of

their subjects' acquisitional pattern of the present tense, past tense and imperative verbal morphology of Spanish revealed that it was again possible to observe a U-shaped developmental pattern similar to the pattern found with children acquiring the past tense and noun plurals in English. The authors further report that their subjects produced more errors on irregulars (mean error rate: 4.6%) than on regulars (mean error rate: 0.001%), produced over-regularisations at a mean rate of 2% of instances, produced no irregularisation errors at all, and tended to over-regularise low-frequency irregulars more often than higher-frequency irregulars, thus reflecting dissociated treatment of regular and irregular forms and frequency effects on irregular forms. So, the data from children acquiring Spanish provides cross-linguistic evidence for the validity of the dual-mechanism model.

Similarly, Clahsen & Rothweiler (1993), who analysed the acquisition of German participles in the spontaneous speech samples of 22 German children, found qualitative and quantitative differences between their subjects' use of regular and irregular participle inflections. It was found that the children under investigation systematically overapplied the regular participle suffix *–t* (as in *gelacht*), but not the irregular suffix *–en* (as in *gegessen*). Despite an approximately equal number of opportunities, 94 instances of over-regularisation (e.g., gegesst) and only 4 instances of irregularisation (e.g., gelachen) were recorded. Comparable results are reported in Weyerts (1997) and Weyerts & Clahsen (1994), who have also found predominantly over-regularisation errors (mean rate: 10%) and only very few irregularisation errors, and have further confirmed a U-shaped developmental pattern for the acquisition of German participles (Clahsen, 1999). The findings from German participles are particularly important in validating the tenets of the dual-mechanism model since the regular participle *–t* has a very low type frequency when compared to the irregular suffix *–en* (Marcus et al.,

1995), which, from a connectionist perspective, should have led to application of the irregular suffix at much higher rates. Despite this fact, children acquiring German have still been found to generalise the regular suffix and not the irregular suffix, which clearly shows that the regular-suffix is frequency-independent and acts as the default despite its low frequency.

Thus, in sum, findings from child acquisition studies of not only English, but also Spanish and German clearly display an asymmetry in the acquisitional patterns of regular and irregular forms. These findings show that children treat regulars and irregulars differently, appear to process them diversely, and thus provide strong, cross-linguistic evidence for the theoretical tenets of the dual-mechanism model.

3.1.3 Findings from Psycholinguistic Experiments

Evidence for differences in the representation of regular and irregular forms has also been sought in psycholinguistic experiments with adults and children, which have demonstrated that regular and irregular forms tend to be treated differently in experimental settings as well.

3.1.3.1 Experiments with Children

Kim, Marcus, Pinker, Hollander & Coppola (1994) ran four elicitation experiments with a total of 70 children (age-range: 3;2-9;6), in which they tested whether children inflected words on the basis of phonological information alone (as posited by connectionist models) or whether they were sensitive to formal grammatical structures. In Experiment 1, 12 children were presented with 9 irregular verbs (*see, buy, meet, drink, fly, stick, write, leave, ring)*, each of which was once used as a verb root as in a) below and once as a denominal verb as in b) (Kim et al., 1994: p.187),

and were asked to complete the final sentence uttered by the experimenter.

a) This airplane is going to fly. Can you say 'This airplane is going to fly'?
This airplane is about to fly through the air.
(Have the airplane fly about)
The airplane just _____.

b) This is a fly. Can you say 'This is a fly?' I'm going to fly this board.
(Put flies all over the board)
I just _____.

If children indeed inflect words on the basis of phonological information alone, then the expected outcome would be that in both instances the verb is inflected in analogy to the irregular pattern, thus resulting in the response *flew* in a) as well as b). However, if children are sensitive to the grammatical structure of words, then they would be expected to realise that the verb used in instance b) is not the irregular verb form they have actually acquired, and to inflect it using the regular past tense suffix in at least some of the instances. The results of Experiment 1 showed that children irregularised verb roots in 87% of instances and regularised them in only 11% of instances, as expected. With denominal verbs, on the other hand, children displayed a reverse pattern and came up with 66.7% regulars (e.g., *flied*) and 17.6% irregulars. Statistical analyses (ANOVAs) showed a significant main effect of grammatical structure, thus indicating that the obtained differences were significant ($F(1,8)=94.75$, $p<.001$). In other words, although the denominal verbs were homophonous to the verb roots used, children tended to treat them differently. These results clearly demonstrated that children were not inflecting words solely on the basis of their phonological properties, but were sensitive to their morpho-syntactic properties. In addition, the

findings clearly showed that children were able to use the past tense rule productively, even in instances where the verb to be inflected was homophonous to an irregular verb form.

In Experiment 3[31], Kim et al. analysed whether the same pattern could also be established for the children's performance on nouns. Therefore, 12 children (age range: 7;1-9;6) were presented with nouns that were homophonous with irregular nouns but had exocentric meanings (e.g., *Mickey Mouse* cf. *mouse*; *Batman* cf. *man*; *Mr. Tooth* cf. *tooth*). The procedure was identical to Experiment 1 and materials included examples like the following (in Kim et al., 1994: p.193):

c)This tooth is red. But this is a purple tooth. Can you say 'This is a purple tooth'?
(Point to another purple tooth)
There are two _____.

d) This is Mr.Tooth. Can you say 'This is Mr. Tooth'?
(Bring out another Mr. Tooth figure)
There are two _____.

The results of Experiment 3 showed that children tended to regularise exocentric nouns (e.g., *There are two Mr. Tooths*) more often (24.1%) than nouns which had no exocentric meaning (4.6%). A 4x2 ANOVA displayed a significant main effect of grammatical structure, thus indicating that the difference was statistically significant ($F(1,8)=13.08$, $p<.01$). This shows that children were sensitive to the grammatical structure of nouns as well, and did not simply inflect them on the basis of

[31] Experiments 2 and 4 were essentially extensions of Experiments 1 and 3, respectively, and led to parallel results. Therefore, they will not be discussed separately.

their phonological properties, either. Just as in the case of irregular verbs (Experiment 1), children thus productively applied the regular plural rule although the exocentric nouns in condition d) were homophonous to irregular nouns. So, to sum up the overall implications of Kim et al.'s study, it can be said that the obtained findings provide strong support for the view that "the input to children's inflectional system cannot just be the phonological representations of words, as it is in [connectionist] models" (Kim et al., ibid: p. 197); rather, children appear to employ a regular-irregular distinction and do indeed make use of morphological rules that they productively apply in novel instances.

Van der Lely & Ullman (2001) conducted a past-tense elicitation experiment with 36 children[32] (age range: 5;5-8;9), in which subjects were presented with two spoken sentences, the first of which contained a verb in the present tense and the second of which needed to be completed by the subjects by using the past tense form of the verb in the former sentence as in e) below (in van der Lely & Ullman, 2001: p. 189).

e) Every day I rob a bank. Just like every day, yesterday I _____ bank.

The verb-stimuli included 16 irregular verbs (e.g., *give-gave*), 16 regular verbs (e.g., *rob-robbed*), 16 nonce irregular verbs, the stems of which were phonologically similar to the stems of real irregular verbs (e.g., **crive-crove/croved* cf. *drive-drove*), and 12 nonce regular verbs, whose stems were phonologically dissimilar to the stems of real irregulars and similar to the stems of real regulars (e.g. **brop-bropped* cf. *drop-dropped*). Furthermore, the real verbs were divided into two groups each,

[32] Additionally, the study also included 12 SLI (Specific Language Impairment) children, whose results will not be reported.

high-frequency verbs and low-frequency verbs, on the basis of their past tense frequencies.

The results for the real verbs showed that the subjects on average correctly inflected 69.5% of the total regular verbs, left around 30% unmarked and irregularised less than 1%. Furthermore, the children displayed no frequency effects on regulars; i.e., the average rate of correct responses for high-frequency and low-frequency real regular verbs was equal, showing that frequency played no role in regular inflection. This is a result that corroborates the predictions of the dual-mechanism model for regulars: since regulars are produced by means of a rule that is supposedly frequency-insensitive, the relative frequency of regular verbs should not effect the correct response rate. For real irregular verbs, the overall average correct response rate was 45% and the average rate of unmarked responses was approximately 27%; the remaining 28% constituted over-regularisation errors (e.g., *gived*). Crucially, statistical analyses revealed that the correct responses to real irregulars showed frequency effects – high frequency irregulars were more often correctly inflected (mean rate: 54.8%) than low frequency irregulars (mean rate: 34.3%). These findings for irregulars are also much in line with the predictions of the dual-mechanism model. Since the dual-mechanism hypothesises that irregulars are stored in an associative memory, frequency effects are expected. Possibly more importantly, the fact that subjects over-regularised, i.e., applied the default rule, whenever they were unable to retrieve an irregular form, provides further evidence for the presence of a rule-system.

The presence of a rule-system was also evident in the subjects' behaviours on nonce verbs. On average, 57.2% of nonce regulars and 42.9% of nonce irregulars were regularised, which means that the children in this study were able productively to apply the past tense rule

to words they had never encountered before – even in instances where the verb stem was phonologically similar to existing irregular patterns as in the case of nonce irregulars. The remaining verbs were predominantly left unmarked (22.9% for nonce regulars, 32.6% for nonce irregulars) and inflection based on similarity to existing forms (irregularisations) was very infrequent for nonce regulars (3.7%) but naturally higher for nonce irregulars (9.3%), which were phonologically similar to existing irregulars.

The results obtained by van der Lely & Ullman (2001) are clearly supportive of the dual-mechanism model. The child-subjects obviously possessed a rule for regulars and tended to apply it as a last resort every time an irregular form could not be accessed in the mental lexicon, which was evident from their regularisations on real and nonce irregulars and nonce regulars. That fact that frequency effects were found for irregulars but not for regulars underscores the view that regulars and irregulars are undeniably treated differently and that irregulars are stored undecomposed in an associative memory while regulars are apparently not. This was also supported by the fact that real regulars were virtually never and nonce regulars only very infrequently irregularised, which shows that regular inflection is insensitive to phonological similarity.

3.1.3.2 Experiments with Adults

Psycholinguistic experiments conducted with adult subjects have yielded comparable results. Investigating the role of frequency in the processing of regular and irregular past tense forms, Prasada, Pinker, and Snyder (1990) ran a speeded production task in which adult native speakers of English were presented with a number of verb stems and were required to produce the past tense form of each verb as quickly and accurately as possible. It was found that, holding stem frequency constant, the production of low-frequency irregular past tense forms took significantly

longer than the production of high-frequency irregular forms. However, this frequency effect was not found for regular past tense forms, supporting the view that frequency plays a role in the processing of irregulars only and, thus, that irregulars but not regulars are retrieved from memory. Similar results were obtained by Ullman (1999), who tested adult native speakers of English to obtain their acceptability ratings of 137 past-tense forms of regular and irregular verbs in past tense sentential contexts. Ullman found a positive correlation between the acceptability ratings and past tense frequencies of irregular verbs ($r=.51$, $p<.001$), but an insignificant negative correlation between acceptability ratings and past tense frequencies of regular verbs ($r=-.17$, $p=.241$). Ullman interprets his results as indicative of storage in associative memory for irregular forms and production by rule for regular forms.

Prasada & Pinker (1993) tested the claim that similarity, like frequency, influences the processing of irregular but not of regular word forms. Prasada & Pinker constructed two sets of novel past tense verbs, which included nonce verbs that varied in the degree to which they rhymed with real regular and irregular verb forms. On the basis of the degree of similarity to real verbs (*prototypical similarity, intermediate similarity, distant similarity*), the two groups of nonce words were each divided into three subgroups[33]:

- Irregular prototypical (e.g., *spling* cf. *cling, sling, fling*)
- Irregular intermediate (e.g., *cleef* cf. *bleed, breed, feed*)
- Irregular distant (e.g., *goav* cf. *blow, know, grow*)
- Regular prototypical (e.g., *plip* cf. *drip, flip, sip*)
- Regular intermediate (e.g., *smeeb* cf. *beam, cream, gleam*)
- Regular distant (e.g., *ploamph* cf. *croak, choke, joke*)

[33] See Prasada & Pinker (1993) for the exact criteria in determining the sub-groups.

Prasada & Pinker (1993) ran three experiments (Experiments 1 & 2: past tense rating experiments, Experiment 3: past tense production experiment). In Experiment 3[34], subjects were asked to produce the past tense forms of the nonce verbs described above. It was found that for regular nonce verbs, independent of the degree of similarity to real regulars, subjects produced an equal number of forms inflected with the regular suffix (-ed). However, for irregular nonce verbs it was found that with decreasing similarity to real irregulars, participants tended to produce more regularised forms (e.g., *goaved*). Prasada & Pinker have claimed that these findings highlight the proposed dissociations between regular and irregular forms and support the theoretical stance that irregulars, but not regulars, show similarity-effects. It should be noted, however, that MacWhinney (1993) presented a strong challenge to the findings of Prasada & Pinker by obtaining the same generalisations pattern in a connectionist model, thus putting the necessity for two distinct mechanisms into question.

Behavioural dissociations between the treatment of regulars and irregulars by adults in psycholinguistic experiments have been reported in many further cross-linguistic psycholinguistic studies like Stemberger & MacWhinney (1988) and Beck (1997) for English; Say (2000) and Say & Clahsen (2002) for Italian; Marcus et al. (1995), Clahsen (1997, 1999), Sonnenstuhl, Eisenbeiss & Clahsen (1999) and Sonnenstuhl & Huth (2002) for German; and Berent, Pinker & Shimron (1999,2002) for Hebrew.

---

[34] Experiments 1 & 2 have yielded results that parallelled those of Experiment 3 and will not be reported here. Only Experiment 3 will be reported as to be able to draw direct comparisons with Murphy (2004), who employed the same task as Prasada & Pinker's Experiment 3 with adult second language learners (see Chapter 3.2.1.2).

3.1.3.3 Non-Supportive Experiments

However, there have also been reports of psycholinguistic experiments with adults the results of which speak against a dual-mechanist view. Orsolini & Marslen-Wilson (1997) tested adult native speakers of Italian on an elicitation task and found phonological similarity effects for both regular and irregular past definite verb forms (Experiment 2). Orsolini & Marslen-Wilson take this result as indicative of full-form storage for regulars and irregulars. In a later analysis of Orsolini & Marslen-Wilson's experiment, however, Say & Clahsen (2002) have shown that the obtained results were due to the fact that the study only included 2nd and 3rd conjugation class Italian verb stems[35], which are known to be similarity-sensitive (hence, irregular). Say & Clahsen state that the results would have been in line with the predictions of the dual-mechanism model if Orsolini & Marslen-Wilson had included 1st conjugation class verbs as well, which Say & Clahsen analyse as default class verbs.

Likewise, Penke & Krause (2002) have challenged the dual-mechanist view that regular inflection equals default inflection by presenting results from a lexical decision task with adult native speakers of German. In many studies on German morphology conducted by proponents of the dual-mechanism model (e.g., Marcus et al., 1995; Clahsen, Eisenbeiss & Sonnenstuhl, 1997; Clahsen, 1999), the conclusion has been reached that among the four plural markers in German (*-e* as in *Stifte (pens), -er* as in *Bilder (pictures), -n* as in *Vasen (vases), -s* as in *Kinos (cinemas*)) the *–s* plural marker is the default plural marker and thus the only plural marker that is derived by means of a rule. However, given the fact that the plural –s marker is the least frequent plural marker and is used with only approximately 7% of nouns, Penke & Krause find it unreasonable

[35] See Say & Clahsen (2002) for a review of Italian verb morphology.

that the remaining 93% of plural nouns should be stored undecomposed in the memory (given the fact that they are classified as irregulars). As a result of a lexical decision task (Experiment 2) which included high and low frequency plural nouns inflected with all four plural endings, it was found that not only the *–s* marker but also the *–en* marker (when attached to nouns of feminine gender) was frequency-insensitive. Thus, nouns taking either of the two suffixes appeared to be inherently rule-products and did not seem to be stored in memory.

On the basis of these results, Penke & Krause make the claim that the unification of the concepts *default inflection* and *regular inflection* can not be correct for German – a point that has also been made by Wunderlich (1999): "the dual mechanism model is correct in dissociating regular from irregular affixation. It is incorrect when it identifies regular affixation with default affixation. There can be … conditions under which affixation is regular, *without* being default" (p. 1045). Penke & Krause thus propose that the –s marker is a regular marker and the default marker, but the –en marker, when attached to feminine nouns, is a regular suffix as well, even if not the default suffix. In this sense they also provide counterevidence to the view that all word forms except those generated by the default marker are stored as whole words in memory.

Baayen, Schreuder, de Jong & Krott (2002) have pointed out comparable problems on account of Dutch nominal[36] inflection. Dutch noun plurals represent an interesting case: there exist two plural suffixes, *-en* and *-s*,[37] which are chosen between while pluralising, on the basis of the phonological, morphological, and semantic properties of the noun stem.

---

[36] Baayen et al. also present results from experiments on Dutch verbal inflection, which will not be discussed at this point.

[37] In fact, Dutch has a third plural suffix, *–eren*, which occurs only in 15 nouns in total and is not further discussed in Baayen et al. (2002).

So, for example, while *–s* is used to form a plural after unstressed syllables, after certain suffixes like the diminutive (*-tje*), and with loan words, the other plural suffix *–en* is used after stressed syllables and after certain suffixes like *–ing*. In some other cases, both suffixes can be used to form the plural (e.g., nouns ending in schwa like *kade* - *kades/kaden*). Interestingly, however, both suffixes act as default plural suffixes in complementary distribution when tested on the criteria of defaulthood listed by Marcus et al. (1995)[38], making it hard to arrive at a definite conclusion as to which is the actual default suffix.

In the actual experiment (Experiment 1), Baayen et al. presented their subjects with 9 different types of pseudo-nouns (nonce-words) and asked them to provide the plural of each noun. The different types of pseudo-nouns constituted nouns which, on the basis of their properties, were expected to be inflected using either only the *–en* suffix (3 types), or only the *–s* suffix (2 types), or either of the two suffixes (4 types). For conditions where only one of the suffixes was possible in accordance with the rules of Dutch, subjects chose the correct suffix in 98.5% of instances. However, in the remaining four conditions where both suffixes can be used to inflect the pseudo-nouns, subjects did not display a strong preference for either of the two suffixes, which showed that the participants did not have the tendency to choose one of the two suffixes as the definite, default inflection. In other words, it seems that Dutch, like German, appears to have two regular plural suffixes; but more importantly, Dutch also seems to have two default plural suffixes – or possibly *no default suffix*, which constitutes a further challenge to the cross-linguistic validity of a default procedure as defined by proponents of the dual-mechanism model.

---

[38] See Chapter 3.1.

In sum, psycholinguistic experiments have provided cross-linguistic results that are largely supportive of the dual-mechanism model, though the findings and basic propositions have not remained unchallenged especially through findings from languages other than English. Unfortunately, psycholinguistic experiments always bear the risk of being biased since results may display variations depending on the selection of a number of variables like the experimental materials, subjects, and the experimental method. Therefore, the above-mentioned studies certainly need to be replicated with different subject groups and a greater variety of languages to arrive at definitive results.

3.1.4 Findings from Neurolinguistic and Neuropsychological Studies

Investigations into the proposed dissociation of regular and irregular forms and the related theoretical explanations have also been carried out by means of neurolinguistic or neuropsychological studies that have focused on subjects suffering from a variety of disorders like brain lesions (e.g., patients with aphasia), neurodegenerative disease (e.g., Alzheimer's Disease, Parkinson's Disease), and developmental disorders (e.g., Specific Language Impairment, Williams Syndrome) as well as healthy (unimpaired) subjects. As has been mentioned before, if the tenets of the dual-mechanism model (and connectedly, the declarative/procedural model) are correct, it should be possible to find selective impairments of either regulars or irregulars in impaired subjects, depending on the affected brain area. In other words, for impaired subjects double-dissociations are expected in the sense that "damage to the neural substrate for lexical memory should cause a greater impairment of irregular forms [and] damage to the substrate for grammatical combination should cause a greater impairment of the rule in regular forms" (Pinker & Ullman, 2002: p.460). For healthy subjects, on

the other hand, tasks involving regulars and irregulars are expected to yield different brain activation levels and regions.

Such a double-dissociation has been found for patients suffering from *aphasia*, which is a cover–term for language impairments resulting from focal lesions in the brain (Ullman, 2004). It has been reported that *non-fluent aphasics* with left-anterior damage and *agrammatism*, an impairment in producing fluent grammatical sequences, are worse at producing and reading regular than irregular English past tense forms, lack over-regularisations (i.e., problems in applying the regular rule), and have great problems in the suffixation of nonce-words (e.g., *ploamphed*). In contrast, patients with *fluent aphasia* (left posterior damage) and *anomia* (word finding problems) have been reported to be worse on irregulars when compared to regulars, frequently produce over-regularisation errors (i.e., have problems accessing a stored irregular and apply the regular instead), very rarely generalise irregular patterns to novel words, but are relative unimpaired in applying the regular rule to nonce-words (Pinker & Ullman, 2002).

In a recent article, Miozzo (2003) reports a case-study of a native English speaking patient (AW), who, following a stroke resulting in damage to the basal ganglia and the medial and superior temporal areas, had no problems in grammatical processing, but displayed word-finding difficulties. Miozzo conducted a number of past tense and plural generation tasks (similar to the task used by van der Lely & Ullman, 2001[39]) with the patient and found that AW performed as accurately in the production of regular past tense forms as normal controls (~98% accuracy) but had problems with the production of irregular past tense forms (~67% accuracy). With plural nouns the dissociation was even

[39] See Chapter 3.1.3.1.

greater: ~43% accuracy on irregular plurals and ~95% accuracy on regular plurals. Of the errors on irregular past tense verbs, 33% constituted over-regularisations (e.g., *fall-falled*), 5% double-marked errors (e.g. *bind-bounded*), 26% no change errors (e.g., *feel-feel*), 26% irregularisation errors (e.g., *flee-flung*), 5% -s additions (e.g., *beat-beats*) and 5% omissions; the errors with irregular noun plurals, on the other hand, were all (100%) over-regularisations (e.g., *childs*). These figures are highly important since they clearly show that AW was able to distinguish between nouns and verbs, and to apply the respective regular rule as a last resort and was not making use of a strategy that led to the indiscriminate application of any suffix to every word she had problems with. In addition, this also shows that nouns and verbs are similarly processed as implied by the dual-mechanism model (Miozzo, 2003)[40]. In sum then, AW represents a clear case of a selective deficit in which the rule-system is spared but the memory access system is affected for nouns and verbs at once.

The double-dissociations predicted by the dual-mechanism model have also been reported for neurodegenerative disease. It has been reported that patients with *Alzheimer's disease*, which is associated with severe degeneration of temporal and temporoparietal regions and relatively less degeneration of the basal ganglia and Broca's area (Ullman, 2001a), have greater problems with the production of irregular past tense forms than with regular past tense forms in English and Italian. Patients with *Parkinson's disease*, on the other hand, show just the opposite pattern. In contrast to *Alzheimer's disease*, *Parkinson's disease* is associated with the degeneration of the basal ganglia (Berkow & Fletcher, 1992) and results in greater problems with regulars than irregulars (Ullman et al.,

[40] The dual-mechanism model does not make the explicit claim that nouns and verbs are processed identically, but implies this point by not proposing separate systems for different lexical types.

1993, 1997). Thus, neurolinguistic studies with patients suffering from neurodegenerative disease also clearly exhibit the same double-dissociation as has been observed for aphasics, showing that the processing of regulars and irregulars (or the mental-grammar and the mental lexicon) depends on different regions in the brain which can be selective impaired.

Selective impairments have also been captured in patients with developmental disorders. Bromberg, Ullman, Coppola, Marcus, Kelly, & Levine (1994; in Ullman & Gopnik, 1999), for example, investigated young adults with *Williams Syndrome*, a genetic developmental disorder associated with severe mental retardation that leaves syntactic abilities intact, but causes abnormal lexical retrieval (Ullman & Gopnik, 1999; Bellugi, Wang & Jernigan, 1994). It was found that the subjects were less impaired at producing regular past tense forms than irregular past tense forms and produced a high number of over-regularisation errors with irregulars. Similar results for Williams Syndrome subjects have been obtained by Clahsen & Almazan (1998, 2001) Thus, obviously the disorder causes selective impairments, not affecting the application of the default rule, but resulting in malfunctions in the retrieval of irregular past tense forms from memory. According to Ullman & Gopnik (1999), these results clearly speak for a dissociation of irregular and regular past tense forms, associating the former with the memory system and the latter with syntactic abilities.

Another developmental disorder, Specific Language Impairment (SLI), results in the opposite pattern and thus forms the other part of the double dissociation. SLI is known as a developmental disorder of language in individuals who do not have any other obvious cognitive, social or neurological deficit (Menyuk, 1964). Recent studies of SLI-children and adults (Ullman & Gopnik, 1999; van der Lely & Ullman, 2001) have

clearly shown that individuals with SLI have problems with the English regular past tense rule. It has been found that SLI-subjects fail to over-regularise, to produce novel regular forms (e.g., *ploamphed*) and exhibit frequency-effects on regular and irregular forms. This has led researchers to the conclusion that SLI-children have problems learning grammatical rules, and therefore tend to memorise regulars as well as irregulars. In other words, it appears that SLI results in a rule-deficit but leaves the associative memory intact (van der Lely & Ullman, 2001). It should be noted, however, that results from studies with SLI-subjects need to be treated with caution since SLI-studies are still in their infancy and studies reporting conflicting results (e.g., Rice, Wexler & Cleave, 1995; studies cited in Leonard, 1998) are not infrequent.

Neurolinguistic evidence for the dissociation of regular and irregular past tense forms has also been obtained from brain studies involving normal (healthy) subject groups. For instance, Jaeger, Lockwood, Kemmerer, Van Valin Jr., Murphy & Khalak (1996) report a PET (Positron Emission Tomography) study in which healthy native speakers of English were asked to read aloud lists of irregular, regular, and nonce verb stems and produce their past tense forms. In their analysis of the brain activation levels related to the processing of regular and irregular forms, it was found that different regions in the brain showed associations for regular and irregular past tense forms. While the *left dorsolateral frontal lobe* was found to be activated for regulars but not for irregulars, the *left middle temporal gyrus* and the *left superior frontal gyrus* are reported to have shown activation for irregulars but not for regulars, thus indicating differential treatment of regulars and irregulars in the brain as reflected by activation loci. It should be noted, however, that Jaeger et al.'s (1996) study was criticised by a number of researchers (e.g., Ullman, 2001a; Seidenberg & Hoeffner, 1998) for methodological reasons.

Dissociations in the processing of regulars and irregulars have also been reported in a number of ERP (Event Related Potential) studies for English (e.g., Newman, Neville & Ullman 1998), Italian (e.g., Say, 2000) and German (e.g., Weyerts, Penke, Dohrn, Clahsen & Münte, 1997; Penke, Weyerts, Gross, Zander, Münte & Clahsen, 1997). In all ERP studies, it was found that the measured brain signals in various tasks were strikingly different for regulars and irregulars. Very simplistically speaking, while regular processing elicited wave forms that are normally linked to grammatical processing, irregular processing resulted in waveforms that are normally recorded for lexical (i.e., stored) processing, which appears to support the dual-mechanist view.

To sum up, the results obtained in acquisition, psycholinguistic and neurolinguistic research independently support the view of the dual-mechanism model that distinct mental mechanisms and neural substrates underlie the mental grammar and the mental lexicon and the processing of regular and irregular forms in L1 processing. The next section will discuss how the dual-mechanism model can be extended to L2 processing and will review the findings that have emerged in L2 studies within this framework.

3.2 Extending the Dual-Mechanism Model to L2 Processing

Although the dual-mechanism model has not been set up as a model of second language processing, it has recently been found worthwhile to investigate its theoretical claims on the processing of second language learners. Pinker (1999) has made the point that particularly the very basic distinction between the two proposed mental mechanisms (an associative memory and a mental grammar) is a *universal* feature of the design of human language. Therefore, if the tenets of the dual-mechanism model are meant to carry *universal* validity, it is expected that they should also

hold for the acquisition and processing of a second language, particularly because L2 learners are assumed to be already employing these two mechanisms in their native language. Thus, just as in L1 processing, it should be possible to encounter similar manifestations of the two distinct mechanisms in the linguistic processing of an L2 as well. If it is indeed the case that the predicted dissociations between regular and irregular forms also hold for L2 processing, then second language acquisition research could provide an additional testing ground for the dual-mechanism model and rival theories.

It is a well-known fact that adult L2 learners usually fail to reach a final state that matches that of native speakers of a given language and especially show deficits in certain areas of implicit grammatical competence when compared to the use of lexical items (Johnson & Newport, 1989; Beck, 1997, 1998). One proposal that has been made in relation to this observation is that this observed deficiency in the processing of grammatical features is due to the fact that grammatical processing is more age-of-exposure sensitive than lexical processing in L2 development and therefore results in a greater reliance on the memory, particularly in adult L2 learners (Ullman, 2001b). If this hypothesis, as it stands, is correct, it implies that especially adult L2 learners to a certain extent eschew symbol manipulation of the kind supposedly applied in the computation of regular word forms and process regular as well a irregular word forms over an associative memory (Beck, 1997). Needless to say, findings supporting this view would constitute counter-evidence for the theory that a dual-mechanism, or at least a strong version of the dual-mechanism model, is also at work in L2 processing.

