MECHANISMS AND STRATEGIES IN THE PROCESSING AND ACQUISITION OF RELATIVE CLAUSES IN TURKISH MONOLINGUAL AND TURKISH-ENGLISH BILINGUAL CHILDREN

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

BY

DUYGU ÖZGE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE
OF DOCTOR OF PHILOSOPHY
IN
THE DEPARTMENT OF FOREIGN LANGUAGE EDUCATION

SEPTEMBER 2010

Approval of the Graduate School of Social Sciences

Prof. Dr. Meliha Altunışık
Director

I certify that this thesis satisfies all the 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.

Assoc. Prof. Dr. Theo Marinis
Co-supervisor

Prof. Dr. Deniz Zeyrek
Supervisor

Examining Committee Members:

Assoc. Prof. Dr. Ayşegül Daloğlu (METU, FLE)

Prof. Dr. Deniz Zeyrek (METU, FLE)

Assoc. Prof. Dr. Theo Marinis (Reading U., CLS)

Assoc. Prof. Dr. Cem Bozşahin (METU, CENG)

Assoc. Prof. Dr. Belma Haznedar (Boğaziçi U., FLE)

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.

Name, Last name : Duygu Özge

Signature :

ABSTRACT

MECHANISMS AND STRATEGIES IN THE PROCESSING AND ACQUISITION OF RELATIVE CLAUSES IN TURKISH MONOLINGUAL AND TURKISH-ENGLISH BILINGUAL CHILDREN

Özge, Duygu
Ph.D., Department of Foreign Language Education
Supervisor: Prof. Dr. Deniz Zeyrek
Co-Supervisor: Assoc. Prof. Dr. Theo Marinis

September 2010, 259 pages

The thesis aims to provide a comprehensive experimental analysis of the processing and acquisition of Turkish relative clauses in Turkish monolingual and Turkish-English bilingual children at the ages of 5-8. The study combines offline techniques with online reaction-time experiments, for the first time in testing monolingual Turkish children, in order to compare the mechanisms and strategies employed by adults and children of a head-final language with rich inflection and variable word order.

In addition, the study presents two off-line experiments investigating the comprehension and production strategies employed by Turkish-English bilingual children and Turkish monolingual children at the ages of 5-8.

A series of experiments in this study confirmed that the subject-object asymmetry that has been reported in several other languages, as well as in Turkish, has also been observed in Turkish speaking monolingual and bilingual children in terms of their comprehension and production of Turkish relative clauses. In all of the experiments, both monolingual and bilingual children showed a better performance in subject RCs compared to object RCs. Moreover, the monolingual children presented a very similar pattern to the adults in some of the experiments, which was taken to indicate that the subject-object asymmetry cannot be caused by a

single factor but rather it arises as a combination of multiple factors such as ambiguity concerning the function of a lexical or morphological item, ease of local attachment to a verb (a la Gibson, 1998), deviation from the canonical word order, frequency, and perceptual factors, among others.

While investigating the underlying causes of this asymmetry, the study also focused on some of the hypotheses offered to account for the strategies used in sentence processing, such as the Filler-Gap Hypotheses (Maratsos, 1974; Wanner & Maratsos, 1974; Fodor, 1978; Clifton & Frazier, 1989; Frazier, Flores d'Arcais & Giovanni, 1989; O'Grady, 1997; among others), the Parallel Function Hypothesis (Sheldon, 1974), and the Canonical Word Order Strategy (Bever, 1970), and showed that none of these hypotheses can fully account for the processing facts from Turkish relative clauses.

The study argues that the present findings could be best accounted for in a constrained-based lexicalist framework. Two such accounts were discussed in the thesis. One is Steedman's (1989, 2000) model of a processor with a highly lexicalized grammar, a bottom-up parsing algorithm, a mechanism that evaluates multiple sources of information in line with the parsing model of a specific language. The other is a processing model by Vasishth and Kruijff (2001) that uses a highly lexicalized grammar, a combination of a top-down and a bottom-up algorithm, and a complexity metric inspired by Gibson (1998) and Hale (2001).

Keywords: incremental interpretation, head-final languages, parsing strategies, acquisition of relative clauses, Turkish

ÖZ

ANA DİLİ OLARAK TÜRKÇE VE TÜRKÇE-İNGİLİZCE ÖĞRENEN ÇOCUKLARIN İLGİ TÜMLEÇLERİNİ ANLAMA VE İŞLEME MEKANİZMA VE STRATEJİLERİ

Özge, Duygu
Doktora, Yababancı Diller Eğitimi Bölümü
Tez Yöneticisi: Prof. Dr. Deniz Zeyrek
Ortak Tez Yöneticisi: Doç. Dr. Theo Marinis

Eylül 2010, 259 sayfa

Bu tez çalışması, Türkçe ilgi tümleçlerinin işlenmesi (processing) ve edinimi hakkında kapsamlı bir deneysel analiz sunmaktadır. Çalışmada anadili olarak Türkçe öğrenen 5-8 yaş arası tek dilli çocuklarla klasik deneysel yöntemlerin yanı sıra ilk kez sözlü cümlelerde reaksiyon süresini ölçen eş-zamanlı yöntemler kullanılmış ve bu çocukların sözlü dil anlama ve çözümleme (parsing) davranışları yetişkinlerle karşılaştırılmıştır. Çalışmada ayrıca Londra'da yaşayan ve anadili olarak Türkçe ve İngilizce öğrenen 5-8 yaş arası iki-dilli çocukların ilgi tümleçlerini anlama ve bu yapıları sözlü dilde kullanma yetileri Türkçe konuşan tek-dilli yaşıtları ile eş-zamanlı olmayan yöntemler kullanılarak karşılaştırılmıştır.

Yapılan bir dizi deney sonucunda bazı diğer dillerde de gözlemlenen özne-nesne bakışımsızlığı (subject-object asymmetry) anadili olarak Türkçe öğrenen tek-dilli ve iki-dilli çocukların Türkçe ilgi tümleçlerini anlama ve kullanma davranışlarında da bulgulanmıştır. Çocuklar, bütün deneylerde özne niteleyen ilgi tümleçlerinde, nesne niteleyen ilgi tümleçleriyle karşılaştırıldığında, anlamlı bir şekilde daha iyi performans sergilemişlerdir. Ayrıca, tek-dilli çocukların eş-zamanlı deneylerde gösterdikleri bazı davranışların yetişkinlerinkiyle aynı örüntüde olduğu bulgulanmış ve bu örüntülerin özne-nesne bakışımsızlığının morfo-sentaks, eyleme kolay bağlanma, sözcük dizilişindeki düzenlilik, sözcüklerdeki çok-anlamlılık ya

da çok-işlevlilikten kaynaklanan muğlaklık ve yapıların ve sözcüklerin birlikte kullanılma frekansı gibi bir çok faktörün birleşmesi ile ortaya çıktığına işaret ettiği iddia edilmiştir.

Bu araştırmada, Türkçe ilgi tümleçlerinde özne-nesne bakışımsızlığının sebepleri araştırılırken, alanyazında insanın dil işleme ve çözümleme mekanizma ve stratejileri hakkında İngilizce gibi çok çalışılan diller için önerilen 'Dolgu-Boşluk Varsayımları' (Filler-Gap Hypotheses) (Maratsos, 1974; Wanner ve Maratsos, 1974; Fodor, 1978; Clifton ve Frazier, 1989; Frazier, Flores d'Arcais ve Giovanni, 1989), 'Koşut İşlev Varsayımı' (Parallel Function Hypothesis) (Sheldon, 1974) ve 'Standart Sözcük Sırası Taktiği' (Canonical Word Order Strategy) (Bever, 1970) gibi belli başlı hipotezler de test edilmiş ve bu hipotezlerin bu çalışmada sunulan deneylerin bulgularını açıklamakta yetersiz kaldıkları gösterilmiştir.

Çalışmadaki bulgular Steedman (1989) ve (2000)'de önerildiği gibi sözcüksel (lexicalist) gramer, aşağıdan-yukarı algoritma (bottom-up algoritm) ve bir çeşit çoklu kısıt değerlendirme mekanizması (multiple constraint satisfaction mechanism) varsayan bir dil işleme modeli ve Vasishth ve Kruijff (2001)'de önerildiği gibi sözcüksel gramer, yukarıdan-aşağı (top-down) ve aşağıdan-yukarı algoritmayı birleştiren sol-köşe algoritması (left-corner algorithm) ve Gibson (1998) ve Hale (2001)'den esinlenen yeni bir complexity metric varsayan bir diğer dil işleme modeli kullanılarak açıklanmıştır.

Anahtar Kelimeler: Artımlı çözümleme, baş-sonlu diller, çozümleme stratejileri, ilgi tümleçlerinin edinimi, Türkçe

To all the kids I adopted, all the cats I abandoned,
and to Umut, who has been with me along the way.

ACKNOWLEDGMENTS

I would like to start by thanking my thesis supervisors, Deniz Zeyrek and Theo Marinis, who have guided me very carefully through each stage of this work and who have always encouraged me. I also would like to express my gratitude to my thesis committee members, Cem Bozşahin and Ayşegül Daloğlu for careful guidance; and Belma Haznedar for being in my defense jury and for providing detailed feedback.

The experimental background was constructed in 2007 when I was working as a research assistant at the University of Reading as part of a project funded by UK Economic and Social Research Council (ESRC) through grant RES-061-23-0137 awarded to Theo Marinis. I was so lucky that I had him as my supervisor, who was extremely patient to guide me through my learning of experimental design and analysis. I am very thankful to him for this very fruitful period.

I also wish to thank my friends in Reading for all their support. Vicky Chondrogianni so generously contributed to my learning by sharing all her knowledge about experimental design, materials, and software. Also, a very informal meeting with Leticia Pablos gave me so much insights that it led me to the idea of preparing the self-paced listening experiment in Chapter 4. I also thank my colleagues and friends at the Reading Psycholinguistics Reading Group for many insightful discussions. Many thanks to Susan Edwards, Douglas Saddy, Christos Salis, Vesna Stojanovic, Christos Pliatsikas, Nick Riches, Malathy Venkatesh, Halit Fırat, Pastora Martinez, and Nina Pereira. I also thank these people for making life in Reading enjoyable with dinners and drinks.

That was a year full of learning in terms of academic and personal issues. I think the most successful part of my PhD work was to go through that period in one piece. Special thanks to Nina for her invaluable support and friendship during that period!

The data was collected in Ankara and London between 2008 and 2009. I would like to thank all the children and adults for taking part in the experiments. Every child participated in 6 or 7 sessions; so we saw each other once a week for the duration of 7 weeks. It is a pity that

I cannot mention their names for ethical reasons but I have to say that I remember something personal about each one of them. They were so cheerful and full of energy that I did not feel tired at all during long hours of testing everyday! I also appreciate the help from Akman Yuva, 100. Yıl Kız Meslek Lisesi Uygulamalı Anaokulu, and Türk-iş Blokları İlköğretim Okulu in Ankara; Brook Community Primary School and DAYMER Supplementary School in London for kindly providing me with permission and space to collect the data. Many thanks to the teachers and administrator at those schools: Gülay Akman, Tülay Akman, Çiçek Gündoğdu, Bahar Günay, Zeki Kaya, Bülent Dikici, Neriman Atalay, Sadık Bayram, Bilgi Bacalan, Fatma Erdal, and Mürüvvet Köksal; and their students. I thank Mustafa Cengiz and other friends at DAYMER (Sevgi, Aslı, Orhan, Mehtap, and all the children and their parents), who were so nice to help me to contact the Turkish-English-speaking children who participated in this study. It is a pity that I never had enough time to work with them in other projects I would be interested in. I am hoping that I could have this chance in the future.

The process of writing up was taken place in London, Ankara, and Namrun.

I spent a lot of time in the British Library for the whole year, I think the staff at Humanities Floor-1, for the quality of the service, and Umut Özge, for wonderful coffee breaks, deserve acknowledgment!

I have benefited a lot from our discussions with Deniz Zeyrek, Cem Bozşahin, and Umut Özge during the time in Ankara; and with Theo Marinis, Belma Haznedar, Sumru Özsoy, Aylin Küntay, Aslı Göksel, Mark Steedman, Patric Sturt, Jesse Snedeker, and Yuki Kamide at different occasions, which helped me sharpen my perspective while designing the experiments or interpreting the data. Also, many thanks to the members of the Ankara Linguistic Circle for very fruitful meetings.

I thank all of my instructors at METU Foreign Language Education Department, especially Deniz Zeyrek, Joshua Bear, and Ayşegül Daloğlu, for always supporting and encouraging me; many thanks to my friends at METU FLE and METU COGS; and to my colleagues and my students at the Department of Modern Languages at METU.

Also, I thank the audience at Reading University Lunch-time Seminar (October 2008), BUCLD 2009, ICTL, 2008 & 2010, AMLAP 2010, and METU Cognitive Science and Psycholinguistics Seminar 2010, and as well as the audience at my thesis defense for feedback and discussion on the data reported in the thesis.

Many thanks to Umut Özge and Cem Bozşahin, who read the CCG chapter with extra care and helped me correct these mistakes and understand the theory better; Ökmen Yıldırım, who worked really hard helping me test the adult participants at METU; Seyhun Topbaş and

Selçuk Güven, who allowed me to test their SLI participants in DİLKOM (unfortunately I am not able to include the SLI data in the thesis); Saniye Samra, who meticulously helped me with the lists when I was trying to finalize the experimental material; Kıvanç İlisulu, Umut Özge, and Onur Kükürt, who recorded the questions for the experimental items with their nice voice; Annette Hohenberger, who shared the e-prime key with me; Çağdaş Tülek, who generously helped me with my e-prime problems; Umut Özge, who wrote a program for the outliers in the online data; Nart Bedin Atalay and Mine Mısırlısoy, who were always ready to help with my silly questions about statistics; Yiğit Karahanoğulları and Çağlar Yalı, who kindly helped me writing the end-text references for another project so that I could work on my thesis; Esra Demirkol, Esra Can, Sibel Gülnar, and Necla Işıklar, who gave me practical support during the submission stage.

Many thanks to the friends in Namrun, Kemal Sofu, Emine Sofu, Ergün Tepebağlı, Tatlıcı Mustafa Abi, Rabia Çoban, Yunus Çoban, and many others for providing us with wonderful natural products as well as very sincere friendship during the time we locked ourselves in the highlands in Toros mountains.

I always felt that I did not spend enough time with my family in the recent years. I thank mum and dad, Zerin and Muvaffak Kükürt and my second parents, Cahide and Sadi Özge for their invaluable support and understanding throughout this incredible period. I thank Çiğdem and Onur for creating our precious Defne, who was born on 24 September 2008 and who has been deeply changing our lives for better. How I wish I could spend more time with you sweetheart! I also thank all the members of my and Umut's family, who were always ready to help. They all have been a great family to us!

I thank all my friends, especially Asuman Özgür, Ozan Keysan, Duygu Türk, Yiğit Karahanoğulları, Çigdem Gökdemir, Onur Kükürt, Serhan Mersin, Nihal Poyraz, Ceyhan Temürcü, Çağlar Yalı, Saniye Samra, Ökmen Yıldırım, Duygu Çınga, Judith Liberman, Berhayat Bahşiş, Belkıs Oğuz, Evrim Özürk, Hamit Oğuz, Serpil Taşkan, Hasan Doğhan, Ebru McCallum, Ferhat Soylu, Başar Tuna, Murat Ulubay, Kaan Bıyıkoğlu, Selim Tezcan, Nazlı Deniz Oğuz, Güneş Acar, Burak İşiaçık, Kadir Beyaztaş, Berfin Aktaş, Gözde Bahadır, Betül Toplu, Ruken Çakıcı, Beste Yolcu Kamalı, and Tuba Yarbay Duman, who have witnessed how crazy this period has been.

I have been thinking that the period of producing this thesis, namely the years between 2007 and 2010 has been very seriously full of learning. At times, I could not help myself feeling like a cat who was about to give a birth and who was madly looking for a shelter from one place to another to do it safely and calmly. Strangely and tragically, this period

has mostly been accompanied by some pregnant stray cats and their kittens adopted (and sometimes abandoned) by us.

Especially at hard times, I got immediately filled with happiness and hope thinking about these kids: Defne Kükürt, Roni Adar Doğhan, Ilgaz Temürcü, Aral Temürcü, Ela McCallum, Deniz Scott; and the kids who participated in this study; and these cats: Piknik, Cimcim, Bal, Balçık, and Yonca; and this person: Umut Özge. This thesis is dedicated to them.

TABLE OF CONTENTS

ABSTRACT iv
ÖZ vi
DEDICATON viii
ACKNOWLEDGMENTS ix
TABLE OF CONTENTS xiii
LIST OF TABLES xviii
LIST OF FIGURES xix
LIST OF SYMBOLS xxi
CHAPTER

1 INTRODUCTION 1
1.1 Present Study 1
1.1.1 Acquisition and Processing of Turkish Relative Clauses 1
1.1.2 Development of Language Processing in a Head-Final Language and Mechanisms and Strategies in Human Language Processing . . 2
1.1.3 Organization of the thesis 4
1.2 Summary 6

2 BACKGROUND 7
2.1 Introduction 7
2.2 Assumptions about Language Processing 8
2.2.1 Language Processing in Adults 8
2.2.2 Language Processing in Children 11
2.3 Acquisition of Relative Clauses in Various Languages 15
2.4 Turkish and Turkish Relative Clauses 22
2.4.1 An Overview of Turkish 22

2.4.2 Turkish Relative Clauses 26
2.5 Acquisition of Turkish Relative Clauses 32
2.6 Summary 36

3 MECHANISMS IN THE PROCESSING OF TURKISH RELATIVE CLAUSES 37
3.1 Introduction 37
3.2 Experiment 1: Filler-Gap Accounts in the Comprehension of Turkish Relative Clauses in Monolingual Children and Adults 40
3.2.1 Method 41
3.2.2 Results 45
3.2.3 Discussion 47
3.3 Experiment 2: Filler-Gap Accounts in the Production of Turkish Relative Clauses in Monolingual Children and Adults 49
3.3.1 Method 51
3.3.2 Results 54
3.3.3 Discussion 59
3.4 Summary 69

4 STRATEGIES IN THE PROCESSING OF TURKISH RELATIVE CLAUSES 70
4.1 Introduction 70
4.2 Filler-Gap Strategies 70
4.2.1 Fodor 1978 70
4.2.2 Active-Filler Hypothesis 72
4.2.3 Trace Reactivation Hypothesis 73
4.3 Dependency Formation Strategies in Head-final Languages 74
4.4 Present Study 79
4.5 Predictions 81
4.5.1 Predictions of the gap-as-a-last-resort strategy 81
4.5.2 Predictions of the gap-as-a-first-resort strategy 83
4.5.3 Predictions of the Lexical-expectation model 85
4.5.4 Predictions of the Active Filler Hypothesis 86
4.5.5 Predictions of the Trace Reactivation Hypothesis 87
4.6 Experiment 3a: Filler-Gap Strategies in the Processing of Turkish RCs in Monolingual Children and Adults 89

4.6.1 Method 89
4.6.2 Results 92
4.6.3 Discussion 95
4.7 Experiment 3b: The Effect of Word Order on the Processing of Turkish Relative Clauses 99
4.7.1 Method 100
4.7.2 Results 101
4.7.3 Discussion 106
4.8 Summary 107

5 INCREMENTAL PROCESSING WITH COMBINATORY CATEGORIAL GRAMMAR 108
5.1 Introduction 108
5.2 Background: Combinatory Categorial Grammar(CCG) 109
5.2.1 Components of a language processor 112
5.3 A CCG account of the data from Experiment 3a 119
5.3.1 Morphemic lexicon and grammar 120
5.3.2 Summary of the results of Experiment 3a 121
5.3.3 Informal Interpretation of the data from Experiment 3a 123
5.3.4 CCG interpretation of the data from Experiment 3a 127
5.4 Another CCG model: Processing as abduction and deduction 136
5.5 Summary 144

6 PARALLEL-FUNCTION HYPOTHESIS 145
6.1 Introduction 145
6.2 Experiment 3c: The Parallel Function Hypothesis in the Processing of Turkish Relative Clauses in Monolingual Children and Adults 149
6.2.1 Method 149
6.2.2 Results 150
6.2.3 Discussion 152
6.3 Experiment 3d: When do Turkish-Speaking Adults Assign a Subject Role to a Relative Clause? 165
6.3.1 Method 166
6.3.2 Results 168

6.3.3 Discussion 171
6.4 Summary 174

7 PROCESSING OF GENITIVE-POSSESSIVE AGREEMENT MORPHOLOGY 175
7.1 Introduction 175
7.2 Experiment 4: Genitive-Possessive Agreement Morphology in the Processing of Turkish Relative Clauses in Monolingual Children and Adults . 176
7.2.1 Method 176
7.2.2 Results 180
7.2.3 Discussion 183
7.3 Summary 184

8 STRATEGIES IN THE COMPREHENSION AND PRODUCTION OF TURKISH RELATIVE CLAUSES IN MONOLINGUAL AND BILINGUAL CHILDREN 185
8.1 Introduction 185
8.2 Experiment 5: Strategies in the Comprehension of Turkish Relative Clauses in Turkish Monolingual and Turkish-English Bilingual Children 187
8.2.1 Methods 190
8.2.2 Results 192
8.2.3 Discussion 193
8.3 Experiment 6: Strategies in the Production of Turkish RCs in Turkish Monolingual and Turkish-English Bilingual Children 197
8.3.1 Method 197
8.3.2 Results 197
8.3.3 Discussion 202
8.4 Summary 213

9 DISCUSSION 215
9.1 Introduction 215
9.2 Summary of the Findings 216
9.2.1 Experiment 1 and Experiment 2 216
9.2.2 Experiment 3a and Experiment 3b 218
9.2.3 Experiment 3c and Experiment 3d 219
9.2.4 Experiment 4 221
9.2.5 Experiment 5 and Experiment 6 221

9.3 Conclusions 223
9.3.1 Conclusions about the Processing and Acquisition of Turkish Relative Clauses 223
9.3.2 Conclusions about the Development of Language Processing in Head-Final Languages and Mechanisms and Strategies in Human Language Processing 225
9.4 Limitations and Ideas for Further Studies 227

REFERENCES 231

LIST OF TABLES

TABLES

Table 4.1 Summary of the Predictions of the Filler-Gap Strategies in Experiment 3a 88
Table 4.2 Summary of the Processing Patterns in Experiment 3a 97
Table 4.3 Summary of the predictions of the Filler-Gap Strategies in Experiment 3a, repeated 98

Table 5.1 Morphemic CCG Analysis of a Subject RC with a Bottom-up Shift-reduce Algorithm 134
Table 5.2 Morphemic CCG Analysis of an Object RC with a Bottom-up Shift-reduce Algorithm 135

LIST OF FIGURES

FIGURES

Figure 3.1 Sample Test Picture for Sentence-referent Matching Task 44
Figure 3.2 Sample Control Picture for Sentence-referent Matching Task 44
Figure 3.3 Sample Control Picture for Sentence-referent Matching Task 45
Figure 3.4 Rate of Accuracy (%) in Subject RCs vs. Object RCs in Children vs. Adults 46
Figure 3.5 Rate of Error Types (%) in Subject RCs vs. Object RCs in Children . . 47
Figure 3.6 Sample Cards for Elicitation Task 52
Figure 3.7 Rate of all RCs (%) out of all Response Types in Children vs. Adults . 55
Figure 3.8 Rate of Grammatical RCs (%) out of all RC Responses in Children vs. Adults 55
Figure 3.9 Rate of Each Response Type (%) in Subject RCs and Object RCs in Children 58
Figure 3.10 Rate of Each Response Type (%) in Subject RCs and Object RCs in Adults 58

Figure 4.1 Segment-by-Segment RTs in Subject RCs and Object RCs with Subject Matrix Role 94
Figure 4.2 Segment-by-Segment RTs in SVO vs. OVS Orders 102
Figure 4.3 Total RTs in SOV, SVO, OSV, and OVS Orders 103
Figure 4.4 Segment-by-Segment RTs in SOV vs. SVO Orders 103
Figure 4.5 Segment-by-Segment RTs in OSV vs. OVS Orders 104
Figure 4.6 RTs at Segment 2 in SOV vs. SVO and OSV vs. OVS Orders 105

Figure 5.1 (a) Pitch Contour of NP-POSS in (140a); (b) Pitch Contour of NP-ACC in (140b) 125

Figure 5.2 (a) Pitch Contour of NP-ACC Followed by a Matrix Verb; (b) Pitch Contour of NP-ACC Followed by a Relativized Verb 130
Figure 5.3 (a) NP-GEN Followed by a Relativized Verb; (b) NP-GEN Followed by a Possessed NP 132

Figure 6.1 Segment-by-Segment RTs in Experiment 3c 150
Figure 6.2 RTs at Critical Segments in Experiment 3c 151
Figure 6.3 (a) Pitch Contour of the Relativized Verb of a Full Subject RC (b) Pitch Contour of the Relativized Verb of a Headless Subject RC 163
Figure 6.4 (a) Pitch Contour of the Relativized Verb of a Full Object RC (b) Pitch Contour of the Relativized Verb of a Headless Object RC 164
Figure 6.5 Segment-by-Segment RTs from Adults in Experiment 3d 169
Figure 6.6 RTs at Critical Segment in Experiment 3d 171

Figure 7.1 RTs at Critical Word in Experiment 4 181
Figure 7.2 RTs at Critical Word in Possessive NPs in Experiment 4 182
Figure 7.3 RTs at Critical Word in Object RCs in Experiment 4 182

Figure 8.1 Rate of Accuracy (%) in Subject RCs vs. Object RCs in Monolingual vs. Bilingual Children 192
Figure 8.2 Rate of Accuracy (%) in Subject RCs vs. Object RCs in two Different Presentation Types in Monolingual vs. Bilingual Children 193
Figure 8.3 Rate of all RC Responses out of all Responses (%) in Monolingual vs. Bilingual Children 198
Figure 8.4 Rate of Grammatical RCs out of all RC Responses (%) in Monolingual vs. Bilingual Children 199
Figure 8.5 Rate of Unexpected Responses (%) in Subject RCs in Monolingual vs. Bilingual Children 201
Figure 8.6 Rate of Unexpected Responses (%) in Object RCs in Monolingual vs. Bilingual Children 202

LIST OF SYMBOLS

ABL	Ablative
ACC	Accusative
AOR	Aorist
CAUS	Causative
CCG	Combinatory Categorial Grammar
DAT	Dative
-DIK	Object relativizing morpheme
EV.COP	Evidential copula
GEN	Genitive
NOM	Nominative
NP	Noun Phrase
PAST	Past
PL	Plural
POSS	Possessive
PRON	Pronoun
RC	Relative clause
S	Sentence
SG	Singular
SOV	Subject Object Verb
VP	Verb phrase
-(y)An	Subject relativizing morpheme

CHAPTER 1

INTRODUCTION

1.1 Present Study

Processing and acquisition of relative clauses (RCs) is one of the most commonly studied phenomena that have engendered numerous psycholinguistic accounts in the literature pertaining to the mechanisms and strategies of human language processing.

The present work uses Turkish RCs to provide the first online language processing data from monolingual Turkish children and compares their performance with that of adults in order 1) to provide a methodologically sound assessment of comprehension and production patterns in Turkish-speaking children and adults; 2) to explore the cross-linguistic validity of some accounts of language processing strategies. To this end, we will report data from two off-line (comprehension and production) and two online processing (self-paced listening and word-monitoring paradigms) experiments from monolingual children and adults. Furthermore, we will provide data from Turkish-English bilingual children in the two off-line experiments from the perspective of the comprehension and production strategies in monolingual and bilingual children in order to gain some insights into the development of processing abilities in a head-final language.

The more specific aims in this research could be broadly listed under the following titles from specific to general.

1.1.1 Acquisition and Processing of Turkish Relative Clauses

Previous research on the acquisition of RCs has shown that in many languages RCs are relatively late acquired and subject RCs are easier to comprehend and produce than object RCs (for a summary, see Diessel, 2004). To date, it is unclear whether or not the same picture emerges in Turkish because the findings of previous studies do not seem to converge; while

some studies suggested that subject RCs yield a better performance, others have reported the opposite pattern of performance (for a review, see Özge, Marinis, & Zeyrek, 2009).

And different studies suggested a different explanation for the pattern they reported. It is crucial to note that subject RCs are different from object RCs in terms of 1) the filler-gap dependencies (subject RCs have a greater number of intervening lexical items between the filler and the gap whereas object RCs have a greater number of structural nodes); 2) the underlying word order (subject RCs have the OV ordering whereas object RCs have the SV ordering); 3) the morphosyntax (each RC-Type is formed by a different relativizing participle; the object relativizer requires the genitive case on the subject, which in turn requires possessive-agreement morphology on the relativized verb whereas the subject relativizer does not require extra morphosyntax); and 4) the frequency (subject RCs are more frequent than object RCs according to Slobin (1986) and Haig (1998)). Naturally, it is important to provide a very careful experimental analysis to disentangle between these factors. The thesis will attempt to combine several techniques in several groups of participants (i.e., monolingual children, adults, and bilingual children) to address this issue and to provide an explanation for the emerging pattern. The research questions specific to the acquisition and processing of Turkish RCs are given below:

- Are subject RCs acquired earlier and processed better than object RCs in Turkish?
- How could we account for the asymmetries that might be observed between subject and object RCs in Turkish?
- Do Turkish monolingual and Turkish-English bilingual children show similar patterns and use similar strategies in their comprehension and production of Turkish RCs?

1.1.2 Development of Language Processing in a Head-Final Language and Mechanisms and Strategies in Human Language Processing

Much of the psycholinguistic research have extensively focused on how linguistic processes combine to derive a meaning out of a spoken or written utterance (comprehension) and how these processes are involved in utterance formation (production) in adults but many of the questions that were laid around the 1960's are still valid even today despite a great deal of knowledge accumulation and methodological innovations in the field.

Nevertheless, it is widely-agreed in the literature that human beings rapidly integrate each incoming linguistic material into the existing structure (i.e., language comprehension is incre-

mental); different levels of processing (such as prosody or context) quickly guides syntactic interpretation; and that probabilistic information about the use of lexical items in relation to each other influences parsing (for a review see Altmann, 2001). It is also generally agreed that the same features are observed in language production. That is, message formulation and syntactic encoding is incremental to a certain extent and the syntactic choice in speech encoding is influenced by the context and frequency (for a review see F. Ferreira & Engelhardt, 2006). Throughout this work, the basic assumption regarding the language processing mechanism will be that both comprehension and production are incremental and influenced by contextual, prosodic, and probabilistic information.

Similarly, psycholinguistic studies have long been trying to show that the human processor applies certain universal strategies. The Filler-Gap Strategies, (Maratsos, 1974; Wanner & Maratsos, 1978, Fodor, 1978, Clifton & Frazier, 1989, Frazier, Flores d'Arcais, & Giovanni, 1989); the Parallel Function Hypothesis, (Sheldon, 1974); and the Canonical Order Strategy, (Bever, 1970) are only some of the strategies that have been shown to capture the facts regarding the processing of structurally complex sentences in various languages. Yet, it still is not established whether these psycholinguistic accounts that elegantly explain the data from head-initial/medial languages can work as effectively for Turkish, a head-final language with variable word order and rich inflection. This thesis will be the first work that combines off-line comprehension and production experiments and online reaction time experiments with monolingual Turkish children and adults in order to address the issue of whether or not these strategies could capture the processing facts (see Hermon, Öztürk, & Kornfilt, 2007; Aydın, 2007 for offline work with children addressing the Filler Gap Accounts; see Özcan, 1997, for an offline study with children addressing the Parallel Function Hypothesis; and see Slobin & Bever, 1982, for an offline study with children addressing the Canonical Word Order Strategy and see Demiral, Schlesewsky, & Bornkessel-Schlesewsky, 2008 for an online study with adults addressing the universal subject-preference strategy).

We involve children in addition to adults in our study because there is comparatively little information about whether and to what extent the features pertaining to the adult language processing mechanisms and strategies are shared by children. This has been a topic of language acquisition studies only since the last decade mostly due to the fact that many of the research tools and methodologies used in adult studies were unsuitable for children. It has been only recently that psycholinguistic studies started using online techniques to compare the processing mechanisms and strategies in children and adults (for a review, see Marinis, 2003; Trueswell & Gleitman, 2007).

Also, most of the influential accounts in the field of children's sentence processing have been formed in light of limited number of verb-initial/medial languages such as English (for a review, see Sekerina, Fernández, & Clahsen, 2008). As the verb appears as one of the initial constituents and there are not many morphological marking in English, the predictions of some of these accounts may not fully capture the processing facts in children acquiring a head-final language. For instance, studies suggest that English-speaking children mostly depend on the verb information in their parsing commitments (e.g., Snedeker & Trueswell, 2004). However, studies from adults speaking head-final languages show that they do not wait until the end of the sentence where the verb appears in order to interpret an utterance but they use each available morphosyntactic information incrementally. To date, there is almost no information available about whether or not children acquiring head-final languages present similarities to children acquiring head-initial languages and to adults speaking head-final languages (but see a recent work in Korean by Choi & Trueswell, 2010). Thus, the present study will also address the issue of whether Turkish-speaking children present similarities to adults in terms of their processing of RCs.

Below we list the research questions we will address concerning the characteristics of language processing mechanisms and strategies in a head-final language and the development of language processing abilities from childhood into adulthood.

- What is the cross-linguistic validity of the processing strategies offered for typologically distinct languages?
- To what extent do monolingual children and adults have access to similar processing mechanisms? To what extent do Turkish adults benefit from morphosyntactic information in an incremental and predictive manner?
- What do the comprehension and production data from children and adults reveal about the development of sentence processing abilities and language acquisition processes in general?

1.1.3 Organization of the thesis

The chapters are not organised on the order of the research questions listed above since each study might simultaneously provide information about various research questions. Chapter 2 provides a background on our assumptions about language processing mechanism in adults and children; it also provides a literature review on the acquisition of RCs in various

languages; on Turkish, Turkish RCs, and on the acquisition of Turkish RCs. Chapter 3 reports two off-line experiment on the comprehension and production of RCs in monolingual children and adults; and discusses the results in relation to the Filler-Gap Accounts. Chapter 4 outlines possible problems with the Filler-Gap Accounts and reviews the literature on the filler-gap strategies. This chapter presents an online experiment in the auditory moving-window paradigm to investigate the use of filler-gap strategies in the processing of Turkish RCs in monolingual children and adults. This chapter also reports data from the control items in the same experiment on the processing of simple sentences in various word orders and discusses the results in relation to the effect of the word order on the processing of Turkish RCs. Chapter 5 presents two processing accounts assuming a processor with a lexicalized grammar and a multiple constraint-satisfaction mechanism to capture the data from Experiment 3a in Chapter 4. Chapter 6 presents two online experiments (one on children and adults; another only on adults) that investigate whether the Parallel Function Hypothesis could account for the processing strategies in monolingual children and adults. Chapter 7 presents an online experiment using the word-monitoring paradigm to test the effect of genitive-possessive agreement morphology on the processing of Turkish RCs. Chapter 8 addresses the issue of how Turkish-English bilingual children perform in the comprehension and production of Turkish RCs in comparison to monolingual children; and what implications the children's comprehension and production strategies provide on language acquisition in general. Finally, Chapter 9 presents the summary of the findings from each experiment and revisits the research questions in the light of the experimental findings reported in the thesis.

Below, each research question is repeated along with a note to provide the reader with a general idea as to which questions are dealt with in each chapter.

- Are subject RCs acquired earlier and processed better than object RCs in Turkish? (Chapter 3 and Chapter 4).
- How could we account for the asymmetries that might be observed between subject and object RCs in Turkish? (Chapter 3 and Chapter 4).
- Do Turkish monolingual and Turkish-English bilingual children show similar patterns and use similar strategies in their comprehension and production of Turkish RCs? (Chapter 8).
- What is the cross-linguistic validity of the processing strategies offered for typologically different languages? (Chapter 4, Chapter 6, and Chapter 8).

- To what extent do Turkish adults benefit from morphosyntactic information in an incremental and predictive manner? (Chapter 4, Chapter 6, and Chapter 7).
- What do the comprehension and production data from children and adults reveal about the development of sentence processing abilities and language acquisition processes in general? (Chapter 4, Chapter 5, and Chapter 8).

The present data could be evaluated from a multidisciplinary perspective: research in several fields such as theoretical linguistics, cognitive science, psychology, language education, applied linguistics, bilingual education, sociolinguistics, clinical language sciences, computational linguistics and computer science address different aspects of the similar research questions attempted to be investigated here. This study will mainly adopt a psycholinguistic perspective and focus on the language processing mechanisms and strategies but it is hoped that this research would induce several specific directions for different fields and generate further studies.

1.2 Summary

This chapter set the context for the present study and presented the research questions that will be addressed in the thesis.

CHAPTER 2

BACKGROUND

2.1 Introduction

Spoken sentence comprehension is a very rapid process of recovering the phonological, syntactic, semantic, and pragmatic analysis of the sentence that conveys the critical information about its meaning. One main question this thesis explores concerns the processes that decode the syntactic structure underlying an utterance, which is generally called *parsing*.

Sentence processing literature has been mainly focusing on two aspects of parsing: (a) how listeners (or readers) recover the thematic information of *who did what to whom* in an utterance. This may involve questions of how we detect the difference between two sentences with exactly the same lexical items such as *John hit Jack* and *Jack hit John* or what factors contribute to the processing asymmetry between various structure types such as actives versus passives or subject versus object RCs. (b) how humans process sentences with more than one meaning. This may involve questions of how we parse locally ambiguous sentences such as *Bill knew John liked Mary.*, where the verb could equally be subcategorized for an NP (i.e., John) or a complement (i.e., that John liked Mary) or how we parse sentences that pose great difficulties in comprehension as in the famous example from Bever (1970) *The horse raced past the barn fell*, where the verb *raced* is ambiguous between a main verb in past tense and a past participle verb in reduced relative clause until the last verb *fell* appear.

This study will investigate the processing of subject and object RCs in Turkish children and adults, hence will mainly contribute to the first line of studies although we think that the two aspects of parsing are closely interrelated.

In this short background, we will provide brief information about our assumptions concerning the mechanisms of the sentence processing in adults and children; we will review the major literature on the acquisition of RCs in various languages; and present brief informa-

tion about Turkish, Turkish RCs, and then we will review the literature on the acquisition of Turkish RCs.

2.2 Assumptions about Language Processing

We assume that language processing in adults and children is largely incremental different processes influence each other, and that probabilistic information guides interpretation in parsing and structure choice in production (for reviews see Altmann, 2001; Pickering, Clifton, & Crocker, 2000, among others).

2.2.1 Language Processing in Adults

Despite a great deal of disagreement on the exact structure of the sentence processing mechanism, most of the sentence comprehension studies converge on the idea that the process of interpretation assignment is largely incremental (e.g., Frazier & Rayner, 1982; Rayner, Carlson, & Frazier, 1983; F. Ferreira & Clifton, 1986; Marslen-Wilson & Tyler, 1980; Crain & Steedman, 1985; G. N. Carlson & Tanenhaus, 1988; Taraban & McClelland, 1988; Altmann & Steedman, 1988; Altmann, 1988; Stowe, 1989; Trueswell & Tanenhaus, 1994; Jackendoff, 2002).

Earliest studies in word recognition have supported this by showing that words are rapidly identified as soon as enough sensory input is available even before the end of the word has been reached (e.g., Marslen-Wilson & Welsh, 1978; Tyler & Wessels, 1983; Marslen-Wilson & Tyler, 1980). In other words, syntactic and semantic properties of words are evaluated in a piecemeal fashion as soon as the initial sounds of the words become available.

Studies in ambiguity resolution have also supported this. For instance, various studies have demonstrated that in ambiguous sentences as in (1), readers prefer to attach the initial NP *the defendant* to the verb *examined* as its subject argument and recover the reduced relative clause analysis of the sentence only after the phrase *by the lawyer* appears. This suggests, among other things, that the processor does not wait until the ambiguity is resolved in order to assign an interpretation to the available input (e.g., Frazier, 1979; Rayner et al., 1983; F. Ferreira & Clifton, 1986; Traxler, Pickering, & Clifton, 1998).

(1) The defendant examined by the lawyer turned out to be unreliable.

Studies from adults speaking head-final languages have also showed that parsing is as incremental in head-final languages as it is in head-initial languages and that morphological

cues on the pre-verbal arguments in morphologically rich languages guide the parser to predict possible arguments even before the verb became available (see Yamashita, 1997, Kamide & Mitchell, 1999 for Japanese; Kiaer, 2005 for Korean; Lin, 2006 for Mandarin).

Studies have also revealed that there is certain interaction between different levels of processing; that is, the syntactic alternatives generated incrementally early in the sentence are effectively pruned by referential context, thematic fit, and prosody, among other things. For instance, Crain and Steedman (1985) demonstrated that sentence fragments such as *the psychologist told the wife that he was having trouble with* did not lead to a garden path when it was supplemented by an appropriate context. That is, they showed that the presentation of a complement supporting context as in (2a) in a complement target sentence as in (2b) significantly diminished the possibility of choosing the modifier analysis of the sentence. In the same way, presentation of a modifier supporting context as in (3a) before a modifier target sentence as in (3b) guided the parser towards the complement analysis of the structure at significant rates. Only when the context and the target sentence did not match, did they found a significant effect of ambiguity, which indicated that incremental interpretation assignment was not independent from the referential context (see also Altmann, 1988, Altmann & Steedman, 1988, Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995, Trueswell, Sekerina, Hill, & Logrip, 1999, among others).

(2) a. A psychologist was counselling a married couple. One member of the pair was fighting with him but the other was nice to him.

b. The psychologist told the wife that he was having trouble with her husband.

(3) a. A psychologist was counselling two married couples. One of the couples was fighting with him but the other was nice to him.

b. The psychologist told the wife that he was having trouble with to leave her husband.

Similarly, Trueswell and Tanenhaus (1994) presented data illustrating that the verb's semantic constraints influence people's expectation of a certain type of a structure. They showed that the use of an inanimate agent in an ambiguous sentence as in (4a) significantly reduced the garden path effect observed in a version with an animate agent as in (4b), revealing that alternative syntactic analyses were evaluated against the semantic fit between the argument and the verb (see also Snedeker & Trueswell, 2004, among others).

(4) a. The evidence examined by the lawyer turned out to be unreliable.

b. The defendant examined by the lawyer turned out to be unreliable.

Furthermore, studies also illustrated that prosodic information is also rapidly integrated into the process of interpretation assignment. For instance, Kjelgaard and Speer (1999) showed that intonational or intermediate prosodic boundaries guided for the intended interpretation in sentences with local ambiguities as in 5 whereas sentences uttered with conflicting prosody led to slower processing (see also K. Carlson & Clifton, 2001 and references therein).

(5) a. When Roger leaves the house is dark

b. When Roger leaves the house it's dark

In addition to incrementality and interaction between the processing levels, we assume that parsing processes are guided by probabilistic information. There is a large pool of evidence for the tabulation of frequency information at the lexical level (e.g., MacDonald, Pearlmutter, & Seidenberg, 1994, Trueswell, Tanenhaus, & Kello, 1993, Trueswell & Tanenhaus, 1994, Spivey-Knowlton & Sedivy, 1995, Trueswell, 1996). It has been asserted that the frequencies of the grammatical properties of lexical items such as their argument structure or subcategorization frames are kept in memory and this must have an effect on people's parsing preferences. For instance, the sentence *John believed Alice saw the wonderland* is ambiguous at the noun *Alice* since it could attach to the verb as its direct object NP or as the subject of a complement clause. Frequency-based accounts suggest that people prefer the complement clause interpretation reflecting their knowledge stating that the verb *believe* is used with a complement clause more often than with a direct object NP. On the other hand, the same sentence with another verb, *understood*, is expected to lead to an opposite expectation as the verb appears more frequently with a direct object NP compared to a complement clause.

Another frequency-based account is the tuning hypothesis of Cuetos and Mitchell (1988) (see also Mitchell & Cuetos, 1991, Cuetos, Mitchell, & Corley, 1996, Mitchell & Brysbaert, 1998). They suggest that people's parsing tendencies are formed in the light of their past experiences involving similar structures, so the frequencies in the spoken corpus should be reflected in people's parsing preferences. This version of the frequency-based accounts contends that frequency values are also tabulated at structural levels.

Apart from psycholinguistic studies, statistical parsing is also widely applied in computational linguistics. Most parsing and learning algorithms make use of the statistical regularities

found in spoken language (e.g., Abney, 1991, Collins, 1996, Jurafsky, 1996, Charniak, 1997, Bangalore and Joshi (1999), Hockenmaier & Steedman, 2002, Collins, 2003, among others). In most of these systems, the parser attempts to assign a structure to each string with the help of the probabilistic information; in these systems that allows syntactic and lexical local ambiguities are resolved on the basis of probabilistic information.

Thus, it appears that the processor rapidly parses utterances in line with each linguistic input combining several information such as context, semantic plausibility, prosody, probabilistic information, and the like.

2.2.2 Language Processing in Children

Until very recently, psycholinguistic studies have dominantly focussed on adult language processing and it has been only several decades that studies started to employ on-line methods to examine how children process language. Although there is an increasing number of work investigating the workings of the child processing system, a greater portion of these are restricted to English. These studies indicate that children present adult-like parsing routines by rapidly integrating the incoming strings on a word-by-word basis so they are as incremental as adults and reflecting the statistical regularities of their native language in their parsing choices. However, they present a different pattern from adults in terms of using contextual and prosodic information while parsing spoken utterances (for a review see Trueswell & Gleitman, 2007).

A study by Tyler and Marslen-Wilson (1981) is one of the earliest on-line investigations that depicted the similarity between adult and child processing. With a word-monitoring task, children at the age of 5 to 10 were tested in their ability to recognize syntactic or semantic anomalies in short stories. Their task was to listen to these stories to detect a pre-specified word in those utterances as well as responding to comprehension questions presented after some of the stories. The target words appeared right after the critical points, half of which involved semantic or syntactic anomaly. Children, just like adults, were reported to become slower to detect the target words after the anomalous speech compared to normal speech, indicating that they were indeed able to recognize the syntactic and semantic anomaly on the fly without waiting until the end of the utterances. This study revealed that children were able to combine syntactic, semantic, and pragmatic information as rapidly as adults.

In another study, Swingley, Pinto, and Fernald (1999) reported that children showed a similar processing pattern to adults in phonological cohorts such as *dog/doll*. In audio sen-

tences like *Look at the doll*, 18-24 months selectively directed their gaze at one of the cohort referents before the end of the word was uttered rather than at an irrelevant picture such as *a mouse*, which demonstrated that the word processing was initiated with the earliest sounds in an incremental fashion. In addition, Fernald, Swingley, and Pinto's (2001) study revealed that 27-month-old children were able to fixate their looks on a ball among the non-rollable objects upon hearing sentence fragments, such as, *Let's roll*. Thus, children are immediately engaged in syntactic and semantic analysis of an utterance in an incremental manner whenever enough information is accumulated.

On the other hand, in one of the earliest eye-tracking experiments with children, Trueswell et al. (1999) showed that 5-year-old children were not sensitive to the referential context in resolving syntactic ambiguities such as *Put the frog on the napkin in the box* by showing a preference for the destination interpretation (i.e., VP attachment) rather than the modifier analysis regardless of the number of referents (i.e., one frog/two frogs) presented in the context. This suggested that they relied on verb-specific syntactic information and avoided revising their initial attachment preferences. However, the data showed that children did not differ from adults in terms of incrementality of their word recognition or referential resolution abilities in unambiguous structures.

Other studies have also shown that children depend largely on lexical information, especially on verbs while deriving the argument structure of a sentence (i.e., making predictions about what the incoming arguments should be). For instance, Snedeker and Trueswell (2004) used eye-tracking methodology to test the effect of verb-bias compared to contextual information in ambiguity resolution in children at the age of 5. They used sentences like *'verb' the frog with the feather* by using verbs that are more likely to be used with an instrument (i.e., high instrument bias; e.g., hit), that are neutral (e.g., feel), or that are not likely to be used with an instrument (i.e., low instrument bias; e.g., choose). They also varied the referential context by having only one referent in some conditions or having two referents in other conditions. Thus, they tested the effect of the verb's selectional bias (i.e., the frequency with which a particular verb appears with an instrument) and the referential context (i.e., the number of referents in the context). Results clearly demonstrated that children fully ignored the referential context in all types of sentences and relied heavily on the verb's selectional restrictions in their attachment preferences. Trueswell and Gleitman (2004) suggested that children's parsing is highly dominated by verb information as a reliable predictor of the syntactic and semantic structure (see also, Snedeker & Yuan, 2008, Bates & MacWhinney, 1987).

Similarly, Thothathiri and Snedeker (2008) showed that children use the verb information

to predict the argument structure and they can construct abstract/structural representations by generalizing their knowledge of specific verbs to unknown verbs.

On the side of the used-based accounts, children have been shown to rely on item-based and verb-specific constructions suggesting that grammatical properties of a language and abstract generalizations emerge later in childhood (e.g., Tomasello, 1992; Tomasello, Call, & Hare, 2003; Tomasello and Brooks, 2003). Thus, the verb seems to be the driving force of English-speaking children's sentence parsing.

This might imply that case marking or word order would not contribute to children's parsing. In fact some offline studies suggest that productive use of case marking is acquired quite late and children are only able to disentangle the specific role of grammatical markers later in childhood. For instance, Dittmar, Abbot-Smith, Lieven, and Tomasello (2008) tested German children's ability to use word order and case marking cues between the ages of 2 to 7. They report that 2-year-old were able to understand sentences when both cues converged, 5-year-olds were able to use word order cues when the two cues conflicted whereas the same did not hold for the case marking cues, and only 7-year-olds were able to use both cue types as successfully as adults. These studies are critical because if children can only use case marking and word order cues very late in life or when these both sources of cues converge, then the children in verb final languages with rich inflection and variable word order would be unable to parse utterances rapidly and incrementally with each incoming each lexical item.

In other words, as the verb appears as one of the initial constituents and there are not many morphological marking in these languages, the proposal that children's processing is verb-based may not seem in contradiction with incremental parsing. However, this seems to be a problem for head-final languages with rich morphosyntax. If children acquiring such languages relied solely on the verb information, then they should be unable to derive an interpretation until the end of the clause, where the verb appears.

There is almost no information available about online processing in children acquiring head-final languages, except a recent study in Korean by Choi and Trueswell (2010). This study reports that Korean speaking children rely mostly on case marking cues and ignore the verb information. This might be indicating that children only use the reliable cues of the input language while ignoring the less reliable ones. Yet, this is also problematic for incrementality since the reliable information might appear sentence finally in free word order languages. This would mean that these children would have to wait until the reliable cues are encountered in the sentence, hence their parsing is not incremental.

Moreover, both findings would cast serious doubts on the claims of continuity from child-

hood into adulthood regarding their parsing mechanisms since adult speakers of verb final languages have been reported not to delay interpretation assignment until the verb but instead make use of every available cue (case marking or verb) to assign an interpretation to a string and to predict the forthcoming structure (e.g., Kamide, Scheepers, & Altmann, 2003; Kamide, Altmann, & Haywood, 2003).