Unfortunately, studies investigating L2 users within the framework of the dual-mechanism model have been quite rare to date and, as will be

further discussed below, the results obtained from these studies have not been able to indicate a clear picture of the extent to which the dual-mechanism-model constitutes a good model of L2 processing. The inconsistent findings across and even within L2 studies (e.g., Beck, 1997) have on the one hand cast doubt on the experimental reliability of these studies, and on the other hand clearly shown that any large-scale conclusions based on the studies conducted so far may run into the danger of being extremely hasty generalisations that lack sound experimental backup. It is of course open to debate whether it will ever be possible to arrive at uniform conclusions regarding the L2 processing of linguistic structures given the fact that in L2 language processing many more intervening factors come into play when compared to L1 language processing, like individual differences, L1 transfer effects, motivational factors, factors related to the way an L2 is acquired (naturalistic vs. instructed L2 acquisition), age-related impacts (especially with adult L2 learners), L2 proficiency effects etc., which are all known as factors that may bring about potentially significant variations among learners and which as such hardly ever cause crucial alterations in L1 processing.

3.2.1 Largely Non-supportive Findings

3.2.1.1 Beck (1997)

Beck (1997) conducted 6 reaction time experiments in which adult native speakers (age range: 20-48) and high-proficiency adult L2 speakers of English (age range: 18-41) from various L1 backgrounds[41] were asked to produce orally the past tense forms of verb stems presented on a

[41] The native languages of the L2 subjects across experiments included typologically different languages like Chinese, Japanese, Urdu, Korean, Malay, Farsi, Indonesian, Ibo, French, Spanish, Norwegian, Arabic, Hungarian, Italian, German, Russian, Bengali, Sri Lankan, Tamil, Thai, Turkish and Czech.

computer screen. To be able to measure potential frequency effects, subjects were presented with high-frequency and low-frequency regular and irregular verbs (matched on stem frequency, mismatched on past tense frequency) and their response times were measured. For results, see Table 1.

Table 1:

Mean reaction times (in milliseconds) for native speakers (NS) and non native speakers (NNS) to regular and irregular high frequency (HF) and low frequency (LF) stimuli across experiments (based on Beck, 1997).

	Regulars		Irregulars	
	LF	**HF**	**LF**	**HF**
Exp. 1 (NS)	477ms	508ms*	581ms	535ms*
Exp. 2 (NNS)	722ms	759ms	818ms	808ms
Exp. 3 (NS)	422ms	424ms	n.r.	n.r.
Exp. 4 (NNS)	582ms	640ms*	n.r.	n.r.
Exp. 5 (NS)	341ms	347ms	n.r.	n.r.
Exp. 6 (NNS)	432ms	432ms	n.r.	n.r.

***p<.05**

(n.r.=not reported)

The results of Beck's study are problematic and vague since she did not arrive at consistent patterns in her experiments. As can be seen in Table 1, the mean reaction times measured for regular verbs are rather unexpected since in a sub-set of her experiments (Experiments 1-4) non-native speakers as well as native speakers exhibited anti-frequency effects for regular verbs (slower reaction times for high frequency regular verbs) which should not have been the case under the dual-mechanism view. From a dual-mechanist perspective, regular word forms are not

expected to be frequency-sensitive since regulars are normally not theorised to be stored as wholes in the associative memory although it may be possible for very high frequency regulars to be listed as well. If, however, there is a recorded frequency effect as the result of full-form storage, which is not entirely ruled out by the dual-mechanism model, then the expected frequency effect should be in the opposite direction to the pattern found by Beck – higher reaction times for low frequency verbs and lower reaction times for high frequency verbs.

Beck claims that the anti-frequency effect obtained must have been an artefact of the experimental design. Her view is that the presentation of regular and irregular forms in one and the same experiment must have affected the application of the regular rule to regular verb stems that share some phonological features with irregulars. In other words, the presentation of an irregular stimuli like *fly* immediately prior to a regular verb like *flow*, with which it shares some phonological features, may have intervened in the application of the regular rule and thus temporarily blocked its application. This disturbance may have manifested itself as higher reaction times for high frequency regular verbs, which happen to share more phonological features with irregulars than low frequency regular verbs (Beck, 1997).[42] Beck therefore ran additional experiments (Experiments 5-6) in which she simply excluded irregular forms and, as a result, obtained no anti-frequency effects for regular forms – as predicted by the dual-mechanism model. However, it is controversial whether the experimental alteration she undertook is justifiable and whether the results she obtained from the additional experiments excluding irregular forms can be accepted as convincing evidence since the removal of the

[42] Zobl (1998) speculates on a different reason for the observed anti-frequency effects. He raises the possibility that high frequency regulars may be accessed as fully listed entries as well as by the application of the past tense rule to the stem, which may lead to competition between the two access routes. This competition could possibly the reason for slower reaction times on high frequency regular forms.

irregular items from the stimulus set may have led the participants to anticipate that they were expected to produce regular forms only. Therefore, the obtained result might as well have emerged as an artefact of this alteration.

A second problem related to her results was that Beck did not find any significant differences in the reaction times for high-frequency and low-frequency *irregular* verb forms (808ms vs. 818ms, p=0.8) with L2 subjects – again a finding not predicted by the dual-mechanism model. Beck attributes this rather unexpected result to the fact that all L2 subjects in her study had gone through years of formal L2 instruction, where students are usually asked to memorise lists of irregular verb forms, which do not take natural input frequency into account. Thus, from the outset of formal instruction, classroom L2 learners are exposed to high-frequency as well as low-frequency irregular verb forms (e.g., *stood* and *spoke*, respectively) to equal degrees. This practice apparently eliminated the frequency-differences in irregular forms for the L2 subjects and caused equal reaction times for the 'high-frequency' and 'low-frequency' irregular forms used in the experiment. This is, of course, only a speculation which can not be accurately evaluated as long as no exact data exists that can provide a clearer picture concerning the input Beck's subjects received. As a whole, the above-mentioned problems related to Beck's (1997) study pose serious doubts to the validity of her findings and there exist largely contradictory opinions in the relevant literature on whether the findings obtained should be evaluated as supportive of the dual-mechanism model or not, though most researchers treat Beck's findings as non-supportive.

3.2.1.2 Murphy (2004)

Another, and more recent, study that analysed the validity of the dual-mechanism model for L2 processing is Murphy (2004). Murphy employed 20 adult non-native learners of English (age-range: 20-24) with various native language backgrounds[43] who had been residing in England for 1 to 6 months and were classified as beginner-level learners on the basis of a proficiency test administered by the language school they were attending. Murphy made use of a nonce-word task very similar to that used by Prasada & Pinker (Experiment 3, 1993) with adult native speakers and used the same nonce regular and irregular stimuli as Prasada & Pinker and their tripartite division based on their similarities to existing verb forms (*prototypical, intermediate, distant*)[44].

It was found that the L2 subjects treated regulars and irregulars differently overall in that they used the regular past tense suffix (*-ed*) more with regular nonce verbs than with irregular nonce verbs. Additionally, the similarity effects on irregular nonce verbs expected by the dual-mechanism model were clearly evident since the participants, just like the L1 participants in Prasada & Pinker (1993), tended to produce more over-regularised irregular verbs as the distance to prototypical irregular verbs increased; in other words, the farther a nonce irregular verb form was to prototypical irregulars (or closer to distant irregulars), the higher was the likelihood for it to be regularised. In this sense, the predictions of the dual-mechanism for irregular verbs were born out since this constituted a clear case of the impact of phonological similarity and thus indicated storage in an associative memory sensitive to phonological features. Unexpectedly, however, a phonological

[43] The participants' first languages are reported as French, Italian, Korean, Spanish, Turkish and Croatian.
[44] For further details, see Chapter 3.1.3.2.

similarity effect was also observed for nonce regular verbs, though in the opposite direction. That is, the closer a nonce regular verb form was to prototypical regulars (or farther to distant regulars), the lower was the likelihood for it to be regularised. As has been pointed out at various places, from the perspective of the dual-mechanism model, no similarity effect whatsoever is expected to be observed for regulars since they are normally not assumed to be stored in memory and regular suffixation is proposed to be a "blind computational procedure" (Murphy, 2004: p.451) that is independent of the phonological similarities of a given stem to the properties of previously encountered word forms (Prasada & Pinker, 1993). In this sense, the findings obtained by Murphy (2004) are in complementary relation to the controversial results of Beck's (1997) study and shed further doubt on the validity of the dual-mechanism model for L2 processing.

3.2.2 Largely Supportive Findings

3.2.2.1 Zobl (1998)

Zobl (1998) proposes a developmental model of L2 processing that, similar to the dual-mechanism model, rests on listings and computations, but develops in two stages: an early *listing stage* and a subsequently evolving *computational stage*. As the names suggest, it is proposed that in the early stages of L2 acquisition the learner goes through a stage in which forms are simply listed in the lexicon, while later on in the developmental process productive rules evolve. The proposed L2 developmental pattern is in this sense very similar to the U-shaped developmental pattern reported in child language acquisition (e.g., Marcus et al., 1992), where it has been found that children initially go through a stage in which they appear to rote-memorise regular as well as irregular forms, followed by a stage in which they start to productively

apply the regular rule and hence to produce over-regularisations and fewer correct irregular forms and finally reach a stage in which they regain accuracy on regulars as well as irregulars. Correspondingly, Zobl proposes that L2 learners initially go through the listing stage in which they tend to rely on fully listed (i.e., rote-memorised) representations of all regular and irregular word forms. L2 learners in this stage are not expected to productively apply any kind of affix and hence should not be able to produce over-regularisations since, as mentioned above, rules are not assumed to have been abstracted at this point. In the later computational stage, however, it is expected that regular inflections become functional and, hence, that over-generalisations should occur and asymmetries between regular and irregular forms emerge. In other words, Zobl's theory offers an extended view of the dual-mechanism model by capturing the two distinct mechanisms proposed in a sequential dimension for L2 processing, claiming that the rule-system is not functional in initial stages of second language acquisition but emerges later, in analogy to child first language acquisition.

To test his claims, Zobl (1998) analysed the spontaneous speech production records of three 30 to 40-year-old L1 Russian adult immigrants in (English-speaking) Canada, who had been residing in the host country for 1-3 years. Data was collected by means of 3 semi-structured interviews each, in which the participants were involved in conversations about their everyday lives. In the analysis of the interview-transcripts, Zobl made use of what he calls 'text-internal frequency', which refers to the frequency a particular word type occurs in a speaker's speech corpus and by means of which he analysed the frequency of occurrence for regular and irregular past tense forms. To determine the text-internal frequency of irregular past tense forms, for example, it is necessary to first count the number of obligatory occasions for irregular past tense forms in the corpus and then count how often irregular past

tense forms were provided in these obligatory occasions. Zobl claims that this measure is a better reflection of a particular L2 learner's linguistic experience when compared to traditional frequency corpora in that it better reflects the frequency of word types in the input and indicates to what extent a given word has actually been utilised in a speaker's repertoire.

Table 2:
Frequency of regular and irregular past tense forms (based on Zobl, 1998).

	Irregulars		Regulars	
	Types[45]/Context	Tokens/Context	Types/Context	Tokens/Context
Speaker 1	9/21 (43%)	9/44 (20%)	6/21 (29%)	10/34 (29%)
Speaker 2	25/33 (76%)	34/51 (66%)	10/38 (26%)	13/63 (21%)
Speaker 3	21/22 (95%)	59/83 (71%)	26/35 (74%)	56/75 (75%)

As can be seen in Table 2, for Speaker 1, whom Zobl classified as the lowest-proficiency speaker, it was found that regular and irregular past tense forms were used to almost equal degrees. Speaker 1 used 9 lexically different past irregulars (out of 21 possible occasions) and 9 out of 44 irregular past tense tokens (43% and 20%, respectively). The same speaker used 6 regular past tense verb types (out of 21 contexts) and

[45] 'Type' frequency refers to the frequency of different lexical verbs like *talk(ed), look(ed)* and *open(ed),* whereas 'token' frequency refers to a simple count of total uses across verb types. For example, if a given speaker uses *talked* 3 times, *looked* 4 times and *opened* 6 times, the type frequency would be 3 (because 3 verb types would have been used) and the token frequency 13.

made use of a total of 10 regulars past tense verbs in 34 possible occasions (29% each). The production frequencies for both regular and irregular past tense forms were thus found to be low for Speaker 1, which Zobl takes as an indication of full-form storage of rote-learned regulars and irregulars. Since Speaker 1 is at an initial stage of L2 development, she does not appear to have lexical representations of a large number of different verbs (like children at initial stages of the acquisition process), and therefore displays a quantitatively low production rate. Evidence for Zobl's view that a rule system has not been developed yet comes from the total absence of over-regularisations in Speaker 1's speech data, and from the fact that the 3rd Person Singular Agreement marker (-s), which is also taken as a rule, is not used productively yet (1/16 verb tokens, 1/11 verb types).

Speaker 2, on the other hand, appears to be more advanced when compared to Speaker 1 since, as can be seen in Table 2, there is a clearly visible increase in the amount of irregular types (76%) and tokens (66%) used in obligatory contexts but no change in the production rate for regulars. This increase in the amount of irregular verbs, similar to the increase of irregular verbs in children's linguistic development, is in fact expected since irregular past tense forms are much more frequent in English when compared to regular past tense forms. Therefore, this comparative higher input-frequency should manifest itself in stronger memory traces for irregulars and higher suppliance when compared to regulars if learners at this stage indeed still rote-learn all forms. From the low suppliance rate for regulars, it is clear that the hypothesised rule-system has not completely evolved yet, which is also evident in the lack of over-regularisation errors and Speaker 2's low rate of the 3 Person Singular Agreement marker use: 6/16 verb types; 6/17 verb tokens.

A completely different picture emerges with Speaker 3, who appears to be the most advanced among the three participants. As can be seen in Table 2, both regular and irregular verb types and tokens are supplied to very high degrees (71%-95%), which is a clear quantitative indication of the fact that the regular rule is being used almost fully productively. The productivity of the rule-system also manifests itself in the observation that Speaker 3 is the only participant who produces over-regularisations (*feeled* and *saided*), and in the fact that Speaker 3 is comparatively much more advanced in agreement marking (23/34 of verb types, 28/54 of verb tokens).

Thus, in sum, the behavioural findings related to the L2 learners in Zobl's (1998) study appear to provide support for his view that L2 learners at initial stages of the acquisition process tend to list all word forms in memory and are not able to productively use a rule-system, which evolves only later in a computational stage with increasing proficiency. The production patterns of Zobl's subjects clearly show that the participant with the lowest L2 proficiency (Speaker 1) behaves like children in the very initial stages of the linguistic development in that she uses only very small amounts of regular and irregular verb forms, which appear to be accessed undecomposed and unanalysed from memory. With increasing proficiency (and relatedly, increasing input), the amount of produced irregular (but not regular) forms appears to increase, which is connected to the well-known fact that irregular past tense forms are more frequent in input than regular forms (Speaker 2). Finally, the rule appears to evolve, which manifested itself in the high suppliance of regulars in addition to irregulars by Speaker 3 and in the occurrence of over-regularisations. Possibly a (much) later stage would thus be one in which over-regularisations gradually vanish and the suppliance rates for regulars and irregulars approach to 100%, as is the case for children. In

this sense, Zobl (1998) can be taken as a study that is supportive of the Dual-Mechanism model.

However, Zobl's study has a number of shortcomings that need to be taken into consideration. Firstly, the fact that the study is cross-sectional in nature but only focuses on 3 subjects raises serious doubts about the extent to which its findings can be generalised. In other words, had Zobl made use of the same number of subjects but applied a longitudinal design that truly reflects the developmental patterns of each speakers or a cross-sectional design with more participants, it would have been more likely that the findings may apply to other contexts and speakers. Secondly, Zobl does unfortunately not provide any kind of information concerning the actual L2 English proficiency of his participants, but equates their developmental patterns with their proficiency levels. However, it is of high significance in the long run to exactly determine at what level of proficiency the movement from the proposed listing stage to the computational stage actually occurs. Proficiency here does not necessarily entail a 'score' from a given language examination, but may constitute any kind of measure that can be subsequently used for comparative purposed with other subjects in further studies. In its present form, Zobl's study is not significantly different from anecdotal evidence.

3.2.2.2 Birdsong & Flege (2001)

Birdsong & Flege (2001) investigated the regular-irregular dissociation in L2 learners by analysing past tense and noun plurals performance of L1 Spanish and Korean learners of L2 English in the USA, paying special attention to potential effects of age of arrival in the US, length of residence in the US and age at testing. Birdsong & Flege employed a total of 60 participants (30 L1 Korean and 30 L1 Spanish), who were matched on length of residence in the USA and mismatched on age at

testing and age of arrival in the USA. The actual experiment involved the presentation of low frequency and high frequency regular and irregular verbs and nouns (80 test items in total) in the form of multiple-choice items on a computer and the recording of reaction times and response accuracy. The subjects were expected to choose the most suitable item to complete a given sentence as in examples 1 and 2 below (in Birsong & Flege, 2001) by pressing the relevant buttons (a,b,c,d,e) on the computer keyboard and the reaction times and accuracy scores of their responses were recorded by an experimental software:

Example 1: High Frequency Irregular Past Tense Verb

Yesterday the little girl	*a.*	*swim*	*for the first time.*
	b.	*swam*	
	c.	*swimmed*	
	d.	*swims*	
	e.	*swammed*	

Example 2: Low Frequency Regular Plural Noun

There are five	*a.*	*knuckli*	*on each hand.*
	b.	*knuckle*	
	c.	*knuckles*	
	d.	*knackle*	
	e.	*knuckleses*	

(Birdsong & Flege, 2001: p. 126)

As can be seen in Table 3, Birdsong & Flege found that the accuracy scores on irregular forms were frequency-sensitive in that both the L1 Korean group and the L1 Spanish group produced significantly higher accuracy scores on high frequency irregular forms (87% and 72%, respectively) than on low frequency irregular forms (66% and 54%,

respectively). For both groups, the observed accuracy differences between high and low frequency irregulars were found to be statistically significant at $p<.05$. For regulars, however, no significant differences were found between the accuracy scores on high and low frequency forms for both groups ($p>.05$).[46] Birdsong and Flege claim that these results are consistent with the prediction of the dual-mechanism model that regulars are not sensitive to frequency, in contrast to irregulars which are dependent on input frequency.

Table 3:
Accuracy rates on high frequency (HF) and low frequency (LF) regulars and irregulars across language groups (adapted from Birdsong & Flege, 2001).

	L1 Korean	L1 Spanish
HF Regulars	97%	94%
LF Regulars	94%	90%
HF Irregulars	87%	72%
LF Irregulars	66%	54%

A further interesting finding Birdsong & Flege obtained was the observation that the computation of irregular forms appeared to be increasingly deficient over age of arrival, which was not the case for regular forms. Thus, a negative correlation between age of arrival and accuracy on irregular forms was found, which Birdsong and Flege take as

[46] Birdsong & Flege provide no details concerning the measured reaction times, but indicate that the reaction time results patterned similarly to the accuracy data.

a possible indication of age effects in the processing of the associative memory, in contrast to what has been proposed by Ullman (2001a, 2001b), who hypothesis age-effects for the procedural memory (i.e., the rule-system) in L2 processing. However, Birdsong & Flege confidently state that they "have evidence that the declarative system may be more susceptible to aging effects than the procedural system" (Birdsong & Flege, 2001: p. 131).

3.2.2.3 Kırkıcı (2002)

The validity of the dual-mechanism model for L2 processing has also been investigated and largely confirmed in relation to learners of L2 English in a formal learning environment[47] by Kırkıcı (2002), who analysed the processing of the English past tense by 49 advanced and less advanced adult L1 Turkish learners[48]. Drawing on the stimuli developed and used by Ullman (1999), Ullman & Gopnik (1999), and van der Lely & Ullman (2001), Kırkıcı (2002) conducted an elicited past tense production task in which the participants orally completed sentences like "Everyday I *go* to work. Just like everyday, yesterday I _____ to work." The 56 stimuli-verbs consisted of high and low frequency regular and irregular verbs, novel regular verbs, and novel irregular verbs. In addition to trying to find dissociations in the behaviours of regular and irregular verb forms, Kırkıcı also had the aim of re-evaluating Zobl's (1998) view that less advanced L2 learners lack a rule-mechanism and compute both regular and irregular verb forms over an associative memory.

---

[47] Often referred to as 'English as a Foreign Language' in contrast to 'English as a Second Language'.

[48] Proficiency levels were determined on the basis of scores obtained from a proficiency test administered at Middle East Technical University, Ankara.

Kırkıcı found evidence to support the view that regular and irregular verb forms are stored and computed distinctively. As can be seen in Table 4, it was found that low proficiency as well as high proficiency participants exhibited frequency effects on irregular past tense forms, which manifested themselves in higher correct responses on high frequency than on low frequency irregular forms (92.3% vs. 47% for low proficiency subjects, 96.6% vs. 60% for high proficiency subjects; both differences $p<.0001$). A similar frequency effect was found in the over-regularisation errors produced. While low proficiency subjects over-regularised high frequency irregulars at 3.6% and low frequency irregulars at 23.8% ($p<.0001$), high proficiency participants over-regularised high-frequency and low-frequency irregulars at 2.9% and 11.4%, respectively ($p<.001$). Thus, these findings clearly show that the participants displayed frequency effects on irregular past tense forms, which is indicative of full-form storage. Furthermore, the observed over-regularisation errors make obvious that both participant groups were able to use the past tense suffix productively in instances where an irregular past tense form could not be retrieved from memory. In this sense, the findings constituted counter-evidence for the views of Zobl (1998) and Ullman (2001b), who claim that in L2 speakers, or less-proficient L2 speakers, the rule-mechanism may be impaired and all (or most) regular and irregular computations are conducted over the associative lexical memory.

Kırkıcı also found that regular forms exhibited frequency-effects as well (mean differences in Table 4 were significantly different, $p<.005$ in both instances), which should not have been the case from the perspective of the dual-mechanism model. Although Kırkıcı does not provide a thorough analysis of this rather unexpected finding, this obviously implies that at least some of the higher-frequency regulars must have been stored as wholes in the memory, which is not something the dual-mechanism model rules out and, in the light of the high amount of over-

regularisations observed (see above), does not provide counter-evidence to the view that L2 learners do possess a rule-system from very early stages on.

Table 4:
Mean response rates (as % of items) for high frequency (HF) and low frequency (LF) regular and irregular verbs by subject groups (based on Kırkıcı, 2002, Table 3).

	Low Proficiency	High Proficiency
HF Regulars		
Correct	92.2%	97.5%
Irregularised	4.7%	1%
LF Regulars		
Correct	84.9%	82.5%
Irregularised	6.3%	10%
HF Irregulars		
Correct	92.3%	96%
Over-regular.	3.6%	2.9%
Irregularised	3%	0.6%
LF Irregulars		
Correct	47%	60%
Over-regular.	23.8%	11.4%
Irregularised	25%	26.9%

A further finding obtained by Kırkıcı (2002) was that the L2 subjects seemed to be more prone to produce irregularisation errors with regulars (e.g., *brush-*brash*) as well as irregulars (e.g., *bring-*brang*) when compared to native child and adult subjects. Although the dual-mechanism model does not necessarily posit a dominant rule for the rule-based mechanism but mainly hypothesizes it as a back-up procedure

(Marcus et al., 1995; Say, 2000), the rates of produced irregularisations still appeared to be marked, especially in comparison to L1 speakers' rates of irregularisations. Kırkıcı suggested the possibility that the lexical memory in L2 learners may be more productive since irregular forms cover a larger lexical space in the lexical memory of L2 learners when compared to L1 speakers due to certain practices related to the learning of these forms; e.g., frequent focus on and reinforcement of the memorisation and retrieval of irregular forms.

Thus, in sum, studies investigating the relevance of the dual-mechanism model for L2 processing have reached rather contradictory results so far which do not draw a clear picture of the mechanism(s) at work. Therefore, as the authors of the L2 studies summarised above admit in unison, the empirical evidence gathered thus far is not sufficient to make definitive claims and the theoretical stance that the dual-mechanism model as originally proposed for L1 processing carries validity for L2 processing as well needs to be seriously substantiated by further research. The following chapters will therefore present the results of two experiments conducted with L1 Turkish learners of L2 English in a formal acquisition setting.

CHAPTER 4

EXPERIMENT 1: A VISUAL LEXICAL DECISION TASK ON THE ENGLISH PAST TENSE

This chapter consists of five main sections. The first section provides the necessary morphological and psycholinguistic background information for Experiment 1. This is followed by the presentation of the research questions and predictions related to Experiment 1 in section 4.2. The third section presents the methodological details of Experiment 1, the results of which are in turn discussed in the fourth section. The final section discusses the obtained results and concludes this chapter.

4.1 Background to Experiment 1

As has been pointed out at various points throughout the preceding discussions, the English past tense has played a major role in the *dual-mechanism – connectionism* debate, which has even led to the formation of the umbrella-term *the past tense debate* to refer to the entirety of the ongoing controversy. Despite the fact that the morphological properties of the English past tense have been outlined, and its exact role in the prevailing controversy, its acquisition by children, and related psycholinguistic and neurolinguistic findings have been reviewed in previous chapters, in what follows the central properties of the English past tense and the debate concerning the way it is processed will be briefly recapitulated to provide the necessary background information for Experiment 1.

The English past tense encodes the time of occurrence of an event relative to the time of a speech act and almost always results in a physical change of the inflected verb stem. While for the majority of verbs the resulting physical change involves, descriptively speaking, the addition of the past tense *–ed* suffix (e.g., *talk-talked, lift-lifted*), for approximately 180 verbs the resulting past tense form is created in idiosyncratic and apparently arbitrary ways[49] (e.g., *bring-brought*, *sing-sang, hit-hit*). Traditionally, verbs falling in the former category have been labelled *regular* verbs, while verbs in the latter category have been referred to as *irregular* verbs.

What makes the English past tense particularly suitable for the testing of rival theories about morphological processing is the fact that it is an isolated system in which neither regular nor irregular forms are affected by the syntactic, semantic or phonological properties of English (Pinker, 1991):

> …no aspect of syntax works differently with regular and irregular verbs. Past tense marking is also insensitive to lexical semantics: the regular-irregular distinction does not correlate with any feature of verb meaning. For example, *hit-hit, strike-struck,* and *slap-slapped* have similar meanings, but three different past tense forms; *stand-stood, stand me up-stood me up,* and *understand-understood,* have unrelated meanings but identical past tense forms. Past tense marking is also independent of phonology … the three pronunciations of the regular suffix (in *ripped, ribbed,* and *ridded*) represent not three independent processes but a single suffix *–d* modified to conform with general laws of English sound patterning (p. 531).

---

[49] 'Irregulars' are in fact known to be originally regular as well and can be traced back to Proto-Germanic and Proto-Indo-European thousands of years ago. They have taken up their contemporary forms due to a number of factors such as the 14^{th} –17^{th} Century phonological revolution called the Great Vowel Shift, the psychological tendency to avoid surplus suffixes, i-mutation etc. For details see Pinker (1999, Chapter 3).

Hence, the English past tense is a good testing ground for theories of morphological/grammatical processing as such, without having to face the impacts of other linguistic sub-systems.

The central point of the dispute between advocates of the dual-mechanism model and proponents of connectionist models, whether or not the human cognitive system employs rules (i.e., symbols) in the processing of language, can be captured quite well within the boundaries of English past tense morphology. As we have seen, from a dual-mechanist perspective, irregular past tense forms are fully stored in an associative memory as memorised pairs of words, whereas regular past tense forms are computed by a rule that, simplistically speaking, has the effect of the addition of the *-ed* suffix to the verb stem. Therefore it is expected that irregular past tense forms are sensitive to the properties of full-form storage in the associative memory and thus exhibit frequency effects and phonological neighbourhood effects whereas regular forms are not expected to be frequency or similarity sensitive. From a connectionist viewpoint, however, both regulars and irregulars are stored in memory, though not as words but as (typically phonological) features. Hence, regular as well as irregular past tense forms are expected to exhibit the impacts of frequency and (phonological) similarity typical for the associative memory.

As reviewed in previous chapters, empirical studies focusing on the processing of the English past tense have to date not provided entirely straightforward results that unambiguously confirm the predictions of either theory. The findings obtained in studies investigating L2 users have been particularly equivocal[50] and learners of English as a Foreign Language have been completely neglected. Therefore, in what follows,

[50] See Chapter 3.2 for a review.

the results of a visual lexical decision task on the English past tense conducted with adult L1 Turkish learners of English as a Foreign Language in Turkey will be reported.

4.2 Research Questions and Predictions

The research questions and outcome predictions specific to Experiment 1 (i.e., the English past tense) are as follows:

1) Do L2 users display asymmetries in their response times to regular and irregular past tense forms that are indicative of a distinction between rule-based vs. association-based mental processes, respectively?