Regarding the use of prosodic cues in sentence processing in children studies have revealed conflicting findings. While some studies showed that children start using the prosodic cues to segment speech into words as early as 6 months old (Jusczyk & Krumhansl, 1993; Morgan, 1996; and Johnson & Jusczyk, 2001; among others), others suggested that they do not show adultlike sensitivity to prosodic cues (Snedeker & Trueswell, 2003; Choi & Mazuka, 2003; Snedeker & Yuan, 2008). These studies show that children rely more on lexical cues while assigning interpretation to strings that are locally or globally ambiguous. This seems to be in line with studies indicating that children are not as sensitive to contextual cues as adults.

Different from the effect of context and prosody, studies suggest that children display sensitivity for the statistical regularities of their language and probabilistic information about the ways of combining lexical items (e.g., Saffran, Aslin, & Newport, 1996; Chater & Manning, 2006; Seidenberg & MacDonald, 1999; Tenenbaum, Griffiths, & Kemp, 2006; among others)

Thus, most of the sentence processing studies with children confirmed that their parsing mechanisms involve rapid and incremental integration of lexical materials and probabilistic evaluation of emerging cues. However, these studies also underlined some features developing in time such as difficulty in revising initial parsing decisions; limited processing capacity; limited sensitivity to context and prosody and high bias for lexical information. We focussed on the issue of incremental processing and argued that some of the accounts from head-initial languages may not ensure incrementality in child processing in head-final languages. This underlines that it is crucial to conduct greater number of studies in typologically distinct languages in order to gain more insights into the nature of language processing in children.

The present study will attempt to provide one of the earliest online processing data from children acquiring a head-final language to address some of these issues (see Choi & Trueswell, 2010). Turkish RCs seem to provide a nice opportunity to address these questions as they involve both morphological cues with varying degrees of ambiguity or reliability (e.g., accusative vs. genitive) and the relativized verbs that appear earlier in the clause. One of the important questions we will address throughout the thesis will be whether or not children

can use the morphosyntax of Turkish RCs (both the cues on the nouns and on the embedded verbs) in an incremental manner.

Below, we will provide a brief review of literature on the acquisition of RCs in various languages and then we will focus on Turkish RCs and on the studies about the comprehension and production of RCs in Turkish children.

2.3 Acquisition of Relative Clauses in Various Languages

There have been a great deal of interest in the investigation of comprehension and production of RCs in child language as a window to the mechanisms of language acquisition and language processing.

Previous empirical research on the acquisition of RCs can be broadly grouped under three categories. The first group focuses on the effect of embedding (right-branching vs. centre-embedded) and focus (the role of the relativized head in the RC and in the matrix clause) on children's processing of these structures. The second group focuses on the clause-structure of the RC itself and reports that object RCs are acquired later than subject RCs or the vice versa. And the third group focuses on the design of the experimental materials and shows that children do not show difficulty in comprehending and producing RCs when tested in specific ways and with specific conditions.[1]

One major study in the first group that focused on the processing of the RC within the matrix clause was Slobin (1973). Slobin showed that the processing becomes harder when a matrix clause is interrupted by another clause. That is, a sentence where an RC is inserted within the arguments of the matrix clause and the matrix verb 'The dog that the cat scratched licked his hand' induce more processing load compared to a sentence where an RC follows the matrix clause as in 'The dog licked his hand that was scratched by the cat'. This strategy is called the Interruption Hypothesis and it is based on the idea that it is easier for human-beings (both children and adults) to keep a complete parse in short-term memory rather than an incomplete or an interrupted parse.

On the other hand, some of the earlier studies such as Sheldon (1974) and Tavakolian (1981) suggested that children used different processing strategies from adults in the comprehension of complex sentences. According to Sheldon (1974), sentences with a noun phrase with the same or parallel grammatical function (i.e., subject or object) both in the embed-

[1]This review is by no means a comprehensive one. We tried to provide a very general picture of different perspectives from earliest studies to more recent ones in various languages.

ded clause and the matrix clause should be processed better than those with noun phrases with different roles in the two clauses as shown in (6). This is called The Parallel Function Hypothesis.

(6) a. SS: The dog that jumps over the pig bumps into the lion.

b. SO: The lion that the horse bumps into jumps over the cat.

c. OS: The pig bumps into the horse that jumps over the cat.

d. OO: The dog stands on the horse that the giraffe jumps over.

Sheldon (1974) proposed this strategy as opposed to Slobin's (1966) Interruption Hypothesis. Considering the sentences in (6), the Interruption Hypothesis expects SS and SO type sentences (as in 6a, b) to be more difficult to comprehend than OS and OO sentences (as in 6c, d) because the former ones locate their RCs between the subject of the matrix clause and the matrix verb. On the other hand, The Parallel Function Hypothesis predicts SO and OS sentences (as in 6b, c) to be more difficult to comprehend since the embedded clause does not have parallel roles in both clauses (the object RC has the subject role in SO and the subject RC has the object role in OS). Apart from the role of the RC in the matrix clause, children in Sheldon's study showed a clear asymmetry between subject and object RCs by showing a much poorer comprehension in object RCs vis-a-vis subject RCs. Yet, Sheldon's hypothesis did not account for this pattern.

Tavakolian (19788) offered another account for why children performed worse in SO RCs than in OS RCs. According to this, children's ability to interpret the phrase structure rules is limited in terms of recursion, which leads them to assign the noun phrases in RCs as if they were part of a conjoined clause as displayed in (7).

(7) a. The sheep knocks down the rabbit and stands on the lion.

b. The sheep knocks down the rabbit that stands on the lion.

Both Sheldon and Tavakolian attributed the emerging pattern to the limited syntactic knowledge and differential processing strategies in children compared to adults.

While these studies focused on embeddedness and focus, there has been a great deal of data suggesting that subject RCs are easier to comprehend and produce than object RCs for English children.

For instance, Bever (1970) showed that English children between the ages of 2 to 5 performed better in subject RCs in cleft constructions such as (8a) compared to object RCs within similar structures as in (8b).

(8) a. It was the dog that bit the cat.

b. It was the cat that the dog bit.

Bever proposed that children might be using a surface order schemas such as NVN (or SVO), which automatically assign the sentence initial NP an agent role, and the post verbal NP the patient role, considering the embedded verb as the verb of the matrix clause. While the NVN schema provides a correct interpretation for (8a), it does not for (8b). In this study, the same strategy was proposed to account for children's problematic comprehension in English passive constructions (Bever, 1970).

Whether the same pattern caused in typologically distinct languages by the same underlying mechanism has been one of the major questions the literature has been interested in.

Slobin and Bever (1982) showed that canonical order schemas come into play in morphologically rich languages with variable word-order whenever there are no case marking cues to provide stronger hint about the role of the NPs in a sentence.

Similarly, studies such as Bates and MacWhinney (1987) suggested that word order strategies work better for strict-word order languages since it provides a reliable cue for children. On the other hand, children speaking morphologically rich languages rely more on case marking cues rather than the word order cues. This suggests that there is not a unique and cross-linguistic cue that could be generalised to all languages. However, Hakuta (1981) reported that Japanese children rely on canonical SOV order cues more than case marking cues while comprehending the RCs. We discuss this issue in detail in Chapter 6 and Chapter 8.

Another possible explanation for the subject-object asymmetry in the acquisition, comprehension and production of RCs has been suggested by a typological study by Keenan and Comrie's (1977). They proposed that there is a hierarchy of accessibility, where a subject position (9) is easier to relativize than a direct object position (10), which is easier to relativize than an indirect object position (11), which is easier to relativize than an oblique object position (12), which is easier to relativize than a possessor (13).

(9) The child who has read the book

(10) The book whom the child has read

(11) The child to whom the librarian lent the book

(12) The librarian with whom the child chatted

(13) The child whose book has been lost

According to the Accessibility Hierarchy, if a position lower in the hierarchy can be relativized all positions above it can also be relativized. Even if the proposal derives from a typological observation, its psycholinguistic application has also been addressed by much work in the acquisition and processing of RCs (Keenan & Comrie, 1979; Gass, 1980; among others). Despite the fact that it has been shown to predict the order of appearance of RCs in child language (or the hierarchy of processing difficulty in adult language) correctly, this model does not address why such a hierarchy is observed, which is a more psycholinguistic question. Therefore, it seems difficult to identify whether an emerging order in the acquisition or processing of RCs certainly derives from this hierarchy or the hierarchy derives from the psychological processes, the cause of which resides in some other source (e.g., for a proposal that relates this hierarchy to the perceptual features of human cognition see Bock & Warren, 1985). It appears that unless the Accessibility Hierarchy makes predictions regarding the moment-by-moment processing of certain phenomenon, it will remain as a descriptive account rather than an explanatory one.

The final account that focuses on the subject-object asymmetry we will address in this review is the Filler Gap Account, which relates the difficulty in object RCs to the greater distance between the head of the RC (i.e., the relativized noun) and the gap (i.e., the position which this noun is extracted from). The basic idea behind this account is that the processing load increases in line with the amount of unintegrated information that needs to be kept in short-term memory (Frazier, 1987).

There are two versions of this hypothesis. One attributes the difficulty to the number of lexical items intervening the filler and the gap, namely the Linear Distance Hypothesis (Wanner & Maratsos, 1978; Gibson, 1998); and the other attributes the difficulty to the number of structural nodes between the filler and the gap, namely the Structural Distance Hypothesis (e.g., O'Grady, 1997; cf., Hawkins, 1999). There have been more support for the Structural Distance Hypothesis relative to the Linear Distance Hypothesis especially from head-final languages (Korean: O'Grady, 1997; Chinese: Hsu, Hermon, & Zukowski, 2009; Jakarta Indonesian: Cole, Hermon, & Tjung, 2003; among others).

A different version of filler-gap accounts has been suggested by Friedmann, Belletti, and Rizzi (2009) (see also Friedmann & Novogrodsky, 2004 for SLI children in Hebrew). According to this account, the type of the intervening element between the filler and the gap is effective in children's processing of complex structures. When the intervening element is of the same type as the extracted element, the processing of the structure becomes harder. Thus, the difficulty in object RCs has been attributed to the higher number of referential NPs between the filler and the gap compared to subject RCs.

However, Diessel (2005) suggested that filler-gap accounts may not work as effectively in languages like German, where the fronted relative pronoun has a case marking indicating the role of the extracted NP. We will address this issue in detail in Chapter 4.

While most of the cross-linguistic work has shown that subject RCs are acquired earlier than object RCs, there have recently been studies revealing an opposite pattern in some languages. These studies report data that do not conform to the subject-object asymmetry in the comprehension or production of RCs in child language.

Gutierrez's (2010) comprehension data from children acquiring Basque as their native language shows that they show better performance in object RCs compared to subject RCs (for similar findings from Basque speaking adults Carreiras, Duñabeitia, Vergara, Cruz-Pavía, & Laka, 2010). Basque is an ergative-absolutive and SOV language with rich inflection. The verbal auxiliary has to agree with subject, direct object, and indirect object as displayed in (14) with the example by Gutierrez, p. 165.

(14) zuk amari liburua eman diozu
you-erg mother-the-dat book-the-abs give 3abs-3dat-3erg
'you have given mother the book.'

Interestingly, Basque RCs are similar to Turkish RCs in that they are pre-nominal and there is no wh-element as a relative pronoun. The RC is marked by a subordinating suffix -en on to the auxiliary verb of the RC as shown in the example in (15) Gutierrez (2010, p. 165). However, different from Turkish RCs, both subject and object RCs are formed with the same relativizer and the word order is the same in both RC-Types. The only difference between subject and object RCs seems to be the case marking on the first NP, which is marked in absolutive in the subject RC and marked in ergative in the object RC. This pattern might be dues to the fact that the first NP in the object RC is the subject of the RC and it gets ergative case, which is in line with the canonical word order; whereas in the subject RC, the first NP is the object and is marked with the absolutive case.

(15) a. Hau da amama muxukatu duen neska
this is grandmother-abs kiss-perf aux-rel girl-abs
'This is the girl who is kissing the grandmother.'

b. Hau da amamak muxukatu duen neska
this is grandmother-erg kiss-perf aux-rel girl-abs
'This is the girl who the grandmother is kissing.'

Another study that report data that is different from the mainstream performance patterns in RCs is Ozeki and Shirai's (2010) longitudinal data from 5 Japanese children. According to this these children presented exactly the opposite pattern to English children by producing RCs to identify referents that do not exist in the context, used stative-attributive predicates, modified generic nouns such as 'thing', 'person', or 'one', and modified these nouns as restrictive RCs. English children as reported by Diessel and Tomasello (2000), on the other hand, used RCs in the predicate nominals and existential constructions, used RCs to give extra information about the nouns that appears in a presentational clause such as 'Here is the tiger that's gonna scare him'. They also underline that Kim's (1987) data from Korean was more like Ozeki and Shirai's (2010) data in that prenominal adjectivals and RCs appeared around the same ages and the modified nouns were usually of the generic type such as 'one' or 'thing'. The authors attributed this difference between Japanese and Korean on one hand, and English on the other hand, to the fact that both of the former languages have a unified structure in RC and adjectival modification in that both are prenominal, whereas English has a differential system where adjectival modification precedes the noun while RC modification follows it.

These studies underline the effect of language-specific features in the processing of grammatical structures. It appears that word order, morphosyntax and various other factors contribute to the processes to a degree; whether or not these factors would speak for or against one RC-Type seems to depend on to the extent the RC-structure that is in question follows the regularities in a specific language.

The last group of studies underline that children might be showing the difficulty in RCs due to the experimental conditions. For instance, Hamburger and Crain (1982) showed that when more reliable test conditions are ensured the success rate in OS relatives increased significantly. The pragmatic condition specifically underlined by Hamburger and Crain was the fact that the referential context should present at least two possible referents, one of which should be chosen in line with the information provided by the RC. This condition

is called the felicity condition. The authors also argue that children must be assuming that conversational maxims are properly satisfied by the speaker due to their limited pragmatic knowledge. This led to the view that children have access to the same linguistic principles as adults but they lack enough world knowledge that would enable them to accommodate the pragmatic limitations in the test utterances reported in the earlier studies (Crain & Thornton, 1998).

An elicitation study from Italian also revealed that children as young as 2-3 years old do display the grammatical knowledge of RCs when contextual factors are carefully constructed (Crain, McKee, & Emiliani, 1990).

Similarly, Goodluck (1978) showed that the performance rate automatically increased when the number of arguments were dropped in those sentences as in (16).

(16) a. The dog kicks the horse that jumps up and down.

b. The pig bumps into the sheep that jumps over the fence.

In line with this, Goodluck and Tavakolian (1982) argued that children's competence grammar should not be different from adults but they have limited processing capacity to integrate all the animate arguments in mind when interpreting these sentences.

In a more recent processing study on Hebrew children by Arnon (2005) and Arnon (2010), it has been shown that structures with lesser number of arguments (e.g., object relatives with pronominal subjects) are indeed more frequent in adult language, which suggests that children reflect the probabilistic nature of the input they receive. Arnon argues that children show difficulty in object RCs because they are usually tested on structures for which they do not receive enough input.

This is also in line with a longitudinal study from four English children by Diessel and Tomasello (2000). The data revealed that these children first produced propositionally simple structures involving a single proposition such as 'The frog hopped up and down'. Diessel and Tomasello also underlined that these children first displayed an ability to combine two (or more) propositions in an RC structure with the right-branching RCs rather than centre-embedded ones.

Thus, these studies indicate that there may not be a universal tendency leading to a subject-object asymmetry in all languages. It appears that the typological features of a particular language as well as the design of the study influence the pattern that is observed. Turkish is another language that has quite different structural characteristics from frequently studied

languages like English. As far as RCs in Turkish child language is concerned, we cannot talk about a unified pattern since the earlier studies have provided conflicting results. We will provide a brief information about Turkish and Turkish RCs in Section 2.4 and then we will summarise the previous studies on the acquisition of Turkish RCs in section 2.5.

2.4 Turkish and Turkish Relative Clauses

2.4.1 An Overview of Turkish

Turkish is an agglutinative language of the Altaic family. Due to this property, syntax and morphology do not appear as distinct systems as they are in other languages like English.

It has quite a rich verbal morphology. Tense-Aspect-Modality (TAM) markers and some syntactic constructions (e.g., relativization, complementation, or passivization) are marked via suffixation on the verb. Also, there is overt case marking on NPs and sentential complements, except for the nominative case and bare object case.

Some brief information on three of the case markings (i.e., nominative, accusative, and genitive) is in order, as it would be informative for the presentation of Turkish RCs. There is no overt marking for the nominative case, which is the default subject case in Turkish (17a). The accusative case unambiguously marks the direct object in Turkish (17b). However, in some cases where the object appears in immediately preverbal position, the accusative case might be optional (17c).

(17) a. Kedi uyu-yor.
Cat-NOM[2] sleep-PROG-3sg
'The cat is sleeping.'

b. Kedi süt-ü iç-ti.
Cat-NOM milk-ACC drink-PAST
'The cat drank the milk."

c. Kedi süt iç-ti.
Cat-NOM milk drink-PAST
'The cat drank milk.'

The genitive case, on the other hand, appears in differen troles: it could be the possessor of a possessive noun phrase (18a), the subject of a complement (18b), or a relative clause

(18c). The genitive case always requires the possessive morpheme (on the possessed NP in (18a), on the complementizer in (18b) and (18c)) followed by the agreement marker.

(18) a. Kedi-nin süt-ü
Cat-GEN milk-Poss3sg
'The cat's milk'

b. Kedi köpeğ-in tavşan-ı ısır-dığ-ı-nı gör-dü.
Cat-NOM dog-GEN rabbit-ACC bite-DIK-Poss3sg-ACC see-Past
'The cat saw that the dog bit the rabbit.'

c. Köpeğ-in ısır-dığ-ı tavşan kaç-tı.
Dog-GEN bite-DIK-Poss3sg rabbit run-Past
'The rabbit that the dog bit ran away'

Subjects agree with verbs in number and person, through verbal morphology. Agreement suffixes follow tense-aspect-modality suffixes as exemplified in (19):

(19) koş-malı-ydı-n
run-NECC-PAST-1sg
'You should have run.'

SOV is accepted as the canonical word order. However, as far as the object is marked in the accusative case, all six word order variations are possible in line with discourse as illustrated in (20).[3]

(20) a. *SOV:*
Ali elma-yı ye-di.
Ali apple-ACC eat-PAST
'Ali ate the apple.'

b. *SVO:*
Ali ye-di elma-yı.
Ali eat-PAST apple-ACC
'Ali ATE the apple.'

[3]We provide the translations in line with a likely discourse option.

c. *OVS:*

Elma-yı ye-di Ali.

Apple-ACC eat-PAST Ali

'As for the apple, Ali ate it.'

d. *OSV:*

Elma-yı Ali ye-di.

Apple-ACC Ali eat-PAST

'It was Ali who ate the apple.'

e. *VSO:*

Ye-di Ali elma-yı.

Eat-PAST Ali apple-ACC

'Ali did eat the apple.'

f. *VOS:*

Ye-di elma-yı Ali.

Eat-PAST apple-ACC Ali

'Ali ATE the apple.'

Both subjects and objects can be dropped depending on the context as exemplified in (21).

(21) a. *Subject Drop:*

pro elma-yı ye-di.

pro apple-ACC eat-PAST

'(He) ate the apple.'

b. *Object Drop:*

Ali pro ye-di.

Ali pro eat-PAST

'Ali ate (it).'

c. *Subject and Object drop:*

pro pro ye-di.

pro pro eat-PAST

'(He) ate (it).'

Turkish is a head-final language; heads consistently follow their arguments. Following from this property, Turkish has postpositions, and nominal modifiers such as RCs, adjectives, or demonstratives precede their head nouns.

Possessive constructions are worth considering in this overview since they share certain morphosyntactic features with object relativization.

In possessive constructions, the possessor NP is marked by the genitive case where the possessed NP has a possessive marker, which agrees with the possessor in person and number as in (135):

(22) a. Adam-ın kitab-ı
Man-GEN book-3sgPOSS
'The man's book.'

b. Adam-ın kitap-lar-ı
Man-GEN book-PL-3sgPOSS
'The man's books.'

The agreement marker on the possessed NPs can be omitted in some colloquial cases as shown in (23). There is no systematic work in this respect but we predict this most probably serves a pragmatic function (i.e., in cases where the speaker wishes to put a distance between the possessor and the possessed; or in cases where the possessed is so obvious to belong to the possessor).

(23) a. *Possessed NP without agreement:*
Ben-im araba ayva-yı ye-di.
1sgPron-GEN car quince-ACC eat-PAST
'My car has been broken down' or literally 'This car ate the quince.'

b. *Possessed NP with agreement:*
Ben-im araba-m ayva-yı ye-di.
1sgPron-GEN car-1sgPOSS quince-ACC eat-PAST
'My car has been broken down' or literally 'My car ate the quince!'

However, the possessive agreement marker cannot be omitted even in colloquial cases when a lexical item intervenes between the possessor and the possessed, which is, to the best of our knowledge, a novel observation (see the examples in (24)).

(24) a. *Possessed NP without agreement:*
*Anne-m-in biricik kardeş vefat et-ti.
Mother-1sgPOSS-GEN only sibling die-PAST
'The only sister of my mother has passed away.'

b. *Possessed NP with agreement:*

Anne-m-in biricik kardeş-i vefat et-ti.

Mother-1sgPOSS-GEN only sibling-3sgPOSS die-PAST

'The only sister of my mother has passed away.'

2.4.2 Turkish Relative Clauses

Turkish RCs are prenominal so the relativized (i.e., modified) head always appears in the right-most head position and the RC always precedes the relativized noun.

There is no overt wh-element or complementizer but there is a verbal head that is marked with participle suffixes. There are two participles for relativization, namely -DIK and -(y)An.

To relativize an object NP, -DIK morpheme is generally used as a relativizing morpheme/participle on the verbal head and the subject is marked with the genitive case, and the participle is followed by the possessive suffix marking the agreement with the subject, as in (25a). A verb relativized by -DIK morpheme could both refer to the past or present depending on the context. There is another morpheme -ACAK that is used when the relativized verb refers to the future, as in (25b). In subject RCs, relativization is carried by the morpheme -(y)An[4] with no extra morphology, as in (25c). Similar to -DIK, -(y)An morpheme also refers to the past or present; when it refers to the future, future marker -ACAK is used with a copula -ol that is marked with the -(y)An suffix, as in (25d).

(25) a. Kedi-nin kovala-dığ-ı köpek

Cat-GEN chase-DIK-3sgPOSS dog

'The dog the cat is going to chase'

b. Kedi-nin kovala-yacağ-ı köpek

Cat-GEN chase-ACAK-3sgPOSS dog

'The dog the cat chased'

c. Kedi-yi kovala-yan köpek

Cat-ACC chase-(y)AN dog

'The dog chasing the cat'

[4]The initial consonant 'y' of the subject relativizing morpheme -(y)AN is in brackets to indicate that it can be dropped in certain contexts.

d. Kedi-yi kovala-yacak ol-an köpek
Cat-ACC chase-FUT be-(y)AN dog
'The dog that will be chasing the cat'

Although, in spoken language, the participle suffixes (-DIK or -(y)An) can be grammatically used both as restrictive and non-restrictive relativizing morphemes, in written language they are more likely to appear with the function of restriction or identification rather than adding extra information about the referents Göksel and Kerslake (2005). All of the test items in this study will involve restrictive RCs rather than non-restrictive ones.

Also, it is possible to omit the head noun modified by a relative clause so long as the context allows it (i.e., if the referent noun is already mentioned or obvious in the discourse). Headless relative clauses can be translated as 'the one that' or 'those who' and so on. All the suffixation (e.g., number, person, or case) that would normally appear on the head noun appears on the verbal head (i.e., the relativized predicate) as in (26a) and (26b) taken from Göksel and Kerslake (2005, p./ 449):

(26) a. [opera-yı sev-me-yen]-ler-e (şaşıyorum).
opera-ACC like-NEG-PART-PL-DAT
'(I am surprised) at those [who don't like opera].

b. [opera-yı sev-me-yen] kişi-ler-e ...
person-PL-DAT
'. . . at people [who don't like opera].'

There have been different accounts regarding the conditions under which when each of the relativizing suffixes should be employed. According to Underhill (1972), the choice of relativizing morpheme depends on the grammatical role of the missing NP (i.e., the gap) in the RC. When the gap is the subject or subconstituent of the subject and when there is no subject in the RC, then -(y)An morpheme is used; and -DIK morpheme is used in all other cases. Hankamer and Knecht (1976) underline a problem in this analysis and suggest that "if there is no subject in the RC at the time of RC formation", only -(y)An participle could be used (p.132).

Barker, Hankamer, and Moore (1990) agree with Hankamer and Knecht (1976) in that the grammatical relation of the gap in relation to the highest nominal in the RC dominating the gap determines the relativizing morpheme to be used. In some cases, the gap in the RC might be the direct object as in the example provided by the authors (p.24), which is shown

in (27) but -(y)An rather than -DIK strategy is used. This leads the authors to suggest that it is not the role of the gap but the role of the clause which contains the gap that is effective in determining the relativizing morpheme. In (27), the constituent out of which the dative object is extracted is the subject of the RC, hence the predicate is relativized by -(y)An.

(27) bizim güven-eceğ-imiz şüpheli ol-an adam
we-GEN trust-COMP-POSS1pl boubtful be-(y)An man
'The man that it is doubtful we will trust'

The same holds true in (28). The relativization is carried by -DIK morpheme when the gap is the subject of the clause but the host of the gap is the direct object of the RC.

(28) kitab-ı getir-eceğ-i-ni san-dığ-ım çocuk
book-ACC bring-COMP-POSS.1sg believe-DIK-POSS.1sg child
'The child that I thought would bring the book'

Barker et al. (1990) also provide an example, where there is a surface subject in the structure but the verb is still relativized with -(y)An (29).

(29) Bacağ-ın-ı arı sok-an kız
leg-POSS-ACC bee sting-(y)An girl
'The girl whose leg a bee/some bee stung'

The authors suggest that having an indefinite or non-specific interpretation and appearing in the pre-verbal position, 'arı', 'bee' is incorporated into the verb in this sentence and hence the structure should be considered subjectless (for a similar analysis see also Hankamer & Knecht, 1976; Knecht, 1985).

Haig (1997) and Haig (1998) disagrees with the subject-incorporation analysis of the examples similar to the one in (29). He provides other examples where the subject has a plural marking as in (30a) or it is preceded by an indefinite article as in (30b). He suggests that incorporated nouns should not involve inflection or cannot take articles as suggested by Hopper and Thompson (1984).

(30) a. Arkeolojik kazı-lar yap-ıl-an bir bölge-ye gel-dik
archaeological excavation-Pl make-PASS-(y)An an area-DAT come-PAST-1pl
'We arrived at an area in which archaeological excavations were being carried out.'

b. Ömer iç-in-de kocaman bir soba yan-an geniş bir oda-da
Ömer inside-POSS3sg-LOC huge an oven burn-(y)An spacious a room-LOC
bir satranç sorusunu çöz-üyor-du.
a chess problem solve-PROG-PAST3sg
'Ömer was in a spacious room in which a huge stove was burning, solving a chess problem.'

Note, however, that both of these sentences involve actions ('yap-ıl-an', 'make-PASS-(y)An';'yan-an', 'burn-(y)An') that is actually done by some other agent rather than the subjects of the sentences ('arkeolojik kazılar', 'archaeological excavation-Pl'; 'soba', 'stove'). Moreover, the sentences in (31) do not sound as grammatical as the one in (29).

(31) a. ? Bacağ-ın-ı arı-lar sok-an kız
leg-POSS-ACC bee-pl sting-(y)An girl
'The girl whose leg a bee/some bee stung'

b. ? Bacağ-ın-ı bir arı sok-an kız
leg-POSS-ACC a bee sting-(y)An girl
'The girl whose leg a bee/some bee stung'

Yet, when a sentential subject is relativized as in (32) both -(y)An and -DIK is acceptable without influencing the interpretation (examples are from Csató, 1996 as cited in Göksel, 2007).

(32) a. biz-im güven-eceğ-imiz şüpheli ol-an adam
we-GEN trust-COMP-1pl.POSS doubtful be-(y)An man
'The man that is is doubtful we will trust'

b. biz-im güven-eceğ-imiz-in şüpheli ol-duğ-u adam
we-GEN trust-COMP-1pl.POSS-GEN doubtful be-DIK-3sgPOSS man
'The man that is is doubtful we will trust'

Haig further argues against the standard accounts of participle choice on account of the fact that they offer three different explanations to account for when a particular relativizing participle is used. He summarises these three accounts as follows(p. 191).

- *The Primary Principle*: [-(y)An] is used for relativization of subjects, [-DIK] is used for non-subjects (Underhill, 1972).

- *The No-Subject Principle*: If the RC is subjectless at the time of RC formation, use [-(y)An] (Hankamer & Knecht, 1976).
- *The Mother-Node Principle*: When subconstituents of a major clause constituent are relativized, the choice of participle is in accordance with what would be predicted by the Primary Principle for the head of that constituent (Hankamer & Knecht, 1976).

Haig provides an alternative principle, namely *the Genitive Subject Condition*, which he claims to capture the phenomenon in a more parsimonious way.

- *The Genitive Subject Condition*: When the subject of the RC takes genitive marking, [-DIK] is used and [-(y)An] is impossible. Elsewhere, [-(y)An] is always possible and vastly preferred.

Along the similar lines with Haig (1997), Güngördü and Engdahl (1998, p. 2) suggest that it is the "existence of the genitive case on the subject that determines the particular relativization suffix on its verbal head". However, different from Haig's analysis, they relate the use of the genitive case to specificity. That is, the subject is non-specific when it lacks the genitive case marking as in (33a) (cf., (33b), which has a specific reading) (examples are from Güngördü & Engdahl, 1998, p. 2).

(33) a. Her gece bir çocuk ağla-yan ev
every night a child cry-(y)An house
'The house where a child cries every night'

b. Her gece bir çocuğ-un ağla-dığ-ı ev
every night a child-GEN cry-DIK3sgPOSS house
'The house where a child cries every night'

The genitive case might be instructive in the choice of the relativizing participle in the sense that whenever the subject of the RC is marked with the genitive case, the verbal head has to be marked with -DIK, followed by a possessive-agreement morphology. Yet, the choice of the relativizing suffix seems to be unrelated to the fact that whether the subject of the RC is specific or non-specific. To illustrate, the subject in an object RC could have a non-specific reading despite it has the genitive case as in (34).

(34) Her gün bir gazeteci-nin öldürül-düğ-ü bir ülke iste-mi-yor-uz.
every day a journalist-GEN kill-CAUS-PASS-DIK3sgPOSS a country want-neg-prog-1pl
'We do not want a country where a journalist is killed every day.'

Kornfilt (1994), on the other hand, relates the participle choice to the existence of the possessive agreement marker or its lack thereof. Whenever the subject requires overt agreement to receive its case marking, -DIK morpheme is used. According to her, the reason why -DIK requires agreement is related to redundancy of the morphology and "alternations between overt agreement morphology and lack thereof are not very salient perceptually and thus two distinct, phonologically unrelated nominalization markers are used in addition to that alternation". The fact that -(y)An is used with no agreement for subject and nominalization marker and that there is overt agreement in all other conditions in some Turkic languages such as Uzbek and Turkmen is given as a support for this perspective.

In parallel to Barker et al. (1990) and Haig (1997), Öztürk (to appear) suggests that the choice of relativizing morpheme depends on the existence of a subject that is marked with the genitive case but she further relates this observation to "whether [Spec, TP] is being projected as a criterial freezing position or not" (p.12) along similar lines with Rizzi and Schlonsky (2005). According to this, [Spec, TP] is a position that does not allow the constituents it hosts to move further. Whenever an NP moves into the [Spec, TP] position, it requires strong agreement and -DIK relativizer that requires verbal agreement; and -(y)An is used in cases where there is no subject in [Spec, TP].

The present study does not aim to dissociate between different analyses of Turkish RCs.[5] We will simply use the term subject RCs for the relativization carried by -(y)An and object RCs to refer to the relativization carried by -DIK. Actually, in all our test items, -(y)An is used when the subject is extracted and -DIK is used when the object is extracted, but for the interpretation of the acquisition data reported in this study, it is important to underline one point that could be derived from the discussion on the choice of participles. There is not a clear-cut regularity in terms of the participle choice in Turkish RCs such that when subject is extracted -(y)An is used and when object is extracted -DIK is used. As we have summarised above, there are cases where -(y)An rather than-DIK is used even if the object is extracted (as in the examples in (29) and (33a)). Independent of the discussion as to whether such structures should be considered subjectless, an important question regards how the child perceives and deals with such irregularity. We will address this issue when we discuss monolingual and

[5]The reader is referred to Hankamer and Knecht (1976), Kornfilt (1984), Kornfilt (2000), Csató (1996), Barker et al. (1990), Özsoy (1994), Kornfilt (1997), Erkman-Akerson (1998), Haig (1998), Güngördü and Engdahl (1998), Aygen (2003), Bozşahin (2002), Bozşahin (2008), and Öztürk (to appear) for different syntactic accounts. However, it is out of the scope of the present work to provide experimental support for or against a specific account of the relativization phenomenon in Turkish.

bilingual children's responses for RCs in the elicitation task in Chapter 8.

2.5 Acquisition of Turkish Relative Clauses

Several acquisition studies in Turkish have addressed the issues of whether or not a subject-object asymmetry would be observed in children acquiring Turkish as their native language. However, findings of those studies seem not to converge. While some suggested that subject RCs yielded a better performance, others proposed the opposite.

Slobin's (1986) study was the first to investigate the acquisition of RCs in 3-to-4 year old Turkish-speaking children. This study was based on a child-parent language corpus elicited from Turkish and American families. The analysis of the frequency of RCs in the two groups showed that American parents and children used RCs more frequently than their Turkish counterparts (96 vs. 49 RCs in American and Turkish children, respectively; 40 vs. 22 RCs in American and Turkish parents, respectively). From the RCs used by Turkish speakers, only 12% were object RCs, and the remaining 88% were subject RCs. This asymmetry between subject and object RCs was in line with the studies on English RCs. To further examine RCs in Turkish children, Slobin also collected experimental data using an act-out task with 4-year-old children. This showed that Turkish children had difficulty comprehending RCs and focused mainly on the canonical SOV sentence structure to act out the sentences.

Ekmekçi (1990) investigated the acquisition of RCs in 3-to-6 year-old Turkish children using an imitation and a production task. In the imitation task, children were asked to repeat after the experimenter subject and object RCs along with simple sentences with adjectives. This showed a developmental effect; there was a significant correlation between age and success level. In addition, there were differences between the three sentence types; on average, the performance in simple sentences was the highest in all groups and the success rate in object RCs was higher than it was in subject RCs at the age of 3, 4, and 5. At the age of 6, the children performed equally well in all sentence types. However, the opposite pattern was observed in the production task as children performed better in subject RCs compared to object RCs. Ekmekçi (1990) suggested that better performance in object RCs in the imitation task could be due to the similarity in articulation between the past tense morpheme and the object relativizing particle. Alternatively, this dissociation could also be due to inconsistencies in the test items. In the examples provided in Ekmekçi's (1990) paper, argument structure varied across the sentence types. Subject RCs involved intransitive verbs, whereas object RCs involved transitive verbs. This may have acted as a confounding factor affecting

the asymmetry between subject and object RCs.

Özcan (1997) investigated the effect of RC-Type in combination with the grammatical role of the relativized noun in the matrix clause, i.e., subject RCs with subject (SS) and object role (OS) in the main clause and object RCs with subject (SO) and object role (OO) in the matrix clause. This study also compared the comprehension patterns of RCs in younger children (mean age = 3.5 and 5.5) with older children (mean age = 7.6). The results showed a significant effect of age on comprehension; the children's performance increased with age, but there was no significant effect of RC-Type or RC-Role. The hierarchy followed by older children was SS >[6] SO > OS > OO whereas for younger ones it was OO > SO > SS > OS. It was concluded that awareness of RC structure appears as early as 3-year-old and that parallelism in the grammatical roles does not facilitate comprehension.

However, when the success rates in all four sentence types were compared, a striking picture emerged. 3-year-old children had very low accuracy in all conditions, but their highest accuracy was in object RCs with the object role (OO) (66 %). In contrast, 5- and 7-year-old children showed the lowest accuracy in OO RCs (58 % and 66 %, respectively).

Although it is not stated whether or not these differences were significant, one explanation for the discrepancy between 3- vs. 5- and 7-year-olds might be that the task demands for 3-year-olds were very high and therefore their performance was in general low. Alternatively, the variation in the performance of the three groups might be related to the variation among the test items in terms of structural complexity (e.g., pro-drop, definiteness, or case marking), sentence length, and reversibility. Some items of the study were semantically reversible (i.e., both referents could equally act as an agent or a patient) while others were not (i.e., semantic features of the lexical items made the theta-role assignment obvious), as illustrated in examples (35a)-(35d) below. In (35a), world knowledge makes it clear that 'the man' is the agent and 'the newspaper' is the patient, but in (35b) and (35c) syntactic knowledge is necessary to assign theta-roles correctly (examples from Özcan, 1997).

(35) a. Gazete oku-yan adam telefon-a cevap ver-di. (SS)
Newspaper read-(y)An man telephone-DAT answer give-PAST
'The man who was reading the newspaper answered the phone.'

b. pro Kedi-yi kovala-yan köpeğ-i sev-di-m. (OS)
cat-ACC chase-(y)An dog-ACC love-PAST-1sg
'I stroked the dog which was chasing the cat.'

[6] '>' is used to indicate a better performance in the former than the latter.

c. pro Köpeğ-in kovala-dığ-ı kedi-yi kucağı-m-a al-dı-m. (OO)
pro dog-GEN chase-DIK-3sgPOSS cat-ACC arm-1sgPOSS-DAT take-PAST-1sg
'I held the cat which the dog was chasing.'

d. pro Ara-dığ-ı oyuncak masa-nın altın-da dur-uyor-du. (SO)
pro look-DIK-3sgPOSS toy table-GEN under-LOC stay-PROG-PAST
'The toy he was looking for was under the table.'

Kükürt (2004) investigated the comprehension patterns presented by 41-to-52-month-old monolingual children and adults with Broca's aphasia with a sentence-picture matching task. Participants were presented with three pictures and asked to choose the one described by the sentence they heard. The test items in this study were controlled for the felicity, semantic reversibility, and consistency among test items. Both children and adults with Broca's aphasia showed above chance performance in subject RCs (children: 88.2%; Broca's patients: 90.9%) but chance or below chance performance in object RCs (47.1% and 27.3%). It was hypothesised that the participants mayhave difficulty in processing the possessive-agreement morphology in object RCs. Two strategies (one relating to the word-order and another to case marking) were suggested to account for the better performance in subject RCs: Pre-Verbal strategy that takes the OV ordering as the canonical order and assigning the pre-verbal NP the patient role; and Acc-Obj strategy that attaches the object role to the NP with the accusative case.

Hermon et al. (2007) used an elicitation task to test the production of RCs in monolingual Turkish children. They tested subject, object, and prepositional-phrase RCs as exemplified in (36).

(36) a. *Subject RC*
Kedi-yi kovala-yan kız mor ol-du
cat-ACC chase-(y)An girl-NOM purple become-PST-3SG
'The girl who is chasing the cat turned purple.'

b. *Object RC*
Kız-ın kovala-dığ-ı kedi sarı ol-du
girl-GEN chase-DIK3SG cat.NOM yellow become-PST-3SG
'The cat that the girl is chasing turned yellow.'

c. *Prepositional-Phrase RC*

Kız-ın üst-ün-den zıpla-dığ-ı çocuk mor ol-du
girl-GEN top-3SG-ABL jump-DIK3SG child-NOM purple become-PST3SG
'The child over which of which the girl is jumping turned purple.'

The results showed that object RCs and prepositional-phrase RCs posed more problems compared to subject RCs. The authors interpreted the results as providing support for the Structural Distance Hypothesis which suggests that the difficulty in object RCs is related to the processing cost due to the number of structural nodes between the filler and the gap O'Grady (1997). The response analysis showed that subject and object RCs did not significantly differ in the number of ungrammatical responses whereas the prepositional-phrase RCs led to greater number of ungrammaticalities compared to subject and object RCs. They further noted that children preferred avoiding object RCs; however, whenever they used the structure, the case marking (i.e., genitive) and possessive-agreement morphology were used correctly. This led them to argue that children's problem was related to their limited processing capacity rather than to the morphosyntax of RCs.

On the other hand, Özcan (2000) reported errors that lacked the genitive case and that involved -(y)An instead of -DIK as in the example in (37).

(37) Köpek kovala-yan tavşan
dog chase-(y)An rabbit
'The rabbit which the dog is chasing.'

Özcan related this to the possibility that "the morphological marking of the relativized NP . . . facilitates the production of subject relativization" (p. 312).

Thus, it is clear that there is not an agreement on the possible causes underlying the subject-object asymmetry in the acquisition of Turkish RCs just as there is no agreement whether or not subject RCs are actually better performed than object RCs. All of the previous studies have employed off-line methodologies that is hardly informative on the possible causes of the difficulty. The present work aims to bridge this gap by combining off-line techniques with on-line tasks that provide information about the moment-by-moment processes involved in the processing of a particular sentence. This way, it aims to provide a comprehensive analysis of the processes involved in the processing and acquisition of Turkish RCs in children.

2.6 Summary

This chapter presented some background assumptions underlying this work regarding language processing in children and adults. It also reviewed some literature about the acquisition of RCs in different languages and provided information about Turkish RCs and studies on the acquisition of Turkish RCs.

CHAPTER 3

MECHANISMS IN THE PROCESSING OF TURKISH RELATIVE CLAUSES

3.1 Introduction

It has been repeatedly shown in the literature that structures such as wh-questions, RCs, and passives in English are difficult to acquire and process. Psycholinguistic accounts since late 1970's have allocated a great deal of effort to investigate the underlying mechanisms that make these structures more complex than simple canonical sentences.

Transformational grammar (Chomsky, 1965) assumed that some lexical items such as wh-phrases in questions or in RCs move from their canonical positions; and Government and Binding Theory (Chomsky, 1981) further postulated the idea that moved/displaced items leave a 'trace' in their canonical position. Minimalist Program (Chomsky, 1995) also assumes that there is a dependency between the displaced element and its silent copy (i.e., trace), which is shown with coindexation as shown in (38). Trace is traditionally represented by 't' and coindexation is shown with the subscripted 'i' on the trace (i.e., t_i) and on the displaced item (i.e., the cake$_i$ or who$_i$).

(38) a. The cake$_i$ that$_i$ Alice ate t_i caused her to get smaller.

b. Who$_i$ did Alice saw t_i while sitting on the riverbank?

From a psycholinguistic perspective, the fact that these structures are difficult to process has mostly been attributed to the assumption that some lexical items do not appear in their original position and that the processor works harder while establishing the dependency between the displaced item and its trace. According to these theories, it is this coindexation or the dependency between the trace and the displaced constituent that guides the interpretation

assignment in these *complex* structures. Within the psycholinguistic literature, the term *filler* or *antecedent* is used to refer to a moved or displaced item (i.e., an item that appears in a place different from its canonical position in a sentence) and the term *gap* is used to refer to a silent or empty category left in the filler's original position. And it has been usually accepted that a distinct mechanism should be at work while processing filler-gap dependencies as compared to the dependencies between a canonical item and its subcategorizer.

According to these accounts (henceforth: filler-gap accounts), memory resources increase in line with the number or the nature of intervening elements between the filler and its gap. In this chapter, we will present an off-line experiment to investigate whether the filler-gap accounts could provide a plausible explanation for the patterns presented by Turkish monolingual children and adults in their comprehension of Turkish RCs.

One of the earliest models in this tradition is the model by Wanner and Maratsos (1978), which takes the linear distance between the filler and the gap as a reason for the processing difficulty in embedded structures. They argue that the longer it takes the filler to attach to its gap, the more difficult it becomes to process the sentence; so the processing is costly when the number of intervening lexical items between the filler and the gap increases. This account is generally called the Linear Distance Hypothesis. Let us see how this hypothesis explains the processing difficulty in object RCs compared to subject RCs in English: In subject RCs (39a), the first NP is the displaced element (i.e., the filler) and the gap appears right after the relative pronoun so there is only one lexical item between the filler and the gap, which is the complementizer 'that'. In object RCs (39b), on the other hand, although the displaced element appears in the same location as in the subject RC, the distance between the filler and the gap is longer here as the displaced element attaches to its gap after the verb 'V'. Thus, while there is only one intervener in subject RCs there are three in object RCs, which leads to more processing cost and lower performance in object RCs.

(39) a. NP_i[that t_iV NP] 'The burglar$_i$ that t_i shot the woman fled.'

b. NP_i[that NP V t_i] 'The burglar$_i$ that the woman shot t_i collapsed.'

In an account that takes the level of embeddings as a determining factor for complexity, O'Grady (1997) argues that it is not the number of lexical items but the number of syntactic nodes or maximal projections between the filler and the gap that increases the processing load. This account is called the Structural Distance Hypothesis and it argues that the difficulty in the processing of object RCs compared to subject RCs lies in the greater number of maximal

projections (i.e., higher structural distance) between the filler and the gap in the former. As shown in an example from O'Grady there is one maximal projection between the filler and the gap in a subject RC (40a), which is the 'S-node' while there are two in an object RC (40b), namely the 'S-node' and the 'VP-node'.

(40) a. The truck$_i$ that [S t$_i$ pushed the car]

b. The truck$_i$ that [S the car [VP pushed t$_i$]]

A similar processing approach that focuses on the locality effects and the nature of the intervening elements between the filler and the gap is the one derived from Rizzi's (1990) Relativized Minimality account, which we will call the Argument Crossing (or A-bar dependency) Accounts (Friedmann et al., 2009). The Argument Crossing Accounts argues that the asymmetry between subject and object RCs stems from the parser's tendency to bind A-bar dependencies as soon as possible. The Argument Crossing Accounts propose that the parser has difficulty whenever the filler and its gap is intervened by another constituent of the same sort as the filler (i.e., the lexical NP). As it is clear from the examples (from Gibson, 1998) in (41), there is no lexical NP between the filler 'the reporter' and the gap 't' in subject RCs as in (41a) but the filler and the gap in object RCs is intervened by an NP 'the senator' as in (41b). Here, 'the senator' provides a more local relation with the gap thereby preventing the dependency relation between the correct filler and the gap.

(41) a. [S The reporter$_i$ [S' who [S t$_i$ attacked the senator]] admitted the error].

b. [S The reporter$_i$ [S' who [S the senator attacked t$_i$]] admitted the error].

Similar explanations that take the existence of an intervening NP, though not derived from the Relativized Minimality, have been put forth to explain the processing difficulties in various populations in different languages (for Broca's aphasia in Hebrew, see Friedmann & Novogrodsky, 2004; for SLI in Hebrew see Friedmann et al., 2009; for typically developing and SLI children in Italian see Adani, 2009; Adani, Lely, Forgiarini, & Guasti, 2010).

The filler-gap accounts do not address the issue of how the parser detects the gap and how it establishes the link between the gap and its filler. The issue might seem quite straightforward in head-initial languages where the filler appears prior to the gap. There has been experimental evidence suggesting that the parser immediately starts searching for a gap as soon as it encounters the displaced NP (i.e., filler) (the Active Filler Hypothesis, Frazier et al. (1989)). Yet, one interesting observation that has gone unnoticed is that it is not clear how

these models could be realized in head-final languages, where the gap might precede its filler. Turkish relativization is a good example for this and we will address this issue in greater detail in Chapter 4. In the following section, we will try to analyse the filler-gap accounts we have just reviewed on the basis of an off-line comprehension experiment.

3.2 Experiment 1: Filler-Gap Accounts in the Comprehension of Turkish Relative Clauses in Monolingual Children and Adults

In all versions of the filler-gap accounts, object RCs are predicted to be more costly than subject RCs for English. The experimental evidence is indeed in line with this; to the best of our knowledge there is no experimental work, reporting subject RCs as more problematic as far as English-speaking children are concerned. In what follows, we will present an off-line study that tests the comprehension of subject and object RCs in Turkish-speaking children.

Let us outline the predictions of each model regarding children's comprehension patterns for Turkish RCs. The Linear Distance Hypothesis predicts that a subject RC as in (42a) should require more memory load since there are more intervening lexical items (i.e., 'kadın-ı vur-an', 'woman-ACC shoot-(y)An') between the sentence-initial gap (i.e., 't') and the filler (i.e., 'hırsız', 'burglar') while there is only one (i.e., 'vur-duğ-u', 'shoot-DIK-3SG.POSS') in the object RC, shown in (42b).

(42) a. [$_{NP}$ [$_{RC}$ t$_i$ [$_{VP}$ Kadın-ı vur-an]] hırsız$_i$]
[$_{NP}$ [$_{RC}$ t$_i$ [$_{VP}$ woman-ACC shoot-(y)An]] burglar$_i$]
'The burglar that shot the woman.'

b. [$_{NP}$ [$_{RC}$ Kadın-ın [$_{VP}$ t$_i$ vur-duğ-u] hırsız$_i$]]
[$_{NP}$ [$_{RC}$ woman-GEN [$_{VP}$ t$_i$ shoot-DIK-3SG.POSS] burglar$_i$]]
'The burglar that the woman shot.'

Contrary to this, the Structural Distance Hypothesis anticipates that an object RC should pose more processing difficulty since it is extracted from a deeper position in a tree. That is, there is only one node (i.e, only the RC-node) between the gap and the filler in a subject RC (42a) whereas there are two nodes (i.e., the VP-node and RC-node) in an object RC (42b).

The Argument Crossing Accounts predict that a subject RC (42a), which hosts an intervening lexical NP (i.e., 'kadın-ı', 'woman-ACC') between the gap and the filler should require more processing cost than an object RC (42b), where the gap is intervened only by the relativized predicate (i.e., 'vur-duğ-u', 'shoot-DIK-3SG.POSS').

Some of the previous off-line studies of Turkish RCs (e.g., Aydın, 2007, Hermon, Kornfilt, and Özt"urk, 2007) found that there is a significant subject preference in the comprehension or production of Turkish RCs and suggested that the subject-object asymmetry in Turkish RCs could be explained by the greater structural distance between the filler and the gap in object compared to subject RCs. However, these studies relied on a single off-line task. The present study aims to combine some on-line techniques with the off-line ones to evaluate whether similar findings would be replicated.

(43) summarizes the predictions of the processing-based accounts.

(43)

Hypothesis	**Prediction**
Linear Distance Hypothesis	OR >[1] SR
Structural Distance Hypothesis	SR > OR
Argument Crossing Account	OR > SR

3.2.1 Method

3.2.1.1 Participants

36 monolingual Turkish children aged 5-8 (M = 6.7, SD = 1.09) participated in this study. The children were divided into two groups: 17 younger (M = 5.6, SD = 0.5) (9 female, 8 male) and 19 older children (M = 7.6, SD = 0.4) (10 female, 9 male). All were reported to be neurologically intact with no behavioural, cognitive, or psychological problems, and all children had normal or corrected to normal vision. Younger children attended a kindergarten and the older ones to a primary school in Ankara. 21 undergraduate students from various departments of the Middle East Technical University served as a control group. Turkish was the first language of all participants.