2) Does the extent to which rule-based vs. association-based mental processes are employed in the processing of regular and irregular past tense forms differ as a function of L2 language proficiency (cf. Zobl, 1998; Kırkıcı, 2002)?

If it is the case that the L2 learners employed for the present study indeed form regular past tense forms by means of a rule and access irregular past tense forms from the associative memory, as posited by the dual-mechanism model, then it is predicted that there will be no significant difference in the participants' response times to high frequency and low frequency regular past tense forms, but it should take them longer to respond to low frequency irregular past tense forms than to high frequency past tense forms.

However, as has been pointed out at the outset of the present study, in reference to the findings obtained in Kırkıcı (2002), it is anticipated that L2 users will utilise the associative memory to a higher extent when

compared to L1 speakers. The reason for this hypothesis is the fact that L2 learners are hypothesised to store a subset of linguistic information initially unanalysed in the memory (e.g., *talked* instead of *talk +* (*-ed*)) and only in later stages of L2 development go through what Lowie (1998) refers to as an 'affix discovery procedure' in which they supposedly attempt to match form with meaning. Learners are thus said to start to recognise a particular affix and to use it productively only after it has been encountered 'frequently enough'[51]. Given the fact that the present study focuses on learners of English as a foreign language, who have only limited exposure to L2 linguistic input, it is likely that opportunities to discover the whole range of the morphological system and to apply implicit grammatical rules productively are restricted. Therefore a considerable part of the morphological knowledge acquired should be stored unanalysed in the memory, which in turn is expected to increase the productivity of the memory. If this is correct, it is predicted that the L2 subjects in the present study produce frequency effects for regular past tense forms (i.e., respond faster to high frequency regular verbal stimuli than low frequency regular stimuli), which would be indicative of full-form storage for at least more frequent regular forms.

In relation to the second research question, it is predicted that this proposed relatively high productivity of and the high reliance on the associative memory will decrease with increasing L2 proficiency. It is assumed that increasing proficiency is a by-product of a higher degree of L2 input, which, as stated above, should lead to the progressively higher employment of the past tense rule and less reliance on the associative memory. It is therefore predicted that higher proficiency L2 subjects will

[51] Needless to say, 'frequently enough' is a rather ambiguous term and can therefore not be taken as a specified criterion.

not display frequency effects on regular past tense stimuli, whereas lower proficiency L2 subjects will.

It will be of specific interest to examine whether it is possible to replicate the findings of Beck (1997), whose lexical decision task study with L2 users[52] did not arrive at frequency-effects for irregular stimuli. It should be remembered that Beck attributed this rather unexpected finding to the widespread educational practice of providing L2 learners with irregular verb-lists which include almost all possible irregular stem-past pairs irrespective of their real-life frequencies. Beck argued that this practice may have eliminated the frequency-differences among irregular verbs for L2 learners, which may in turn have resulted in the lack of frequency-effects on irregular verbal stimuli. Given the fact that the L2 subjects in the present study have learned L2 English almost exclusively in classroom-settings, it is very likely that the same practice of providing irregular verb-lists and reinforcing the memorisation of the listed verb pairs has been the case in their educational contexts as well. If this is the case, a similar lack of a frequency-effect on irregular past tense forms may be observed.

4.3 Experimental Methodology

The experimental paradigm employed for Experiment 1 was a visual lexical decision task, which is basically a computerised word/non-word discrimination task with accuracy of response and reaction time (RT) in milliseconds (ms) as the dependent variables. A participant's task in a visual lexical decision experiment is basically to discriminate between existing words and non-existing words (i.e., nonce-words) that appear on a computer screen and press the appropriate button on a response box.

---

[52] See Chapter 3.2.1.1

The fundamental rationale behind lexical decision tasks is that words in the memory with a higher frequency are faster accessed than words with a lower frequency, and thus lead to faster response times, since the strengthening of memory traces as a result of increased exposure facilitates the access process.

Juffs (2001) highlights the fact that despite reaction-time data having been used extensively in psychometric experiments for about a century to analyse mental processes, L2 studies employing this experimental paradigm are immensely rare, which he describes as "slightly embarrassing for the SLA community" (p. 207). The visual lexical decision task, one of the most frequently employed experimental paradigms measuring reaction time in psycholinguistics, is widely accepted as being sensitive in detecting word traces in the memory and able to tap stored, undecomposed representations since it encourages subjects to rely on memory representations (Clahsen, Eisenbeiss, Hadler & Sonnenstuhl, 2001). It therefore appears to be a particularly suitable methodology for the purposes of the present study since the primary aim is to analyse to what extent regular and irregular past tense forms are processed as decomposed or listed units.

There are, however, also serious counterarguments to the view that the lexical decision task is an appropriate means of analysing lexical access mechanisms, which need to be taken into consideration. Balota & Chumbley (1984) have made the claim that the frequency effect found on the lexical decision task may in fact not always arise during lexical access, but at a decision stage that comes into play after lexical access. Balota and Chumbley assert that low-frequency words are more similar to non-words in terms of familiarity and meaningfulness, two factors which clearly separate real words from non-words, than high-frequency words. This difference on familiarity and meaningfulness, they claim, results in

an extra checking (or deciding) process for low frequency words to be able to decide whether the stimulus is a real word or not, which requires higher time consumption and therefore inflates the influence of word frequency. However, Balota (1994) has made it explicit that what was suggested in Balota & Chumbley (1984) was not that *all* frequency effects on lexical decision tasks are due to post-access processes, but rather that it needs to be taken into consideration that not all word frequency effects in visual lexical decision tasks can be unambiguously attributed to word access processes. Instead, frequency-effects may be brought about by task-specific factors in addition to lexical-access related factors.

Similarly, McCann & Besner (1987) have also criticised the lexical decision task for containing a post-lexical decision process that is likely to exaggerate the influence of lexical frequency. McCann & Besner (1987) and McCann, Besner & Davelaar (1988)[53] have found that while the response-time to name a pseudo-homophone[54] is not affected by the frequency of the word to which it is homophonic, the response-time to say that the pseudo-homophone is pronounced identically to a word is affected by frequency. On the basis of these results, the claim was made that frequency-effects occur during a familiar/unfamiliar discrimination task, which is argued to be a post-lexical-access stage, but not during naming responses. Since a lexical decision task is also taken to involve familiar/unfamiliar discrimination, it is asserted that frequency-effects on lexical decision tasks stem from post-access effects rather than lexical access effects. Yet, it is noted by Taft (1991) that the results obtained by McCann and colleagues need to be treated with caution since the orthographic similarity of pseudo-homophones to real words was not

[53] Both studies reported in Taft (1991).
[54] A pseudo-homophone is a nonce-word that is homophonous to a real word, like BRANE (in Taft, 1991).

controlled, which possibly eliminated the frequency effects and therefore makes the results unreliable.

Thus, in sum, although there have been criticisms raised at the suitability of the lexical decision task for the investigation of lexical access processes, which have shown that the method bears an effective post-lexical-access decision stage the impact of which needs to be taken into consideration, overall "there is little support for the claim that the lexical decision task is a poor measure of lexical access" (Taft, 1991: p.31). Furthermore, considering that the lexical decision task has been a widespread method in psycholinguistic research and has been used as the primary means of data collection in some of earlier L2 studies into the validity of the dual-mechanism model in L2 processing (e.g., Beck, 1997; Birdsong & Flege, 2001), the employment of this experimental paradigm in the present study appeared to be imperative to be able to conduct comparative analyses.

4.3.1 Procedure and Apparatus

The experiment was run on a Fujitsu-Siemens Amilo D7820 Pentium IV laptop computer with a 15" monitor, controlled by *E-Prime* experimental software, Version 1.4.1.1 (Schneider, Eschman & Zuccolotto, 2002a, 2002b). All subjects were tested individually in a silent office.

Each trial consisted of the presentation of a fixation cross (+) in the middle of the computer monitor, followed after 600 ms by the stimulus in the same position. The stimuli were presented in Arial 24 point with white letters on a dark background and in a pseudo-randomised order making sure that no more than two stimuli of the same type occurred in sequence to avoid priming effects. The stimuli stayed visible on the screen for 400 ms. The measuring of the reaction times began with the presentation of

the target. The subjects reacted by pressing a green button to classify the stimulus as a real word or a red button to classify the stimulus as a nonce-word on a response box.[55] After an intertrial time of 1,000 ms, the next trial was initiated (see also Figure 5). For each trial, the computer recorded response accuracy, response time and relevant descriptive statistical information like standard deviations, sequence of presentation etc.

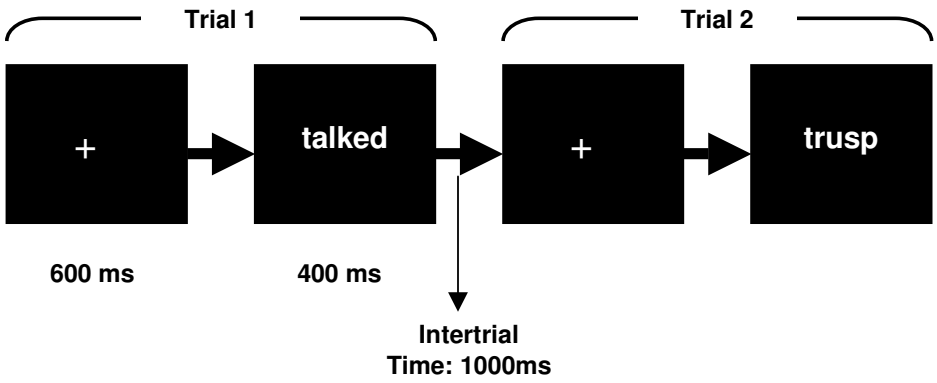


Figure 5: Visual representation of experimental procedures (Experiment 1)

Before the actual experiment, the participants received an oral orientation to the task in Turkish and went through a short practice phase. The primary purpose was to ensure that the participants understood what exactly their task was, clarify that the experiment did not constitute a test of English, and help them get used to the workings of the response box. The overall duration of an experimental session (excluding the oral orientation and practice phase) was approximately 15 minutes.

[55] The serial response box used was the PST SRB (Psychology Software Tools).

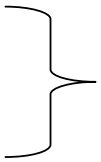
4.3.2 Materials

The experiment incorporated a total of 112 test stimuli, 52 of which constituted the actual experimental items and the remaining 60 of which were distractors of various kinds. 13 high frequency regular, 13 low frequency regular, 13 high frequency irregular, and 13 low frequency irregular verb forms were selected as experimental stimuli from the Brown Corpus (Francis & Kučera, 1982), a one-million-word corpus of American English[56]. Following the standard psycholinguistic procedures (e.g., Prasada et al., 1990; Clahsen et al., 2001), matched pairs of regular and irregular verb forms were chosen. That is, in order to be able to investigate word-form frequency effects, items were selected pairwise so that both members of a pair had a similar stem frequency but a different past tense form frequency. For example, the low frequency regular verb *flow* and the high frequency regular verb *jump* were matched since both verbs have a stem frequency of 13 (per 1 million), but a past tense form frequency of 4 and 31, respectively. That is, both verbs occur 13 times in the Brown-Corpus in their stem forms (*flow*/*jump*), but whereas *flowed* occurs only 4 times, *jumped* occurs 31 times. This paired design (the frequency match in stems and frequency mismatch in past forms for each pair of verbs) aims to circumvent the potential problem created by the recall time of the stem. If the stem forms were not matched for frequency, the retrieval time of the stem itself would create a bias in the reaction time results (Beck, 1997).

[56] Note that the Brown Corpus is not an L2 corpus, but an L1 corpus which is rather old. This may of course be taken as a limitation. However, given the fact the Brown Corpus has been made use of in a number of recent L1 and L2 psycholinguistic studies (e.g., Beck, 1997), the selection of word frequencies and items from it may prove to be useful for comparative purposes.

This selection procedure resulted in a total of four sets, which made up a 2x2 overall design with the independent factors verb type (regular vs. irregular) and past tense frequency (high frequency vs. low frequency):

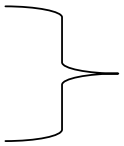
1. 13 high frequency regular past forms
   matched with
2. 13 low frequency regular past forms



regular past tense forms

and

3. 13 high frequency irregular past forms
   matched with
4. 13 low frequency irregular past forms



irregular past tense forms

The individual test item pairs, together with their frequencies, are presented in Appendices A and B[57]: The test items were arranged so that the stem frequency difference between two members of a pair would not exceed 10 and the past tense frequency difference not be less than 10 (per 1 million). Statistical analyses revealed that there was no statistically significant difference between the mean stem frequencies of high frequency and low frequency regular forms (21.4 vs. 20 occurrences per million, respectively, $t = .210$, $p = .835$). The difference between the mean past tense forms of high frequency and low frequency regular forms, on the other hand, was statistically significant (45.2 vs. 8.47 occurrences per million, respectively, $t = 3.846$, $p = .001$). Similarly, statistical analyses revealed that there was no statistically significant difference between the mean stem frequencies of high frequency and low frequency irregular

[57] Most of these experimental items have also been used by Beck (1997), though Beck used a slightly different experimental setting and has not provided details concerning the exact ordering of her items.

forms, either (53.85 vs. 52.3 occurrences per million, respectively, t = .073, p = .943). The difference between the mean past tense forms of high frequency and low frequency irregular forms, on the other hand, was statistically significant (75.38 vs. 24 occurrences per million, respectively, t = 2.401, p = .024). In other words, in both groups of stimuli, high frequency and low frequency forms had the same mean stem frequencies but significantly different mean past tense frequencies.

In addition to the experimental items, the experiment also included 60 filler items (20 real words and 40 pseudo-words, resulting in a total of 112 items when taken together with the experimental items) to prevent the subjects from developing expectancies and getting into an automatic routine. The 20 real words consisted of 10 relatively high frequency adjectives and 10 relatively high frequency nouns (Appendix C). The 40 pseudo-words, on the other hand, consisted of 10 intermediate pseudo-regulars, 10 distant pseudo-regulars, 10 intermediate pseudo-irregulars, and 10 distant pseudo-irregulars, all originally used in Prasada & Pinker (1993). Prasada & Pinker report that the *intermediate pseudo-regular* test items (Appendix D) were designed to be very different from existing regular and irregular verbs, beginning with consonant cluster-vowel sequences not existing in English verbs (e.g., [ploa], [smai]), and ending with non-existing vowel-consonant clusters (e.g., [aig]), e.g. *smaig* and *ploab*. *Distant pseudo-regular* (Appendix D) test items are reported to be maximally different from existing verbs. Distant pseudo-regulars differ from intermediate pseudo-regulars in that the former have an additional non-existing final consonant cluster (e.g., *ploamph*, *smeerg*). *Intermediate pseudo-irregulars* (Appendix 5) rhymed with the prototype clusters of irregular verbs, but contained the change of the initial and/or final consonant cluster (e.g., *ning,* cf. *swing, sting*). In *distant pseudo-irregulars* (Appendix E), on the other hand, the initial and final consonant clusters were changed even further (e.g., *nist*).

In the experiment, the subjects did not see the stem forms of these pseudo-words, they saw only their past tense forms. The past tense forms of pseudo-regulars (Appendix D) were created by adding the *–ed* suffix to the stem forms (e.g., *ploamphed, smeejed*), whereas the past tense forms of pseudo-irregulars (Appendix E) were formed by changing the vowel(s) in the stem form in accordance with existing irregular stem-past tense patterns (e.g., *ning-nung*, cf. *swing-swung*).

4.3.3 Subjects

Three groups of subjects were employed for the present study: 22 low-proficiency L2 subjects, 24 high proficiency L2 subjects and 6 native English subjects.

The low-proficiency subjects were randomly selected among beginner-group students at the Department of Basic English, Middle East Technical University (METU), Ankara. Among the 22 low-proficiency students, there were 11 male and 11 female subjects, ranging in age from 17 to 23 (mean age: 18.5). These students had taken the METU English proficiency exam in September 2003 and, on the basis of their low scores, had been evaluated as total or false beginners and placed into the beginners group at METU English Preparatory School, which is the lowest proficiency group in the department. Unfortunately, almost none of the subjects was able to report their exact proficiency scores, the reason being that their scores were so low that they had been directly placed in the lowest proficiency group at the English Preparatory School, without being informed about their exact scores. However, it is known that students in the beginner group are those who have scored around

20-25 (out of 100).[58] At the time when the experiment was ran, the participants had been going through an intensive English for Academic Purposes program for approximately 1.5 months.

The high-proficiency subjects were randomly selected among the undergraduate student population of the METU Department of Foreign Language Education and were all being trained to become English teachers. In the selection of the high-proficiency group, special care was observed to employ as much as possible only students who had passed the METU proficiency exam with high grades. The high proficiency group consisted of 5 male and 19 female participants, ranging in age from 18 to 21 (mean age: 19.5). The mean proficiency score of the high proficiency subjects was 85.6 (range: 69.5-97).

In addition, the experiment was also run with 6 native speakers of English (3 males and 3 females), who were all teachers of English at the Turco-British Association in Ankara and whose mean age was 38.5 (range: 24-72)[59]. The purpose in having a group of native speakers was on the one hand to obtain a control baseline to compare the L2 subjects' results with and on the other hand to find out whether the findings obtained in previous studies with native speakers of English could be replicated.

All participants participated in the experiment on a voluntary basis, reported themselves as having normal or corrected-to-normal vision and were naive with regard to the purpose of the experiment. Following detailed explanations concerning the procedure of the experiment and the right to withdraw at any desired stage of the experiment, each

[58] Two of the low proficiency subjects reported their proficiency scores as 20 and 24, respectively.
[59] 4 of the native subjects were speakers of British English and 2 of US English.

participant was required to fill out a participant consent form in English or Turkish (Appendices F & G).

4.3.4 Preliminary Analysis of Errors

Nonword-responses to real words and word-responses to nonce stimuli were analysed as errors and were removed from the data set prior to any further statistical analyses on the data. The total rate of errors was 8.6%. Similarly, in line with standard psycholinguistic procedures (e.g., Clahsen et al., 2001), extremely fast and slow reaction times exceeding more than 2 standard deviations from a subject's mean reaction time in each condition were also removed. Extreme reaction times accounted for 4% of the total data. Thus, 12.6% of the total data had to be removed, leaving 87.4% of the total data available for further statistical and qualitative analyses.

4.4 Results

4.4.1 Native Controls

As graphically displayed in Figure 6, the mean reaction times for the native English subjects on high and low frequency regulars (493 ms, SD: 28.3 vs. 497 ms, SD: 35.2, respectively) as well as on high and low frequency irregular forms (480 ms, SD: 37.6 vs. 506 ms, SD: 36.5, respectively) were quite close. A 2x2 repeated measures ANOVA (verb type: regular, irregular x frequency: high, low) performed on reaction times by subjects did not reveal significant main effects for either verb type ($F(1,5)=.192$, $p=.680$) or frequency ($F(1,5)=3.394$, $p=.125$). The lack of these main effects indicated that neither verb type nor form frequency played a significant role in the obtained reaction times. This finding was

also confirmed by the insignificant interaction between verb type and frequency ($F(1,5)=1.400$, $p=.290$).

In terms of the processing of regular past tense forms, the results thus turned out to be as predicted by the dual-mechanism model. The lack of frequency effects on regular stimuli speaks against full-form storage of regular past tense forms as proposed by advocates of associationist models and, instead, implies that regulars must be accessed in a decomposed fashion by means of a rule that is frequency-insensitive as hypothesised by proponents of the dual-mechanism model. Had it been the case that the reaction times to high and low frequency regulars were significantly different from each other, it would have been necessary to speculate on the possibility that the associative memory may be strongly involved in the processing of regular forms as predicted in associationist accounts. In the light of the present findings, however, this possibility can be safely ruled out.

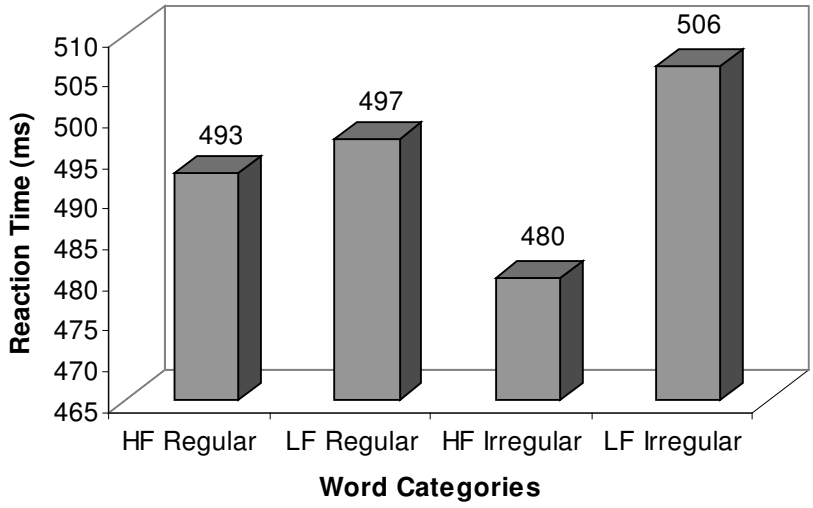


Figure 6: Mean reaction times (in ms) for native subjects (n=6).

In terms of the processing of irregular verb stimuli, on the other hand, the obtained results proved to be rather unexpected. As mentioned before, from the perspective of both the dual-mechanism model and associationist accounts, it is expected that irregular verb forms are frequency-sensitive, which was not the case, though. A cautious, and somewhat speculative, post-hoc explanation of this rather unexpected pattern might be that the subject-group was simply not large enough to obtain a statistically significant pattern. Indeed, a careful examination of the irregular response-time pattern in Figure 6 shows that although the difference between the mean reaction times on high and low frequency irregular stimuli was not significant, the participants' response-time tendencies clearly went into the predicted direction and the mean reaction time difference between high frequency and low frequency stimuli (26 ms) was essentially in the 16-29 ms difference-range reported by Prasada et al. (1990) for native English subjects. Thus, it might be speculated that this observed trend could have been a significantly different one had a larger subject-population been chosen. However, as mentioned above, for now this constitutes nothing more than a speculative post-hoc explanation that requires substantiation.

4.4.2 High Proficiency L2 Subjects

The findings obtained for the high proficiency group show overall striking parallelisms to those obtained by Beck (1997). Figure 7 displays the mean by-subjects reaction times per condition. As can be seen, the high proficiency L2 subjects displayed slightly longer lexical decision times for high frequency regulars than for low frequency regulars: 573ms (SD: 89.9) vs. 567ms (SD: 77.3), respectively. For irregular past tense stimuli, the response times to high frequency and low frequency forms were 544ms (SD: 90.5) vs. 547 ms (SD: 76.3), respectively. A 2x2 repeated measures ANOVA (verb type: regular, irregular x frequency: high, low)

performed on reaction times by subjects revealed a significant main effect for verb type ($F(1,23)=14.605$, $p<.005$) but not for frequency ($F(1,23)=.054$, $p=.819$). The interaction between verb type and frequency was also found to be insignificant ($F(1,23)=.877$, $p=.359$).

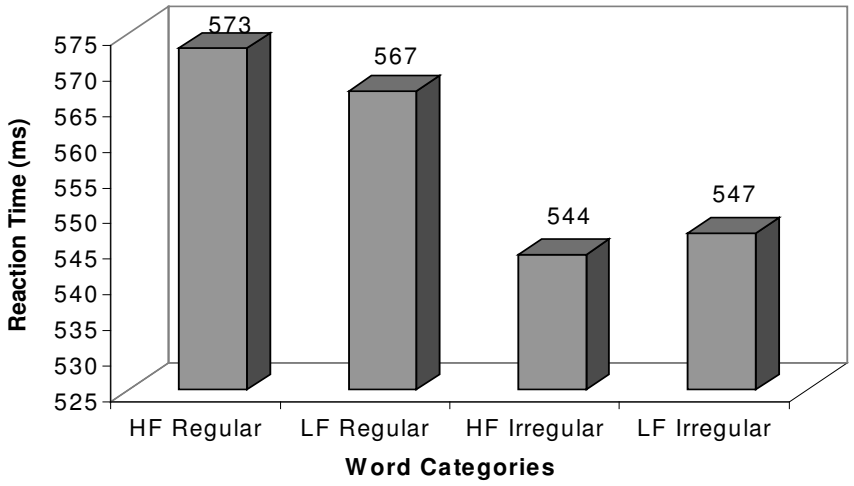


Figure 7: Mean reaction times (in ms) for high proficiency L2 subjects (n=24).

The significant main effect for verb type indicated that it took the subjects overall longer to respond to regular stimuli than to irregular stimuli. The lack of a significant main effect for frequency, on the other hand, indicated that verb frequency played no significant role in the processing of stimuli. Thus, high frequency and low frequency stimuli were responded to with equal speed. Finally, the lack of a significant interaction between frequency and verb type showed that the processing of high vs. low frequency stimuli did not differ between verb types.

The lack of a frequency effect for regular stimuli can again be taken as evidence against full-form storage as would be predicted by the dual-mechanism model since otherwise it would be expected that low

frequency regular stimuli lead to statistically slower reaction times. In this sense, it may confidently be concluded that the high proficiency L2 participants in this study behaved like the native controls on regular stimuli and accessed regular past tense form in a decomposed fashion by means of a grammatical rule that is insensitive to frequency, which is clearly reflected in the recorded response times.

What is initially unexpected about the results obtained from the high proficiency L2 group, however, is the fact that no frequency effects have been obtained for irregular stimuli, either. From the perspective of both the dual-mechanism model and associationist theories, irregular forms are definitely expected to elicit frequency effects due to their hypothesised full-form storage in the associative memory, which is known to be extremely sensitive to input-properties and particularly to the frequency of occurrence of word forms. A possible explanation for this observed pattern may be provided in reference to Beck's (1997) account, who found exactly the same pattern for irregular stimuli with her L2 subjects. Beck claims that the observed lack of frequency effects on irregular stimuli may be an artefact of the way L2 learners have learned irregular verb types. As is well known, it is common practice in formal teaching environments to provide learners with lists of irregular verb forms, which are memorised by learners and repeatedly drilled and tested by means of oral and written examinations, quizzes, etc. Given the fact that these word lists do not take into account the natural input frequencies of irregular verb forms but present almost all irregular stem-past tense pairs irrespective of their frequencies, the actual frequency differences among past tense forms disappear and through repeated reinforcement all irregular verb forms become equally frequent for the learner. In other words, as a result of this educational practice, the associative memory is expected to establish equally strong memory

representations for all irregulars and treat them as if they all have approximately the same frequency.

Since the high proficiency L2 subjects in the present study had all been going through many years of formal English instruction[60], the explanation provided by Beck (1997) appears to be very relevant to the findings obtained for irregulars in the present study as well. Following post-experimental personal communications with a number of students and instructors at Middle East Technical University (METU) and teachers of English at secondary and high schools, it was found that the same practice of supplying learners with irregular-lists as reported by Beck (1997) was also being implemented at METU English preparatory school and was also a routine practice in secondary and high schools, where the participants of the present study had laid the foundations of their L2 English proficiency. Furthermore, general reference-grammar books commonly used by students at METU (e.g., Azar, 1999) were analysed for such irregular verb lists and it was found that they also contained similar lists of irregular verbs. Azar's (1999) alphabetical list of irregular verbs (pp. 22-23), for example, was found to cover almost all irregular verb forms in contemporary English and crucially included *quit* and *lend*, the two lowest-frequency verb stimuli in Experiment 1, as well as *stand* and *tell*, which constituted the two highest-frequency stimuli (see Appendix B). Likewise, fill-in-the-blanks and multiple-choice exercises testing the ability to produce irregular English past tense verbs in the same book also included a variety of high frequency and low frequency verb forms without taking into account their "real-life" occurrence frequencies. Hence, as hypothesised by Beck (1997), the frequency distinctions assumed for the irregular stimuli in the present study may not

[60] The mean length of exposure to formal English instruction for high-proficiency L2 subjects was reported to be 9.1 years (range: 7-10 years).

have constituted realistic accounts of the actual input frequencies for the participants in the present study, which may be taken as a speculative explanation for the lack of frequency-effects on irregulars. Thus, the present findings related to irregular past tense verbal stimuli constitute a replication of Beck's findings, implying that the observed effect is robust across populations and suggesting that the way in which lexical items are learned may have a profound effect on the way they are processed.

The results for high proficiency L2 subjects, as such, do not fully reflect the predictions of the dual-mechanism model because although regular items were not found to be frequency-sensitive, as predicted, the frequency insensitivity of irregulars is not a result that would be predicted by the model. As mentioned above, a possible explanation for this unexpected response pattern on irregular stimuli response-pattern might be sought within certain educational practices which may result in the disappearance of 'real-life' frequencies of lexical items. However, this cautious explanation can at present not be convincingly proven. What has undoubtedly been attested for the high proficiency L2 subjects is that their processing of regular forms, which constitutes the major point of controversy in the 'past-tense' debate, can by no means be a mental process that is implemented on the basis of an associative memory as put forward by proponents of associationist models of language processing. Rather, it seems, regular past tense forms are processed in interaction with a rule, which is obvious from the lack of the frequency-effect in the responses to regular stimuli.

4.4.3 Low Proficiency L2 Subjects

Figure 8 displays the mean by-subjects reaction times per condition for low proficiency L2 subjects. As can be seen, the low proficiency L2 subjects produced longer lexical decision times for low frequency

regulars than for high frequency regulars: 649ms (SD: 93.8) vs. 618ms (SD: 80.3), respectively. For irregular past tense stimuli, the response times to high frequency and low frequency forms were 584ms (SD: 89.9) vs. 602 ms (SD: 80.1), respectively. A 2x2 repeated measures ANOVA (verb type: regular, irregular x frequency: high, low) performed on reaction times by subjects revealed significant main effects for verb type ($F(1,21)=10.016$, $p<.01$) as well as for frequency ($F(1,21)=7.156$, $p<.05$). These main effects indicated that high frequency stimuli were generally processed faster than low frequency items and that the factor 'verb type' played a role in the reaction times, resulting in slower reaction times for regular items. The interaction between verb type and frequency, however, was found to be insignificant ($F(1,21)=.539$, $p=.471$), showing that the processing of high frequency vs. low frequency stimuli was similar for regular and irregular items.

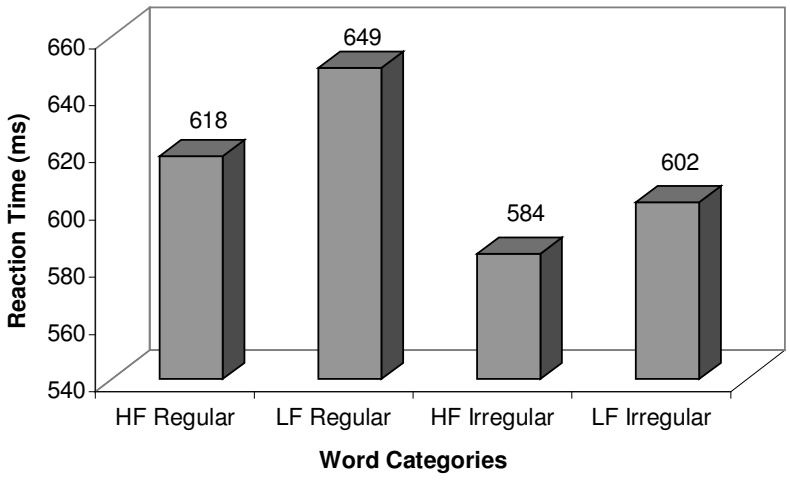


Figure 8: Mean reaction times (in ms) for low proficiency L2 subjects (n=22).

On the basis of the lack of frequency-effects for the irregular stimuli of high-proficiency L2 participants (see above), it was expected that the low

proficiency L2 participants would display the same pattern for irregular stimuli. However, as the statistical results revealed, the low-proficiency L2 subjects displayed a tendency to respond slower to low frequency irregular stimuli than to high frequency irregular stimuli, which was also clearly visible in the 18 ms difference between the mean reaction times to high and low frequency irregular stimuli. Building upon Beck's explanation based on the educational practice of having L2 learners memorise irregular verb lists adopted for the high proficiency L2 participants, it is only natural that the low proficiency L2 subjects displayed a frequency-effect on irregular items because apparently the exposure to the irregular verb lists and related frequency-insensitive material had not been strong enough yet to completely terminate the effects of individual verb forms' past tense frequencies. In other words, comparatively less exposure to formal teaching (mean length of exposure reported: 4.5 years; range: 3 months – 10 years) and related educational practices that may result in the recurrent reinforcement of irregular verb forms appears to have resulted in partial retainment of individual verb forms' frequencies as reflected in the frequency-effect for irregulars items.

The results obtained for regular stimuli, on the other hand, are unquestionably indicative of frequency-effects because it took the participants significantly longer to react to low frequency regular stimuli when compared to high frequency regular stimuli (mean reaction time difference: 31 ms). In this sense, the results definitely imply that the associative memory must have been involved in the processing of regular forms since otherwise such an unambiguous impact of frequency would not have been expected. At first glance the results may even appear to be supportive of the strong hypothesis proposed by Zobl (1998) and Ullman (2001b) that low proficiency L2 users lack a rule system altogether and instead store all regular as well as irregular word forms undecomposed in the associative memory. However, taken into

consideration that comparable low-proficiency L2 users tested by Kırkıcı (2002)[61] in a past tense elicitation task using almost identical stimuli were clearly able to use the past tense rule productively with real as well as nonce stimuli (see Chapter 3.3), Zobl (1998) and Ullman's (2001b) strong view that a rule-system is completely lacking in low proficiency L2 users is open to doubt. Instead, two possible alternative explanations for the observed pattern emerge.

The first possibility is simply that the associative memory is comparatively more involved in the processing of regular forms in low proficiency L2 users than in higher proficiency L2 users and native speakers of English – a possibility that was also underscored in Kırkıcı (2002). What this would mean is that a considerable amount of regular verb forms are probably stored undecomposed in the associative memory, which possibly led to the observed frequency-effects, whereas a subset of regular forms are directly processed via the rule system. A second probability relates to the modes in which the participants were tested in Kırkıcı (2002) and the present study. It should be remembered that Kırkıcı (2002) ran an experiment in which his participants were asked to *orally produce* the past tense forms of regular and irregular verb stems, whereas in the present experiment the participants were to *recognise* past tense forms. The two experiments may therefore have tapped two different things: the ability to apply the past tense rule to a verbal stem and the ability to recognise a regularly inflected verb form. Thus, it may as well be the case that participants at this proficiency level are able to productively apply the regular past tense suffix to verb stems (possibly not fully analysed), but are not able to analyse an already inflected regular past tense form and therefore tend to store and/or access it in full-

[61] The low proficiency L2 subjects tested by Kırkıcı (2002) were at exactly the same proficiency level, had the same L1, and had received almost an identical amount of exposure to formal English instruction as the low proficiency participants in the present study.

form instead. Unfortunately, neither Zobl (1998) nor Ullman (2001b) make explicit which mode they are actually referring to when they talk about the inability to make use of productive rules, but judging from the general discussion in their articles, it may be inferred that what they imply is actually the disability to *produce* rules rather than to comprehend them. In this sense, it appears of importance to reiterate that the strong versions of their hypotheses can be ruled out since, as pointed out above, previous studies have clearly shown that low-proficiency L2 speakers are indeed able to make productive use of the past tense rule and probably rules in general.

However, in either case, what is undeniably evident is that the low-proficiency group employed the full-listing/direct access route to a much higher extent than the other two groups, which highlights the effect that the associative memory has on the processing of complex word forms by L2 users at initial stages of the acquisitional process.

4.5 Discussion and Conclusion

The overall picture that emerges from the cross-sectional analyses conducted on the English past tense speaks for a developmental restructuring in the representation of morphologically complex word forms in which the impact of the associative memory and the tendency to implement whole-form storage for regulars and irregulars decreases as proficiency increases. If the two L2 subject groups employed for the present study can be accepted as more or less representative of users of English at two significantly different levels of proficiency (with low proficiency L2 participants being very close to the initial state and high proficiency L2 participants being closer to the final state of L2 development), what follows from the findings is that the earliest stages of L2 acquisition are marked by a high level of employment of the

associative memory and the tendency to store morphologically complex word forms (regulars as well as irregulars) as single units as was evident from the frequency effects for both regular and irregular past tense verbal stimuli. However, it is highly questionable whether all regular forms are stored unanalysed in the memory or whether a subset of regulars is analysed into stem and affix. In this sense, the strong views of Zobl (1998) and Ullman (2001b) that L2 speakers at early stages of development are completely deficient in employing rules and completely rely on full-form storage can neither be completely rejected at this point, nor can this hypothesis be comfortably accepted given the fact that earlier L2 studies have clearly shown that morphological decomposition constitutes a part of the linguistic repertoire of low proficiency L2 users. For now, the view proposed by Kırkıcı (2002) that the associative memory is definitely stronger and comparatively more involved in low proficiency L2 users will be embraced and it is expected that the results of Experiment 2 (Chapter 5), which requires participants to produce complex word forms, will point in the same direction.

The developmental picture emerging at higher levels of proficiency is complex and open to speculations as well. For the high proficiency L2 participants, the ability to use the regular rule (i.e., decompose regular forms into stem and suffix) is very evident as captured in the lack of frequency-effects on regular stimuli. For irregular stimuli, which, contrary to what would normally be expected under a dual-mechanist view, did not produce frequency-effects, Beck's (1997) explanation that the frequency-properties of irregulars were eliminated due to the widespread educational practice of providing learners with frequency-insensitive irregular verb lists has a certain degree of appeal and will be embraced here. Crucially, it was possible to replicate the frequency-insensitive response-pattern on irregular items which Beck had obtained in her lexical decision task. Therefore, as suggested before, it may well be

concluded that this appears to be a robust effect and that the way in which irregular verbs are learned in educational settings (e.g., rote-memorisation and frequent drilling) has a significant effect on the way irregular items are processed by L2 learners who have had a sufficient amount of exposure. Thus, as a whole, the results obtained from the high proficiency L2 subjects in the present study do not provide strong support for the dual-mechanism model in that although responses to regular stimuli were clearly frequency-insensitive as expected – a pattern by no means predicted under an entirely associationist view -, the frequency-insensitivity on irregulars runs counter to the predictions of the model.

Unfortunately, it was not possible to arrive at strong conclusions on the basis of the results obtained from the native subjects due to the fact that the subject group was possibly too small to observe a robust response-tendency, particularly on irregular stimuli. Nevertheless, it should be noted that the lack of frequency-effects on regular stimuli, which constitutes the most important point-of-dispute in the past-tense debate, provides partial evidence for the predictions of the dual-mechanism model since in the light of these findings added to results of previous L1 studies, the claim that regulars are stored as undecomposed wholes can be confidently rejected.

In sum, then, it may be said that on the basis of the findings and the assumptions of Experiment 1, a pattern has evolved in which at very early stages of L2 development the associative memory appears to be highly effective in the processing of regular as well as irregular word forms and results in the predominant undecomposed storage of both word types, but loses its priority on the processing of regular forms as linguistic proficiency increases. The ability to productively implement linguistic rules and decompose complex morphological word forms appears to be rather limited initially, but gains power with increasing

linguistic proficiency. The possibility that the rule-system is initially entirely missing as proposed by other researchers, however, is accepted as a very weak option given the fact that previous studies have manifested the ability to productively use rules in low proficient L2 users. Unfortunately, almost all studies focusing on this topic (including Experiment 1 in the present study) have focused on the English past tense and have neglected other morphological phenomena. It is thus very important to see whether the developmental pattern attested for the English past tense can also be captured for another morphological structure, which will be done in the next chapter.

CHAPTER 5

EXPERIMENT 2: AN ELICITED PRODUCTION TASK ON ENGLISH LEXICAL COMPOUNDS

This chapter consists of five main sections. The first section (5.1) provides the necessary morphological and psycholinguistic background information for Experiment 2. Section 5.2 presents the research questions and the predicted outcomes. The third section (5.3) presents the methodological details of the experiment, the results of which are discussed in the fourth section (5.4). The final section (5.5) discusses the obtained results and concludes this chapter.

5.1 Background to Experiment 2

Lexical compounding is a productive word-formation process in English that involves the concatenation of lexical units to form compound word forms such as *flat-mate, lunch table, windbreaker* etc., with the head element (i.e., *mate, table, breaker*) in final position and the modifying non-head element (i.e., *flat, lunch, wind*) in initial position[62]. A widespread tendency that has been observed about the construction of English lexical compounds (e.g., Kiparsky, 1982) is that while irregular plural nouns may occur as non-head elements within compounds (e.g., *mice killer*,), regular plural nouns do not generally occur as non-head elements

[62] Another type of compounding frequently used in English is *phrasal compounding*, which involves phrasal non-head elements such as in *over-the-fence gossip, God-is-dead theology,* and *off-the-rack dress* (in Clahsen & Almazan, 2001). See Wiese (1996) for a thorough discussion of phrasal compounds and an explanation for why phrasal compounds are taken to be clearly different from lexical compounds.

within compounds (e.g., */?*keys ring*, */?*shoes seller*), even if the non-head referent is semantically plural as in *shoe seller*. Although it is obvious that a shoe-seller typically sells *pairs* of shoes and not single shoes, the resulting lexical compound *shoe-seller* nevertheless contains a singular rather than a plural non-head noun.

Proponents of the dual-mechanism model strongly accentuate this observed general tendency and present it as a manifestation of the difference between the proposed mental processes involved in the generation of irregular and regular forms and, thus, also as further proof for the theorised distinction between regular and irregular morphology. As has been pointed out before, the dual-mechanism model basically assumes that irregular plural forms are stored already inflected in the mental lexicon whereas this is not normally the case for regular plural forms, which are computed on-line by the concatenation of the regular plural suffix to the stored stem. Therefore, irregular plurals, just like any other entry stored in memory, can easily be fed into compounds, which are created as the result of word formation processes and are thus also created in the mental lexicon. Regular plurals, on the other hand, can not be fed into compounds since from a dual-mechanist viewpoint they are "complex products of a rule, formed outside of the mental dictionary, too late in the chain of processes for inclusion in the compounding operation" (Marcus et al., 1995: p. 208).

For a long time, this 'constraint' or 'tendency' not to include regular plural nouns in lexical compounds was based upon informal observations or reports by linguists. More recently, however, this issue has become the focus of a small number of psycholinguistic studies in which it has been experimentally investigated whether the above-mentioned observation on the differential treatment of regular and irregular nouns in compounds holds for L1 and L2 acquirers. In what follows, first some of the most

influential studies conducted to illuminate this observed tendency will be reviewed. After that, a lexical compounding experiment run with adult L1 and L2 speakers of English will be presented. The results of the experiment will be discussed in relation to previous findings and to the central tenets and predictions of the dual-mechanism model.

5.1.1 Compounding Experiments with Children

In a seminal study, Gordon (1985) tested to what extent young acquirers of L1 English would adhere to the above-mentioned 'constraint'[63] that prohibits regular nouns in lexical compounds. Gordon elicited novel deverbal synthetic compounds from 33 young children by asking them questions of the type *What do you call someone who eats X?,* where the noun X, which was going to be used as the non-head element of the compound to be constructed (i.e., *X-eater*), was always presented in plural form. It was found that all child-subjects, even the youngest ones, who were on average only 3;8 years old, frequently produced irregular plural nouns in compounds but consistently avoided using plural regular nouns in compounds: 90% of the irregular noun stimuli were used by the child-subjects in their plural forms (e.g., *mice-eater*), whereas regular nouns were pluralised in only 2% of instances (e.g., *rats-eater*) and were instead used in their singular forms in the remaining 98% of instances. In other words, Gordon's young child-subjects obviously treated irregular and regular nouns differently within compounds, pluralising the former to high extents but the latter almost never. Thus, Gordon provided

[63] Gordon's aim in running his (1985) study was not to test the validity of the dual-mechanism model, which in fact had not yet been spelled out as a theory at that time, but to gather evidence for the innateness of the *level-ordering model* (Kiparsky, 1982), which also predicted differential treatment of regular and irregular nouns in lexical compounds, though for different reasons. Nevertheless, the findings in Gordon (1985) are directly related to the actual problem at hand and bear important insights to how children use irregular/regular nouns in compounds. See Murphy (2000) for a thorough discussion of the level-ordering model in relation with English lexical compounds.

experimental evidence for the general observation that regular and irregular nouns are treated distinctly in lexical compounds. But what is even more important according to Gordon is that his subjects, whose average ages ranged between 3;8 and 5;6, were possibly too young to have learned this constraint on the basis of evidence in the input alone, which led Gordon to the conclusion that children acquiring L1 English must have this information available as part of their innate knowledge.

However, a methodological procedure in Gordon's (1985) study that shed doubt on the findings he obtained was the fact that the head-element provided to the child-subjects was always the same; i.e., the child-subjects in Gordon's study were always required to produce compounds with *eater* as the head-noun (*mice-eater, rat-eater, teeth-eater,* etc.). Thus, Gordon's study could have arrived at such clear-cut results not because children dissociate regulars and irregulars in general but because they do so specifically with the noun 'eater' on the basis of input-related deductions. Clahsen, Marcus & Bartke (1993; reported in Murphy, 2000) overcame this weakness by running an experiment with children acquiring L1 German, similar in procedure to Gordon (1985), but with the important difference that the head-elements of the synthetic compounds to be produced were varied so that a number of different nouns had to be used within the compounds. In spite of this methodological and linguistic variation, Clahsen et al.'s (1993) findings were identical to Gordon's (1985) and thus not only refuted the claims that Gordon's findings were methodological artefacts but also showed that the differential treatment of regular and irregular nouns within synthetic lexical compounds was the case for children acquiring L1 German as well.

5.1.2 Compounding Experiments with Adult L1 and L2 Speakers

The findings obtained from studies conducted with child-subjects have recently motivated researchers to investigate whether the regular/irregular noun dissociation within compounds manifested for children acquiring L1 English and German also holds for adult L1 and L2 acquirers. Lardiere (1995) ran an experiment almost identical to Gordon's (1985) study, in which she tested 15 L1 Spanish and 11 L1 Chinese learners of English as a Second Language who were classified as being at intermediate to high-intermediate proficiency-levels. It should be noted that the comparison of L1 Spanish and L1 Chinese was of special interest to Lardiere since lexical compounds in Spanish allow for regular plural non-heads, whereas Chinese has no plural inflection at all (Lardiere, 1995) and therefore also no compounds with plural non-heads. Hence, it was possible to test for potential L1 effects; i.e., whether the way in which compounds are constructed in the respective L1s influences the production of compounds in the L2. In addition, Lardiere (1995) also briefly reported on results obtained from 12 adult L1 English speakers, whom she had previously tested (in Lardiere, 1994). Similar to Gordon (1985), Lardiere asked her participants questions of the type *What do you call somebody who eats X?,* which the participants were expected to answer orally by forming deverbal synthetic compounds. However, in contrast to Gordon, who constantly used the same verb (*eat*) in his elicitation questions, Lardiere presented the participants with various verbs to be constructed as head-elements in the synthetic lexical compounds to be produced, as in Clahsen et al. (1993).

The results obtained from the native control subjects showed that regulars were not used in their plural forms within compounds at all (i.e., 100% singular regular nouns) while irregulars were pluralised at a rate of 4.8%, which showed that regulars and irregulars were differentiated

marginally within compounds by adult native speakers of English. The results obtained from the L2 subjects showed that they, too, overall differentiated between regular and irregular nouns as predicted by the dual-mechanism model. Lardiere's L1 Chinese participants pluralised only 30% of the regular noun-stimuli (i.e., produced 70% singular regular nouns within compounds), but pluralised 65% of the irregular stimuli. Thus, the Chinese subjects evidently treated regular and irregular nouns differently within compounds. For the L1 Spanish subjects, however, the results were not that clear-cut. The Spanish subjects pluralised irregular nouns to a higher extent than regular nouns (90% vs. 73%, respectively) or, in other words, they omitted regular plurals in compounds more than irregular plurals (27% vs. 10%), thus displaying a marginal dissociation between regular and irregular nouns[64]. Lardiere (1995) accepts these overall L2 results as supportive of the dual-mechanism model since the within-groups results indicated differential treatment of regulars and irregular as predicted by the model. However, as underscored by Lardiere (1995), the Spanish subjects' comparatively higher use of regular plurals within compounds when compared to the Chinese subjects is rather striking and sheds serious doubts on whether the dissociations predicted by the dual-mechanism model are immune to L1 impacts since, as mentioned above, in Spanish the use of regular plural compound-internal nouns is grammatical and appears to have impacted on the Spanish subjects' performance.

Murphy (2000) conducted a study similar to Gordon (1985) and Lardiere (1995) with 100 adolescent L1 French learners of L2 English (mean age: 12.4 years) and an additional 15 adult native control subjects (mean age: 24.2 years) in Canada. Murphy states that compounding in French is

---

[64] Although Lardiere did not run statistical analyses on these results, she reports that Clahsen and Marcus (personal communication, in Lardiere, 1995) have found statistical differences between the use of compound-internal regular and irregular nouns in Lardiere's (1995) L2 data.

similar to compounding in English in that regular inflection within lexical compounds in French is very rare. To test for proficiency-effects, the L2 subjects, who were students at a secondary school, were subdivided into three proficiency groups on the basis of the scores they obtained from an in-house proficiency exam administered by their schools. Murphy's study was almost identical to the previous compound-studies, with the difference that Murphy's subjects were to respond to the oral elicitation questions in written form due to the fact that French speakers tend to devoice word final consonants and thus make it difficult to score their oral responses.

The results of the study showed that the native control subjects produced irregular plurals within compounds in 28% of instances, but regular plurals in only 1.7% of instances. This difference was found to be statistically significant ($F(1,32)=82.96$, $p<.001$). Thus, compared to the adult native controls in Lardiere (1995), Murphy's native controls displayed a much clearer dissociation between regulars and irregulars. The analysis of the L2 groups' responses revealed that the three L2 groups on average produced regular plurals in 46% of instances and irregular plurals in 74% of instances – a difference that was found to be statistically significant ($F(1,97)=88.76$, $p<.001$) and that was stable across proficiency groups. So, overall, the L2 subjects – independent of their proficiency levels – as well as the L1 subjects in Murphy (2000) clearly treated regulars and irregulars differently just as the Chinese and Spanish L2 subjects in Lardiere (1995) did.

According to Murphy (2000) her findings and those in Lardiere (1995) may be taken as supportive of the dual-mechanism model since "a statistically reliable difference between regulars and irregulars in compounding is exactly what Marcus (1995c) and Pinker and Prince (1988, 1992) argued constitutes (in part) further support for the notion

that regular and irregular inflectional features are dissociated" (p. 182). On the other hand, Murphy correctly adds that the observed dissociation is not as sharp as one would expect under a strong version of the dual-mechanism model since although regular plurals were used to a statistically lesser extent than irregular plurals in compounds, it can not be overlooked that the L2 subjects in Lardiere (1995) and Murphy (2000) pluralised compound-internal regulars in 30%-73% of instances. Marcus (1995c), however, evaluates the considerably high rates of regular plurals as 'experimental noise' and adds that rather than the absolute numbers, what counts is that L2 users do overall dissociate between regulars and irregulars.

In sum, then, experimental compounding studies have so far shown that adult and child native speakers of English as well as L2 speakers of English at various proficiency levels tend to treat regular and irregular nouns differently within compounds, which can be taken as supportive of a weak version of the dual-mechanism model. An important, but currently unexplained, observation that has been made on the basis of the limited number of L2 studies is that the native languages of the participants appears to have a considerable amount of influence on the L2 performance since, as mentioned above, for the L1 Spanish subjects in Lardiere (1995) the strength of the dissociation between regulars and irregulars was weaker compared to Lardiere's (1995) L1 Chinese subjects and Murphy's (2000) L1 French subjects. Considering the fact that compound-internal regular plurals are widespread in Spanish but (almost) non-existent in French and Chinese, a natural inference that could be made is that the L1 of participants interferes with the process(es) involved in compounding. It is therefore important to run further tests with L2 English speakers of various L1 backgrounds to see whether the strong impact of the L1 manifested for the Spanish subjects in Lardiere (1995) are merely experimental artefacts or not.

In the next sections, the results of a lexical compound elicitation task similar to the studies reported above will be presented which focuses on L1 Turkish learners of English as a Foreign Language. It will thus be tested whether Lardiere's (1995) and Murphy's (2000) findings that the predictions of the dual-mechanism model in terms of lexical compounding also hold for L2 processing can be further supported on the basis of findings obtained from L1 Turkish subjects. Since former studies have neglected foreign language learners altogether but have exclusively focused on L2 learners of English learning the L2 in an English-speaking country, the present study will also constitute a first analysis of foreign language learners' productions of English lexical compounds and their treatments of regular and irregular nouns within compounds in the framework of the dual-mechanism model.

5.2 Research Questions and Predictions

In line with the overall research questions of the present study (see Chapter 1.5), the following research questions and outcome predictions specific to Experiment 2 were set up:

1) Do L1 Turkish learners of L2 English display a differential treatment of regular vs. irregular nouns within compounds as predicted by the dual-mechanism model?

2) Does the treatment of regular vs. irregular nouns within compounds change as a function of L2 language proficiency?

If the L2 learners employed for the present study dissociate between regular and irregular nouns within compounds as posited by the dual-mechanism model, it is predicted that the ratios of regular and irregular

plural compound-internal nouns should be significantly different so that irregular plurals are used to a higher extent compound-internally than regular plurals. As mentioned above, previous L2 studies (Lardiere, 1995; Murphy, 2000) have shown that L2 users indeed differentiate between regular and irregular nouns as proposed by the dual-mechanism model in that they pluralise irregular nouns more than regular nouns within compounds.

However, the fact that this dissociation was weaker for L2 users with an L1 Spanish background compared to L2 users speaking Chinese or French as their L1s raised the question whether the L1 of participants might or might not have a strong effect on the production of compounds and, thus, on the linguistic mechanisms involved. In this sense, the present study will help to take a further step towards the clarification of this question since the L2 participants employed come from an L1 background (Turkish) that has not been investigated as part of the studies conducted within the dual-mechanism framework so far. An important property of Turkish plural inflection is its absolute morphological regularity. A regular/irregular dissociation as in English does not exist and plural inflection is exclusively obtained by the attachment of the plural marker *–lAr*. Although no study is known to exist that explicitly focuses on the distribution of singular/plural non-head nouns in deverbal synthetic compounds in Turkish, it can cautiously be stated that Turkish may be classified as patterning with Chinese, French and English since although it is sometimes possible to find plural nouns within lexical compounds (e.g., *kadınlar matinesi, mezunlar derneği, yıldızlar geçidi*), deverbal synthetic compounds do not usually contain plural non-head elements (e.g., *şarapsever*, *cam temizleyicisi, çocuk bakıcısı* vs. **/?şaraplarsever, */?camlar temizleyicisi, */?çocuklar bakıcısı*). Therefore, if the L1 has indeed as powerful an impact on the processing of lexical compounds as claimed, it is predicted that the L1 Turkish subjects in the present study

will tend to behave as they do in their L1 and predominantly avoid plural suffixation within compounds. Irregular plurals, on the other hand, are hence predicted to occur in their plural forms because they do not involve the attachment of the regular plural suffix. In sum, it is predicted that the participants in this study behave like the L1 Chinese and L1 French subjects in previous studies reported above and dissociate between regular and irregular nouns within compounds, particularly abstaining from using regular plurals in compound constructions.

A difference that the present study embodies when compared to previous L2 compounding-studies is that the L2 subjects employed are foreign language learners, who are chiefly exposed to the L2 in formal teaching environments, whereas previous studies have exclusively focused on second language learners who have had ample naturalistic input. Thus, it will be of interest to see whether or not the language learning environment brings about a difference. If the dual-mechanism model is meant to carry universal validity, a gross difference between second and foreign language learners is not expected since the dissociation between morphological mechanisms has been shown to exist in foreign language learners for other morphological phenomena like the English past tense (see Chapter 4).

A final important variable to be tested as part of Experiment 2 is proficiency-effects. As has been mentioned in previous chapters, Zobl (1998) has made the strong point that language proficiency plays an important role in the processing of linguistic information in that learners at initial stages of L2 development are supposedly not able to dissociate between rule-based and memory-based processes. If this proposal is correct, then it would be expected that low-proficiency L2 subjects produce regular and irregular plurals to the same extent within compounds. As reported above, Murphy (2000) tested L2 subjects from 3

different proficiency groups and did not find any significant differences between their performances on the compounding task as all three L2 groups dissociated equally between regular and irregular nouns within compounds. Low proficiency and high proficiency subjects in Experiment 1 (this study) and in Kırkıcı (2002), however, behaved considerably differently from each other in their performances on past tense tasks. It might therefore be the case that the proficiency-exam used in Murphy (2000) was not a good predictor of L2 proficiency and, thus, that the three proficiency groups were in fact more or less at the same level of L2 English proficiency. In line with the findings in Experiment 1 and Kırkıcı (2002), it is therefore predicted that proficiency will have a significant effect on the performance of the L2 subjects in the compounding experiment to be reported and that the proposed dissociation between regular and irregular morphology will be weaker for low proficiency L2 subjects than for high proficiency L2 subjects.

5.3 Experimental Methodology

5.3.1 Procedure

The experimental paradigm employed for Experiment 2 was a deverbal synthetic lexical compound elicitation task similar to the experiments conducted in Gordon (1985), Lardiere (1995) and Murphy (2000). Thus, roughly following previous studies, participants were asked questions of the type “What do you call a person who eats mice?” and were expected to form novel deverbal synthetic compounds of the type “a mouse/mice eater”. Like in Murphy (2000), who elicited written responses from her subjects, the participants in the present study were also required to provide their answers in written form rather than orally. The reason for this was that it appeared of specific relevance to be able to draw direct comparisons to Murphy (2000) because in that study proficiency effects

were also tested for. Since Murphy (2000) had her participants respond in written form, the same response modality was also chosen for the present study. Additionally, it was believed that having participants write their responses would also help overcome the potential problem of incorrectly scoring responses due to unclear pronunciation or articulation, which was particularly likely in cases like *man/men* and *woman/women*.