3.2.1.2 Materials and Design

Our task consisted of 32 experimental and 28 control items. Two factors were manipulated in the experimental items: relative clause type (RC-Type) and Presentation-Type. In terms of RC-Type, each item was composed of a semantically reversible RC modifying either a subject (Subject RC) or an object (Object RC). With respect to the Presentation-Type, each RC was presented either within an imperative sentence or within a question. A sample sentence for the test items and the control items is provided in (44) and (45), respectively. In this chapter, we will only focus on the effect of RC-Type on comprehension. We will provide the analysis

and discussion regarding the effect of the presentation type in Chapter 8, when we present data from Turkish-English bilingual children in comparison to Turkish monolingual children.

(44) Test Items:

- 16 semantically reversible subject RCs presented within a question and within an imperative sentence:
  Ex.: Hangisi tavşanı öpen fare? / Which one is the mouse that is kissing the rabbit.
  Ex.: Tavşanı öpen ördeği göster. / Show me the duck that is kissing the rabbit.
- 16 semantically reversible object RCs presented within a question and within an imperative sentence:
  Ex.: Hangisi farenin gıdıkladığı tavşan? / Which one is the rabbit the mouse is tickling?
  Ex.: Ördeğin gıdıkladığı tavşanı göster. / Show me the rabbit the duck is tickling.

(45) Control Items:

- 8 semantically non-reversible subject RCs presented within a question and within an imperative sentence:
  Ex.: Hangisi dondurma yiyen çocuk? / Which one is the boy who is eating ice cream?
  Ex.: Dondurma yiyen çocuğu göster. / Show me the boy who is eating ice cream.
- 8 semantically non-reversible object RCs presented within a question and within an imperative sentence:
  Ex.: Hangisi çocuğun tuttuğu dondurma? / Which one is the ice cream the child is holding?
  Ex.: Çocuğun tuttuğu dondurmayı göster. / Show me the ice cream the child is holding.
- 12 intransitive (subject) RCs presented within a question and within an imperative sentence:
  Ex.: Hangisi uyuyan kuş? / Which one is the bird that is sleeping?
  Ex.: Uçan kuşu göster. / Show me the bird that is flying.

All verbs in the experimental items were transitive. Control items consisted of two types: semantically non-reversible subject RCs and object RCs with animate agents and inanimate objects, and subject RCs with intransitive verbs.

We adapted our comprehension task from Adani (2009) who adapted De Vincenzi's (1996) design testing the comprehension of Italian RCs. It is a sentence-referent matching task, where each sentence is accompanied by one picture depicting three entities (animal or human) performing an action. The pictures have a specific pattern: one animal appears both on the left and on the right; and there is another animal in the middle (e.g., an elephant chasing a lion that is chasing another elephant)(see Figure 3.1). We adapted this pattern but we slightly revised the test to make it in line with our present purposes. In Adani's version some pictures had two animals in the middle (i.e, there were four animals in total in some pictures) since she was testing the effect of the number marking on the RC-head. In our version of the task, we had one animal on the right, one animal on the left and one in the middle to avoid any confounding factors due to the extra inflectional cues on the RC-head. Also, the pictures for the filler items in the original version were not fully felicitous. For instance, for the sentence 'Point to the boy who is eating the ice-cream' there were three boys in the picture, only one of which had an ice-cream. We wanted to use those sentences as control items to test the effect of reversibility. We made them more felicitous by having one boy holding an ice-cream and another one eating an apple in addition to the one eating the ice cream. In other words, we had three boys in total: one eating an ice-cream, one eating an apple, and one holding an ice-cream (see Figure 3.2). In addition to this, to test the effect of transitivity and number of arguments we used another set of pictures, where three animals were performing an intransitive action. For the sentence, 'Point to the bee that is sleeping', we used one bee that is sleeping, one bird that is sleeping, and another bee that is flying (see Figure 3.3). All pictures for the target items were composed of animals and the ones with the control items were composed of either animals or humans.

Finally, all lexical items in the experiment were controlled for morpheme length, imageability, frequency and age of acquisition.[2] In total, there were 16 animals and 8 action verbs, each one of which was repeated four times throughout the test. To avoid using exactly the same animals and action verbs in more than one sentence, each pair of animals was used with two different actions, and the theta-roles were reversed. For example, in one picture a rabbit was kissing a mouse, and in another picture a mouse was tickling a rabbit. In addition, we controlled for animal size in order to prevent a bias for bigger animals to be identified as agents.

[2]For frequency and age of acquisition, we used an English database (Bird, et al., 2001) because there is no such database for Turkish.

Figure 3.1: Sample Test Picture for Sentence-referent Matching Task. Sample sentence: 'Aslanın kovaladığı fili göster.'; 'Show me the elephant that the lion is chasing.'

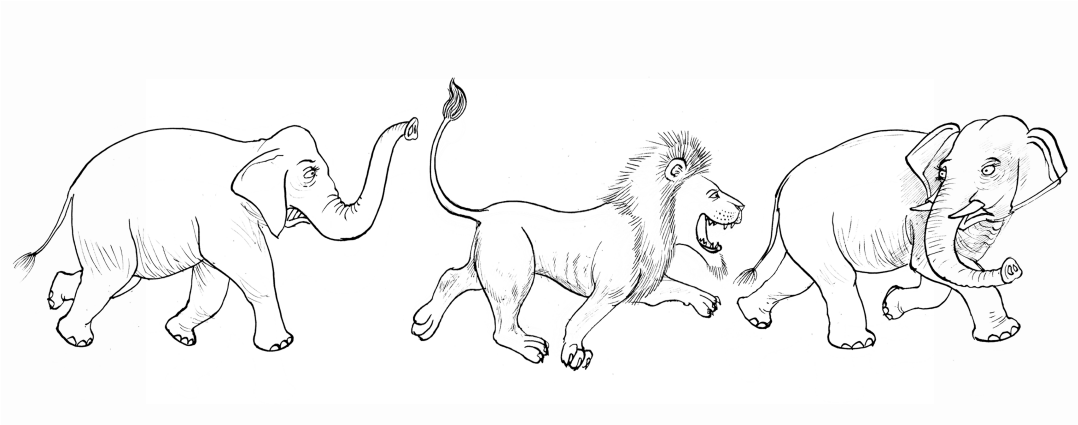


Figure 3.2: Sample Control Picture for Sentence-referent Matching Task. Sample sentence: 'Dondurma yiyen çocuğu göster.'; 'Show me the boy that is eating an ice cream.'

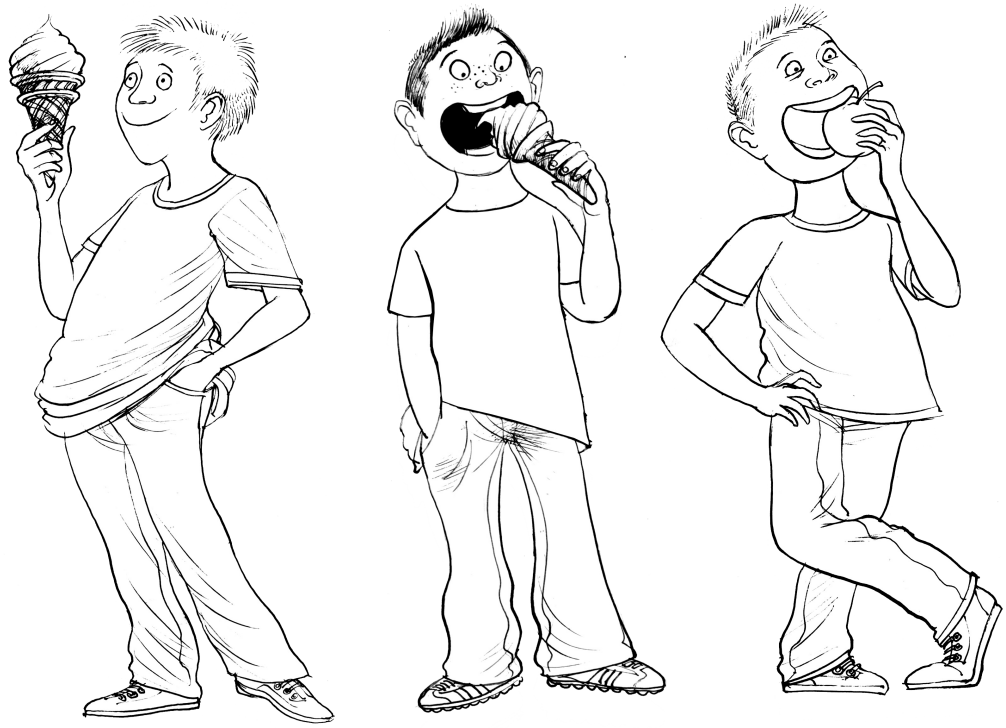
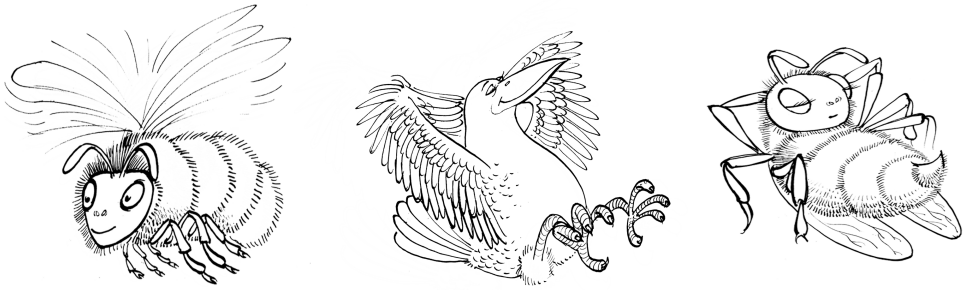


Figure 3.3: Sample Control Picture for Sentence-referent Matching Task. Sample sentence: 'Uyuyan arıyı göster.'; 'Show me the bee that is sleeping.'



3.2.1.3 Procedure

Participants were orally presented with a sentence accompanied by one picture with three animals (see Figure 3.1), and asked to point to the correct animal asked by the sentence. The correct answer appeared equal number of times on the right, left or in the middle. Possible responses were as follows: choosing the correct animal by assigning correct theta-roles, choosing the animal with the reversed theta-role (role-reversal), or choosing the wrong animal in the middle.

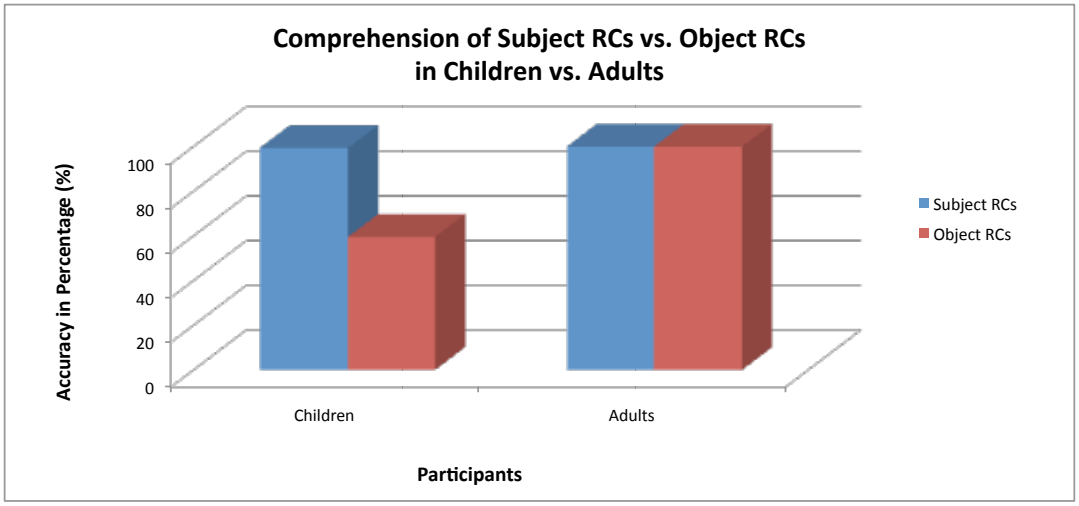
Each participant was tested individually in a quiet room. The following instruction was read aloud: "You will now see a picture. There will be animals or humans performing some actions. Listen to the sentence I will read aloud and point to the referent I am asking about."

3.2.2 Results

Figure 3.4 displays the rate of accuracy in children's and adults' comprehension of subject RCs and object RCs.

A repeated-measures ANOVA was conducted with the factors Group (Children, Adults) as a between-subjects factor and RC-Type (Subject, Object) as a within-subjects factor. According to this, there was a significant effect of RC-Type $F(1, 73) = 30.05$; $p < .001$. Pairwise comparisons with Bonferroni correction showed that subject RCs were performed better ($M = 93.84$; $SE = 2.47$) than object RCs ($M = 77.47$; $SE = 2.99$). There was also an effect of Group $F(1, 73) = 38.29$; $p < .001$; and an RC-Type by Group interaction $F(1, 73) = 29.73$; $p < .001$. Pairwise comparisons revealed that children had lower accuracy rate ($M = 71.39$;

Figure 3.4: Rate of Accuracy (%) in Subject RCs vs. Object RCs in Children vs. Adults



SE = 2.19) than adults (M = 99.92; SE = 4.05); and that the interaction was due to the fact that children performed significantly poorer than adults in object RCs (Children: M = 55.06; SE = 2.84; Adults: M = 99.98; SE = 5.26), $p < .001$; whereas their accuracy in subject RCs did not significantly differ from that of adults'(Children: M = 87.71; SE = 2.36; Adults: M = 99.97; SE = 4.36), $p > .1$.

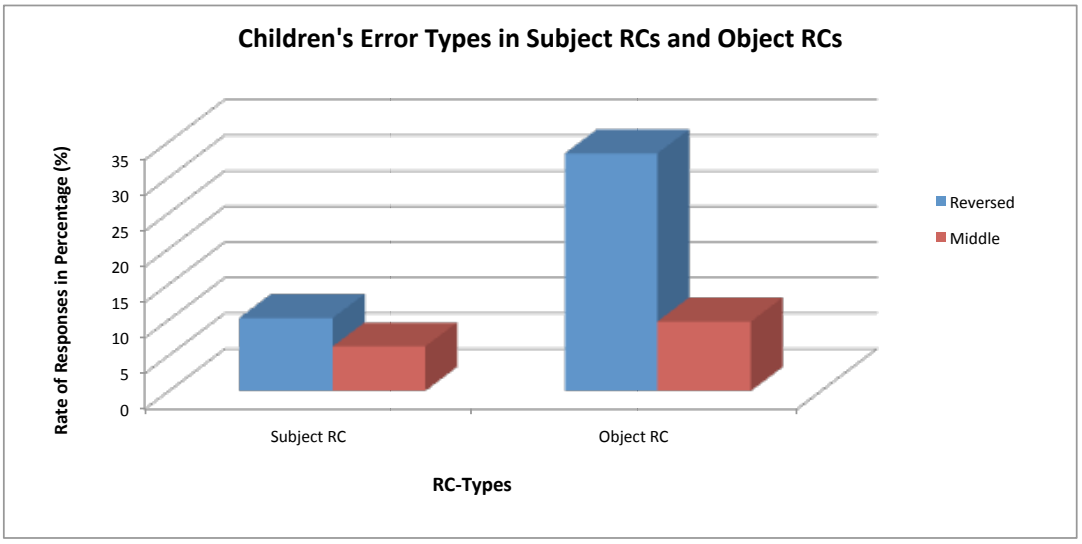
To further investigate the effect of RC-Type on children's comprehension, a repeated-measures ANOVA was conducted with the factors Group (younger, older) as a between-subjects factor, RC-Type (Subject, Object) as within-subjects factor. This showed a significant main effect of RC-Type $F(1, 35) = 91.062$, $p < .001$. Pair-wise comparisons with the Bonferroni correction showed that children performed better in subject RCs (M = 97.04, SD = 16.95) compared to object RCs (M = 66.84, SD = 47.11).

There was also a significant interaction between Group and RC-Type $F(1, 35) = 6.472$, $p = .01$. Independent samples t-test comparing the two groups in subject and object RCs showed that the difference between the two groups was significant only in object RCs ($t(35) = 2.192$, $p = .03$). On average, younger children had more difficulty in object RCs (M = 58.98 SD = 21.88) than the older children (M = 72.61, SD = 15.99). Yet, the difference in subject RCs was not significant ($t(35) = -1.350$, $p > 1$). This reveals a developmental pattern for object RCs but not for subject RCs.

Figure 3.5 shows the rate of error types made by the children in subject and object RCs.

Finally, to investigate the types of errors made in each RC type, we conducted a mixed

Figure 3.5: Rate of Error Types (%) in Subject RCs vs. Object RCs in Children



repeated-measures ANOVA with the factors Group (younger, older) as a between-subjects factor, RC-Type (Subject, Object) and Error Type (Role Reversal, Middle) as a within-subjects factor. This showed a significant main effect of RC-Type $F(1, 35) = 86.74$, $p < .001$ and Error Type $F(1, 35) = 52.68$, $p < .001$. There was also a significant interaction between RC-Type and Error Type $F(1, 35) = 33.456$, $p < .01$.

To break down this interaction, we performed first pair-wise comparisons between the two error types in subject and object RCs. These showed that for both object and subject RCs there was a significantly larger number of errors in the form of role reversals (object RCs: M = 4.65 SD = 3.25; subject RCs: M = 0.49 SD = 0.83) rather than middle responses (object RCs: M = 0.68 SD = 1.00; subject RCs: M = 0.08 SD = 0.27) (object RCs: $t(36) = 6.625$, $p < .01$; subject RCs: $t(36) = 3.402$, $p < .01$). Pairwise comparisons between subject and object RCs showed that there were more reversal errors in object RCs (M = 4.65 SD = 3.25) compared to subject RCs (M = 0.49 SD = 0.83) ($t(36) = 7.403$, $p < .01$), and the same was true for middle responses (object RCs: M = 0.68 SD = 1.00; subject RCs: M = 0.08 SD = 0.27; $t(36) = 3.392$, $p < .01$).

3.2.3 Discussion

The results of this study showed that the adults performed at ceiling in all RC-types. In addition, all groups showed high performance in the control items, i.e. intransitive and tran-

sitive non-reversible RCs, reflecting their ability to use lexical and discourse-related cues to comprehend RCs.

Similarly to previous studies with English children, Turkish children showed lower accuracy in the comprehension of object RCs compared to subject RCs, and there was a developmental effect in object RCs (i.e., accuracy increased with age), but not in subject RCs. This indicates that subject RCs are fully acquired at an earlier stage than object RCs. These findings are in line with most of the research in the acquisition of Turkish RCs (Slobin, 1986, Özcan, 1997, Kükürt, 2004, and Hermon, et al., 2007; however cf. part of Ekmekçi, 1990 and part of Özcan, 1997), and provide more solid evidence for the asymmetry between subject and object RCs.

Let us now analyse how the present data could inform us regarding the mechanisms in the comprehension of RCs, namely the filler-gap accounts. The Linear Distance Hypothesis expected that subject RCs would be more problematic since there were more lexical items intervening the gap and the filler; the Structural Distance Hypothesis, on the other hand, predicted that object RCs would lead to poorer performance since the gap appeared deeper in the syntactic representation; and the Argument Crossing Accounts anticipated poorer success rates in subject RCs due to an intervening lexical NP between the gap and the filler. The present data revealed that only the Structural Distance Hypothesis made correct predictions since our child participants showed significantly better performance in subject RCs compared to object RCs. This is in line with Aydın (2007) and Hermon et al. (2007).

However, given that the processing cost is based on the filler-gap dependencies in the Structural Distance Hypothesis and that the gap appears prior to its filler in Turkish RCs, the question arises as to what strategies the parser should use in order to detect the gap, which is a silent element that cannot be detected on its own.

Since gaps appear earlier than their heads, the relativization phenomenon in Turkish provides us with a good opportunity to critically evaluate the filler-gap strategies offered in the literature. Yet, it is barely possible to provide a systematic evaluation of these accounts with the present off-line task. Therefore, Chapter 4 will present an extra task that employs an online auditory moving-window experiment to evaluate the gap-based and filler-based dependency formation strategies.

3.3 Experiment 2: Filler-Gap Accounts in the Production of Turkish Relative Clauses in Monolingual Children and Adults

Data from our comprehension task revealed that monolingual Turkish children had difficulty in assigning the correct theta-roles in object RCs but not in subject RCs. We have reviewed several filler-gap accounts and showed that only the Structural Distance Hypothesis predicted the existing asymmetry in Turkish RCs. However, since the difference between subject RCs and object RCs is not confined to the structural distance per se, it is crucial to rule out other possible factors. For instance, there might also be an effect of the morphosyntactic factors such as differential case marking in each RC-Type (Genitive vs. Accusative), type of the relativizing marker used for each RC (-DIK vs. -y(A)n), and whether or not the structure requires extra morphosyntax (possessive agreement morphology is necessary in object RCs but not in subject RCs).

To our knowledge, there have been no testable proposals as to how to single out the effect of depth of embedding compared to morphological factors. O'Grady, Lee, and Choo (2003) and Hsu et al. (2009) suggest that the problem in object RCs reflects the increased processing cost due to the increased number of nodes between the filler and the gap rather than a structural or morphological problem. The responses reported in these studies from Korean and Chinese speakers do not include morphological errors and this was taken as evidence for the Structural Distance Hypothesis. Thus, it can be gathered from these studies that if the Structural Distance Hypothesis makes correct predictions, speakers' utterances should not include morphological errors and their unexpected responses should be restricted to performance errors, slips of the tongue, or avoidance strategies (i.e., choosing a more accessible and equally appropriate structure).

One recent work in support of the Structural Distance Hypothesis is the production study by Hermon et al. (2009). They showed that Turkish children at the ages of 4-6 used more avoidance strategies (e.g., simple sentences, conjoined sentences, possessive NPs, and compounds) for object compared to subject RCs while they did not significantly differ in terms of ungrammatical responses. Children reversed the RC-Type or used wrong heads as exemplified in (46) and (47). Thus, the message that should be expressed with an object RC was forced into the structure of subject relativization.

(46) a. *Expected Response*

Kuzu-nun kovala-dığ-ı kedi-ye bak -ıyor
lamb-GEN chase-DIK-3SG cat-DAT look.at-PresProg-3SG
'(The mouse) is looking at the cat that the lamb is chasing.'

b. *Reversal Error*
Kuzu-yu yakala-yan kedi-ye bak-ıyor
lamb-ACC catch-(y)An cat-DAT look.at-PresProg-3SG
'(The mouse) is looking at the cat that is catching the lamb.'

(47) a. *Expected Response*
Oğlan-ın izle-diğ-i televizyon-a (bakı-yor)
boy-GEN watch-DIK-3SG TV-DAT (look.at-PresProg-3SG)
'(The mouse is looking) at the TV that the boy is watching.'

b. *Wrong-Head Error*
televizyon izle-yen oğlan-a
TV watch-(y)AN boy-DAT
'at the boy that is watching TV.'

The authors also noted that there were some errors with wrong case or lack of case on the subject of the object RC and with resumptive pronouns and resumptive NPs in the extraction site. They did not provide examples for such responses most probably because they were quite rare. Only 5 of the 160 responses in object RCs involved resumptive pronouns/NPs and there were no such responses in subject RCs.

The high rate of avoidance responses and the limited number of morphological errors for object RCs led the researchers to argue that the greater structural distance between the filler and the gap in object RCs compared to subject RCs might be the cause of this asymmetry. Yet, the avoidance strategies might not be sufficient to rule out other factors despite being a necessary support for the Structural Distance Hypothesis.

On the other hand, as mentioned earlier, Özcan's (2000) study provided examples of morphological errors in object RCs from Turkish children as exemplified in (48b) (cf., the target utterance in (48a)). Children omitted the genitive case on the subject of the RC and used the -(y)An relativizer instead of -DIK as well as omitting the possessive agreement morphology on the relativized verb.

(48) a. *Target Utterance:*

Adam-ın öp-tüğ-ü kadın

Man-GEN kiss-3sgPOSS woman

'The woman that the man kissed'

b. *Child's Response:*

Adam öp-en kadın

Man-GEN kiss-(y)An woman

'The woman that kissed the man'

Thus, one issue that needs to be addressed is whether or not children's errors in Turkish RCs reflect any morphosyntactic problems. This seems crucial in terms of the viability of the Structural Distance Hypothesis. This section will employ a novel elicitation task to test whether the predictions of the Structural Distance Hypothesis will be confirmed in the production of RCs. We will investigate whether or not the subject-object asymmetry observed in the comprehension study and in the production studies reported above will be observed in Turkish monolingual children at the ages of 5-8 and adults. Also, we will provide a detailed response analysis to see if they reveal any hint about the underlying cause of the emerging pattern.

3.3.1 Method

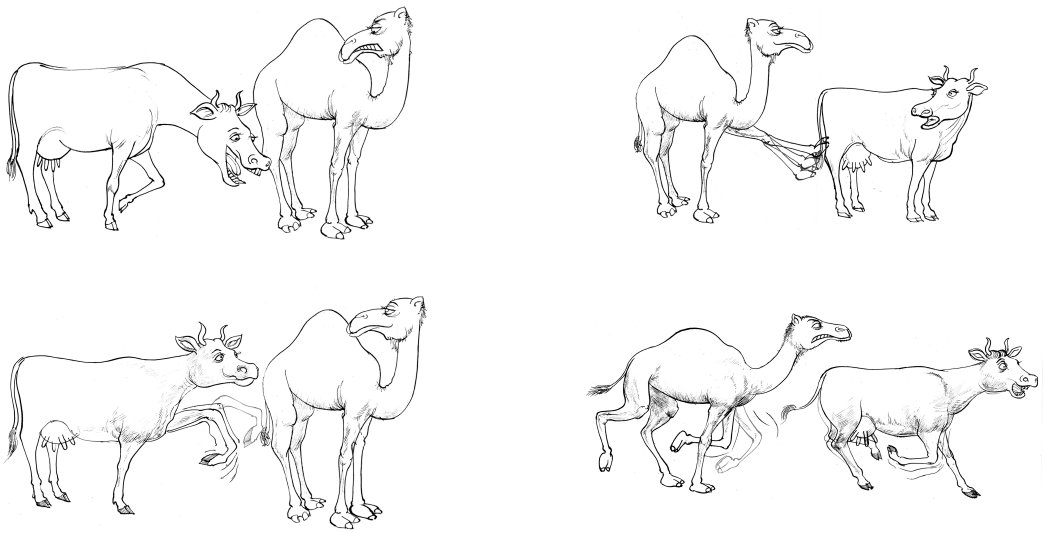
3.3.1.1 Participants

The same child and adult participants reported in Experiment 1 in Section 3.2.1 participated in this study.

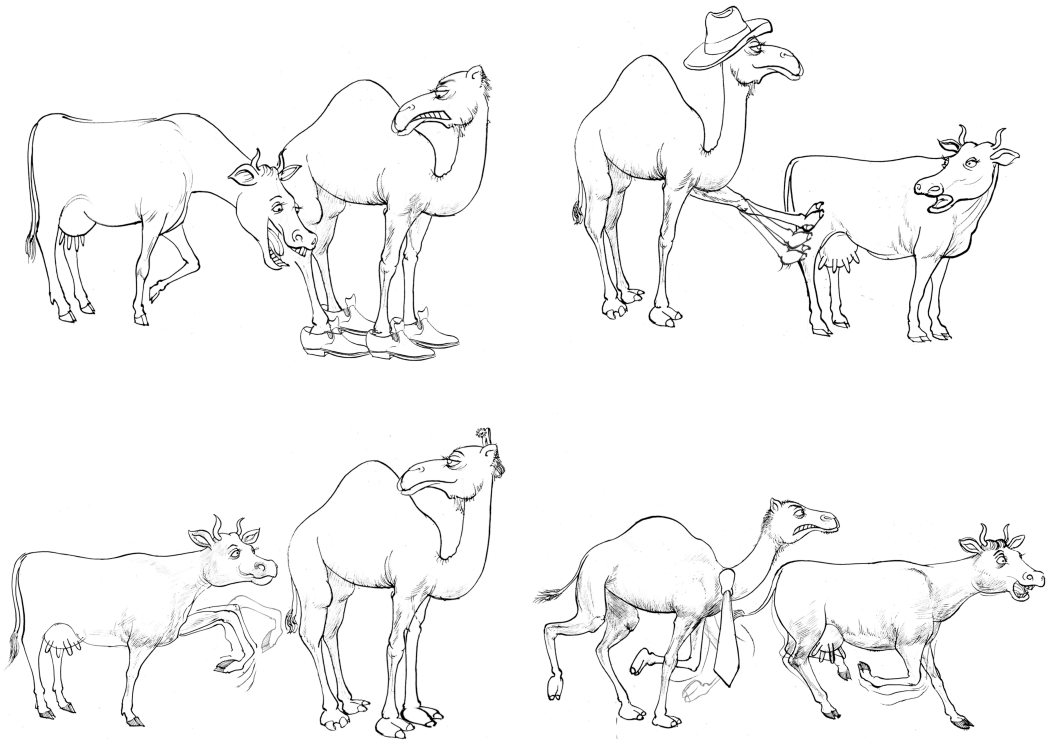
3.3.1.2 Materials and Design

A novel elicitation task was designed to test the production of RCs in children and adults. We used 8 picture cards and 24 items to elicit subject and object RCs. Each card was divided into four parts and consisted of four different pictures. Each picture in a card depicted the same pair of animals performing a different action. There were two sets of cards, one for the participant and one for the researcher, as shown in Figure 3.6. The former had some of the animals with accessories such as a hat, a bag, a tie, or a hair clip, whereas the animals in the latter card had no accessories.

Figure 3.6: a) Sample Researcher's Card: animals do not have accessories; b) Sample Participant's Card: animals have accessories



(a)



(b)

Accessories were used as a means to elicit RCs. The aim of the task for the participant was to describe which animal was wearing which accessory to help the researcher identify the correct animal in her own card.

The task was designed as a game as it aimed to elicit RCs in a communicative and felicitous way without tapping into meta-linguistic knowledge. Only three of the four pictures in each card were used to make the task felicitous (i.e., to provide the child with a real purpose to describe each picture).

The task included 8 animals and 8 action verbs in total, each of which was repeated two to five times throughout the task. All lexical items to be elicited were controlled for morpheme length, imageability, frequency, and age of acquisition using an English database (Bird, Franklin, and Howard (2001)). Also, we coupled animals of similar size to prevent bias from animal size. Finally, the number of times each accessory appeared was controlled as well as whether it appeared on an agent or a patient referent.

3.3.1.3 Procedure

Children were tested individually in a quiet room allocated for this research in their school. They were shown the cards and were informed that the researcher had a different set with no accessories. They were instructed to hold each of their cards without showing it to the researcher and to try to describe the animal with a particular accessory in line with the question asked by the researcher so that the researcher could identify the animal with the correct accessory on her card. The task was always initiated by a 'who question' for the first item followed by a 'which question' for the rest of the items until the task ended. The researcher paid special attention to keep the instruction language simple and consistent (see example (49) for a likely dialogue between the researcher and participants).

(49) *Sample dialogue between the participant and the researcher:*

Researcher:

Hangi deve şapka tak-mış?

Which camel hat put-EV.COP

'Which camel is wearing the hat?'

Participant:

İneğ-i tekmele-yen deve.

Cow-ACC push-(y)An camel

'The camel that is kicking the cow.'

Researcher:

Hangi deve ayakkabı giy-miş?

Which camel shoe wear-EV.COP

'Which camel is wearing the shoes?'

Participant:

İneğ-in tekmele-diğ-i deve.

Cow-GEN kick-DIK-3SG.POSS camel

'The camel that the cow is biting.'

The task was designed in such a way to lead the child to use the target structures. First, the animals taking part in each activity in each picture were almost the same except for the activities they were involved in and their theta-role (i.e. whether they took part in the activity as an agent or a patient). Secondly, the child was reminded that the order of the animals might change in the researcher's card and s/he would not be able to see the card the child was holding, so answers such as 'the first dog' would not be acceptable. Finally, the child was also advised to focus on the activities performed rather than the physical features of the animals. These rules were made clear before the task and were repeated during the task if the need arose. Apart from this, no negative feedback was given upon the production of any kind of responses. That is, the child was always praised for being very cooperative and motivated but not for the correctness or falsity of her/his responses. Also, children's responses were both recorded and written down by the researcher.

3.3.2 Results

Figure 3.7 shows the rate of RCs (both grammatical and ungrammatical) out of all response types in children and adults.

A preliminary repeated-measures ANOVA with the factor Group (younger, older) showed no differences between the groups in the use of RCs $F(1, 35) = 1.54$, $p > .1$, and the two groups were, therefore, collapsed into one for further analyses. A repeated-measures ANOVA with the factors Group (children, adults) and RC-Type (Subject, Object) showed that children used fewer RCs than adults $F(1, 58) = 7.54$, $p < .01$, and both groups used fewer object than subject RCs $F(1, 58) = 22.46$, $p < .001$, but there was no Group by RC-Type interaction.

Figure 3.8 shows the rate of grammatical RCs out of all RC responses in children and adults.

To investigate possible differences between the two groups and the two RC Types on

Figure 3.7: Rate of all RCs (%) out of all Response Types in Children vs. Adults

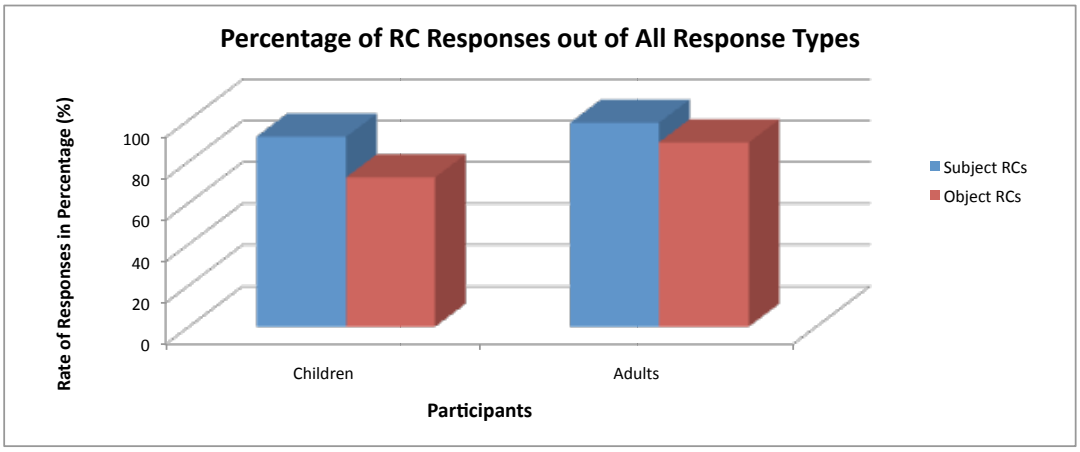
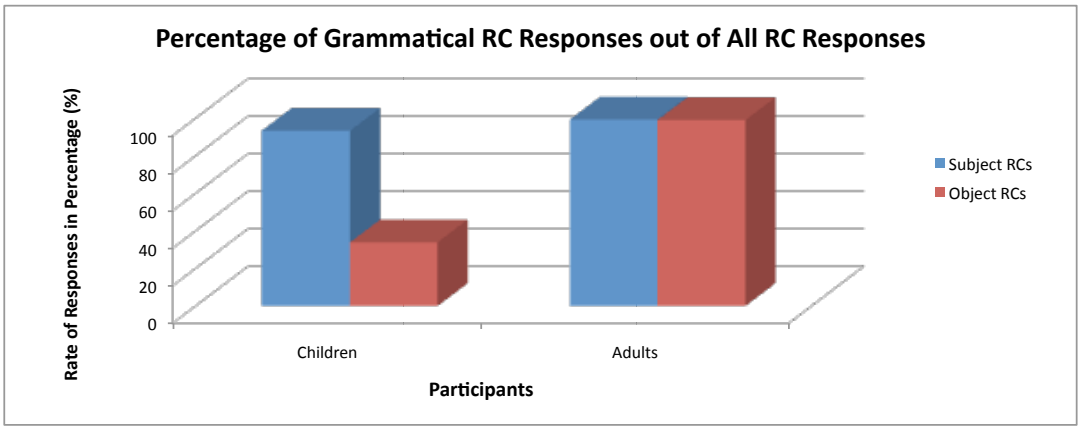


Figure 3.8: Rate of Grammatical RCs (%) out of all RC Responses in Children vs. Adults



the rate of grammatical RCs out of all RC responses, we conducted a similar ANOVA. This showed a main effect of Group F (1, 58) = 77.25, $p < .001$, a main effect of RC-Type F (1, 58) = 66.33, $p < .001$, and an interaction of Group by RC-Type F (1, 58) = 64.6, $p < .001$. Pairwise comparisons using Bonferroni correction indicated that this interaction was due to the fact that children showed an asymmetry between subject RCs and object RCs whereas adults did not. That is, children showed significantly lower performance in object RCs (M = 33.93, SD = 33.30) compared to adults (M= 99.04, SD = 2.52). As for the subject RCs, the difference between the two groups was not significant (children: M= 93.41, SD = 15.82; adults: M= 99.43, SD = 1.86).

Although the task successfully prompted RCs most of the time, it also prompted conjoined sentences, as shown in (50), passives, as shown in (51), and structures with perspec-

tive shift, as shown in (52), which we will call *avoidance strategies*, in line with Schachter (1974). Avoidance strategies were observed both in children and adults.

(50) *Conjoined Clauses*

Hani inek o-nu koval-ıyor ya işte o koyun

Well cow-NOM he-ACC chase-PROG well that's that sheep

'You know the cow is chasing him, that is the sheep.'

(51) *Passive Voice*

İt-il-en koyun

Push-PASS-(y)An sheep

'The sheep that is pushed.'

(52) *Perspective Shift*

a. İnek-ten kaç-an koyun

Cow-ABL run-(y)An sheep

'The sheep that is running away from the cow.'

b. Şapka tak-an koyun inek-ten kaç-ıyor

Hat wear-(y)An sheep cow-abl run-prog

'The sheep wearing a hat is running away from the cow.'

c. *Postpositional Phrases relativized by -ki*

Koş-an ineğ-in ön-ün-de-ki koyun

Run-(y)An cow-GEN front-POSS3sg-dat-rel sheep

'The sheep that is in front of the cow that is running.'

Unlike adults, children used RC-type reversals, i.e., subject RCs instead of object RCs, as shown in (53), which we will call *reversal errors*.

(53) *Reversal Errors*

Koyun-u it-en inek

Sheep-ACC push-(y)AN cow

'The cow that is pushing the sheep.'

In addition, children used responses that were pragmatically inappropriate, as shown in (54), which we will call *non-pragmatic responses*.

(54) *Non-Pragmatic Responses*

İnek koyun-u it-er-ken şapka tak-mış.

Cow sheep-ACC push-AOR-CV hat put-EV.COP

'The sheep wore the hat when the cow was pushing him.'

Finally, they consistently employed some strategies that were not observed in adults. We will call these *non-adult responses* as shown in (56) (cf.,(55)).[3]

(55) *Target Utterance*

İneğ-in it-tiğ-i koyun

cow-GEN push-DIK-3SG.POSS sheep

'The sheep that the cow is pushing.

(56) *Non-Adult Responses*

a. İnek o-nu it-en koyun

cow he-ACC push-(y)AN sheep

b. İnek koyun-u it-en koyun

cow sheep-ACC push-(y)AN sheep

c. İnek it-en koyun

cow push-(y)AN sheep

d. İneğ-in koyun-u it-tiğ-i koyun

cow-GEN sheep-ACC push-DIK-3SG.POSS sheep

'The sheep that the cow pushed the cow.'

Figure 3.9 and Figure 3.10 displays the rate of each response type in both RC-Types in children and adults, respectively.

To investigate the rate of each response type in each RC-Type among children, we conducted a mixed repeated-measures ANOVA with RC-Type (Subject, Object) and Response Type (avoidance, reversal, non-pragmatic, and non-adult) as a within-subjects factors. This showed a main effect of RC-Type $F(1, 35) = 161.38$, $p < .001$, a main effect of Response Type $F(3, 108) = 10.11$, $p < .001$, and a significant interaction between RC-Type and Response Type $F(3, 108) = 9.01$, $p < .001$.

[3]We do not provide the translation for most of the non-adult responses not to mislead the reader since these sentences are ungrammatical in Turkish but their English translation might be grammatical. So we suggest the reader compare each ungrammatical response with the expected response, which should be as in (55).

Figure 3.9: Rate of Each Response Type (%) in Subject RCs and Object RCs in Children

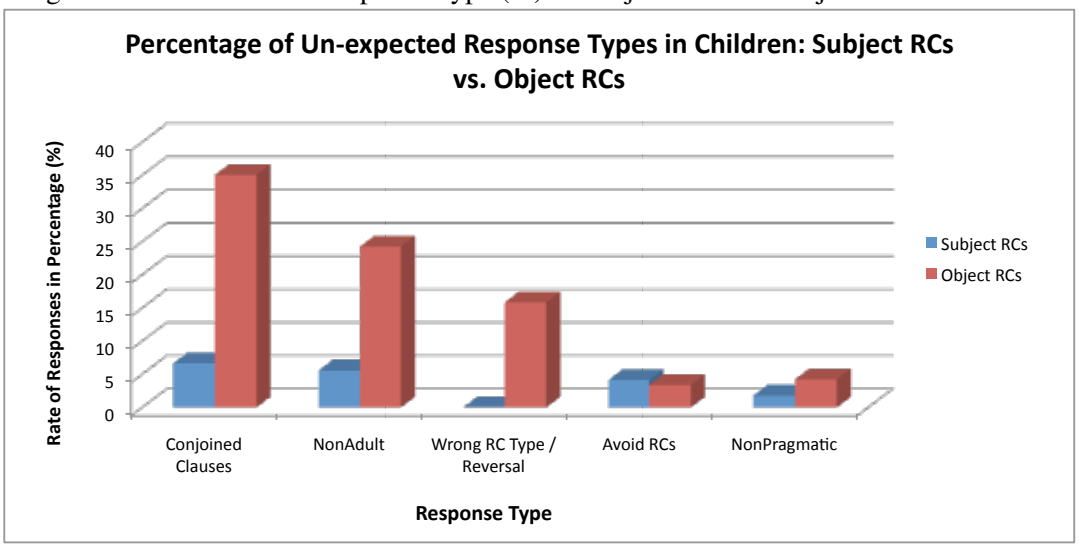
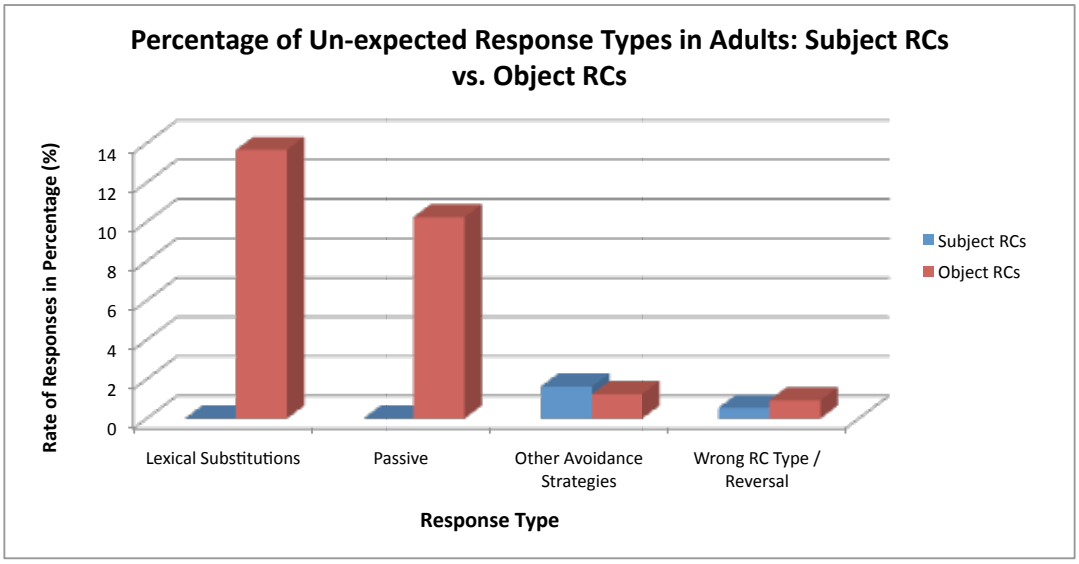


Figure 3.10: Rate of Each Response Type (%) in Subject RCs and Object RCs in Adults



Separate repeated-measures ANOVA for each RC-Type showed that for object RCs the rate of avoidance strategies (M = 35.05, SD = 28.85) was significantly higher than the rate of role-reversals (M = 15.83, SD = 18.67) and non-pragmatic responses (M = 4.24, SD = 11.47) ($p < .05$). Non-adult responses constituted the second most frequent response type after avoidance strategies and the difference between non-adult responses (M = 24.27, SD = 23.99) and non-pragmatic responses (M = 4.24, SD = 11.47) was significant ($p < .001$). The difference between the avoidance strategies and non-adult responses did not reach significance but the difference between role reversals (M = 15.83, SD = 18.67) and non-pragmatic responses (M = 4.24, SD = 11.47) was significant ($p < .001$). For subject RCs, on the other hand, only the difference between avoidance strategies (M = 6.67, SD = 11.33) and role reversals (M = .72, SD = 2.09) reached significance ($p < .05$). The rate of non-adult and non-pragmatic responses for subject RCs was as follows: M = 5.58, SD = 14.69 and M = 1.80, SD = 8.84, respectively.

Adults, on the other hand, only used avoidance strategies (passives: M =10.24, SD = 22.15 and perspective shift: M = 13.66, SD = 16.67) and role-reversals (M = .93, SD = 2.45) for object RCs. Only two participants used role-reversals for subject RCs (M = .54, SD = 1.80).

3.3.3 Discussion

Participants' overall attempts to use RCs show that the present task successfully taps the use of the target structure.

There were no significant differences between younger and older children so we did not observe a developmental path in the age-range (5-8) we tested. Both children and adults used more subject RCs than object RCs and children were less accurate in the production of object RCs compared to subject RCs. The subject-object asymmetry in children is overall in line with Slobin (1986), Özcan (2000), Hermon et al. (2010). On the other hand, the finding that adults avoided object RCs at significant rates even in an elicitation task is a novel finding, although it was previously observed by Slobin (1986) that child-directed adult language did not include as many object RCs as subject RCs. Similarly, Haig (1997) reported that object RCs constituted only 29% of the corpus of 1000 RCs in written texts. Therefore, our study verified that the same preference for subject RCs is observed in adults even in an elicitation task.

The response analysis showed that children used more avoidance strategies in object RCs

compared to subject RCs. The adults also used avoidance strategies for object RCs but not for subject RCs; however, different from children they did not use conjoined clauses or prepositional phrases but they used passives and perspective shift. Apparently, they preferred encoding their message from the perspective of the theme by locating it in the subject role. That is, they tended to choose the *subject perspective*. This is also observed in other production experiments, where speakers located the conceptually more accessible items in the subject role (Bock & Warren, 1985).

Children produced more role-reversal errors, non-pragmatic responses and non-adult strategies in object RCs than in subject RCs. Yet, adults did not produce ungrammatical responses (i.e., non-pragmatic and non-adult responses) as children did. Since children's non-pragmatic responses are not directly related to their syntactic development, we take these as another means of avoiding object RCs. On the other hand, the rate of children's non-adult responses in object RCs indicates that they acquire the mechanism for subject RCs earlier than object RCs. Further studies with younger children are needed to verify this.

3.3.3.1 What do Avoidance Responses Reveal about Structural Distance Hypothesis

We will evaluate the Structural Distance Hypothesis by analysing children's and adults' avoidance responses from two perspectives: the avoidance of complex or ambiguous morphosyntax and incrementality in speech production.

Avoiding Ambiguous Morphosyntax in Speech Production and Structural Distance Hypothesis

The Structural Distance Hypothesis predicted responses that avoid object RCs but it did not anticipate morphosyntactic errors.

It is true that both children and adults used avoidance strategies at significant rates. Considering the response types under avoidance strategies, one notices the use of conjoined clauses, perspective shift, prepositional phrases, and passives as exemplified in (57).

(57) a. *Expected Answer*

İneğ-in kovala-dı-ğ-ı koyun
cow-GEN chase-DIK-3SG.POSS sheep
'The sheep that the cow is chasing.

b. *Conjoined Clauses*

Hani inek o-nu koval-ıyor ya işte o koyun

Well cow-NOM he-ACC chase-PROG well that's that sheep

'You know the cow is chasing him, that is the sheep.'

c. *Passive Voice*

Ḱovala-n-an koyun

Chase-PASS-(y)An sheep

'The sheep that is being chased.'

d. *Perspective Shift*

İnek-ten kaç-an koyun

Cow-ABL run-(y)An sheep

'The sheep that is running away from the cow.'

e. Şapka tak-an koyun inek-ten kaç-ıyor

Hat wear-(y)An sheep cow-abl run-prog

'The sheep wearing a hat is running away from the cow.'

f. *Postpositional Phrases relativized by -ki*

Koş-an ineğ-in ön-ün-de-ki koyun

Run-(y)An cow-GEN front-POSS3sg-dat-rel sheep

'The sheep that is in front of the cow that is running.'

It is crucial to note that all these avoidance responses are equally plausible to express the same message that could be expressed via object RCs. On the other hand, subject RCs could only be replaced with conjoined clauses. In other words, the fact that there are more structural options to express the meaning inherent in object RCs might be one reason for the increase in the number of replacements in object RCs relative to subject RCs. Furthermore, all three avoidance structures lack the ambiguous morphosyntax of object RCs (i.e., genitive case, -DIK relativizer, and agreement morphology) so one cannot be sure whether these avoidance strategies actually reflect participants' processing strategies related to filler-gap dependencies. Participants might very well be avoiding the morphosyntax of object RCs. This will be further discussed below when we analyse children's non-adult responses.

Incrementality in Speech Production and the Structural Distance Hypothesis

Another interesting feature observed in avoidance strategies is that the participants accommodate the theme as the Subject of their utterance (except for conjoined clauses). That

is to say that they express the theme's experiences from the perspective of the agent. For instance, instead of saying 'The sheep that the cow was chasing', they say 'The sheep that was running away from the cow', 'The sheep that wears a hat is running away from the cow', or 'The sheep that is in front of the cow that is running'. In all these responses, *the sheep* is the one that wears the hat and the speakers tend to take the perspective of *the sheep* and locate it in the subject role while describing the event. Similar findings and the role of conceptual saliency in speech formulation and speech perception have been observed in the literature since 1960s.