All participants were individually tested in a silent classroom. Prior to the actual experiment, each subject went through a training phase in which s/he was first asked to orally define five compounds (*can-opener, taxi-driver, stamp-collector, dish-washer, story-teller* – in Murphy, 2000) either in English or Turkish. After this, the participants were familiarised with the compounding task as in Murphy (2000) by asking them to produce compounds using (uncountable) mass nouns (e.g., *What do you call a person who sells cheese/drinks wine/etc.?* – see Appendix H). The reason for using mass nouns in the practice phase was to prevent the participants from guessing that the actual focus was on compound-internal inflection. As can be seen in Appendix H, a subset of the practice items was constructed of uncommon noun-verb pairs (e.g., *water-painter, air-buyer* – see Appendix H for a full list). The reason for doing this was to be completely sure that the participants were able to produce novel compounds and were not being tested on compound words they had encountered before. In addition, this was also thought to constitute a good preparation for the L2 learners since most of the actual experimental items were going to be constructed out of infrequently co-occurring words as well (e.g., *bone/bones-breaker, man/men-kicker*). In the final stage of the training-phase, subjects were presented with a list of all individual non-compound words that would eventually be used to construct the experimental items out of context and were asked to point out unfamiliar ones as done by Lardiere (1995). Since none of the actual experimental items was reported as unfamiliar by the participants, it was

unnecessary to go through any kind of teaching or familiarisation procedure.

Following the training phases, participants were presented with the actual experimental elicitation questions. In the actual experiment, the nouns in the elicitation questions were presented in their plural forms as had been the case in previous compounding studies. The elicitation questions, which were printed on separate flash-cards, were read out by the experimenter in random order twice each. The randomisation of the elicitation questions was achieved by thoroughly shuffling the flashcards before the testing of every participant. Each participant was asked to write his/her response on an answer sheet after every single elicitation question. Different from Gordon (1985) and similar to Lardiere (1995) and Murphy (2000), the verbs in the stimulus-questions were varied so that participants would not realise that the main point of the task was to monitor their pluralisation performances within compounds (cf. Gordon, 1985). It took each participant approximately 20 minutes to complete the experiment.

5.3.2 Materials

The experimental stimuli used consisted of a total of 25 nouns (see Table 5), which were used with 13 different verbs in 26 elicitation questions[65] and some of which had also been used in previous compounding-studies (e.g., Lardiere, 1995; Murphy, 2000). Two sample elicitation-questions are presented in (1) and (2) below (see Appendix I for the total list of elicitation questions).

[65] The noun *hands* was used twice.

(1) What do you call a person who **hates animals**?

(2) What do you call a person who **washes feet**?

Special care was observed to include nouns and verbs of high frequency so that even the lower-proficiency participants would be familiar with the prompts. Of the 25 stimulus-nouns, 14 were regular plural nouns, 6 were irregular plural nouns and the remaining 5 were classified as 'other nouns'. Among the latter category of nouns, 3 were pluralia tantum nouns, which have no singular forms (*clothes, people, pants*) and the other 2 (*fish*[66] and *sheep*) were nouns whose plural and singular forms were identical. The prompts which were classified as 'other nouns' were only included as distractor items and were not included in subsequent analyses.

Table 5: Stimuli used in the compounding task

Regular	Irregular	"Other"
Dresses	Feet	Pants
Hands	Women	People
Animals	Children	Fish
Boys	Mice	Sheep
Babies	Teeth	Clothes
Cats	Men	
Bones		
Shoes		
Students		
Heads		
Seas		
Winters		
Eyes		
Words		

[66] Note that *fishes* is acceptable as the plural form of *fish* as well, though very rarely used (Azar, 1999) and taught in many mainstream grammar books as having identical singular and plural forms.

5.3.3 Subjects

The subjects employed for Experiment 2 were the same as those in Experiment 1 (see Chapter 4.3.3). The majority of subjects participated in the two experiments on the same day; only three of the subjects participated on separate days due to time restrictions or fatigue. Thus, just as in Experiment 1, three subject groups were tested in Experiment 2: a native control group (n=6), a low-proficiency L2 group (n=22) and a high-proficiency L2 group (n=24).

As in Experiment 1, all subjects participated in the experiment on a voluntary basis and were naive with regard to the purpose of the experiment. Each participant had already filled out a participant consent form in English or Turkish (Appendices F & G) as part of Experiment 1, was presented with detailed explanations concerning the aim of the experiment and knew that s/he had the right to withdraw from the study at any desired stage of the experiment.

5.4 Results

5.4.1 Native Controls

As illustrated in Figure 9, the analysis of the native speakers' responses revealed that regular nouns were not pluralised within compounds at all (0%), but were instead used in their singular forms in all instances (100%). Irregular nouns, on the other hand, were used in their plural forms in 30.6% of instances and in their singular forms in the remaining 69.4% of instances (mean response rates across subjects).

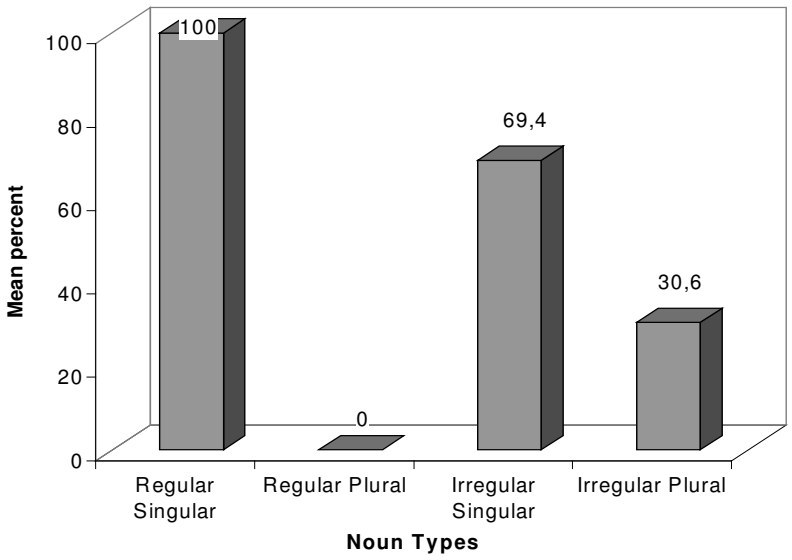


Figure 9: Native participants' mean percentage of regular and irregular singular and plural nouns within compounds.

A one-sample t-test run on the mean plural responses showed that the mean response rates on irregulars were not significantly different from 50% chance performance ($t(1,5)=-1.558$, $p=.180$). In other words, the native participants had no significant preference for singular or plural irregular compound-internal nouns. For regular nouns, however, the results clearly displayed that plurals were not licensed within compounds since, as stated above, regular nouns were not pluralised at all.[67] In this sense, the native subjects behaved very similar to adult native English speakers in previous studies, who also tended to avoid regular plural nouns within compounds (0% in Lardiere, 1995; 1.7% in Murphy, 2000).

The next step was to analyse whether the prediction of the dual-mechanism that regular and irregular nouns are treated differently within

[67] It was not possible to run a statistical test for the regular noun data since the percentage of regular plurals was 0% and, hence, the standard deviation was 0.

compounds could be confirmed statistically. A repeated measures ANOVA on plural regular and irregular mean response rates (by subjects) showed that there was a statistically significant difference between the use of regular vs. irregular nouns within compounds ($F(1,5)=6.003$, $p<.05$). Thus, the native participants were indeed found to dissociate regular and irregular nouns within lexical compounds just as proposed by the dual-mechanism model and as has been reported to be the case for adult native English speakers in Murphy (2000) as well[68].

5.4.2 High Proficiency L2 Subjects

The high proficiency L2 participants' mean response rates to regular and irregular prompts are reflected in Figure 10. As can be seen, regular nouns were pluralised on average in only 13.9% of instances (by subjects) and were used in the singular in the remaining 86.1% of instances. For irregulars, an opposite pattern was observed: in 64.6% of instances irregular nouns were pluralised and in 35.4% of instances they were used in the singular. One sample t-tests on mean plural response rates showed that the mean response rates for both regulars and irregulars were significantly different from 50% chance performance ($t(1,23)=-6.693$, $p<.001$ and $t(1,23)=2.445$, $p<.05$, respectively). Thus, the high proficiency L2 subjects apparently preferred to use regular nouns in their singular forms but irregular nouns in their plural forms within compounds. A repeated measures ANOVA was run to test whether regular and irregular nouns were indeed dissociated within compounds as predicted by the dual-mechanism model. It was found that the difference between responses to regular and irregular stimuli was significant ($F(1,23)=69.119$, $p<.0001$), which means that overall the high

[68] Unfortunately, no statistical analyses are reported for the adult native speakers in Lardiere (1994).

proficiency L2 subjects dissociated between regular and irregular prompts, preferring regular singular but irregular plural nouns within compounds.

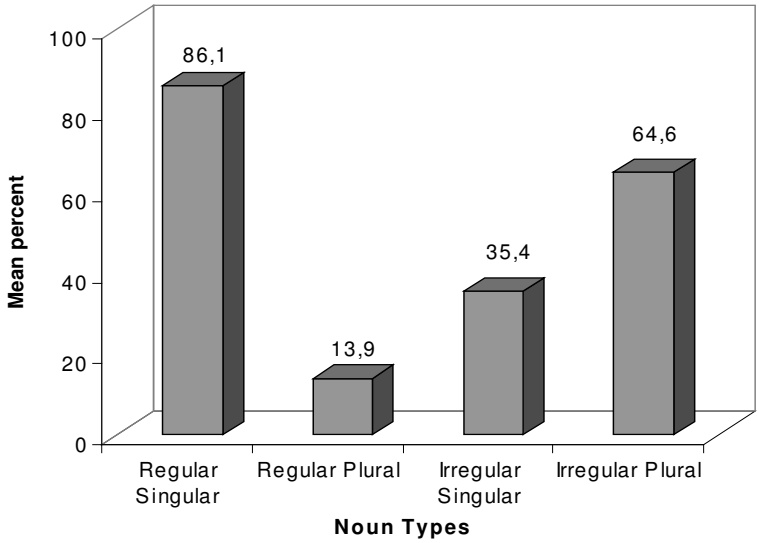


Figure 10: High proficiency L2 participants' mean percentage of regular and irregular singular and plural nouns within compounds.

This dissociation was also captured in an analysis of individual subjects, which showed that only 11 out of the 24 high proficiency L2 subjects used plural regular nouns compound-internally once or more. Only 2 out of these 11 subjects used regular plural nouns consistently within compounds.[69] The remaining 9 subjects used plural regular nouns only very sparingly (range: 1-3 times). Irregulars, on the other hand, were pluralised at least once by 22 out of 24 subjects. Out of these, 11

[69] 'Consistently' here refers to the 75% 'internal-consistency' criterion (cf. Clark & Barron, 1988), which roughly equals to 11 out of 15 total regular nouns for the present study.

subjects pluralised irregular nouns consistently (5 out of 6 possible) and the remaining 11 subjects at frequencies between 2/6 and 4/6.

5.4.3 Low Proficiency L2 Subjects

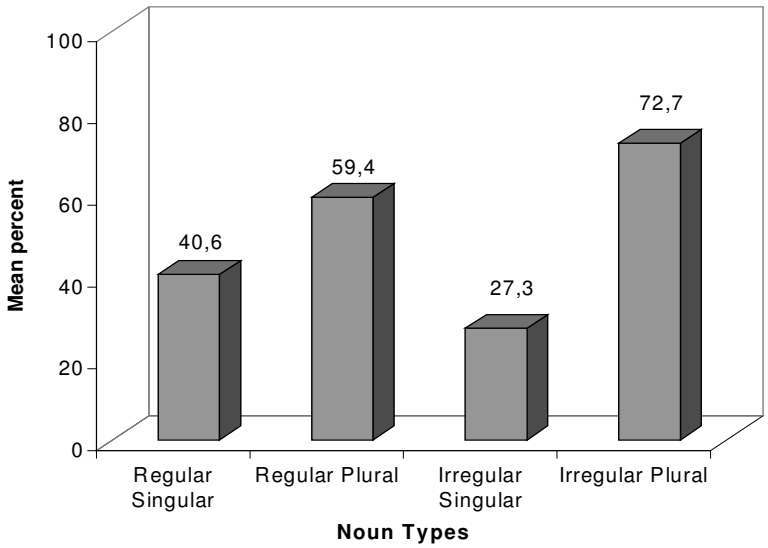


Figure 11: Low proficiency L2 participants' mean percentage of regular and irregular singular and plural nouns within compounds.

For the low-proficiency subjects, a slightly different picture emerged. As is graphically represented in Figure 11, the low-proficiency subjects preferred to use irregular nouns more often in their plural forms (72.7%) than in their singular forms (27.3%) just as was the case with the high-proficiency L2 subjects. A one-sample t-test on mean plural response rates showed that the mean response rate on irregular items was significantly different from 50% chance performance ($t(1,21)=3.814$, $p<.005$). For regular nouns however, the low proficiency L2 subjects did not appear to have a significant preference: regular nouns were pluralised in 59.4% of instances and were used in the singular in 40.6%

of instances. This lack of preference also showed itself in the lack of a significant difference from 50% chance performance ($t(1,21)=1.362$, $p=.188$). Thus, in contrast to the high-proficiency L2 and the native control subjects, plural and singular regular nouns were equally acceptable within compounds for the low-proficiency L2 participants.

In spite of the fact that low-proficiency L2 subjects thus accepted singular as well as plural regulars equally well within compounds, the answer to the central question whether there was a dissociation between regular and irregular nouns as predicted by the dual-mechanism model was not different from the other two subject groups. A repeated measures ANOVA showed that there was a significant difference in the treatment of regular and irregular compound-internal nouns by low proficiency L2 subjects ($F(1,21)=6.342$, $p<.05$), indicating that irregulars were more often pluralised than regulars and thus supporting the view that regulars and irregulars were treated differently.

To arrive at a more detailed picture of this obtained dissociation, an individual subjects analysis was run for the low-proficiency L2 participants as well. This analysis revealed that 21 out of the total 22 low-proficiency subjects used a regular noun in its plural form at least once. 12 of these participants pluralised regular nouns consistently within compounds (≥11/15). The remaining 9 subjects used plural regular nouns at frequencies between 1/15 and 10/15. Irregular nouns were also pluralised at least once by 21 out of the total 22 low-proficiency subjects. Among these 21 subjects, 12 consistently pluralised irregulars (5/6). The remaining 9 subjects pluralised irregular nouns at frequencies between 1/6 and 4/6.

5.4.4 L2 Proficiency Effects: Between-Groups Analyses

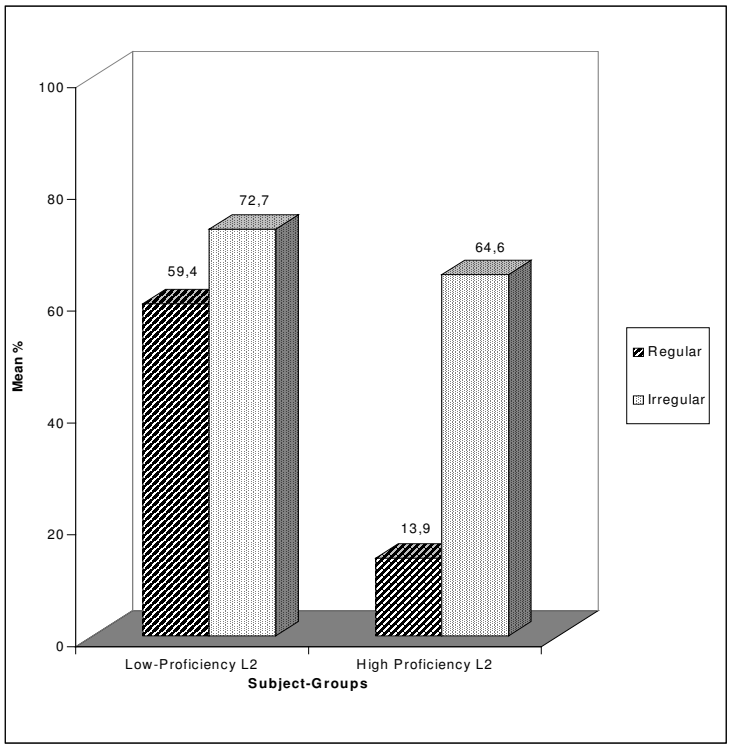


Figure 12: Mean percentage of regular and irregular plural nouns within compounds across L2 proficiency groups.

What the analyses of the individual L2 groups thus revealed was that both low-proficiency and high-proficiency L2 participant groups handled regular nouns differently from irregular nouns within compounds, which can be taken as supportive of the dual-mechanism model. However, an interesting observation was that although both L2 groups behaved as predicted by the dual-mechanism model, there still appeared to be an L2 developmental effect since for the low-proficiency L2 subjects the use of regular plural nouns within compounds was clearly more acceptable than for the high-proficiency L2 subjects, which was also obvious from the individual subjects analyses. To test whether this initial observation was

correct and the proficiency-levels of the L2 participants had an important impact upon the response-patterns, a statistical analysis was run in which the responses of the L2 groups were compared with each other (see Figure 12).

A 2x2 ANOVA (Subject Group: low proficiency, high proficiency x Noun Type: regular, irregular) on mean plural response rates by subjects was carried out, which revealed significant main effects for noun type ($F(1,44)=61.861$, $p<.0001$) and subject group ($F(1,44)=12.673$, $p<.005$), and a significant interaction between group and noun type ($F(1,44)=21.075$, $p<.0001$). The significant main effect of noun type (regular vs. irregular) indicates that irregulars were pluralised to a higher extent than regulars. In other words, regulars and irregulars were treated differently overall, as predicted by the dual-mechanism model and as was also reported in the analyses of individual groups above. The significant main effect for proficiency group indicates that the two subject groups differed significantly in terms of the mean percentage of regular and irregular plurals they produced. The significant interaction effect, on the other hand, suggests that noun types were treated differently by the two subject groups, implying that the participants' L2 proficiency had a bearing on how they performed on the compounding task.

To investigate this observed pattern further, two one-way ANOVAs were run which compared the subject groups' mean plural response rates (by subject) on regular and irregular items. It was found that the low-proficiency L2 subjects produced significantly more regular plurals than the high proficiency L2 subjects ($F(1,45)=27.464$, $p<.0001$). What this implies is that the L2 participants in the present study used plural regulars to a decreasing extent with increasing proficiency, which speaks for a developmental effect in the production of regular compounds as predicted.

The second ANOVA, which compared the subject groups' mean plural response rates on irregular nouns, however, revealed that there was no significant difference between the amount of irregular plurals produced by the two L2 groups ($F(1,45)=.931$, $p=.340$). In other words, L2 proficiency did not appear to have an effect on the amount of irregular plural nouns produced within compounds because both high-proficiency and low-proficiency L2 subjects made equally high use of plural (rather than singular) compound-internal irregular nouns. Thus, the L2 developmental effect found for regular nouns was not manifested for irregular nouns.

5.5 Discussion and Conclusion

The results of the compounding experiment have demonstrated that L1 speakers of English as well as L1 Turkish low and high-proficiency learners of L2 English in this study dissociated between regular and irregular nouns in the production of English lexical compounds. As was shown, regular plurals were used less often in lexical compounds than irregular plurals by all three subject groups. As such, the obtained findings can be evaluated as supportive of a weak version of the dual-mechanism model. As mentioned at various points throughout the preceding discussions, the dual-mechanism model basically theorises that regulars and irregulars are processed via distinct mechanisms – a rule system for regulars and an associative memory for irregulars. A strong version of the dual-mechanism model would predict that regular plural nouns can not be fed into lexical compounds since, as mentioned before, regular inflection is a process that is theorised to take place outside the lexicon and therefore too late to be part of a word-formation process (Marcus et al., 1995). Such a sharp distinction, however, was not found in the responses of the L2 subjects, who produced regular plural nouns within compounds at rates between 14% and 59%. Under a weak

version of the dual-mechanism model, on the other hand, the occurrence of regular plurals in compounds may be expected since the full-form storage of (particularly high frequency) regular plural nouns in the memory is not entirely ruled out (Gordon & Alegre, 1999; Pinker & Ullman, 2002), which makes them partly available for word-formation processes. Thus, under this view, to be able to make the claim that the dual-mechanism model is functional in the processing of lexical compounds what is necessary is not a completely sharp distinction between regulars and irregulars that manifests itself in the form of entirely non-occurring regular plural nouns within compounds, but rather an overall, graded dissociation between regulars and irregulars (cf. Marcus, 1995c), which was clearly the case for the L2 subject groups in the present study. In this sense, the first research question set up for the compounding experiment, whether L1 Turkish learners of L2 English display a differential treatment of regular vs. irregular nouns within compounds as predicted by the dual-mechanism model, receives an affirmative answer.

However, the results have also shown that this observed dissociation of regular vs. irregular nouns in lexical compounds becomes stronger with increasing L2 proficiency – a finding that runs counter to the results obtained by Murphy (2000). As mentioned before, Murphy (2000) tested whether L1 French learners of L2 English at three distinct levels of proficiency behaved differently on the compounding task and found no significant differences between the three proficiency groups she employed. The present study, on the other hand, clearly found L2 proficiency-related differences as the extent to which regular plural nouns were used in compounds fell significantly as a function of increasing L2 proficiency from ~59% to ~14%. Under a dual-mechanism view, what this developmental pattern may imply is that the low-proficiency subjects in the present study had the tendency to store regulars predominantly as

unanalysed full-forms rather than as rule-products and thus were able to directly feed them into the compounds from the lexicon. However, this full-form storage of regular forms was apparently not the case for the entirety of regular nouns since almost 40% of the regular stimuli were used in their singular forms compound-internally. For the high-proficiency subjects, on the other hand, regular nouns were thus predominantly analysed into stem and suffix, which prevented the insertion of regular plurals in compounds to such high extents. Note that this explanation, though speculative and clearly premature, is very much in line with earlier findings that low-proficiency L2 learners tend to show a comparatively higher reliance on the associative memory than on the proposed rule-system (e.g., Kırkıcı, 2000; Experiment 1 in this study) and to store complex word forms as unanalysed wholes. This does not mean, however, that the strong proposal of Zobl (1998), who stated that L2 learners at initial stages of development completely are not able to dissociate between regular and irregular morphology at all, is correct since the low-proficiency L2 subjects in the present study clearly displayed this dissociation.

Comparing the L2 subjects of the present study to L2 participants that have taken part in almost identical experiments in previous studies (summarised in Table 6), one finds striking similarities between all subject groups' response patterns with the exception of Lardiere's (1995) Spanish subjects. As was mentioned previously, compounding in Spanish is different from compounding in French, Chinese, Turkish and English since in the former (regular and irregular) plural nouns are licensed within lexical compounds whereas in the latter languages this is either the exception (English, French and possibly also Turkish[70]) or even

[70] Note that the exact distribution for Turkish lexical compounds is, as mentioned under 5.2, currently unexplored and that this is merely a cautious statement based upon personal observations.

completely non-existent (Chinese). On the basis of the finding that the low-proficiency L1 Turkish subjects in the present study behaved similarly on English lexical compounds to L1 Chinese and French learners of L2 English, the view that a certain amount of L1 influence must be in play receives considerable support. Considering, however, that the high-proficiency L2 participants in this study behaved clearly differently from the low-proficiency subjects on regular compound-internal nouns, it may additionally be concluded that this L1-effect declines with increasing proficiency. Unfortunately, none of the previous studies involved L2 subjects that are proficiency-wise comparable to the high-proficiency subjects in the present study, which makes the above conclusions rather provisional and in need of substantial cross-linguistic support. Thus, on the one hand largely confirming the validity of a weak version of the dual-mechanism model for L2 processing, the results of the present study, together with findings obtained in previous studies, on the other hand further suggest that the L1 exercises a significant influence on the L2 processing of English lexical compounds – especially at lower levels of proficiency.

A further interesting and related point emerging on the basis of the response-patterns reflected in Table 6 is that, curiously, the L2 participants in all mentioned studies, almost entirely independent of L1 background and L2 proficiency-level, display a strong tendency to use irregular nouns in their plural forms within lexical compounds. In spite of the fact that this tendency does not appear to be a crucial one when evaluated within the premises of the dual-mechanism model, which allows both singular and plural irregulars to appear in lexical compounds, and as such does not add much to the basic reasoning of the present study, it emerges as cross-linguistically firm and (on the basis of the Turkish L1 data) proficiency-independent.

Table 6:

Comparison of response rates of L2 subjects in previous studies and high-proficiency (HP) and low-proficiency (LP) L2 subjects employed for the present study.

	Regular Plurals	Irregular Plurals
Lardiere (1995)		
L1 Spanish	73%	90%
L1 Chinese	30%	65%
Murphy (2000)		
L1 French	46%	74%
This Study		
LP L1 Turkish	~59%	~73%
HP L1 Turkish	~14%	~65%

Needless to say, any attempt to explain this tendency would be merely speculative unless more studies are conducted that confirm the captured pattern for L2 subjects with varying proficiency-levels and L1 backgrounds, but a possible explanation might be sought within the nature of the elicitation questions. It is known from morphological priming studies that the consequent presentation of two identical words results in the facilitation of access to the lexical entry, resulting in a faster reaction time for the second occurrence of the word (Clahsen, 1999). Similarly, the prior presentation of a regular inflected word form has been found to facilitate the subsequent access to the stem form (e.g., Stanners et al., 1979; Kempley & Morton, 1982). With respect to irregulars, on the other hand, no such facilitation effect on the access of the stem forms has been reported and in some studies (e.g., Marslen-Wilson, Hare & Older, 1993) an inhibitory effect was found. Considering the fact that the elicitation questions in compounding-experiments contain exclusively plural noun

prompts, it might be the case that the subsequent lexical access to irregular stem forms is inhibited (or at least not facilitated), thus resulting in the predominant use of irregular plural forms. However, as mentioned above, it is clearly necessary to run more, well-controlled experiments in which such variables are explicitly tested to arrive at conclusive results.

A further point that arises on the basis of the above comparison with previous L2 studies is that the amount and type of L2 input does not appear to play a determining role in the processing of lexical compounds. In spite of the fact that the subjects in the present study were learners of English as a foreign language with only limited, classroom-based L2 exposure, in contrast to previous studies which focused exclusively on learners of English as a second language with much natural exposure to the L2, the production rates and patterns were somewhat similar as summarised above. This high similarity despite qualitative and quantitative input-differences would be difficult to explain by means of solely input-based explanations as put forward by proponents of connectionist models. Murphy (2000) discusses this option in her analysis of the results obtained from compounding studies with L1 subjects. She questions whether the dissociation between regular and irregular morphology observed for native subjects has to be interpreted as the reflection of morphological constraints as suggested by theories like the dual-mechanism model and speculates that the observed dissociation "may be due to the overwhelming pattern in the input that there are no regular plurals found in the middle of words" (2000: p.187), which would suggest an input-sensitive associationist account as put forward by proponents of connectionist models. However, as Urano (2001) stresses, such an explanation would make it hard to explain the data gathered so far in L1 compounding experiments. As was mentioned before, both the adult native speakers in Murphy (2000) and the young child-participants in Gordon (1985) used regular plurals in compounds to almost the same

extent (1.7% and 2%, respectively). Given the fact that adult native speakers have had certainly more exposure than young children to natural input, which hardly ever contains compounds with regular plural nouns, a question that emerges is why this difference in input-exposure does not lead to a difference in the production patterns. If input was indeed such an effective variable, then the children in Gordon (1985) would have been expected to behave at least marginally differently from adult native speakers, which was not the case though (Urano, 2001). In the same vein, considering the fact that even the low-proficiency L2 participants in the present study behaved almost identically to L2 participants in previous studies, who had undeniably more exposure to natural input, an explanation based upon input-effects alone becomes hard to maintain.

CHAPTER 6

GENERAL DISCUSSION AND CONCLUSION

This chapter consists of two major sections. The first major section (6.1) summarises the results of the study and presents the general conclusions that have been drawn on the basis of these results. Section 6.2 presents the implications of the present study and provides suggestions for further research.

6.1 Summary of the Study and General Discussion

The central aim of this study was to assess the validity of the dual-mechanism model (Pinker & Prince, 1988; Pinker, 1991) for the second language processing of English morphology by adult L1 Turkish learners of English as a foreign language. Thus, it was sought to find out whether L2 speakers display dissociations between the processing of so-called regular and irregular word forms that may be taken as indicative of rule-based vs. association-based processes as put forward by proponents of the dual-mechanism model. A second major purpose was to investigate whether L2 proficiency was a determining factor in the mental representation and processing of L2 inflectional morphology as proposed by Zobl (1998), who claimed that particularly low-proficiency L2 learners initially lack a rule-system altogether and store all simplex and complex word forms in an unanalysed fashion in the associative memory. To this end, a lexical decision task on English past tense morphology and an elicited production task on English deverbal synthetic compounds were run with L1 Turkish adult low and high proficiency speakers of L2 English

and adult native English speakers, the results of which have been reported in Chapters 4 and 5, respectively. In the following sections, an overall evaluation of the results will be presented and it will be discussed to what extent the general picture that has emerged from the present study speaks for or against the tenets of the dual-mechanism model.