For instance, Osgood, Suci, and Tannenbaum (1971) theorize that pre-linguistic and perceptual experiences constitute the cognitive basis of the linguistic system. Osgood and Bock (1977) put salience as an important cognitive dynamic of interaction. According to them, naturalness, and vividness are two components of saliency. The perceptual features of the context determine naturalness: What is natural in action relations is the ACTOR-ACTION-RECIPIENT and what is natural in static relations is the FIGURE-STATE-GROUND. They suggest that saliency enhances processing in significant ways and that more salient items tend to appear sentence-initially. Also, more salient items tend to be surface subjects in line with Johnson-Laird (1968) and Ertel (1977).

Similarly, MacWhinney (1977) suggest that having an access to the starting point in interpretation or selecting one in sentence construction engages the language user in a process of perspective construction. According to him, identification is the main source of starting point choice. Figures rather than grounds and unmarked relations rather than marked ones are easier to identify with, hence better candidates for being starting points. The linguistic context also influences this. Starting points may function to assign "(a) the attentional focus, (b) the perspective, (c) the agent, and (d) the given". Thus, a starting point is always expected to be an active and potent element, and if a starting point does not coincide with the agent some kind of conflict arises, which MacWhinney calls *a complex perspective*.

Bock and Warren (1985) argue that the underlying basis for the relational hierarchy of the type Keenan and Comrie (1977) or Pullum (1977) suggested is the conceptual accessibility, which is described as "the ease with which the mental representation of some potential referent can be activated in or retrieved from memory (p.4)." According to this, noun phrases that are conceptually more accessible are likely to represent higher order relations such as the subjecthood in an utterance.

What is at issue here is the fact that conceptual accessibility has been related to incremental encoding in speech production.

According to Nice and Dietrich (2003) 'the first conceptualized referent will continue onward as the first-lexicalized and, ultimately, as the first in word order' (p.829) in line with Kempen and Hoenkamp (1987)'s lexically-driven incremental production model.

Less radically, F. Ferreira (2002) takes incrementality as a technique to reduce processing load by starting the utterance with simple structures and dealing with the difficult parts during articulation.

Similarly, F. Ferreira and Engelhardt (2006) see incrementality as a mechanism that enables the 'selection of a syntactic structure that allows accessible materials to be mentioned sooner' (p.77).

It appears that many studies agrees on incrementality at least to a certain level so another important point to consider is to what extent the Structural Distance Hypothesis is compatible with incremental encoding. If speakers really prefer structures with minimal structural nodes between the filler and the gap, they should formulate their utterances at least until the end of the clause while formulating structures that present the filler clause finally. In other words, they are expected to project each possible structure first and then chose the 'simpler' one. The same problem does not apply for languages that present the filler prior to the gap (e.g., English). It has been reported that speakers are able to plan the initial words of their utterances; several researchers take the clause as the minimal unit of syntactic encoding (Garrett, 1988; Bock & Cutting, 1992) so it is a possibility.

Yet, a question arises as to how this would be realised when the distance between the gap and the filler extends with the intervening lexical and structural items. Take the example in (58). The gap is located right after the subject of the embedded clause 'Araştırmacı-nın' (Resarcher-GEN) and the relativized head appears 17 words later. To determine the number of nodes between the filler and the gap, the processor has to first project the structure until the filler, which seems implausible considering the limits in processing resources.

(58) Araştırmacı-nın geçen yıl bölüm-ü-nün öner-diği
Researcher-GEN last year department-3sg-GEN suggest-DIK-3sgPOSS

bazı öğrenci-ler-le baş-lat-tı-ğ-ı ve sonuç-lar-ı-nı
some student-PL-ABL start-DIK-3sgPOSS and results-3sg-GEN

Bilimler Akademisi-nin iki yılda bir düzenle-diğ-i kongre-de
Science Academy-GEN two year once organise-DIK-3sgPOSS conference-DAT

sun-du-ğ-u proje büyük ilgi topladı.

present-DIK-3sgPOSS project great attention gather-PAST

'The project that the researcher started with the students that his department suggested and the results of which he presented at the conference organized by the Academy of the Sciences twice a year attracted a great deal of attention.'

It appears that the incremental encoding in speech production also raises a challenge for the plausibility of the Structural Distance Hypothesis. Of course, these results should be supported with online studies in production and parsing. We leave the online investigation of whether language production in head-final languages is as incremental as it is in head-initial languages for future research but we will present an online parsing study in Chapter 4 to address this issue in real-time language comprehension.

3.3.3.2 Children's Non-Adult Responses and the Structural Distance Hypothesis

The Structural Distance Hypothesis does not predict morphosyntactic errors (O'Grady et al., 2003; Hsu et al., 2009; Hermon, et al., 2009) in speaker's utterances.

We have already underlined that our participants' avoidance strategies might be related to ambiguity or complexity in the morphosyntax of object RCs rather than the filler-gap dependencies. We will supplement our position with ungrammatical responses children produced in object RCs.

Two response types exemplified in (59b) and (59c) are quite informative in this respect. In these examples, children omit the genitive case that should appear on the subject of the RC and replace the object relativizing morpheme -DIK with the subject relativizing morpheme -(y)An. This automatically enables them to avoid the genitive-possessive agreement morphology that should appear on the relativized verb in the object RC as shown in the target utterance in (59a). Similar errors were also reported by Özcan (2000) but she did not provide a response analysis in her paper.

(59) a. *Target:*

Köpeğ-in kovala-dığ-ı kedi

dog-gen chase-DIK-Poss3sg cat-null

'The cat that the dog was chasing'

b. *Response:*

Köpek kovala-yan kedi

dog-NOM chase-(y)An cat-NOM

c. *Response:*

*Köpek o-nu / kedi-yi kovala-yan kedi

*dog-NOM 3sgPRON-ACC / cat-ACC chase-(y)An cat-NOM

'The cat that the dog is chasing the cat/him"

In addition to these omissions or replacements, the example in (59c) depicts that children also insert a pronoun or a full NP in the extraction site. Both of these items appear in accusative case and in the canonical object position, however, different from a resumptive error in English (60), the morphosyntax of the clause is totally altered. Also, note that we did not observe any examples of resumption that is usually observed in child language in English, which might look like (61). This is why, we tend not to consider this as a mere gap-filling.

(60) The cat that the dog is chasing her/the cat.

(61) Köpeğ-in on-u / kedi-yi kovala-dığ-ı kedi

dog-gen 3sgPRON-ACC / cat-ACC chase-DIK-Poss3sg cat-null

'The cat that the dog was chasing her/the cat'

Importantly, one has to explain why similar resumptive errors were not observed in subject RCs. Hsu et al. (2009) consider this as gap-filling and argues that children might be having difficulty to keep the head-noun in memory across the nodes and utters it in its canonical position. However, this reasoning is based on the assumption that the processor plans and encodes the whole sentence first. As already mentioned, there is support both for and against incremental processing in production so one has to first prove that production is non-incremental for this position to be true.

The use of resumptive pronouns in object RCs could be due to the greater number of structural nodes between the filler and the gap. However, it could also be due to the canonical SOV ordering. That is, the fact that resumptive pronouns were not used in subject RCs might be related to the fact that subjects can freely be dropped and OV ordering (that is observed in subject RCs) is quite plausible in Turkish. In object RCs, on the other hand, the structure starts with the subject and this might be expected to be followed by an object in line with the canonical SOV ordering. Of course, this also needs to be supported with further experiments.

Finally, even if the problem was related to the filler-gap dependencies,one needs to explain why children produced morphosyntactic errors.

3.3.3.3 Possible Causes of the Subject-Object Asymmetry in Turkish Relative Clauses

The present production facts lead us to suggest that the asymmetry between subject and object RCs in Turkish might be caused by the following interplay of factors: (a) ambiguous morphemes due to multiple form-function mappings, (b) local attachment to a verb, 3) frequency of subject RCs compared to object RCs, (c) word-order, (d) perspective shift. Each one of these factors will be discussed in turn.

Multiple form-function mappings

The subject in an object RC appears in the genitive case. Genitive case has more than one function; apart from marking the subject in object RCs as in (62), it marks the possessor in possessive NPs as in (63) and the subject of complement clauses as in (64). In subject RCs, on the other hand, the object appears in the accusative case, which more straightforwardly marks the direct object.[4]

(62) İneğ-in iç-tiğ-i süt
cow-GEN drink-DIK-3SG.POSS milk-NOM
'The milk that the cow drank'

(63) İneğ-in süt-ü
cow-GEN milk-3SG.POSS
'The cow's milk'

(64) İneğ-in süt-ü iç-tiğ-i-ni gör-dü-m.
cow-GEN milk-ACC drink-DIK-3SG.POSS-ACC see-PAST-1SG
'I saw that the cow drank the milk.'

Considering the multiple functions of the genitive case, it might be the case that the activation of linguistic item in speech encoding becomes more difficult as the number of its functions increases.

Local attachment to a verb

Genitive NP is part of a composite structure so it cannot be attached to a verb to form a sentence before it it attached to its head, which always requires possessive-agreement morpheme. Accusative NP, on the other hand, can immediately attach to a verb to form a sentence.

[4]We do not argue that the accusative morpheme is free from ambiguity. It has to be noted that it may be ambiguous between the third person possessive marker and the accusative case. We discuss in Chapter 5 that ambiguity is gradient in nature and the genitive morpheme is more ambiguous than the accusative morpheme at the sentence-initial position.

It has been observed that Turkish-speaking children acquire the genitive case at a later age than the accusative and the nominative case, especially when it appears as the subject of an embedded clause (e.g., Aksu-Koç & Slobin, 1985; Ketrez & Aksu-Koc, 2009). We suggest that the factors described above (i.e., multiple form-function mappings, being a composite structure, and the ease of attaching to a verb) might be the main cause of its late acquisition. This may also contribute to the lower performance in and late acquisition of object RCs compared to subject RCs.

Frequency

Subject RCs seem to be more frequent than object RCs in child-directed speech Slobin (1986). In the corpus analysed by Slobin, Turkish-speaking children and adults used significantly less object RCs than subject RCs. Similarly, in a written corpus of 1000 Turkish RCs, Haig (1997) finds only 29% object RCs in adult language. This is in line with our data that both children and adults produced more subject RCs than object RCs. Responses from the adult participants revealed that although they produced the target RC type most of the time, there was a tendency to replace object RCs with other structures that are equally acceptable (e.g., passives and perspective shift). Despite a significant difference in the overall success rate between children and adults, the response pattern of the two groups looked similar in terms of the avoidance strategies. Hence, in addition to other factors, the ratio of subject versus object RCs in children's utterances seems to reflect the frequency of the input s/he is exposed to. Another support for this comes from a recent study by Sarılar and Küntay (in press), who report that providing training and input in subject RCs facilitates comprehension of this structure in significant ways.

Word-order

The word-order in subject RCs is OVS and preserves the canonical order of Turkish in terms of verb and object (i.e. OV) whereas the object is sent to the post-verbal position in object RCs (i.e. VO). This might also be contributing to the preference for subject RCs over object RCs.

Perceptual or Conceptual Accessibility

We think the perceptual factors such as conceptual accessibility, dominance of the subject perspective and avoidance of perspective shift, may have contributed to the participants' better performance in subject RCs compared to object RCs. The fact that our participants preferred locating the theme as the subject of their utterances seems to reflect the effect of conceptual accessibility (a la Bock and Warren (1985), among others) suggesting that conceptually more accessible elements receive higher order grammatical roles (e.g., subject) in

an utterance.

Additionally, in line with MacWhinney (1977), we assume that the prompting question in our task provided a starting point for the participants by focusing their attention on the agent in the subject RC and on the patient in the object RC. According to MacWhinney, starting points may function to assign (a) the attentional focus, (b) the perspective, (c) the agent, and (d) the given. Moreover, a starting point is always expected to be an active element (i.e. the agent). If a starting point does not coincide with the agent, a conflict arises, which he calls a complex perspective.

Let us analyse the dialogue between the researcher and the participants, exemplified previously in (49), which is repeated below in (65) from this angle. Hearing the question that aims to prompt a subject RC (i.e., 'which camel is wearing the hat?'), the participants direct their attention to the camel that is wearing the hat. There is no complex perspective here, since the starting point here is the agent (i.e., the camel is both wearing the hat and it is performing the action). On the contrary, in the case of an object RC, the referent to which the question (i.e., 'which camel is wearing the shoes?') draws the attention is not the agent of the action that is depicted in the picture, thereby causing a complex perspective. In short, the task demanded a perspective shift in object RCs, but not in subject RCs. This may also have contributed to the asymmetry between subject and object RCs.

(65) *Sample dialogue between the participant and the researcher:*

Researcher:

Hangi deve şapka tak-mış?

Which camel hat put-EV.COP

'Which camel is wearing the hat?'

Participant:

İneğ-i tekmele-yen deve.

Cow-ACC push-(y)An camel

'The camel that is kicking the cow.'

Researcher:

Hangi deve ayakkabı giy-miş?

Which camel shoe wear-EV.COP

'Which camel is wearing the shoes?'

Participant:

İneğ-in tekmele-diğ-i deve.

Cow-GEN kick-DIK-3SG.POSS camel

'The camel that the cow is biting.'

To conclude, success in the processing of RCs seem to depend on the successful convergence of multiple factors at different linguistic and non-linguistic (e.g., perceptual and conceptual) levels. These factors seem to be affecting children and adults at different rates. Adults surely have more successful linguistic and processing resources to tackle them.

3.4 Summary

In this chapter, we reported two off-line experiments to test the comprehension and production of Turkish RCs in monolingual children and adults. Both tasks revealed an asymmetry between subject RCs and object RCs in children.

Analysis of the comprehension data with respect to the filler-gap accounts revealed that only the Structural Distance Hypothesis predicted the preference for subject RCs. Further response analysis from the production data suggested that the deeper embedding in object RCs compared to subject RCs may not be the (only) cause of this asymmetry.

We also underlined that the filler-gap accounts need to specify specific strategies about how the parser might detect the gap before it encounters the filler in head-final languages in order to ensure incremental processing. Our interpretation of the unexpected responses indicated that speech encoding must be incremental and that multiple-factors must be involved in the present pattern.

The issue of incremental parsing and gap-detection strategies in Turkish RCs that present the gap prior to the filler will be addressed in the next chapter via an online processing experiment.

CHAPTER 4

STRATEGIES IN THE PROCESSING OF TURKISH RELATIVE CLAUSES

4.1 Introduction

We presented two off-line experiments in Chapter 3 to evaluate the filler-gap accounts that have been proposed to account for the subject-object asymmetry in RCs. We showed that the Linear Distance Hypothesis and the Argument Crossing Accounts wrongly predicted subject RCs to be problematic in Turkish. The off-line data suggested that children but not adults had difficulties in assigning correct theta-roles to referents in object RCs vis-a-vis subject RCs. It appears that the Structural Distance Hypothesis predicted this pattern correctly. However, although this theory has been derived from Korean (O'Grady, 1997), which patterns with Turkish regarding the gap location (i.e., the gap precedes the filler), the issue of how the parser should detect the gap before it detects the filler in head-final languages needs a systematic investigation. This chapter will address this question in an on-line experiment testing the phrase-by-phrase parsing of Turkish RCs in monolingual children and adults.

There have been various hypotheses about how the filler is identified, how it is linked to its gap and how it receives an interpretation. Below, some of the major hypotheses offered in this direction will be briefly summarised and then they will be analysed with respect to the processing data that will be reported in Section 4.6 below.

4.2 Filler-Gap Strategies

4.2.1 Fodor 1978

Fodor (1978) presents three possible heuristics the parser might apply while detecting the exact location of the gap and integrating it with its filler. These are *last-resort*, *first-resort*,

and *lexical-expectation* models of gap finding which are defined as follows.

(66) *Gap as a last resort strategy*

The parser analyses a clause containing a fronted wh-constituent just as it would analyse an untransformed declarative main clause. The possibility of a gap is appealed by the parser only as a last resort, when all other structural hypotheses about that part of the sentence have been tried and have failed (p. 433).

(67) *Gap as a first resort strategy*

The parser always favours the hypothesis that there is a gap in cases of temporary ambiguity (p. 435).

(68) *Lexical-expectation model*

When a phrase is expecting a noun phrase to occur next in the sentence, it activates a subroutine to find words that can be construed as the internal constituents of a noun phrase, and it is this subroutine that hypothesises that there is a gap if no noun phrase constituents are forthcoming in the surface structure (p. 438).

The gap-as-a-last resort strategy is motivated by Jackendoff and Culicover's (1971) gap-finding routines in dative questions and suggests that the parser waits until enough unambiguous evidence accumulates in order to search for a gap. The gap-as-a-first-resort strategy postulates a gap as soon as enough information is available (e.g., right after encountering the verb), and the lexical expectation model is derived from Wanner and Shiner's (1974) study and Wanner and Maratsos's (1978) Augmented Transition Network (ATN) theory. According to this, whenever there is a noun phrase hypothesis, the parser lists all possible surface realisations, which also includes the gap as its final possibility. That is, both the gap-as-a-last-resort and the lexical-expectation model apply the *try-the-next-constituent* principle. Fodor summarizes this as follows: 'whenever the parser is looking for a noun phrase and finds one in the surface sentence, the one it finds is indeed the one it was expecting, and there is no gap; whenever it is looking for a noun phrase and does not find one in the surface sentence, there is a gap (p.442).'

One important observation Fodor makes is that neither gap-as-a-first-resort nor gap-as-a-last-resort strategy could successfully be generalised to explain all filler-gap phenomena.

For instance, she shows that gap-as-a-last-resort strategy incorrectly predicts (69) to be harder than (70). It also incorrectly predicts no processing difference between (71) and (72).

(69) Which book$_i$ did the teacher read t$_i$ to the children?

(70) Which picture$_i$ did the teacher show t$_i$ to the children?

(71) Which book$_i$ did the teacher read t to the children from t$_i$?

(72) Which student$_i$ did the teacher go to the concert with t$_i$?

Likewise, she notes that the gap-as-a-first-resort strategy fails to predict that there is not a considerable processing difference between sentences like (72) and (73), and that sentences like (74) are more difficult than the ones like (70).

(73) Which student$_i$ did the teacher walk t to the cafeteria with t$_i$?

(74) Which student$_i$ did the teacher walk t$_i$ to the cafeteria?

She stresses that although the parser seems to make use of different strategies for different types of sentences, the lexical-expectation model appears to account for a greater number of phenomena. Yet, assuming a different strategy for different construction types may not be desirable considering the computational plausibility and parsimony of a processing account.

4.2.2 Active-Filler Hypothesis

After Fodor's (1978) paper, many studies in English investigated the parser's routines in filler-gap dependencies and most of them lent support to the gap-as-a-first-resort strategy.

In a self-paced reading study, Crain and Fodor (1985) showed that the participants showed longer RTs at the NP after the verb (i.e., 'us') in a wh-sentence as in (75a) compared to the same NP in a sentence with no gaps as in (75b). They reasoned that the parser showed a surprise effect upon finding a lexical phrase in the expected gap position. This was taken as a support for the gap-as-a-first-resort strategy entrusting the wh-filler to trigger the search for a gap in the first available position.

(75) a. Who$_i$ had the little girl expected *us* to sing those stupid French songs for t$_i$ at Christmas?

b. The little girl had expected us to sing those stupid French songs for Cherly at Christmas.

A similar result was obtained from Stowe's (1986) study, which reported a similar surprise effect after 'us' in (76a) compared to (76b).

(76) a. My brother wanted to know who$_i$ Ruth will bring us home to t$_i$ at Christmas.

b. My brother wanted to know if Ruth will bring us home to Mom at Christmas.

Investigating the filler-gap dependencies in Dutch, a head-final language, Frazier and Flores D'Arcais (1989) offered a more formal version of the gap-as-a-first-resort strategy in the form of Active Filler Hypothesis, which is given in (77) .

(77) Active Filler Hypothesis (Frazier and Flores D'Arcais, 1989)
Assign an identified filler as soon as possible: i.e., rank the option of a gap above the option of a lexical noun phrase within the domain of an identified filler (p.332).

4.2.3 Trace Reactivation Hypothesis

Another filler-gap hypothesis claims that the displaced items are reactivated only at the gap position, as shown in (78).

(78) *Trace Reactivation Hypothesis*
Reactivation of potential antecedents is restricted by grammatical constraints. An antecedent is reactivated only at the trace position.

Swinney, Ford, Frauenfelder, and Bresnan (1988) employed a cross-modal priming paradigm to investigate how wh-traces in RCs were reactivated. They presented the participants with sentences where there was more than one referent that could bind the referentially dependent element (e.g., boy vs. crowd) as in (79) and asked them to listen to these sentences and make a lexical decision for the simultaneously presented word/nonword items. These items visually appeared in certain points during the sentence such as the before the verb, right after the gap, or after the final determiner as identified with '*' below. In the critical cases, the visual target was either semantically related or unrelated to the filler (e.g., boy vs. body). Swinney and colleagues reported a significant difference between the related and the unrelated target only at the gap position, which supported the Trace Reactivation Hypothesis.

(79) The policeman saw the boy$_i$ that$_i$ the crowd at the party * accused t$_i$ * of the * crime.

Similarly, Love and Swinney's (1996) work on English Object RCs also demonstrated that semantically related words to the filler the new pen led to reduced lexical decision times at the gap position vis-a-vis the position after the subcategorizer *purchased*.

(80) Jimmy used the new pen$i$ that his mother-in-law recently ti purchased.

However, the following design choices might have acted as a confounding factor in these experiments. 1- The subcategorizer is the last word in the test items: a- It would be hardly possible to get any effect following the subcategorizer since the parser would be aware that it is the end of the sentence; b- Even if there is any effect at this position, we doubt that we could consider it as stemming from the filler-subcategorizer attachment; any effect found at sentence-final position might be a spill-over of an earlier effect; 2- As also underlined by Pickering and Barry (1991), the lexical decision task was introduced right after the verb in Swinney et al.'s (1988) study so it cannot distinguish the filler-gap between the filler-subcategorizer effect; 3- The lexical decision task was introduced right after the adverbial in Love and Swinney's (1996) study. The adverbial clearly encodes the category of the incoming item so one might argue that the parser predicted the incoming verb and showed an earlier activation of filler-subcategorizer attachment. Thus, these two experiments seem not to properly dissociate whether the filler is activated at the gap position or at the subcategorizer.

4.3 Dependency Formation Strategies in Head-final Languages

There have been some studies investigating the filler-gap dependency routines in head-final languages. Interestingly, they have yielded some conflicting results. There has been at least one study that supports one of the reviewed hypothesis. Nakano, Felser, and Clahsen (2002) reported gap-site priming effects in preverbal positions in Japanese scrambling, supporting the Trace Reactivation Hypothesis. The data from Aoshima, Phillips, and Weinberg (2002) supported the revised version of the Active Filler Strategy as a grammatically sensitive process that tries to satisfy the grammatical constraints at each point in a sentence.

Nakano et al. (2002) reported gap-site priming effects in preverbal positions in Japanese scrambling. In these structures, a direct object moves from inside an embedded clause to the sentence-initial position. They used the cross-modal priming paradigm with high-span and low-span individuals (i.e., people with high or low scores in short term memory tests) to evaluate filled-gap effects in Japanese scrambling constructions as shown in (81).

(81) Banana-o$_i$ [Tom-ga Mary-ni [John-ga sono saru-ni t$_i$ yatta-to]
banana-ACC$_i$ [Tom-NOM Mary-DAT [John-NOM that monkey-DAT t$_i$ gave-COMP]

itteiru] (koto)

tell-PRES-PROG (fact)

'(the fact that) the banana, Tom is telling Mary that John gave (to) that monkey.'

Nakano et al's findings for the high-span individuals showed reactivation at the canonical position of the dislocated object, which was compatible with the Trace Reactivation Hypothesis. However, the low-span individuals did not show the same effect. The authors suggested that this might be due to the number of intervening NPs between the filler and the gap, which could have been overwhelming for low-span participants (for similar results in German scrambling see Clahsen and Featherston, 1999).

In another study, Aoshima et al. (2002) investigated how the filler-gap dependencies were processed in Japanese wh-constructions. They used a self-paced reading task to explore the underlying motivation behind the Active Filler Strategy: whether active filler effects are derived from syntactic requirements of the predicate or whether they can be triggered by syntactic and semantic requirements of any lexical element. They compared the structures where the wh-phrase stays in situ with the scrambled ones where the wh-phrase appears sentence-initially. Each condition appeared with the question particle and with the declarative complementizer on the embedded verb as shown in (82) (examples are taken from Aoshima et al., 2002, p.8).

(82) a. Wh-Scrambled and Declarative Complementizer:

Wh-dat/	NP-top/	NP-nom/	NP-acc/	V-DeclC
Dono-seito-ni	tannin-wa	koocyoo-ga	hon-o	yonda-to

which student-dat class teacher-top principal-nom book-acc read-DeclC

Adverb /	NP-dat /	V-QP
tosyositu-de	sisyo-ni	iimasita-ka?

library-at librarian-dat told-QP

'Which student did the class teacher tell the librarian at the library that the principal read a book for?'

b. Wh-in-situ and Declarative Complementizer:

NP-top /	NP-nom /	Wh-dat /	NP-acc /	V-DeclC
Tannin-wa	koocyoo-ga	dono-seito-ni	hon-o	yonda-to

class teacher-top principal-nom which student-dat book-acc read-DeclC

Adverb / NP-dat / V-QP

tosyositu-de sisyo-ni iimasita-ka?

library-at librarian-dat told-QP

'Which student did the class teacher tell the librarian at the library that the principal read a book for?'

c. Wh-Scrambled and Question Particle:

Wh-dat / NP-top / NP-nom / NP-acc / V-QP

Dono-seito-ni tannin-wa koocyoo-ga hon-o yonda-ka

which student-dat class teacher-top principal-nom book-acc read-QP

Adverb / NP-dat / V

tosyositu-de sisyo-ni iimasita

library-at librarian-dat told

'The class teacher told the librarian at the library which student the principal read a book for.'

d. Wh-in-situ and Question Particle:

NP-top / NP-nom / Wh-dat / NP-acc / V-QP

Tannin-wa koocyoo-ga dono-seito-ni hon-o yonda-ka

class teacher-top principal-nom which student-dat book-acc read-QP

Adverb / NP-dat / V

tosyositu-de sisyo-ni iimasita.

library-at librarian-dat told

'The class teacher told the librarian at the library which student the principal read a book for.'