6.1.1 General Discussion of Native Control Results

The overall results obtained from the adult native control subjects have shown that while even a strong version of the dual-mechanism model is maintainable for the L1 processing English deverbal synthetic compounds (Experiment 2), in which regular and irregular word forms were clearly treated differently by the participants, the results of the lexical decision task involving the English past tense (Experiment 1) do not exactly mirror the predictions of the model. The results of the lexical decision task on the English past tense (Experiment 1) showed that the native control subjects' reaction-times to high-frequency and low-frequency past tense verbal stimuli were not significantly different on regular and irregular items. Under the dual-mechanism view, these findings are rather unexpected since what would be expected is a dissociation between regular and irregular verb forms that manifests itself in frequency-effects for irregulars and no frequency effects for regulars. Thus, while the response pattern on regulars turned out to be as predicted, irregulars elicited an unexpected response pattern. However, as mentioned in Chapter 4, a possible explanation for this unexpected pattern may be related to the fact that the number of native participants was rather small and therefore not sufficient to arrive at powerful conclusions, which can certainly be taken as a shortcoming of the present study. Hence, to arrive at firmer conclusions in future investigations, it is definitely necessary to employ a larger subject-group.

An unambiguous dissociation between regular and irregular stimuli, however, was found as a result of the deverbal synthetic compound elicitation task (Experiment 2). As reported in Chapter 5, the adult native subjects clearly treated regular and irregular nouns differently in the lexical compounds they produced in that regular nouns were exclusively used in their singular forms (100%) and were never pluralised, whereas irregular nouns were pluralised in 30.6% of instances. The results of the statistical analysis showed that this difference was statistically significant and, hence, that native speakers indeed tended to dissociate between regular and irregular nouns within lexical compounds as predicted by the dual-mechanism model. It needs to be taken into consideration, however, that the small number of native subjects, which was taken as a possible intervening factor in the lexical decision task results, could have played a role in the results of the compounding-task as well. Thus, although the predicted regular-irregular noun dissociation was found, it might be speculated that this dissociation might not have been as sharp as was the case for the subjects in this study if a larger native subject population had been chosen. Nevertheless, given the fact that the obtained dissociation was very sharp, it seems unlikely that a substantial difference in the results would have been obtained had a larger subject group been employed.

Thus, overall, the findings of the experiments conducted with the native speakers present an inconclusive picture. While the results of the compounding-experiment are highly consistent with the tenets and predictions of the dual-mechanism model and display important parallelisms to the findings obtained in similar previous studies that have analysed native English speakers' processing of lexical compounds (see Chapter 5), the results of the lexical decision task run partly counter to both the tenets of the dual-mechanism model and the findings obtained in previous studies (see Chapter 4). Therefore, the first general conclusion

of the present study is that only the results obtained from the compounding-experiment conducted with native speakers of English are fully compatible with a strong version of the dual-mechanism model, which predicts unambiguous dissociations between fully listed, undecomposed irregular word forms and decomposed regular word-forms, theorised to be rule-products. The results of the lexical decision task on the English past tense, on the other hand, are as such not fully supportive of the dual-mechanism model since neither regular nor irregular stimuli elicited frequency effects. While this pattern is exactly what is predicted by the dual-mechanism model for regulars, the lack of frequency-effects on irregular stimuli creates a challenge to the view of the dual-mechanism model (as well as associationist models) that irregular items are fully listed in an associative memory. However, as mentioned above, it should not be disregarded that this unexpected outcome may be an artefact since the relatively small number of participants employed for the experiments might as well have led to the obtained results.

6.1.2 General Discussion of L2 Results

The results of the experiments conducted with L2 participants have very evidently displayed that L2 proficiency plays an important role in the relative weight the two hypothesised routes take on and that particularly for L2 learners at lower levels of L2 development the associative memory is very effective. The results of the lexical decision task on the English past tense (Experiment 1) showed that high proficiency L2 subjects did not display response time differences between high and low frequency irregular past tense forms. Although unexpected from the perspective of both associationist and dual-mechanist models, which both predict frequency-effects for irregular forms, the speculative explanation was made that educational practices entailing the memorisation of irregular

verb lists caused the disappearance of the expected frequency-effects (cf. Beck, 1997). On the other hand, for the low proficiency L2 subjects a frequency-effect on irregular stimuli was manifested, possibly because they have undergone fewer years of L2 English instruction and have arguably been less exposed to such educational practices. Unfortunately, the confirmation or rejection of this speculative explanation is not possible without a careful inspection of the exact input L2 learners receive and will therefore remain an unresolved aspect of the present study. However, this finding has shown that an important aspect of L2 processing that certainly needs to be closely monitored in future studies of this kind is the input L2 learners, and especially foreign language learners, receive.

For regular verbs, it was found that while the high-proficiency L2 subjects displayed no response-time differences between high and low frequency regular stimuli as expected by the dual-mechanism model, the low-proficiency L2 subjects responded significantly faster to high frequency regular verbs. This frequency-effect obtained for low-proficiency L2 subjects on regular stimuli can be taken as a strong indication of full-form storage for regular verbs. As such, these findings initially appear to be supportive of Zobl's (1998) claim that L2 learners at initial stages of interlanguage development completely lack the ability of implementing rules and store all regular and irregular forms as undecomposed wholes. However, Zobl's strong view is cautiously ruled out, particularly on the basis of Kırkıcı (2002), who found that L2 learners at the same level of proficiency as the low-proficiency L2 subjects in the present study were able to use the English past tense rule productively and even over-applied it to nonce verbs and irregular verb stems. Instead, it is proposed that full-form storage in the associative memory is a route that is comparatively stronger in low-proficiency L2 users than in high-proficiency L2 users. In other words, particularly at lower levels of L2 proficiency the storage of complex word forms (i.e., regular as well as

irregular forms) as undecomposed wholes appears to be the more dominant processing route, while the decomposition route appears to be more limited, though not entirely non-existent. With increasing proficiency, however, the distinction between the two routes appears to grow stronger, which leads to a gradual dissociation between the processing of regular and irregular items and an increase in the employment of the decomposition route for regular items.

The results of the compounding experiment are less equivocal since processing dissociations between regulars and irregulars were clearly visible. Both low-proficiency and high-proficiency L2 subjects have been found to differentiate between regular and irregular nouns within lexical compounds, preferring to produce irregular nouns more often in their plural forms within compounds than regular nouns – as predicted by the dual-mechanism model. However, the production patterns of L2 subjects evidently showed that the processing of compounds was also partially effected by the relative L2 proficiency-levels of participants. While low-proficiency L2 subjects produced regular plural nouns in 59.4% of instances, high-proficiency L2 subjects used regular nouns in their plural forms in only 13.9% of instances – a difference that was found to be statistically significant. In other words, with increasing proficiency, L2 subjects apparently underwent changes in the processing of regular nouns or the processing of compound-internal regular nouns. Such a proficiency-effect was not found, however, for the processing of irregulars since both groups of L2 subjects used irregular nouns in their plural forms to almost equal extents. As such, the findings from the compounding-experiment also provide support for the view that particularly L2 users at lower levels of interlanguage development tend to store complex word forms predominantly as undecomposed wholes since apparently an important amount of regular plurals were analysed as single units and could therefore be directly fed into lexical compounds just like irregular

plurals. For the majority of high-proficiency L2 subjects, on the other hand, full-form storage was apparently the exception rather than the rule, which manifested itself in the predominant use of singular regular nouns within compounds and thus speaks for a successful decomposition of regular plurals into stem and suffix. In other words, the dissociation between rule-based regular and fully-listed irregular compound-internal nouns forms, though clearly existent at lower levels of L2 development, was found to grow stronger with increasing proficiency.

Thus, on the whole, three general conclusions can be drawn on the basis of the results obtained from the experiments conducted with L2 subjects. Firstly, it can confidently be concluded that the two processing routes theorised within the framework of the dual-mechanism model (decomposition and lexical storage) are utilised for the processing of lexical compounds by L2 users at both lower and higher levels of proficiency. Crucially, this constitutes the first verification (together with Kırkıcı, 2002) of the validity of the dual-mechanism model for learners of a foreign language. As mentioned at various points throughout the present study, previous studies have exclusively dealt with learners of a second language who were exposed to rich, natural L2 input. The L2 subjects in the present study, on the other hand, were almost exclusively exposed to classroom-based L2 input and this to only very limited extents. Unfortunately, it is not directly possible to make a strong conclusion related to the processing of English past tense morphology, since the results obtained are open to speculative analyses and dependent upon further factors like the exact nature of the input received, which have not been controlled sufficiently in the present study.

The second general conclusion is that this utilisation of the two proposed processing routes has been found to display significant changes as a function of L2 proficiency since at higher levels of L2 proficiency the

dissociation between the two processing routes appeared stronger, whereas at lower levels of L2 proficiency the decomposition route has been found to be rather limited and lexical storage in the associative memory appeared to be the predominant processing route employed. This was visible in both the significant decrease of the use of plural regular nouns in the compounding task and the disappearance of frequency-effects on regular verbal stimuli in the lexical decision task with high-proficiency L2 subjects. As such, neither the hypothesis of Zobl (1998) that lower-proficiency L2 users do not dissociate between regulars and irregulars nor the view of Ullman (2001b) that L2 users in general rely almost exclusively on lexical storage received strong support through the findings of the present study. The hypothesis of Zobl can not be accepted in its strong form because the lower-proficiency L2 subjects were clearly dissociating between regular and irregular nouns in the compounding task. Instead, a weaker version of Zobl's theory that assumes higher (but not complete) reliance on the associative memory in early stages of L2 proficiency might be proposed in the light of the findings. Ullman's view that lexical storage is the dominant processing route in L2 processing independent of L2 proficiency, on the other hand, runs counter to the findings obtained with high proficiency L2 subjects on the lexical decision task since it was clearly visible that frequency played no significant role in the response times of answers provided to regular items, which speaks against a full-listing view.

A final tentative conclusion, which is not based upon the initial principal aims of the present study but which evolved in the course of the analysis of the results, relates to the possible effects the L1 may be exerting on L2 morphological processing. The comparison of the results obtained from the compounding experiment (Experiment 2) with results obtained from similar studies conducted with L2 speakers of different L1 backgrounds has shown that the morphological properties of the L1 may be highly

influential on the processing of L2 morphology, especially at lower levels of L2 proficiency. What this provisional conclusion might imply is that the relative weights of the two processing routes proposed by the dual-mechanism model, which have been found to be employed in L1 and L2 processing, may in part be determined by the way a given morphological structure is handled in the L1 or L2. In other words, carefully designed examinations of a given morphological phenomenon the processing of which has been well-established in a given L1 and L2 may possibly result in the conclusion that the prevailing processing route of the more dominant language (most probably the L1) affects the way the morphological structure is processed in the other language. Unfortunately, it is not possible to draw any confident conclusions concerning this observation on the basis of the present study since the exact nature of the L1 processing of synthetic compounds in Turkish has not been established and because it is not entirely clear whether the L2 subjects in studies conducted so far are, proficiency-wise, comparable or not. Therefore, this observation will, for now, remain as a speculative remark that may be further explored in further studies.

6.2 Implications and Directions for Further Research

The results of the present study bear a number of implications for further research studies investigating the processing of L2 (inflectional) morphology. First of all, it may prove potentially fruitful to include L2 participants in further studies whose input can be better controlled and more closely monitored. Though possibly not very feasible for studies working with learners of a second language, monitoring the input provided to learners of a foreign language in formal teaching environments may be easier. The evident advantage of such a measure would be that speculative cause-effect relationships of the kind hypothesised in the present study to exist between certain teaching-

practices and the processing of given morphological structures may be based on firmer ground. An obvious shortcoming of the present study has, in this sense, been the fact that no detailed information concerning the subjects was accessible. Therefore, the lack of frequency-effects observed for L2 subjects on irregular stimuli in Experiment 1 was cautiously tied to the speculative explanation which had previously been stated by Beck (1997) that the common educational practice of presenting L2 learners with frequency-independent irregular word lists was responsible for the disappearance of normally expected frequency-effects (see Chapter 4). Although post-experimental inquires have shown that this practice is also very widespread at the institutions in which the L2 subjects of the present study were/had been learning English, there still remains a certain amount of doubt whether this constitutes the sole possible explanation in the face of the limited knowledge concerning the exact input these subjects received. Consequently, a better control of L2 input appears to be a vital requirement for further studies to be able to arrive at more confident conclusions.

A second implication that emerges from the present study is that future studies conducted within the framework of the dual-mechanism model need to be designed such that potential L1 (or L2, L3, Lx) effects are taken into consideration and constitute part of the general research scope from the outset. Although the effect of the L1 on the processing of the L2 has not been one of the major considerations of studies analysing the dual-mechanism model (partly because the model was not meant to be a theory of L2 processing), the comparison of the results of the present study with results from previously conducted studies has suggested that this appears to be a potentially illuminating research path.

A final implication relates to the morphological phenomena that are analysed. A shortcoming of the present study as well as almost all

previously conducted studies basing their analyses of the dual-mechanism model upon L1 or L2 English is the fact that the morphological structures that are studied have uncomplicated two-way distinctions between so-called regular and irregular word forms as in the case of past tense verb forms and plural noun forms. In other words, the morphological structures that have been chosen to seek evidence for the dual-mechanism model in English to date have predominantly been fairly simple and straightforward binary morphological systems the members of which can somewhat easily be determined as regular or irregular. The situation may become more complicated, however, once a morphological system is chosen for analysis in which such a distinction is either non-existing, as in the case of the English simple future tense, which is apparently fully regular and always formed with the modal *will* or where the status of the involved morphological structures is unclear, as in the case of English comparative adjectives. An analysis of the L2 processing of English comparative adjectives within the framework of the dual-mechanism model will be explored as a suggestion for further studies below.

6.2.1 English Comparative Adjectives: A Suggestion For Further Research

An analysis of the L2 processing of English comparative adjectives within the framework of the dual-mechanism model may constitute a potentially fruitful but at the same time challenging research endeavour due to the fact that the distribution of the morphological processes involved is complex when compared to the English past tense or English plural nouns. As is well known, comparative adjectives in English can be

formed by *–er* suffixation[71] (e.g., *small-smaller*), by a periphrastic form using *more* (*interesting-more interesting*) or by a suppletive form (e.g., *good-better*). In contrast to better-studied structures like the English past tense, comparative adjectives bear an important difference in that it is not entirely clear which of the three above-mentioned processes involved in the formation of comparative adjectives lead(s) to forms that have regular or irregular status. In addition, how these three forms are processed by the language faculty is not settled, either; while it is generally accepted that suppletive forms are lexically listed (e.g., separate entries exist in the mental lexicon for *good* and *better*), the mental representations of the *–er* comparative suffix and the periphrastic construction are still points of controversy (Graziano-King, 1999). It could therefore be of particular value to investigate whether any of these three structures can be identified as the *default* regular process and to seek evidence for rule-based vs. association-based (i.e., decomposition vs. full-listing) processes in the processing of comparative forms as proposed by the dual-mechanism model.

As a general rule, it is often stated that monosyllabic adjectives (e.g., *long, big*) and disyllabic adjectives ending in *–y* (e.g., *happy*) form comparatives by means of the suffix *–er*, whereas all other multi-syllabic adjectives form their comparative forms periphrastically (e.g., *more interesting, more beautiful*). However, a likely problem in arriving at satisfactory, clear-cut conclusions as the result of an psycholinguistic analysis of English comparative adjectives is the fact that many exceptions exist to this distribution, which indicate the strong impact of syllable structure and phonological structure and which make it therefore

[71] The status of the *–er* comparative morpheme in terms of being derivational or inflectional is still largely undecided in the relevant literature (e.g., Matthews, 1974). However, in keeping with the majority of views in the morphological literature, it will be here referred to as inflectional.

hard to arrive at firm conclusions on the basis of morphological analyses alone (listed in Clahsen & Temple, 2003):

- The ungrammaticality of **apter* (cf. Aronoff, 1976)
- The grammaticality of *stupider* (cf. Aronoff, 1976)
- The use of monosyllabic adjectives with *more* in correlative constructions in some dialects (e.g., *The more old he is, the more wise he becomes)*[72] and than-clauses (*e.g., John is more mad than Bob)*
- The resistance of borrowed gradable monosyllabic adjectives to *–er* suffixations (e.g., *chic-*chicer*)
- The requirement to use *–er* suffixation with a number of disyllabic adjectives ending in *–ple, -ble, -tle* and *–dle* (e.g., *simple, nobler, subtler, idler)*
- The availability of both the suffixation and the periphrastic option for a number of disyllabic adjectives ending in *–ly, -some* and *–er* (e.g., *lovely, narrow, handsome, clever),* and disyllabic adjectives with initial or final syllable stress like *pleasant* and *profound* (cf. Frank, 1972)

Thus, as the above exceptions suggest, the distribution of English comparative forms is less neat than 'simple' structures like the English past tense or English plural nouns. Hence, a potentially successful psycholinguistic account of the processing of English comparative adjectives needs to be one that is able to explain all these exceptions without ending up with a mere list. Unfortunately, psycholinguistic studies to date have not been able to arrive at definitive conclusions concerning the L1 processing of English comparative adjectives. While some studies (e.g., Di Sciullo & Williams, 1987) are reported to have arrived at the conclusion that comparative adjective formation is morphophonologically

[72] All examples from Clahsen & Temple (2003), if not stated otherwise.

conditioned, in a more recent study Graziano-King (1999) has abstained from setting up phonology-based explanations and has made the speculative claim that all *–er* comparatives are lexically listed in memory and periphrastic comparatives constitute the default syntactic rule[73]. However, the scarcity of research into the processing of comparative adjectives makes it almost impossible to arrive at conclusive results for now.

As can thus be inferred, given the fact that L1 studies have not arrived at clear results, running a study on the L2 processing of English comparative adjectives may lead to intricate results but is also likely to constitute a valuable contribution to the field. Therefore, one potentially revealing route to follow in future research could be to run a study in which a sufficient number of L1 and L2 subjects are tested by means of different on-line and off-line psycholinguistic experiments that trace the processing of comparative adjectives. Unfortunately, Graziano-King (1999) employed exclusively off-line experiments (elicited production tasks and cloze tests with real and nonce adjectives) and did not include an on-line experimental dimension (i.e., a lexical decision task). Hence, further studies would certainly benefit from including this dimension as well.

[73] Providing the exact details of her reasoning would lie far beyond this discussion. For details see Graziano-King (1999).

REFERENCES

Alegre, M. & Gordon, P. 1999. Rule-based versus associative processes in derivational morphology. *Brain and Language* 68, 347-354.

Allen, M.R. 1978. *Morphological Investigations.* Unpublished Ph.D. Dissertation, Storrs, Connecticut: University of Connecticut.

Aronoff, M. 1976. *Word Formation in Generative Grammar.* Cambridge, Massachusetts: MIT Press.

Ashby, W.R. 1952. *Design for a Brain*. New York: Wiley.

Azar, B. 1999. *Understanding and Using English Grammar*. New York: Longman.

Baayen, H., Schreuder, R., de Jong, N. & Krott, A. 2002. Dutch inflection: the rules that prove the exception. In Nooteboom, S., Weerman, F. & Wijnen, F (Eds.), *Storage and Computation in the Language Faculty.* Dortrecht: Kluwer Academic Publishers.

Balota, D.A. 1994. Visual word recognition. In Gernsbacher, M.A. (Ed.), *The Handbook of Psycholinguistics*. New York: Academic Press.

Balota, D.A. & Chumbley, J.I. 1984. Are lexical decisions a good measure of lexical access? The role of word-frequency in the neglected decision stage. *Journal of Experimental Psychology: Human Perception and Performance* 10, 340-357.

Beck, M.-L. 1997. Regular verbs, past tense and frequency: Tracking down a potential source of NS/NNS competence differences. *Second Language Research* 13(2), 93-115.

Beck, M.-L. 1998. L2 acquisition and obligatory head movement: English-speaking learners of German and the local impairment hypothesis. *Studies in Second Language Acquisition* 20(3), 311-348.

Bellugi, U., Wang, P.P., & Jernigan, T.L. 1994. Williams syndrome: An unusual neuropsychological profile. In S.H. Broman & J. Grafman (Eds.), *Atypical Cognitive Deficits in Developmental Disorders: Implications for Brain Functions.* Hillsdale, NJ: Erlbaum.

Berent, I., Pinker, S. & Shimron, J. 1999. Default nominal inflection in Hebrew: evidence for mental variables. *Cognition*, 72, 1-44.

Berent, I., Pinker, S. & Shimron, J. 2002. The nature of regularity and irregularity: evidence from Hebrew nominal inflection. *Journal of Psycholinguistic Research*, 31(5), 459-502.

Berko, J. 1958. The child's learning of morphology. *Word*, 14, 150-177.

Berkow, R. & Fletcher, A.J. (Eds.) 1992. *The Merck Manual of Diagnosis and Therapy.* Rahway, NJ: Merck Research Labs.

Bialystok, E. 2002. Cognitive Processes of L2 Users. In Cook, V. (Ed.), *Portraits of the L2 User*. Clevedon: Multilingual Matters.

Birdsong, D. & Flege, J.E. 2001. Regular-irregular dissociations in L2 acquisition of English morphology. *BUCLD 25: Proceedings of the 25th Annual Boston University Conference on Language Development*. Boston, MA: Cascadilla Press.

Bromberg, H., Ullman, M.T., Coppola, M., Marcus, G., Kelly, K., & Levine, K. 1994. *A dissociation of memory and grammar: Evidence from Williams syndrome.* Paper presented at the 18th Annual Boston University Conference on Language Development.

Brown, R. 1973. *A First Language.* Cambridge, MA: Harvard University Press.

Bybee, J.L. 1991. Natural morphology: the organisation of paradigms and language acquisition. In Huebner, T. & Ferguson, C. (Eds.), *Crosscurrents in Second Language Acquisition and Linguistic Theories*. Amsterdam: Benjamins.

Carlton, L.E. 1947. Anomalous preterite and past participle forms in the oral language of average fourth grade children. *American Speech* 22, 40-45.

Chomsky, N.A. 1957. *Syntactic Structures.* The Hague: Mouton.

Chomsky, N.A. 1965. *Aspects of the Theory of Syntax*. New York: MIT Press.

Chomsky, N.A. & Halle, M. 1968. *The Sound Patterns of English*. New York: Harper & Row.

Christiansen, M.H. & Chater, N. 1999. Connectionist natural language processing: The state of the art. *Cognitive Science* 23(4), 417-437.

Clahsen, H. 1995. German plurals in adult second language development. In Eubank, L., Selinker, L., & Sharwood Smith, M. (Eds.), *The Current State of Interlanguage: Studies in Honor of William E. Rutherford.* Amsterdam: John Benjamins Publishing.

Clahsen, H. 1997. The representation of German participles in the German mental lexicon: evidence for the dual-mechanism model. *Yearbook of Morphology 1996*, 73-96.

Clahsen, H. 1999. Lexical entries and rules of language: a multidisciplinary study of German inflection. *Behavioral and Brain Sciences,* 22, 991-1060.

Clahsen, H. & Almazan, M. 1998. Syntax and morphology in Williams syndrome. *Cognition*, 68, 167-198.

Clahsen, H. & Almazan, M. 2001. Compounding and inflection in language impairment: Evidence from Williams Syndrome (and SLI). *Lingua*, 111, 729-757.

Clahsen, H. & Rothweiler, M. 1993. Inflectional rules in children's grammars: evidence from German participles. *Yearbook of Mophology 1992*, 1-34.

Clahsen, H. & Temple, C. 2003. Words and rules in children with Williams syndrome. In Levy, Y. & Schaeffer, J. (Eds.), *Language Competence Across Populations.* Mahwah, NJ: Erlbaum Press.

Clahsen, H., Aveledo, F. & Roca, I. 2002. The development of regular and irregular verb inflection in Spanish child language. *Journal of Child Language*, 29, 591-622.

Clahsen, H., Eisenbeiss, S. & Sonnenstuhl, I. 1997. Morphological structure and the processing of inflected words. *Theoretical Linguistics*, 23, 201-249.

Clahsen, H., Marcus, G. & Bartke, S. 1993. Compounding and inflection in German child language. *Essex Research Reports in Linguistics* 1, 1-31.

Clahsen, H., Eisenbeiss, S., Hadler, M., & Sonnenstuhl, I. 2001. The mental representation of inflected words: An experimental study of adjectives and verbs in German. *Lingua* 77(3), 510-543.

Clark, E.V. & Barron, B.J.S. 1988. A thrower-button or a button-thrower? Children's judgement of grammatical and ungrammatical compound nouns. *Linguistics* 26, 3-19.

Di Sciullo, A.M. & Williams, E. 1987. *On the Definition of Word.* Cambridge: MIT Press.

Egedi, D.M. & Sproat, R.W. 1991. *Connectionist Networks and Natural Language Morphology.* Unpublished Manuscript, Murray Hill, NJ: Linguistics Research Department Lucent Technologies.

Elman, J.L. 1990. Finding structure in time. *Cognitive Science* 14, 179-211.

Elman, J.L., Bates, E., Johnson, M., Karmiloff-Smith, A., Parisi, D., & Plunkett, K. 1996. *Rethinking Innateness: A Connectionist Perspective on Development.* Cambridge, MA: MIT Press.

Ervin, S.M. 1964. Imitation and structural change in children's language. In Lenneberg, E.H. (Ed.), *New Directions in the Study of Language*. Cambridge, MA: MIT Press.

Francis, W.N. & Kučera, H. 1982. *Frequency Analysis of English Usage: Lexicon and Grammar.* Boston: Houghton Mifflin.

Frank, M. 1972. *Modern English: A practical reference guide.* Englewood Cliffs: Prentice-Hall.

Gordon, P. 1985. Level-ordering in lexical development. *Cognition* 21,73-93.

Gordon, P. & Alegre, M. 1999. Is there a dual-system for regular inflections? *Brain and Language* 68, 212-217.

Graziano-King, J. 1999. *Acquisition of Comparative Forms in English*. Unpublished PhD dissertation. New York: City University of New York.

Halle, M. & Mohanan, K. 1985. Segmental phonology of modern English. *Linguistic Inquiry*, 16, 57-116.

Hinton, G.E. 1986. Learning distributed representations of concepts. *Proceedings of the Eighth Annual Conference of the Cognitive Science Society.* Hillsdale, NJ: Erlbaum.

Hinton, G.E. 1990. *Connectionist Symbol Processing.* Cambridge, Mass: MIT Press.

Holyoak, K.J. & Hummel, J.E. 2000. The proper treatment of symbols in a connectionist architecture. In Dietrich, E. & Markman, A. (Eds.), *Cognitive Dynamics: Conceptual Change in Humans and Machines.* Mahwah, NJ: Erlbaum.

Jaeger, J.J., Lockwood, A.H., Kemmerer, D.L., Van Valin Jr., R.D., Murphy, B.W., & Khalak, H.G. 1996. A positron emission tomographic study of regular and irregular verb morphology in English. *Language*, 72, 451-497.

Johnson, J.S. & Newport, E.L. 1989. Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology* 21, 60-99.

Juffs, A. 2001. Psycholinguistically oriented second language research. *Annual Review of Applied Linguistics* 21, 207-220.

Kempley, S. & Morton, J. 1982. The effects of priming with regularly and irregularly related words in auditory word recognition. *British Journal of Psychology* 77, 441-454.

Kırkıcı, B. 2002. *The Mental Representation of L2 English Past Tense Morphology: A Psycholinguistic Analysis*. Unpublished MA dissertation, Colchester: University of Essex.

Kim, J.J., Marcus, G.F., Pinker, S., Hollander, M. & Coppola, M. 1994. Sensitivity of children's inflection to grammatical structure. *Journal of Child Language*, 21, 173-209.

Kiparsky, P. 1982. Lexical phonology and morphology. In I.S. Yang (Ed.), *Linguistics in the Morning Calm*. Seoul: Hansin.

Lachter, J. & Bever, T. 1988. The relationship between linguistic structure and associative theories of language learning – a constructive critique of some connectionist learning models. *Cognition*, 28, 195-247.

Lardiere, D. 1994. *The Acquisition of Word-formation Rules for English Synthetic Compounding*. PhD Dissertation, Boston University.

Lardiere, D. 1995. L2 acquisition of English synthetic compounding is not constrained by level-ordering (and neither, probably, is L1). *Second Language Research* 11 (1), 20-56.

Leonard, L.B. 1998. *Children with Specific Language Impairment*. Cambridge, Mass.: MIT Press.

Lowie, W. 1998. *The Acquisition of Interlanguage Morphology*. Unpublished PhD dissertation. Groningen: University of Groningen.

MacWhinney, B. 1993. Connections and symbols: closing the gap. *Cognition*, 49, 291-296.

MacWhinney, B. & Leinbach, J. 1991. Implementations are not conceptualisations: Revising the verb learning model. *Cognition,* 40, 121-157.

Marcus, G.F. 1995a. The acquisition of the English past tense in children and multi-layered connectionist networks. *Cognition*, 56, 271-279.

Marcus, G.F. 1995b. Children's overregularizations of English plurals: A quantitative analysis. *Journal of Child Language*, 22, 447-459.

Marcus, G.F. 1995c. L2 learners treat regular and irregular inflection differently in compounding. *Second Language Research* 11, 88-89.

Marcus, G.F. 1998. Rethinking eliminative connectionism. *Cognitive Psychology*, 37, 243-282.

Marcus, G.F. 2000. Children's overregularisation and its implication for cognition. In Broeder P. & Murre, J. (Eds.), *Models of Language Acquisition*. Oxford: Oxford University Press.

Marcus, G.F. 2001. *The Algebraic Mind: Integrating Connectionism and Cognitive Science*. Cambridge, Mass: Bradford.

Marcus, G.F., Pinker, S., Ullman, M., Hollander, M., Rosen, T.J., & Xu, F. 1992. Overregularization in language acquisition. *Monographs of the Society for Research in Child Development*, 57(4), Serial No. 228.

Marcus, G.F., Brinkmann, U., Clahsen, H., Wiese, R., & Pinker, S. 1995. German inflection: The exception that proves the rule. *Cognitive Psychology*, 29, 189-256.

Marslen-Wilson, W.D. & Tyler, L.K. 2003. Capturing underlying differentiation in the human language system. *Trends in Cognitive Science* 7(2), 62-63.

Marslen-Wilson, W.D, Hare, M. & Older, L. 1993. Inflectional morphology and phonological regularity in the English mental lexicon. *Proceedings of the Fifteenth Annual Conference of the Cognitive Science Society.* Hillsdale: Erlbaum.

Matthews, P.H. 1974. *Morphology*. Cambridge: Cambridge University Press.

McCann, R.S. & Besner, D. 1987. Reading pseudohomophones: Implications for models of pronunciation assembly and the locus of word frequency effects in naming. *Journal of Psychology: Human Perception and Performance* 13, 13-24.

McCann, R.S., Besner, D. & Davelaar, E. 1988. Word recognition and identification: Do word-frequency effects reflect lexical access? *Journal of Psychology: Human Perception and Performance* 14, 693-706.

McClelland, J.L. & Patterson, K. 2002. Rules or connections in past-tense inflections: what does the evidence rule out? *Trends in Cognitive Science* 6(11), 465-472.

Menyuk, P. 1964. Comparison of grammar of children with functionally deviant and normal speech. *Journal of Speech and Hearing Research*, 7, 109-121.

Miller, G. & Chomsky, N. 1963. Finitary models of language user. In Luce, R., Bush, R. & Galanter, E. (Eds.), *Handbook of Mathematical Psychology*. Wiley.

Miozzo, M. 2003. On the processing of regular and irregular forms of verbs and nouns: evidence from neuropsychology. *Cognition* 87, 101-127.

Moe, A.J., Hopkins, C.J. & Rush, R.T. 1982. *The Vocabulary of First-Grade Children.* Springfield: Charles C. Thomas Publisher.

Mohanan, K.P. 1982. *Lexical Phonology.* Bloomington: Indiana University Linguistics Club.

Murphy, V.A. 2000. Compounding and the representation of L2 inflectional morphology. *Language Learning* 50(1), 153-197.

Murphy, V.A. 2004. Dissociable systems in second language inflectional morphology. *Studies in Second Language Acquisition*, 26, 433-459.

Newman, A., Neville, H., & Ullman, M.T. 1998. Neural processing of inflectional morphology: An event related potential study of English past tense. Paper presented at the *5th Annual Meeting of the Cognitive Neuroscience Society*, San Francisco.

Nooteboom, S., Weerman, F., & Wijnen, F. 2002. Minimising or maximising storage? An introduction. In Nooteboom, S., Weerman, F., & Wijnen, F. (Eds.), *Storage and Computation in the Language Faculty*. Dordrecht: Kluwer Academic Publishers.

Orsolini, M. & Marslen-Wilson, W. 1997. Universals in morphological processing: evidence from Italian inflection. *Language and Cognitive Processes* 12(1), 1-47.

Penke, M. & Krause, M. 2002. German noun plurals: a challenge to the dual-mechanism model. *Brain and Language,* 81, 303-311.

Penke, M., Weyerts, H., Gross, M., Zander, E., Münte, T. & Clahsen, H. 1997. How the brain processes complex words: an ERP study of German verb inflections. *Cognitive Brain Research*, 6, 37-52.

Pesetsky, D. 1979. *Russian Morphology and Lexical Theory*. Manuscript. Cambridge, Mass: MIT.

Pinker, S. 1984. *Language Learnability and Language Development*. Cambridge, MA: Harvard University Press.

Pinker, S. 1991. Rules of language. *Science*, 253, 530-535.

Pinker, S. 1999. *Words and Rules: The Ingredients of Language*. New York: Basic Books.

Pinker, S. 2001. Four decades of rules and associations or whatever happened to the past tense debate? In Dupoux, E. (Ed.), *Language, Brain, and Cognitive Development. Essays in Honour of Jacques Mehler*. Cambridge, MA: Cambridge University Press.

Pinker, S. & Prince, A.S. 1988. On language and connectionism: Analysis of a parallel distributed processing model of language acquisition. *Cognition* 28, 73-193.

Pinker, S. & Prince, A.S. 1991. Regular and irregular morphology and the psychological status of rules of grammar. In Sutton, L.A., Johnson, C., & Shields, R. (Eds.), *Proceedings of the 17th Annual Meeting of the Berkeley Linguistics Society*. Berkeley, CA: Berkeley Linguistics Society.

Pinker, S. & Prince, A. 1992. Regular and irregular morphology and the psychological status of rules of grammar. In Sutton, L.A., Johnson, C., & Shields, R. (Eds.), *Proceedings of the 17th Annual Meeting of the Berkeley Linguistics Society.* Berkeley: Berkeley Linguistics Society.

Pinker, S. & Ullman, M.T. 2002. The past and future of the past tense. *Trends in Cognitive Science* 6(11), 456-463.

Plunkett, K. & Marchman, V. 1991. U-shapd learning and frequency effects in a multilayered perceptron: Implications for child language acquisition. *Cognition*, 38, 43-102.

Plunkett, K. & Marchman, V. 1993. From rote learning to system building: Acquiring verb morphology in children and connectionist nets. *Cognition*, 48, 21-69.

Plunkett, K. & Juola, P. 1999. A connectionist model of English past tense and plural morphology. Cognitive Science 23(4), 463-490.

Prasada, S. & Pinker, S. 1993. Generalisation of regular and irregular morphological patterns. *Language and Cognitive Processes*, 8, 1-56.

Prasada, S., Pinker, S., & Snyder, W. 1990. Some evidence that irregular forms are retrieved from memory but regular forms are rule-generated. Paper presented to the *Annual Meeting of the Psychonomic Society*, New Orleans.

Rice, M., Wexler, K. & Cleave, P. 1995. SLI as a period of extended optional infinitive. *Journal of Speech and Hearing Science,* 38, 850-863.

Rosenblatt, F. 1962. *Principles of Neurodynamics*. New York: Spartan Books.

Rumelhart, D.E. & McClelland, J.L. 1986. On learning the past tenses of English verbs. In McClelland, J.L., Rumelhart, D.E., & PDP Research Group (Eds.), *Parallel Distributed Processing: Explorations in the Microstructure of Cognition* (Vol.2). Cambridge, MA: Bradford/MIT Press.

Rumelhart, D.E. & McClelland, J.L. 1987. Learning the past tense of English verbs: implicit rules or parallel distributed processing? In MacWhinney, B. (Ed.), *Mechanisms of Language Acquisition*. Hillsdale, NJ: Erlbaum.

Rumelhart, D.E., Hinton, G.E. & Williams, R.J. 1986. Learning representations by back-propagating errors. *Nature* 323, 533-536.

Say, T. 2000. *The Mental Representation of Italian Morphology: Evidence for the Dual-Mechanism Model.* Unpublished Ph.D. dissertation, Colchester: University of Essex.

Say, T. & Clahsen, H. 2002. Words, rules and stems in the Italian mental lexicon. In Nooteboom, S., Weerman, F. & Wijnen, F (Eds.), *Storage and Computation in the Language Faculty.* Dortrecht: Kluwer Academic Publishers.

Schneider, W., Eschman, A. & Zuccolotto, A. 2002a. *E-Prime User's Guide*. Pittsburgh: Psychology Software Tools Inc.

Schneider, W., Eschman, A. & Zuccolotto, A. 2002b. *E-Prime Reference Guide*. Pittsburgh: Psychology Software Tools Inc.

Seidenberg, M.S. & Elman, J.L. 1999. Networks are not "hidden rules." *Trends in Cognitive Science* 3, 288-289.

Seidenberg, M.S. & Hoeffner, J.H. 1998. Evaluating behavioural and neuroimaging data on past tense production. *Language*, 74, 104-122.

Siegel, D. 1974. *Topics in English Morphology.* Doctoral Dissertation. Cambridge, Mass: MIT.

Sonnenstuhl, I. & Huth, A. 2002. Processing and representation of German –n plurals: a dual mechanism approach. *Brain and Language,* 81, 276-290.

Sonnenstuhl, I., Eisenbeiss, S. & Clahsen, H. 1999. Morphological priming in the German mental lexicon. *Cognition*, 72, 203–236.

Spencer, A. 1991. *Morphological Theory*. Oxford: Blackwell.

Sproat, R. 1992. *Morphology and Computation*. Cambridge, MA: MIT Press.

Stanners, R.F., Neiser, J.J., Hernon, W.P. & Hall, R. 1979. Memory representations for morphologically related words. *Journal of Verbal Learning and Verbal Behaviour* 18, 399-412.

Stemberger, J.P. & MacWhinney, B. 1988. Are inflected forms stored in the lexicon? In Hammond, M. & Noonan, M. (Eds.), *Theoretical Morphology: Approaches in Modern Linguistics*. New York: Academic Press.

Taatgen, N.A. 2001. Extending the past-tense debate: a model of the German plural. In Moore, J.D. & Stenning, K. (Eds.), *Proceedings of the 23rd Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Erlbaum.

Taft, M. 1991. *Reading and the mental lexicon*. Hove and London: Lawrence Erlbaum Associates.

Taylor, J.R. 2002. *Cognitive Grammar.* Oxford: Oxford University Press.

Touretzky, D.S. & Hinton, G.E. 1988. A distributed connectionist production system. *Cognitive Science* 12, 423-466.

Ullman, M.T. 1999. Acceptability ratings of regular and irregular past-tense forms: Evidence for a dual-system model of language from word frequency and phonological neighbourhood effects. *Language and Cognitive Processes* 14(1), 47-67.

Ullman, M.T. 2001a. The declarative/procedural model of lexicon and grammar. *Journal of Psycholinguistic Research* 30(1), 37-69.

Ullman, M.T. 2001b. The neural basis of lexicon and grammar in first and second language: the declarative/procedural model. *Bilingualism* 4(2), 105-122.

Ullman, M.T. 2001c. A neurocognitive perspective on language: the declarative/procedural model. *Natural Review Neuroscience* 2, 717-726.

Ullman, M.T. 2004. Contributions of memory circuits to language: the declarative/procedural model. *Cognition* 92, 231-270.

Ullman, M.T. & Gopnik, M. 1999. Inflectional morphology in a family with inherited specific language impairment. *Applied Psycholinguistics*, 20, 51-117.

Ullman, M.T., Corkin, S., Pinker, S., Coppola, M., Locascio, J., & Growdon, J.H. 1993. Neural modularity in language: Evidence from Alzheimer's and Parkinson's diseases. *Society for Neuroscience Abstracts*, 19, 1806.

Ullman, M.T., Corkin, S., Coppola, M., Hickok, G, Growdon, J.H., Koroshetz, W.J. & Pinker, S. 1997. A neural dissociation within language: evidence that the mental dictionary is part of declarative memory, and that grammatical rules are processed

by the procedural system. *Journal of Cognitive Neuroscience* 9(2), 266-276.

Urano, K. 2002. Level-ordering effect in SLA: Representation of L2 inflectional morphology. Unpublished Manuscript. University of Hawai'i.

van der Lely, H.K.J. & Ullman, M.T. 2001. Past tense morphology in specifically language impaired and normally developing children. *Language and Cognitive Processes* 16(2/3), 177-217.

Weyerts, H. 1997. *Raguläre und Irreguläre Flexion: Psycholinguistische und Neurophysiologische Ergebnisse zu Erwerb, Verarbeitung und Mentaler Repräsentation* [Regular and Irregular Inflection: Psycholinguistic and Neurophysiological Results Concerning the Acquisition, Processing and Representation]. Unpublished Ph.D. Dissertation, Düsseldorf: University of Düsseldorf.

Weyerts, H. & Clahsen H. 1994. Netzwerke und symbolische Regeln im Spracherwerb: Experimentelle Ergebnisse zur Entwicklung der Flexionsmorphologie [Networks and symbolic rules in language acquisition: experimental results concerning the development of inflectional morphology]. *Linguistische Berichte,* 154, 430-460.

Weyerts, H., Penke, M., Dohrn, U., Clahsen, H. & Münte, T. 1997. Brain potentials indicate differences between regular and irregular German noun plurals. *NeuroReport,* 8, 957-962.

Wiese, R. 1996. Phrasal compounds and the theory of word syntax. *Linguistic Inquiry,* 27, 183-193.

Wunderlich, D. 1999. German noun plural reconsidered (Commentary on Clahsen, 1999). *Behavioral and Brain Sciences,* 22, 1044-1045.

Xu, F. & Pinker, S. 1995. Weird past tense forms. *Journal of Child Language*, 22, 531-556.

Zobl, H. 1998. Representational changes: From listed representations to independent representations of verbal affixes. In Beck, M.-L. (Ed.), *Morphology and its Interfaces in Second Language Knowledge*. Amsterdam: John Benjamins Publishing.

APPENDICES

APPENDIX A

Stem Frequencies and Past Tense Frequencies for Low and High Frequency Regular Verbs[74] (Experiment 1)

Low Frequency Stimuli			High Frequency Stimuli		
Verb	**Stem Freq.**	**Past Tns. Freq.**	**Verb**	**Stem Freq.**	**Past Tns. Freq.**
own	20	14	point	25	45
print	3	8	shout	4	32
hunt	5	2	pause	5	24
boil	7	1	laugh	7	40
sail	6	7	climb	9	36
hire	14	6	roll	16	32
aid	21	2	sound	21	28
flow	13	4	jump	13	31
view	18	2	cross	23	25
join	60	33	pass	62	88
fill	46	30	call	44	155
match	26	1	drop	30	66
save	52	10	love	49	42
Means:	**20**	**8.47**		**21.4**	**45.2**

[74] All frequencies: out of 1,189,209 total words in the Brown Corpus.

APPENDIX B

Stem Frequencies and Past Tense Frequencies for Low and High Frequency Irregular Verbs[75] (Experiment 1)

Low Frequency Stimuli			High Frequency Stimuli		
Verb	**Stem Freq.**	**Past Tns. Freq.**	**Verb**	**Stem Freq.**	**Past Tns. Freq.**
bind	2	5	flee	1	22
quit	10	2	sink	10	17
lend	13	3	ring	7	17
cost	28	10	ride	30	39
deal	45	7	win	52	46
bear	41	12	drive	43	54
fight	40	22	draw	40	59
sell	38	20	catch	37	46
sing	26	28	wear	32	62
eat	55	13	sit	61	112
feed	58	8	send	65	65
speak	101	79	stand	103	184
keep	222	103	tell	219	257
Means:	**52.3**	**24**		**53.85**	**75.38**

[75] All frequencies: out of 1,189,209 total words in the Brown Corpus.

APPENDIX C

Real-Word Fillers (Experiment 1)

Nouns	Adjectives
house	short
pen	tall
car	black
board	white
name	blue
plane	fast
class	quick
school	slow
exercise	long
train	fat

APPENDIX D

Nonce Regular Fillers:
Stem and Past Tense Forms(Experiment 1)[76]

Intermediate Pseudo-regulars		Distant Pseudo-regulars	
Stem Forms	**Past Forms**	**Stem Forms**	**Past Forms**
brilth	brilthed	frilg	frilged
glinth	glinthed	krilg	krilged
plimph	plimphed	trilb	trilbed
ploab	ploabed	ploamph	ploamphed
ploag	ploaged	ploanth	ploanthed
smeeb	smeebed	smeelth	smeelthed
smeeg	smeeged	smeenth	smeenthed
smeej	smeejed	smeerg	smeerged
smaib	smaibed	smairg	smairged
smaig	smaiged	smairph	smairphed

[76] Adapted from Prasada & Pinker (1993).

APPENDIX E

Nonce Irregular Fillers:
Stem and Past Tense Forms(Experiment 1)[77]

Intermediate Pseudo-irregulars		Distant Pseudo-irregulars	
Stem Forms	**Past Forms**	**Stem Forms**	**Past Forms**
fring	frung	trisp	trusp
ning	nung	nist	nust
frink	frunk	blip	blup
cleef	clef	gleef	glef
preek	prek	keeb	keb
queef	quef	meep	mep
foa	foo	goav	goov
voa	voo	joam	joom
jare	jore	flape	flope
grare	grore	blafe	blofe

[77] Adapted from Prasada & Pinker (1993).

APPENDIX F

Participant Consent Form

Project Title: **The Mental Representation of L2 Inflectional Morphology**

1. I have been informed about the aim of this project by **Bilal Kırkıcı** and all of my questions have been clearly answered.
2. I know that I am participating on a voluntary basis and that I can withdraw from the study any time.
3. I have been given a copy of this consent form.

Surname, Name:

Signature:

Date:

APPENDIX G

Katılımcı Rıza Formu

Proje Başlığı: **İkinci Dil'de Çekim Eklerinin Zihinsel Gösterimi**

1. Bu projenin amacı ve katılımcı olarak benden beklenenler bana **Bilal Kırkıcı** tarafından anlatıldı ve sorularım cevaplandırıldı.
2. Katılımımın tamamiyle gönüllü olduğunu ve projeden istediğim zaman ayrılabileceğimi biliyorum.
3. Bana bu rıza formunun bir kopyası verildi.

İsim:

İmza:

Tarih:

APPENDIX H

Practice Items for Compounding Task
(Experiment 2)

1. What do you call a person who teaches English?
2. What do you call a person who drinks wine?
3. What do you call a person who eats meat?
4. What do you call a person who sells cheese?
5. What do you call a person who buys air?
6. What do you call a person who paints water?
7. What do you call a person who produces milk?

APPENDIX I

Experimental Items for Compounding Task
(Experiment 2)

What do you call…

1. a person who wears dresses?
2. a person who wears pants?
3. a person who washes hands?
4. a person who washes feet?
5. a person who hates animals?
6. an animal that hates people?
7. a person who catches fish?
8. a person who catches sheep?
9. a person who loves boys?
10. a person who loves women?
11. a person who protects children?
12. a person who protects babies?
13. a mouse that watches cats?
14. a cat that watches mice?
15. a person who breaks teeth?
16. a person who breaks bones?
17. a person who cleans clothes?
18. a person who cleans shoes?
19. a person who kicks men?
20. a person who kicks students?
21. a person who shakes hands?
22. a person who shakes heads?
23. a person who likes seas?
24. a person who likes winters?
25. a person who checks eyes?
26. a person who checks words?

APPENDIX J

Turkish Summary

Giriş ve Kuramsal Artalan

Dilsel ve özellikle de biçimbilimsel bilgilerin insan zihninde ne şekilde işlemlendiği uzun süredir dilbilim ve psikodilbilim alanlarında bir tartışma konusudur. Bu tartışmanın özünde, daha geleneksel dilbilimsel ve bilişsel kuramlarda sıkça başvurulan dilbilgisel 'kurallar'ın gerçekte insan zihni tarafından kullanılıp kullanılmadığı sorusu yatmaktadır. Dil, uzun bir süre neredeyse tamamen kurallardan oluşan bir bilişsel yeti olarak görülmüş ve özellikle Chomsky tarafından 1950'lerden itibaren geliştirilen ve çok etkili olan dilbilimsel kuramlarda (ör: Chomsky, 1957, 1965) neredeyse tamamen kurallarla işleyen bir yeti olarak açıklanmıştır. Ancak, 1980'lerde çağrışımcı ağlar (İng. associative networks) vasıtasıyla gerçekleştirilen dilbilimsel ve biçimbilimsel modellemeler sonucunda (ör: Rumelhart ve McClelland'ın 1986'da gerçekleştirdikleri İngilizce geçmiş zaman edinimi modeli), geleneksel olarak dilbilimsel kuramlarda önemli bir yer kaplayan kuralların psikolojik gerçeklikleri tartışılmaya başlanmış ve çağrışımcı kuramlar gittikçe ön plana çıkmıştır. Çağrışımcı ağları destekleyen kuramlara göre, tüm dilsel bilgiler zihinde çağrışımcı prensipler üzerine kurulu olan ve kullanım sıklığı ve fonolojik benzerlik gibi özelliklere çok hassas olan bir ağ üzerinden işlemlenir. Buna göre, daha geleneksel dilbilimsel kuramlarda var olan zihinsel dilbilgisi-zihinsel sözlük ayrımı yoktur, biçimbilimsel açıdan basit ve karmaşık kelime

ayrımı yoktur ve gerçekte insan zihni dilsel işlemler gerçekleştirirken kurallara başvurmaz – kurallar tamamen betimsel araçlardır.

Çağrışımcı ağlar üzerine kurulan kuramların yarattığı bilimsel ve felsefi tartışmalar, bir süre sonra kuralların insan zihnindeki rolünü ve psikolojik gerçekliğini savunan kuramların ve söylemlerin yeniden ortaya çıkmasına sebep oldu. Özellikle Rumelhart ve McClelland (1986) tarafından geliştirilen ve İngilizce'deki geçmiş zamanın ediniminin bir simülasyonu olan model çok yoğun eleştirilere maruz kalmış ve ortaya çıkartılan eksiklikleri salt çağrışımcı prensipler üzerine kurulu olup kuralları tamamiyle yok sayan kuramlara karşı kanıt olarak kullanılmıştır (ör: Pinker & Prince, 1988; Lachter & Bever, 1988). Ancak, yapılan incelemelerde Rumelhart ve McClelland modelinin düzenli fiillerin geçmiş zaman hallerinin (ör: *talk-talked*, *paint-painted*) ediniminin simülasyonunda çok ciddi sorunlar yaşarken, düzensiz fillerde (ör: *sing-sangt,bring-brought)* çok isabetli sonuçlara vardığı gözlemlendi. Bunun neticesinde, Pinker ve arkadaşları (ör: Pinker & Prince, 1991), içinde hem kurallar hem de çağrışımcı prensipler barındıran bir karma model geliştirdiler. Adı *İkili Mekanizma Modeli* (İng. Dual-Mechanism Model) olan bu modele göre, düzenli yapılar geleneksel dilbilimsel modellerdeki gibi kurallar vasıtasıyla işlemlenirken, düzensiz yapılar çağrışımcı ağlar üzerine kurulan kuramlarda öne sürülen biçimlere benzer şekillerde zihinsel sözlükte depolanmaktadırlar. Örneğin, İngilizce'de düzenli bir fiil olan *talk*'ı geçmiş zamana çevirmek için İngilizcedeki geçmiş zaman kuralı olarak kabul edilen "fiil gövdesine -ed ekini ekle" kuralı işletilirken ve böylece *talked* fiili zihinsel dilbilgisinden gelen kural ve zihinsel sözlükten gelen fiil gövdesinin birleşmesiyle oluşturulurken, düzensiz bir fiil olan *sing*'in hem fiil gövdesi hem de geçmiş zaman hali olan *sang* hazır bir şekilde zihinsel sözlükte bulunmakta. Aynı şekilde, düzenli bir isim olan *chair*'i çoğullaştırmak için İngilizcedeki çoğullaştırma kuralı olarak kabul edilen "isim gövdesine –s ekini ekle" kuralı işletilirken,

düzensiz bir isim olan *child*'ın hem isim gövdesi hem de çoğul hali olan *children* hazır bir şekilde zihinsel sözlükte bulunmakta.

**Childs* veya **singed* gibi, düzensiz olduğu halde düzenli muamelesi görüp söz konusu eki almış yapıların (yani *aşırı düzenlileştirilmiş* yapıların, İng. *over-regularised*) engellenmesi ise *engelleme mekanizması* (İng. *blocking mechanism)* olarak adlandırılan bir mekanizma sayesinde gerçekleştirilmekte. Buna göre, zihinsel sözlükte bir düzensiz yapıya ulaşılabilinmesi halinde engelleme mekanizması devreye giriyor ve düzenli kuralın (ör: geçmiş zamandaki –ed ekininin eklenmesini emreden kuralının) uygulanmasını engelliyor. Böylelikle de *aşırı düzenlileştirilmiş* yapıların ortaya çıkması engellenmiş oluyor. Ancak eğer zihinsel sözlükte bir sebepten dolayı düzensiz bir kelimenin çekimlenmiş hali bulunmuyorsa, ki buna çeşitli faktörler sebep olabilir (ör: kalıtsal zihinsel rahatsızlıklar, beyin travmaları, kelimenin henüz öğrenilmemiş olması, vs.), o zaman söz konusu kelime gövdesine düzenli ek getirilme ihtimali (ör: *singed*), yani aşırı düzenlileştirmeye gidilmesi, ikili mekanizma kuramına göre yüksek.

Özetle, ikili mekanizma modelinin en temel savı düzenli ve düzensiz yapıların iki farklı mekanizma tarafından yürütüldüğüdür. Mekanizmaların biri kural işleten bir dilbilgisel mekanizma iken, öteki mekanizma kelimelere doğrudan çağrışımcı özelliklere sahip bir bellekten erişen bir zihinsel dilbilgisi mekanizmasıdır. Çağrışımlar sık tekrarlarla ve benzerliklere bağlı olarak güçlendiklerinden, çağrışımcı belleğe kaydedilen yapıların sıklık ve benzerlik gibi faktörlerden etkilenmeleri beklenmektedir. Örneğin, bellekte bulunan ve daha sık rastlanılan kelimelerin daha nadir rastlanılanlardan daha iyi ve daha çabuk hatırlanacakları beklenmekte. Ancak aynı beklenti kurallar sonucu oluşan yapılar için söz konusu değildir çünkü aynı kuralın farklı kelime gövdelerine uygulanmasının aynı sürede gerçekleşmesi beklenmektedir.

İkili Mekanizma modelinin geliştirilmesinden bu yana, bu kuramın geçerliliğini gerek İngilizce gerekse başka dillerde inceleyen çok sayıda bilimsel çalışma gerçekleştirilmiştir. Çocuk anadil edinimi, çocuk ve yetişkinlerle gerçekleştirilen psikodilbilimsel deneyler, ve sinirdilbilimsel deneyler olarak üçe ayrılan bu çalışmaların sonucunda genel olarak İkili Mekanizma modelini destekler nitelikte sonuçlar elde edilmişse de, bazı araştırmaların sonuçları bu kuramın geçerliliğinin sorgulanmasına yol açmışlardır. İlgili literatürde, İkili Mekanizma modelini İngilizce'nin anadil olarak edinimi çerçevesinde inceleyen ve söz konusu kuramı destekler sonuçlara ulaşan araştırmaların arasında en sık anılanları Marcus ve diğerleri (1992), Marcus (1995) ve Xu & Pinker (1995)'tir. İspanyolca'nın anadil olarak edinimini inceleyen Clahsen ve diğerleri (2002) ve Almanca'nın anadil olarak edinimini inceleyen Clahsen & Rothweiler (1992) ve Weyerts (1997) de benzer bir şekilde ikili mekanizma modelinin geçerliliğini kanıtlayan sonuçlara varmışlardır. İkili mekanizma modelini anadil edinimi çerçevesinde inceleyen çalışmaların arasında modelin temel savlarını reddeden bir araştırmaya rastlanılmamıştır. Benzer biçimde, çocuklar ve yetişkinlerle yürütülen psikodilbilimsel ve sinirdilbilimsel çalışmalar da genel olarak ikili mekanizma modelini destekler nitelikte sonuçlara ulaşmıştır.

Amaç ve Biçimbilimsel Odak

Bugüne kadar İkili Mekanizma Kuramı'nı irdelemek üzere yürütülen çalışmaların çok büyük bir bölümü inceleme alanı olarak anadili seçmiştir ve ikinci dil araştırmaları çoğunlukla ihmal edilmiştir. İkili mekanizma kuramının geçerliliğini ikinci dil konuşucuları üzerinde inceleyen araştırmalar ancak son on yıldır ivme kazanmıştır (ör: Clahsen, 1995; Beck, 1997; Zobl, 1998; Kırkıcı, 2002), fakat bu araştırmalar hem sayıca yetersiz kalmaktadırlar, hem de elde edilen sonuçlar bugüne kadar çok

çelişkili ve tartışmalara açık bir tablo çizmiştir. Bazı çalışmalar İkili Mekanizma kuramının ikinci dil için geçerliliğini destekler bulgulara erişirken, bazı araştırmalarda ortaya çıkan sonuçlar bu kuramın ikinci dildeki geçerliliğinin ciddi bir şekilde sorgulanmasına yol açmıştır.

Bu çalışmanın temel amacı ikili mekanizma modelinin ikinci dil için geçerliliğini incelemek ve böylece bugüne değin elde edilen karmaşık sonuçların netleşmesine katkı sağlamaktı. Yukarıda anlatıldığı gibi, ikili mekanizma kuramının en temel savı düzenli ve düzensiz dilsel yapıların iki farklı mekanizmanın ürünleri olduklarıdır. Dolayısıyla da, kişilerin düzenli ve düzensiz yapıları farklı şekilde kullanmaları ve gerek algılamakta gerekse üretimde net bir şekilde ayırt etmeleri gerekmektedir. Bu amaç doğrultusunda, ikili mekanizma kuramının öne sürdüğü düzenli-düzensiz yapı ayrımının incelenebileceği iki biçimbilimsel yapı seçildi. Bunlar, daha evvel de bu yöndeki araştırmalara konu olan *İngilizce geçmiş zaman* ve *İngilizce bileşik adlar* olarak belirlendi.

İkiliz mekanizma çerçevesinde yürütülmüş olan çalışmaların büyük bir çoğunluğu İngilizce geçmiş zamanı incelediklerinden, bu proje için de biçimbilimsel araştırma odaklarından birini İngilizce geçmiş zaman teşkil etti. Bunun en büyük avantajı, ortaya çıkacak sonuçların daha önce yapılmış çalışmalarla beraber karşılaştırmalı olarak değerlendirilebilecek olmalarıydı. Yukarıda İngilizce geçmiş zamanın özellikleri ve ikili mekanizmanın geçmiş zaman için varsayımları özetlendiğinden, bunlar burada tekrar edilmeyecektir.

İngilizce'deki geçmiş zamana ek olarak, ikinci biçimbilimsel araştırma odağı olarak İngilizce'deki bileşik adlar'ın (ör: *wind-breaker, mice-chaser*) incelenmesine karar verildi. İngilizce'yi anadil olarak konuşan yetişkinlerde ve çocuklarda gözlemlenen önemli bir özellik, bileşik adlarda yer alan baş olamayan düzenli adları çoğullaştırmadan kaçındıkları, fakat

aynı eğilimin düzensiz adlar için söz konusu olmadığıdır (ör: Gordon, 1985). İkili mekanizma kuramı açısından, bu eğilim kuramın öne sürdüğü düzenli-düzensiz ayırımının ve bu yapıların zihinde işlemlenmelerinin doğal bir yansımasıdır. Kurama göre düzensiz adların hem gövdeleri hem de çoğullaştırılmış halleri zihinsel sözlükte depolandığından, bunların gerek tekil gerekse çoğul halde bileşik adlarda yer almaları (ör: *mouse-chaser* ve *mice-chaser*) bir sorun teşkil etmemektedir. Ancak, kurama göre düzenli adların sadece gövdeleri, dolayısıyla da tekil halleri, zihinsel sözlükte bulunduğundan, çoğul adların ise zihinsel dilbilgisinden gelen bir biçimbilimsel ek vasıtasıyla oluşturulduklarından, düzensiz çoğul adların bileşik adlarda yer almaları mümkünken düzenli çoğul adlar için bu mümkün değil. Gerçekten de çeşitli zamanlarda yapılan deneylerde (ör: Lardiere, 1995; Murphy, 2000) İngilizce'yi anadili olarak konuşan kişilerin düzenli çoğul adları hemen hemen hiç bileşik ad yapıları içinde kullanmadıkları, düzensiz çoğul adların ise çeşitli oranlarda bileşik ad yapıları içerisinde kullanıldıkları bulunmuştur. İngilizce'yi ikinci dil olarak kullanan kişilerle yapılan çalışmalarda da benzer bir eğilim ortaya çıkmıştır, ancak bu eğilimin anadil kullanıcılarına göre daha az keskin olduğu ortaya çıkmıştır. Lardiere (1995) ve Murphy (2000)'nin anadilleri İspanyolca, Çince ve Fransızca olan deneklerle yaptıkları deneylerde düzenli çoğul isimlerin İngilizce bileşik adlarda kullanım oranlarının sırasıyla %70, %30 ve %46 iken aynı oranların düzensiz çoğul adlar için sırasıyla %90, %65 ve %74 olduğu belirlenmiştir. Her üç gurupta da düzenli ve düzensiz adlar arasında anlamı bir fark ortaya çıktığından, bu sonuçların ikili mekanizmayı destekledikleri kabul edilmiştir.

Çalışmanın ikincil bir amacı, Zobl (1998) tarafından ortaya atılan ve ikili mekanizmanın ikinci dil konuşucularında dil seviyelerine göre farklılıklar gösterdiğini iddia eden kuramı incelemekti. Zobl'a göre ikinci dil seviyeleri düşük olan kişilerde ikili mekanizmanın sadece çağrışımcı belleği işlevseldir ve gerek düzenli gerekse düzensiz yapılar tümüyle bu

çağrışımcı bellek vasıtasıyla işlemlenmektedirler. Kural mekanizması ise belirli bir ikinci dil seviyesine erişilene kadar işlevsel değildir. Bu amaç doğrultusunda, aşağıda da anlatılacağı gibi, bu çalışma için ikinci dil seviyeleri birbirilerinden farklı iki ikinci dil denek gurubu seçilmiştir.

Denekler

Yukarıda bahsedilen amaçlar doğrultusunda, anadilleri Türkçe olan 46 ve anadilleri İngilizce olan 6 kişiyle iki deney yürütülmüştür. Anadilleri Türkçe olan denek gurubunun tümü Orta Doğu Teknik Üniversitesi'nde eğitimlerini sürdüren ve bu projeye gönüllü olarak katılan öğrencilerden oluştu. Bunların 22'si İngilizce bilgisi düşük olup eğitimlerini ODTÜ Yabancı Diller Yüksek Okulu'ndaki en düşük İngilizce kurunda sürdüren öğrencilerdi. Bu öğrencilerin ODTÜ İngilizce Seviye Tespit Sınavından elde ettikleri sonuçlar 20-25/100 seviyesindeydi ve İngilizce seviyeleri düşük olan ikinci dil denek gurubunu oluşturdular. Geriye kalan 24 öğrenci ise ODTÜ Eğitim Fakültesi, İngilizce Öğretmenliği bölümünde okuyup İngilizce seviyeleri yüksek olan gurubu oluşturdu. Bu öğrenci gurubunun ODTÜ İngilizce Seviye Tespit Sınavı ortalaması 85.6/100 (69.5-97) olarak tespit edilmiştir. Bu şekilde İngilizce dil seviyesine bağlı olarak iki gurubun oluşturulmasının sebebi, yukarıda bahsedilen Zobl (1998) tarafından ortaya atılmış olan kuramın geçerliliğinin incelenmesidir.

Anadilleri İngilizce olan 6 kişiyi bu çalışmaya dahil etme amacı, sonuçları karşılaştırabilecek bir kontrol gurubunun oluşturulmasıydı. Bu 6 kişinin tümü Ankara'da Türk-İngiliz Kültür Derneği'nde görev yapan ve yaş ortalamaları 38.5 (24-72) olan İngilizce öğretmenleriydi. Bu 6 deneğin 4'ü Amerika Birleşik Devletleri ve 2'si Birleşik Krallık uyrukluydu ve tümü çalışmaya gönüllü olarak katılmıştır.

1. Deney: İngilizce Geçmiş Zaman

Yapılan ilk deney İngilizce geçmiş zaman üzerine kurulu bir yanıt süresi ölçüm deneyiydi (İng: reaction time experiments). Yanıt süresi ölçüm deneylerinde denekler bilgisayar ekranında bir kelime görmektedirler ve mümkün olan kısa zamanda gördükleri kelimenin gerçek bir kelime olup olmadığına karar vermeleri ve buna göre bir yanıt kutusunda bulunan iki düğmeden birine basmaları gerekmektedir. Bu arada bilgisayar ve deneysel yazılım da deneğin verdiği yanıtın süresini milisaniye (ms) olarak hesaplar ve doğruluğunu denetler. Yanıt süresi ölçüm deneylerindeki temel mantık yüksek frekanslı (yani sık rastlanılan) kelimelerin düşük frekanslı kelimelere göre daha çabuk hatırlandığıdır. Yüksek frekanslı kelimelere daha sık rastlanıldığından, bu kelimelerin bellek izleri daha güçlüdür ve dolayısıyla da bunlara erişmek daha kolay ve hızlıdır. İkili Mekanizma modeline göre, bu yüksek-düşük frekans farklılığı bellekte kaydedilen düzensiz fiillerin erişiminde fark yaratmalı ancak kurama göre bellekte kaydedilmeyip her defasında bir kural yoluyla oluşturulan düzenli geçmiş zaman fiillerinde bu frekans farklılığı yanıtlarda bir hız değişikliğine yol açmamalı. Deney için kullanılan bilgisayar, 15" ekranlı bir Fujitsu-Siemens Amilo D7820 Pentium IV dizüstü bilgisayardı ve kullanılan deneysel yazılım da psikodilbilimsel deneylerde yaygın olarak kullanılan *E-Prime* isimli yazılımdı (Schneider, Eschman & Zuccolotto, 2002).

Deney için kullanılacak toplam 112 kelime seçildi. Bunların 52 tanesi gerçek deneysel kelimelerdi ve geriye kalan 60 kelime asıl deneyle ilgisi olmayıp sadece deneğin artalandaki amacı anlamaması için kullanılan çeşitli türdeki kelimelerdi. 1 milyon kelimelik Brown derleminden (Francis & Kuçera, 1982) seçilen deneysel kelimelerin dağılımları aşağıdaki gibidir:

1. 13 adet geçmiş zaman halleri yüksek frekanslı (YF) düzenli fiil (ortalama frekans: 45.2 / 1 milyon)
2. 13 adet geçmiş zaman halleri düşük frekanslı (DF) düzenli fiil (ortalama frekans: 8.47 / 1 milyon
3. 13 adet geçmiş zaman halleri yüksek frekanslı (YF) düzensiz fiil (ortalama frekans:75.38 / 1 milyon)
4. 13 adet geçmiş zaman halleri düşük frekanslı (DF) düzensiz fiil (ortalama frekans: 24 / 1 milyon)

Anadili İngilizce olan deneklerin sonuçları, YF ve DF düzenli fiillerdeki ortalama yanıt sürelerinin birbirilerine çok yakın (493 ve 497 ms), düzensiz YF ve DF fiillerdeki yanıt sürelerin (480ms ve 506ms) ise birbirilerine göreceli olarak daha az yakın olduğunu gösterdi. SPSS vasıtasıyla uygulanan 2x2 varyans analizi testi (ANOVA) ne fiil türünün (düzenli, düzensiz), ne de frekansın (yüksek, düşük) anlamlı bir fark yarattığını gösterdi (sırasıyla, $F(1,5)=.192$, $p=.680$ ve $F(1,5)=3.394$, $p=.125$). Aynı şekilde, fiil türü ve frekans değişkenlerinin arasındaki ilişki de istatistiksel açıdan anlamsız bulunmuştur ($F(1,5)=1.400$, $p=.290$).

Düzenli fiillerin işlemlenmesi açısından bu sonuçlar ikili mekanizmayı desteklemektedir. Frekansın düzenli fiillerin yanıt süreleri üzerinde anlamı bir etki yaratmaması, bu fiillerin frekans-bağımsız olduklarına ve dolayısıyla da muhtemelen etkileşimci bir zihinsel sözlükte depolanmadıklarına işaret etmekte ve böylece ikili mekanizma kuramının düzenli fiiller için ortaya koyduğu savları desteklemekte. Ancak, aynı sonucun düzensiz fiiller için de ortaya çıkması ne ikili mekanizma ne de çağrışımcı modeller açısından beklenen bir sonuçtur çünkü her iki yaklaşıma göre düzensiz yapıların çağrışımcı özelliklere sahip bir bellekte saklanması ve dolayısıyla da frekansa karşı hassas olmaları beklenmektedir. Spekülatif olmakla birlikte, sonuçların bu şekilde çıkmasının bir muhtemel sebebi denek gurubunun sayıca küçük

olmasıdır. Düzensiz fiillerde ortaya çıkan eğilime bakıldığında, her ne kadar istatistiksel açıdan anlamlı olmasa da, DF ve YF fiiller verilen yanıtların arasında beklenen yönde 26ms'lik bir fark olduğu anlaşılmaktadır. Dolayısıyla, denek sayısının daha büyük olması durumunda bu farkın anlamı hale gelebileceğini spekülatif bir tahmin olarak sunmak çok da gerçek dışı görünmemektedir. Zira, daha önce anadili İngilizce olan deneklerle yapılan çalışmalarda sonuçlar genellikle bu yönde çıkmıştır. Fakat, bu tahmin somut bir çalışmayla gerçeklik kazanmadıkça, spekülatif bir yorum olmaktan öteye gidemeyecektir.

İngilizce seviyeleri yüksek olan ikinci dil gurubuna üye deneklerin yanıtları da gerek düzenli gerekse düzensiz fiillerde frekanstan etkilenmiş görünmemekte. YF düzenli fillerdeki ortalama yanıtlama süresi 573 ms iken, DF düzenli fiillerde bu değer 567 ms; YF ve DF düzensiz fiillerde ortalama yanıtlama süreleri ise sırayla 544 ms ve 547 ms. SPSS vasıtasıyla uygulanan 2x2 ANOVA testi, fiil türünün (düzenli, düzensiz) anlamlı bir fark yarattığını ortaya koymuştur ($F(1,23)=14.605$, $p<.005$). Bu sonuç, deneklerin genel yanıtlama sürelerinin fiil türüne göre farklılık gösterdiğine ve yanıtlama sürelerinden anlaşılacağı üzere düzenli fiillere verilen yanıtların daha üzün sürdüğüne işaret etmektedir. Frekansın (yüksek, düşük) ise anlamlı bir fark yaratmadığı ortaya çıktı ($F(1,23)=.054$, $p=.819$). Yani yüksek ve düşük frekanslı fiillere verilen yanıtların süreleri genel olarak birbirilerine yakın bulundu. Aynı şekilde, fiil türü ve frekans değişkenlerinin arasındaki ilişki de istatistiksel açıdan anlamsız bulunmuştur ($F(1,23)=.877$, $p=.359$), ki bu da farklı fiil türlerinde YF ve DF fiillere yaklaşık aynı şekilde yanıt verildiğini göstermektedir.

Beklendiği ve İkili Mekanizma modelinde öngörüldüğü gibi, düzenli fiillerde frekansa bağlı bir yanıtlama süresi farkı bulunmadı. Dolayısıyla bu seviyedeki ikinci dil deneklerinin de aynı anadili İngilizce olan deneklerde olduğu gibi düzenli fiillerin geçmiş zaman hallerini

belleklerinden değil de, bir kuralın uygulanması sonucunda zihinsel dilbilgileri vasıtasıyla kurduklarını ya da onlara eriştiklerini söylemek mümkün görünüyor. Ancak ilginç olan, ve ne İkili Mekanizma modeli ne de çağrışımcı ağ kuramlarınca beklenen bulgu, düzensiz fiillere verilen yanıtların da frekanstan etkilenmiş olmaması. Hatırlanacağı üzere, her iki kuramda da düzensiz yapılar çağrışımcı bir bellekte saklanmakta ve dolayısıyla da frekansın (yani erişim sıklığının) yanıtlama sürelerine etki etmesi beklenmektedir.

Bu beklenmeyen sonucu açıklamanın bir yolu daha önce benzer bir çalışma yürütmüş olan ve düzensiz fiillerle aynı sonuçlara ulaşan Beck (1997)'in getirdiği açıklamayı göz önünde bulundurmak olabilir. Beck'e göre bu beklenmeyen sonucun sebebi yabancı dil eğitim ortamlarında sıkça başvurulan İngilizce'deki düzensiz fiillerin tümünü artarda listeleyip öğrencilere ezberletme yöntemi olabilir. Bilindiği gibi, bu tür düzensiz fiil listeleri okullarda ve üniversitelerde kullanılan kitapların çoğunluğunda bulunmakta ve derslerde bu listeler sıkça kullanılmakta. Bu tür listelerin önemli bir özelliği tüm fillerin, gerçek hayattaki kullanım sıklıklarına (yani frekanslarına) bakılmaksızın, bir arada bulunması. Böylece böyle bir listeyi ezberleyen bir öğrenci gerçek hayatta YF ve DF fiillere aynı sıklıkta erişmekte ve dolayısıyla da bu kelimelerin frekans farklılıkları bu öğrenciler için ortadan kalkmaktadır. Diğer bir değişle, tüm düzensiz fiiller neredeyse aynı derecede YF ya da DF olmaktadır. Dolayısıyla da bu çalışmaya katılan deneklerin yanıtlama sürelerinin YF ve DF düzensiz fiiller için neredeyse aynı olması anlaşılır bir sebepten kaynaklanıyor. Ayrıca Beck'in 1997'de anadilleri muhtelif olan İngilizce öğrencileriyle elde ettiği sonucun mevcut çalışmada anadili Türkçe olan deneklerle de elde edilmiş olması, dilsel yapıları öğrenme şeklinin dilsel yapıların zihindeki işlemlenmesi üzerinde önemli bir etkiye sahip olabileceğine işaret etmektedir.

İngilizce seviyeleri düşük olan ikinci dil gurubunda YF düzenli fiillere verilen yanıtların ortalama süresi 618 ms, DF düzenli fiillere verilen yanıtların ortalama süresi ise 649 ms. Düzensiz fiillerde ise bu süreler YF fiiller için 584 ms, DF fiiller için 602 ms. SPSS kullanarak gerçekleştirilen 2x2 ANOVA testi, hem fiil türünün (düzenli, düzensiz), hem de frekansın (yüksek, düşük) anlamlı fark yarattığını ortaya koymuştur (sırasıyla $F(1,21)=10.016$, $p<.01$ ve $F(1,21)=7.156$, $p<.05$). Bu sonuçlar YF fiillere verilen yanıt sürelerinin DF fillerine göre daha kısa olduğunu ve genel olarak düzenli fillere verilen yanıtların daha üzün süre aldığını göstermektedir. Fiil türü ve frekans değişkenlerinin arasında ise istatistiksel açıdan anlamlı bir ilişki bulunamamıştır ($F(1,21)=.539$, $p=.471$), ki bu da farklı fiil türlerinde YF ve DF fiillere benzer şekilde yanıt verildiğini göstermektedir.

Diğer iki deney gurubunun aksine, hem düzenli hem de düzensiz fiillerde çok net bir şekilde frekansın yanıt süreleri üzerinde bir etkisi olduğunu görmek mümkün. Bu sonuçlardan her iki türdeki fiillerin önemli bir kısmına çağrışımcı bellekten erişildiği net bir şekilde ortaya çıkıyor. Ancak burada önemli olan soru düzenli fiillerin tümünün mü yoksa sadece bir kısmının mı bellekte kaydedildiğidir. Eğer tüm düzenli fiiller bu denek gurubu tarafından tamamen bellekte depolanıyorsa ve kurallar hiçbir şekilde işletilemiyorsa, o zaman Zobl'ın ortaya attığı kuramın doğruluğu ve ikili mekanizmanın bu seviyedeki dil öğrencileri için geçerli olmadığı şeklinde bir sonuca varılabilir. Ancak daha önce yapılan bir çalışmada, Kırkıcı (2002) mevcut çalışmadaki deneklerle tamamen aynı seviyedeki deneklerden İngilizce geçmiş zaman fiillerini üretmelerini istemiş ve çok net bir şekilde kuralların uygulanabildiğini bulmuştur. Dolayısıyla şu aşamada düzenli fiillerin tümünün bellekte depolanıyor olması daha düşük bir ihtimal gibi görünmektedir. Gerçekliliği daha fazla görünün açıklama, çağrışımcı belleğin dilsel bilgilerin işlenmesinde bu seviyedeki öğrencilerde kural mekanizmasına göre daha etkin olduğudur. Ancak bu

hipotezin kesin geçerlilik kazanması için gelecekte daha kontrollü çalışmalar yapmak gerekmektedir.

Birinci deneyin sonucu olarak, İkili Mekanizma modelinin ikinci dil öğrencilerinin dilsel işlemlerini açıklamakta mevcut haliyle sadece kısmen yeterli olduğu ortaya çıkmıştır. Her ne kadar ortaya konan düzenli-düzensiz ayrımı geçerliliğini ikinci dil öğrencileri için kısmen muhafaza etmiş görünse de, kuramın belirlediği keskin hatlı ayrımı destekler nitelikte bulgulara ulaşılmamıştır. Ortaya çıkan sonuç ikinci dil öğrencilerinde ve özellikle ikinci dil seviyeleri düşük olan öğrencilerde çağrışımcı belleğin kural-mekanizmasına göre daha etkin bir rol üstlendiğine ve anadili İngilizce olan kişilerde kural yoluyla işlemlenen yapıların önemli bir kısmının çağrışımcı bellek tarafından devralındığına işaret etmektedir.

2. Deney: İngilizce Bileşik Adlar

Bileşik adlar deneyinde kullanılan yöntem, deneklere daha önce benzer deneylerde de kullanılan "What do you call a person who eats mice?" türünde sorular sorup, deneklerden yanıt olarak bileşik adlar (ör: *mice-eater* veya *mouse*-eater) kurmalarını istemekti. Deneklere, 25 ad ve 13 fiil kullanarak toplam 26 soru yöneltilmiştir (sorulan soruların tümü Ek I'de sunulmuştur). Kullanılan 25 adın 14'ü düzenli çoğul, 6'sı düzensiz çoğul, 3'ü tekil halleri olmayan (ör: *clothes*) ve 2'si tekil ve çoğul halleri genellikle aynı olarak kabul edilen (ör: *sheep*) adlardı, ancak değerlendirmeye sadece 20 düzenli ve düzensiz çoğul kelime alındı[78].

Anadili İngilizce olan deneklerin sonuçları, yanıt olarak oluşturulan bileşik adlarda düzenli adların hiç birinin (%0) çoğul halde, düzensiz adların ise

[78] Deneylerde kullanılan tüm adlar için bkz. Tablo 5.

yaklaşık %31'inin çoğul halde kullanıldıklarını ortaya koydu. Yani beklendiği ve ikili mekanizma kuramı çerçevesinde beklenildiği gibi, düzenli adların çoğul halleri bileşik adlarda hiçbir zaman kullanılmadı. SPSS'de yürütülen ANOVA, düzenli ve düzensiz adların çoğul kullanım oranlarındaki farkın istatistiksel açıdan anlamlı olduğunu gösterdi ($F(1,5)=6.003$, $p<.05$). Bu sonuç da ikili mekanizma kuramının varsaydığı düzenli-düzensiz ayrımının bu çalışmadaki anadili İngilizce olan deneklerce uygulandığını teyit eder nitelikteydi.

İngilizce seviyeleri yüksek olan ikinci dil gurubunun sonuçları, düzenli adların çoğul hallerinin yanıt olarak verilen bileşik adların sadece ortalama %13.9'unda, düzensiz adların çoğul hallerinin ise yanıtların ortalama %64.6'sında kullanıldıklarını ortaya koydu. SPSS'de yürütülen ANOVA, bu ortaya çıkan farkın anlamlı bir fark olduğunu gösterdi ($F(1,23)=69.119$, $p<.0001$). Bu sonuç düzenli-düzensiz ayrımının bu seviyedeki ikinci dil kullanıcıları tarafından uygulandığını gösterdi. İngilizce seviyeleri düşük olan ikinci dil gurubunun sonuçları, düzenli adların çoğul hallerinin yanıt olarak verilen bileşik adların ortalama %59.4'ünde, düzensiz adların çoğul hallerinin ise yanıtların ortalama %72.7'sinde kullanıldıklarını ortaya koydu. SPSS'de yürütülen ANOVA, bu ortaya çıkan farkın da anlamlı bir fark olduğunu gösterdi ($F(1,21)=6.342$, $p<.05$). Bu sonuç düzenli-düzensiz ad ayrımının düşük seviyedeki ikinci dil kullanıcıları tarafından da uygulandığını gösterdi.

Bu sonuçlar, ikili mekanizma kuramının bileşik adlarda düzenli-düzensiz ad ayrımı iddialarını gerek anadil gerekse ikinci dil kullanıcıları için net olarak desteklemiştir. Ancak ikinci dil kullanıcılarının sonuçlarına dikkatli bakıldığında, bileşik adlarda düzenli çoğul ad kullanım oranının yüksek seviyeli ikinci dil gurubunda düşük seviyeli ikinci dil gurubuna göre çok daha düşük olduğu görülmektedir. Bu da ilk bakışta ikinci dil gelişimiyle orantılı ve dolayısıyla da muhtemelen ilişkili bir değişimin işareti olarak

göze çarptı. Ortaya çıkan farkın anlamlı bir fark olup olmadığını anlamak için her iki gurubun çoğul yanıtları bir 2x2 ANOVA'da (ikinci dil seviyesi: yüksek, düşük x ad türü: düzenli, düzensiz) incelenmiştir. ANOVA'nın sonuçları, hem ad türünün hem de ikinci dil seviyesinin anlamlı fark yaratan değişkenler oldukları bulunmuştur (sırasıyla $F(1,44)=61.861$, $p<.0001$ ve $F(1,44)=12.673$, $p<.005$) ve bu iki değişkenin arasında anlamlı bir ilişki olduğu anlaşılmıştır ($F(1,44)=21.075$, $p<.0001$). Bu anlamlı etkileri daha iyi anlayabilmek için, her iki gurubun düzenli ve düzensiz adlara verdikleri çoğul yanıtlarını karşılaştıran iki ANOVA yürütülmüştür. İki gurubun düzenli ad kullanarak verdikleri yanıtları karşılaştıran ilk ANOVA düşük seviyeli ikinci dil kullanıcıların düzenli adları yüksek seviyeli ikinci dil kullanıcılarına göre daha fazla çoğullaştırdıklarını göstermiştir ($F(1,45)=27.464$, $p<.0001$). Düzensiz ad kullanarak verilen yanıtları karşılaştıran ikinci ANOVA ise grupların çoğul yanıtları arasında anlamlı bir fark bulmamıştır ($F(1,45)=.931$, $p=.340$). Dolayısıyla, ortaya çıkan sonuçlar düzenli adların bileşik adlar içindeki kullanımlarının ikinci dil seviyesiyle doğrudan ilişkili olabileceğine işaret etmiştir. Görünüşe göre, düşük seviyeli ikinci dil kullanıcıları düzenli adların tekil hallerinin yanısıra çoğul hallerinin de büyük bir çoğunluğunu çağrışımcı bellekte depoladıklarından, bunları doğrudan bileşik ad yapısının içine yerleştirmek mümkün olmuştur. Ancak ikinci dil seviyesi arttıkça çağrışımcı bellekte depolanan çoğul adların sayısı azaldığından, bunların bileşik adlardaki kullanım oranları da düşüyor. Bu sonuç, ilk deneydeki buluları destekler niteliktedir. Zira, ilk deneyde de düşük seviyeli ikinci dil kullanıcıların çağrışımcı belleklerini daha güçlü bir şekilde kullandıkları sonucuna varılmıştı.

Genel Sonuçlar

Elde edilen bulgular, ikili mekanizma kuramının savlarının gerek anadil gerekse ikinci dil kullanıcılarının bileşik ad üretimlerinde desteklendiğini

gösterir nitelikteydi. Yukarıda anlatıldığı gibi, düzenli ve düzensiz adların bileşik ad içinde kullanım oranları arasında ciddi farklılıklar gözlemlenmiştir. İngilizce geçmiş zamanla ilgili sonuçlar ise göreceli olarak daha karmaşık ve kesin sonuçlara varabilmek için gelecekte bazı faktörlerin (ör: ikinci dil kullanıcıların öğrenme şekilleri) daha iyi kontrol edilmesi gerekir. Ancak, her iki biçimbilimsel yapının analizleri net bir şekilde seviyeleri düşük ikinci dil kullanıcıların çağrışımcı belleklerini yüksek seviyeli ikinci dik kullanıcılarına göre daha fazla kullandıklarına işaret etti.

VITA

Bilal Kırkıcı was born in 1975 in Siegen, Germany. He received a B.A. in English Language Teaching (with a minor in German) and an M.A. in English Language Teaching from Middle East Technical University in 1997 and 2000, respectively. In 2002, he received a further M.A. (in Applied Linguistics) from the University of Essex, United Kingdom, which was sponsored by the European Commission through a Jean Monnet Scholarship. Between October 1997 and February 2005, he worked as a Research Assistant at the Foreign Language Education Department of Middle East Technical University, where he taught a number of undergraduate linguistics courses like Language Acquisition, Turkish Syntax and Semantics, and Turkish Phonetics and Morphology. His main areas of academic interest include first and second language processing, the processing of relative clause attachment ambiguities in Turkish, and psycholinguistic aspects of bilingualism.