Aoshima et al. (2002) reasoned that if the Active Filler Strategy is motivated by the argument structure requirements, a slowdown in reading times should occur right after the embedded verb in the Wh-Scrambled and Question Particle condition (82c) compared to its declarative counterpart (82a). The reasoning is as follows here: the earliest position to posit a gap is after the first NP. If the gap is posited in position, then the readers need to expect that the entire sentence is a direct question, which locates the scope marker for the wh-word within the matrix verb. If the Active Filler Strategy is sensitive to the requirements of the argument saturation and wh-scope licensing, then the gap should be expected at the verb in the embedded clause, which should lead to exactly the opposite results. That is, slowdown should occur after the verb in the Wh-Scrambled and Declarative Complementizer condition (82a) relative to its question counterpart (82c). This line of thinking also predicts to get

similar results for the wh-in-situ conditions.

The results supported the Active Filler as a grammatically sensitive strategy due to the slowdown in reading times at the embedded verb that is marked with a declarative complementizer, both in the wh-in-situ and the wh-scrambled conditions. This was taken to reflect the processor's structure building ability taking into consideration the verb final property of Japanese that locates the deeply embedded verbs earlier than the matrix verb. Thus, the authors concluded that the driving force in the Active Filler Strategy should be the urge to satisfy the grammatical constraints such as thematic interpretation and wh-scope licensing. They also suggested that the memory-based accounts that derive from the earlier version of the Active Filler Strategy, which is purely position-based, cannot explain Japanese data but that their results might be compatible with the memory-based accounts that calculate the cost in terms of the syntactic and semantic constraints.

Although both studies focus on filler-gap effects in head-final languages, neither of them presents cases where the parser is required to detect the gap before the filler. This is why, these findings could not be generalised to those cases. Two studies that use examples where the gap precedes the filler in head-final languages like Korean and Mandarin are Kwon, Polinsky, and Kluender (2006) and Lin and Bever (2006), respectively. These studies do not directly address the filler-gap strategies but we could interpret their data in this respect.

Kwon et al. (2006) tested word-by-word reading of relative and adjunct clauses in Korean as exemplified in (83).

(83) a. hyengsa-ka t_i sinloyha-n kica$_i$
detective-NOM t_i trust-ADN reporter
'The reporter whom the detective trusted.'

b. t_i hyengsa-ul sinloyha-n kica$_i$
t_i detective-ACC trust-ADN reporter
'The reporter that trusted the detective.'

c. Minswu-ka t_i silhehay-se sonye-ka phati-lul ttenassta
M-NOM t_i hate-BECAUSE girl-NOM party-ACC left
'Because Minswu hate (her), the girl left the party.'

d. t_i Minswu-lul silhehay-se sonye-ka phati-lul ttenassta
t_i M-ACC hate-BECAUSE girl-NOM party-ACC left
'Because she hates Minswu, the girl left the party.'

Object gap sentences as in (83a) and (83d) took longer to read than subject gap sentences at the matrix subject (i.e., the filler) position. Kwon et al. (2006) underline that the fact that object gap sentences elicited longer RTs not only in RCs but also in adjunct clauses might require the Structural Distance Hypothesis to revise its hypothesis as 'count the nodes between the gap and the predicate that subcategorizes for the missing argument' (p.8).

Lin and Bever (2006) reported similar effects in Mandarin RCs, exemplified in (84). Subject RCs elicited shorter reading times at the RC-Head than object RCs.

(84) a. pro yaoqing fuhao de guanyuan
pro invite tycoon DE official
'The official who invited the tycoon'

b. fuhao yaoqing de guanyuan
tycoon invite DE official
'The official who the tycoon invited'

The authors underline that a canonical declarative sentence cannot be distinguished from an RC until the relativizer 'DE' and they suggest that this might be the reason why the parser immediately posits a gap right after the segment following the relativizer.

One interesting aspect of these two studies is that both reported longer RTs at the RC-Head in relation to previous words both in subject and object RCs, which suggests that the parser does not recognise the relativization until this point. Yet, this does not rule out an incremental parser as also shown in studies suggesting that the parser uses the morphosyntactic information in head-final languages like Japanese to predict the incoming head before the head becomes available (Kamide & Mitchell, 1999), ruling out the strictly head-dependent parsing. We presume the slowdown at the RC-Head might be resulting from the fact that the case marking cues in a canonical declarative sentence did not differ from the cues prompting relativization in Korean and Mandarin. In Korean it is possible to drop arguments so a declarative sentence might follow the same order as a relative clause until the relativizer, as exemplified in (85), which is taken from Kwon et al (p.3) (cf., the relativization examples in 83).

(85) a. pro kica-lul sinloyha-n-ta
pro reporter-ACC trust-PSR-DECL
'Someone trusts the reporter.'

b. kica-ka pro sinloyha-n-ta
detective-NOM pro trust-PRS-DECL
'The detective trusts someone.'

We think the parser might be relying on the frequencies with which the nominative or accusative case might be followed by certain structures and ranking the relative clause expectation lower than canonical declarative sentences. That is to say that the parser might be interpreting the adjacent lexical and morphological items locally on the basis of probabilistic information without projecting functional categories or empty categories top down.

4.4 Present Study

In Chapter 3, a comprehension and a production experiment were reported. In both experiments, participants performed poorly in object RCs vis-a-vis subject RCs. The data was interpreted with regards to various filler-gap accounts such as the Linear Distance Hypothesis, the Structural Distance Hypothesis, and the Argument Crossing Account. Only the Structural Distance Hypothesis made correct predictions since the other two accounts predicted subject RCs to be more problematic. We underlined the possibility that the subject-object asymmetry in the processing of Turkish RCs might not be caused by the filler-gap effects per se but there might also have an effect of an interplay of several factors such as multiple form-function mapping, morphosyntax, frequency, word-order regularities, and perceptual factors. We also underlined that filler-gap accounts should specify which strategy the parser uses in order to ensure incremental interpretation (i.e., how the parser detects the gap as soon as it appears, without waiting until the filler).

The present study investigates whether the available filler-gap strategies reviewed above (i.e., gap-as-a-last-resort strategy, gap-as-a-last-resort strategy, lexical-expectation model, active-filler hypothesis, and trace reactivation hypothesis) could provide an explanation for the subject-object asymmetry in the processing of Turkish RCs. As exemplified in (86), Turkish RCs are structures that do not present their lexical items in the canonical SOV order. According to the transformational theories, the RC-Head moves to the clause final position leaving a gap in its canonical position. Recall that the gap precedes its filler in Turkish RCs, which is similar to Korean or Mandarin but opposite to English.

(86) a. *SOV sentence*

Adam Mary-i sev-iyor.

Man-NOM Mary-ACC love-PROG3sg

'The man loves Mary.'

b. *Subject RC*

t_i Mary-i sev-en adam$_i$

t_i Mary-ACC love-(y)An man$_i$

'The man that loves Mary.'

c. *SOV sentence*

Mary adam-ı sev-iyor.

Mary-NOM Man-ACC love-PROG3sg

'Mary loves the man.'

d. *Object RC*

Mary-nin t_i sev-diğ-i adam$_i$

Mary-GEN t_i love-DIK-3sgPOSS man$_i$

'The man that Mary loves.'

To gather the moment-by-moment processing of RCs by children and adults, an experiment was designed in the auditory-moving window paradigm. In this design, participants listen to each sentence in a segment-by-segment fashion in their own pace. The listening times for each segment in each RC-Type provide some insights about the processing routines applied in these structures. More information about the method, participants, and the procedure will be provided below in Section 4.6.1 but a set of sample test items will be given in (87) and (88) to provide a ground to discuss the predictions of each strategy.

(87) *Subject RC*

	Segment 1	/ Segment 2	/ Segment 3
GAP$_i$	NP-ACC	/ V-(y)An	/ NP-NOM$_i$
t_i	Haylaz goril-i	/ hızlıca it-en	/ güçlü aslan$_i$
t_i	naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM$_i$

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.

slow elephant-ACC / kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

(88) *Object RC*

Segment 1		/ Segment 2	/ Segment 3
NP-GEN	GAP_i	/ V-DIK-AGRPOSS	/ NP-NOM$_i$
Haylaz goril-in	t_i	/ hızlıca it-tiğ-i	/ güçlü aslan$_i$
naughty gorilla-GEN	t_i	/ hard push-DIK-3sgPOSS	/ strong lion-NOM$_i$

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

4.5 Predictions

The predictions as to how each filler-gap strategy reviewed above, namely gap-as-a-last-resort strategy, gap-as-a-last-resort strategy, lexical-expectation model, active-filler hypothesis, and trace reactivation hypothesis would process the phrases in the test items given in (87) and (88) are presented below.

4.5.1 Predictions of the gap-as-a-last-resort strategy

Below, the description of Gap-as-a-last-resort strategy is repeated as (89).

(89) Gap-as-a-last-resort strategy

> The parser analyses a clause containing a fronted wh-constituent just as it would analyse an untransformed declarative main clause.(...) The possibility of a gap is appealed by the parser only as a last resort, when all other structural hypotheses about that part of the sentence have been tried and have failed (Fodor, 1978, p.433).

Predictions for Segment 1: Longer RTs is expected at Segment 1 in subject RCs compared to Object RCs because sentence-initial NP-ACC in subject RCs notifies us that the subject of the sentence is missing whereas sentence-initial NP-GEN in object RCs might lead to an *untransformed* sentence: NP-ACC could be followed by a main verb, as in (90) and NP-GEN could be followed by a possessed NP, as in (91).

(90) pro $_i$ NP-ACC V$_i$

pro$_i$ haylaz goril-i it-ti$_i$.

pro$_i$ naughty gorilla-ACC push-PAST$_i$

'pro$_i$ pushed$_i$ the naughty gorilla.'

(91) NP-GEN NP-AGRPOSS V

Haylaz goril-in anne-si gel-di.

naughty gorilla-GEN mother-3SGPOSS come-PAST

'Naughty gorilla's mother came.'

Predictions for Segment 2: No RT differences should be observed between subject and object RCs in Segment 2 because both NPs are followed by an unexpected item in this segment: it was expected that NP-ACC would receive a main verb, as in (90) and it was expected that NP-GEN would receive a possessed NP, as in (91). Yet, both of them are followed by the relativized verb as in (92) and (93), respectively.

(92) GAP$_i$ NP-ACC V-(y)An$_i$

t$_i$ Haylaz goril-i hızlıca it-en$_i$

t$_i$ naughty gorilla-ACC hard push-(y)An$_i$

'The one that pushed the naughty gorilla'

(93) NP-GEN GAP$_i$ V-DIK-AGRPOSS$_i$

Haylaz goril-in t$_i$ hızlıca it-tiğ-i$_i$

naughty gorilla-GEN t$_i$ hard push-DIK-3sgPOSS$_i$

'The one that the naughty gorilla pushed'

Thus, in the case of the subject RC, the parser should realise that the gap created in the first segment is not a 'pro' but a subject gap in a subject RC, which is shown in (94) below. And in the case of the object RC, the parser should recognize an object gap: that is, it should realise that the NP-GEN is not a possessor of the possessive phrase but a subject in an object RC, as in (95).

(94) Input 1: NP-ACC

Hypothesis 1: GAP + NP-ACC + V-simple

Input 2: V-(y)An

Hypothesis 2: GAP + NP-ACC + V-(y)An

(95) Input 1: NP-GEN

Hypothesis 1: NP-GEN + NP-AGRPOSS

Input 2: NP-GEN + V-DIK-AGRPOSS

Hypothesis 2: NP-GEN + GAP + V-DIK-AGRPOSS

Predictions for Segment 3, 4, and 5: No differences should be observed between the two RC-Types in these segments since the sentences have exactly the same lexical items from the 3rd segment onward, as in (96) and in (97) below. In Segment 3, both structures receive their head NPs; in Segment 4 the matrix object that is marked with the accusative case is introduced; and Segment 5 presents the matrix verb.

(96) *Subject RC*

	Segment 1	/ Segment 2	/ Segment 3
GAP_i	NP-ACC	/ V-(y)An	/ NP-NOM_i
t_i	Haylaz goril-i	/ hızlıca it-en	/ güçlü $aslan_i$
t_i	naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM_i

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

(97) *Object RC*

Segment 1		/ Segment 2	/ Segment 3
NP-GEN	GAP_i	/ V-DIK-AGRPOSS	/ NP-NOM_i
Haylaz goril-in	t_i	/ hızlıca it-tiğ-i	/ güçlü $aslan_i$
naughty gorilla-GEN	t_i	/ hard push-DIK-3sgPOSS	/ strong lion-NOM_i

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

4.5.2 Predictions of the gap-as-a-first-resort strategy

Below, the description of Gap-as-a-fist-resort strategy is repeated as (98).

(98) Gap-as-a-first-resort strategy

The parser always favours the hypothesis that there is a gap in cases of temporary ambiguity (Fodor (1978); p. 435).

Predictions for Segment 1: We expect the parser to posit a gap right after the first segment in both structures because there is a temporary ambiguity in the first segment in both structures. Thus, we do not expect any difference between subject and object RCs in this segment. Sentence-initial NP-ACC is ambiguous because it could be followed in many different ways: simple pro-drop sentence as in (99); RC as in (100); complement clause as in (101), and so on. The generation of the gap after NP-ACC should be in the form of reanalysis because in all cases the gap should precede the NP-ACC. That is, hearing the NP-ACC, the parser should realise that there must have been an earlier gap.

(99) pro$_i$ NP-ACC V$_i$
pro$_i$ haylaz goril-i it-ti$_i$
pro$_i$ naughty gorilla-ACC push-PAST$_i$
'pro$_i$ pushed$_i$ the naughty gorilla.'

(100) GAP$_i$ NP-ACC V-(y)An$_i$ NP-NOM$_i$
t$_i$ Haylaz goril-i hızlıca it-en$_i$ güçlü aslan$_i$
t$_i$ naughty gorilla-ACC hard push-(y)An$_i$ strong lion-NOM$_i$
'The strong lion that pushed the naughty gorilla'

(101) pro$_i$ pro$_j$ NP-ACC V-DIK-AGRPOSS-ACC$_j$ V$_i$
pro$_i$ pro$_j$ haylaz goril-i hızlıca it-tiğ-i-ni$_j$ gördü-m$_i$.
pro$_i$ pro$_j$ naughty gorilla-ACC hard push-DIK-3sgPOSS-ACC$_j$ see-PAST-1sg$_i$.
'I saw that pro pushed the naughty gorilla.'

Similarly, sentence-initial NP-GEN is equally ambiguous as it could be a part of many different structures: it could be a possessor of a possessive phrase that is the subject of a simple intransitive sentence (102); subject in an RC as in (103); and subject in a complement clause as in (104), among others. Different from NP-ACC, the NP-GEN should receive the gap as its next argument. Thus, gap generation in this structure will not be in the form of reanalysis. This fact might cause the NP-ACC to lead to longer listening times than NP-GEN.

(102) NP-GEN NP-AGRPOSS V
Haylaz goril-in anne-si gel-di.
naughty gorilla-GEN mother-3SGPOSS come-PAST
'Naughty gorilla's mother came.'

(103) NP-GEN GAP$_i$ V-DIK-AGRPOSS$_i$ NP-NOM$_i$
Haylaz goril-in t$_i$ / hızlıca it-tiğ-i / güçlü aslan$_i$
naughty gorilla-GEN t$_i$ hard push-DIK-3sgPOSS strong lion-NOM$_i$
'The strong lion that the naughty gorilla pushed'

(104) pro$_i$ NP-GEN$_j$ NP-ACC V-DIK-AGRPOSS-ACC$_j$ V$_i$
pro$_i$ Haylaz goril-in güçlü aslan-ı hızlıca it-tiğ-i-ni gördü-m$_i$.
pro$_i$ naughty gorilla-GEN strong lion-ACC hard push-DIK-3sgPOSS-ACC see-PAST-1sg$_i$.
'I saw that the naughty gorilla pushed the strong lion.'

Predictions for Segment 2: Now that the parser has generated a gap in both structures with the incoming NPs in the first segment, the expectation in Segment 2 should have a structure in line with the existence of the gap. This is actually the case since the 2nd Segment is the relativized verb in both structures, as displayed in (105) and in (106). This is why, no significant difference is expected between the two RC-Types in this segment.

(105) Input 1: NP-ACC
Hypothesis 1: GAP + NP-ACC
Input 2: GAP + NP-ACC + V-(y)An
Hypothesis 2: GAP + NP-ACC + V-(y)An

(106) Input 1: NP-GEN
Hypothesis 1: NP-GEN + GAP
Input 2: NP-GEN + GAP + V-DIK-3sgPOSS
Hypopthesis 2:NP-GEN + GAP + V-DIK-3sgPOSS

Predictions for Segment 3, 4, and 5: No differences should be observed since the sentences have exactly the same lexical items from the 3rd segment onward.

4.5.3 Predictions of the Lexical-expectation model

Below, the description of Lexical-expectation model is repeated as (107).

(107) Lexical-expectation model

When a phrase is expecting a noun phrase to occur next in the sentence, it activates a subroutine to find words that can be construed as the internal constituents of a noun phrase, and it is this subroutine that hypothesises that there is a gap if no noun phrase constituents are forthcoming in the surface structure (Fodor, 1978; p. 438).

Predictions for Segment 1: NP-ACC is a complete NP and it indicates that there is a missing subject NP before itself so the gap position for this earlier gap will be recovered via reanalysis. On the other hand, NP-GEN could be followed by a noun phrase (possessed NP), in which case it does not require a gap, as illustrated in the first hypothesis of (108) and of (109). For this reason, NP-GEN should have shorter RTs than NP-ACC.

(108) Input 1: NP-ACC

Hypothesis 1: GAP + NP-ACC

Input 2: NP-ACC + V-(y)An

Hypothesis 2: GAP + NP-ACC + V-(y)An

(109) Input 1: NP-GEN

Hypothesis 1: NP-GEN + NP-POSS

Input 2: NP-GEN + V-DIK-3sgPOSS

Hypothesis 2: NP-GEN + GAP + V-DIK-3sgPOSS

Predictions for Segment 2: Now that the subject gap position is created via reanalysis after NP-ACC, the parser should be expecting a structure that is in line with this configuration. So the relativized verb (V-(y)An) introduced in the second segment does not violate the parser's expectations. However, the expectations created in the second hypothesis of (109) after NP-GEN are not fulfilled in the second segment, which is the relativized verb, not a possessed NP. This should result in reanalysis in this segment in object RCs but not in subject RCs. Thus, there should be a slowdown in this segment in object RCs compared to subject RCs, as shown in the second hypothesis of (108) and of (109).

Predictions for Segment 3, 4, and 5: No differences should be observed since the sentences have exactly the same lexical items from the 3rd segment onward.

4.5.4 Predictions of the Active Filler Hypothesis

Below, the description of Active Filler Hypothesis is repeated as (110).

(110) Active Filler Hypothesis

Assign an identified filler as soon as possible: i.e., rank the option of a gap above the option of a lexical noun phrase within the domain of an identified filler (Frazier and Flores D'Arcais, 1989; p.332).

Predictions for Segment 1, 2, 3: The Active Filler Hypothesis does not trigger a gap-search until it finds the filler. Both subject RCs and object RCs locate the filler in the third segment, as shown in input 1, 2, and 3 in (111) and (112). This means we should not observe any RT differences between these structures in the first three segments. When the filler is introduced in the third segment, the parser should recognise that there had actually been a gap in the structure. This should result in reanalysis in both structures, as displayed in the first hypothesis of (111) and of (112). Thus, no difference between RC-Types is expected but there might be a slowdown at the third segment compared to the first two segments within each structure.

(111) Input 1: NP-ACC

Input 2: NP-ACC + V-(y)An

Input 3: NP-ACC + V-(y)An + FILLER (RC-HEAD)

Hypothesis 1: GAP + NP-ACC + V-(y)An + FILLER (RC-HEAD)

(112) Input 1: NP-GEN

Input 2: NP-GEN + V-DIK-3sgPOSS

Input 3: NP-GEN + V-DIK-3sgPOSS + FILLER (RC-HEAD)

Hypothesis 1: GAP + NP-GEN + V-DIK-3sgPOSS + FILLER (RC-HEAD)

Predictions for Segment 4 and 5: No differences should be observed since the sentences have exactly the same lexical items from the 3rd segment onward.

4.5.5 Predictions of the Trace Reactivation Hypothesis

Below, the description of Trace Reactivation Hypothesis is repeated as (113).

(113) *Trace Reactivation Hypothesis*

Reactivation of potential antecedents is restricted by grammatical constraints. An antecedent is reactivated only at the trace position.

Table 4.1: Summary of the Predictions of the Filler-Gap Strategies for Each Segment in Subject RCs and Object RCs.
'>' indicates that longer RTs in the former compared to the latter and '=' indicates the RTs for the former and the latter do not differ statistically. 'SR' refers to Subject RCs and 'OR' refers to Object RCs.

RC-Type	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Segment 5**
Subject RC	NP-ACC	V-(y)An	NP-NOM	NP-ACC	Verb
Object RC	NP-GEN	V-DIK-3sgPOSS	NP-NOM	NP-ACC	Verb
Model	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Segment 5**
Gap-as-a-last-resort	SR > OR	SR = OR	SR = OR	SR = OR	SR = OR
Gap-as-a-first-resort	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR
Lexical expectation	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR
Active Filler	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR
Trace Reactivation	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR

Similar to the Active Filler Hypothesis, the Trace Reactivation Hypothesis requires that the filler is identified first. The former says that when the filler is identified, the parser generates the gap in the first available position and the latter says when the filler is identified, it needs to be attached to its original gap to receive its theta-role. Since the gap precedes its filler in Turkish RCs, the difference between these two hypotheses disappears. Thus, we expect exactly the same pattern of activation predicted in the Active Filler Hypothesis: an effect of reanalysis in segment 3 in both structures, which is shown in (111) and in (112).

The summary of the predictions of each strategy we have just reviewed is provided in Table 4.1.

4.6 Experiment 3a: Filler-Gap Strategies in the Processing of Turkish RCs in Monolingual Children and Adults

4.6.1 Method

4.6.1.1 Auditory moving-window (Self-Paced Listening) Task

We designed the experiments in the auditory moving-window/self-paced-listening paradigm devised by F. Ferreira, Anes, and Horine (1996). It is similar to the self-paced reading paradigm, where participants press a button to visually unfold a sentence on the screen segment by segment (in words or phrases) on their own pace. Instead of the visual words, this version presents recorded sentences over headphones to the participants who control their listening pace by pressing the button to receive each segment of a sentence. The idea behind the self-paced listening task is that the listening times between the onset of the segment and the next button press for each segment reflects the processing time attached to it, whereby providing information about the time needed to combine each incoming speech segment into the previous structure.

4.6.1.2 Participants

Thirty-five of the child participants that took part in the previous experiment successfully completed this task, and 34 undergraduate students from the Middle East Technical University participated as a control group. Please see the method section of Chapter 3 for detailed information about our participants.

4.6.1.3 Materials and Design

The test items were composed of 32 sentence-initial subject RCs and object RCs with the subject role in the matrix clause as displayed in (114) and (115).

(114) *Subject RC*

	Segment 1	/ Segment 2	/ Segment 3
GAP_i	NP-ACC	/ V-(y)An	/ NP-NOM_i
t_i	Haylaz goril-i	/ hızlıca it-en	/ güçlü $aslan_i$
t_i	naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM_i

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

(115) *Object RC*

Segment 1		/ Segment 2	/ Segment 3
NP-GEN	GAP$_i$	/ V-DIK-AGRPOSS	/ NP-NOM$_i$
Haylaz goril-in	t$_i$	/ hızlıca it-tiğ-i	/ güçlü aslan$_i$
naughty gorilla-GEN	t$_i$	/ hard push-DIK-3sgPOSS	/ strong lion-NOM$_i$

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

In these sentences (i.e.,(114) and (115)), the RC appears as the first NP and it functions as the subject in the matrix clause. This chapter will focus only on these sentences. However, we further manipulated the matrix role of the RCs to test the effect of RC-Role on the processing; we had 64 more sentences to do this (32 subject-RCs and 32 object-RCs with the object matrix role) and all of these RCs appeared sentence-initially. These sentences enabled us to evaluate another hypothesis, namely the Parallel Function Hypothesis (Sheldon, 1974). We will report the related analyses separately in Chapter 6 to provide an easier exposition. For adult participants, we also manipulated the location of the RC in the matrix clause and added 64 more sentences that presented the RC as the second NP, which will also be reported in Chapter 6.

In addition, we had 128 control items involving non-complex sentences divided equally in four different word-order variations (SOV, OSV, OVS, SVO). We will present the related results separately in Section 4.7.

All in all, the task was composed of 256 items divided into 4 sessions consisting of 32 test items and 32 control items (64 items in total per session). All NPs were selected among animal names and all verbs were selected among agentive actions. To make sure each segment is long enough to provide enough processing time for the participants, each NP was preceded by an adjective and each verb was preceded by an adverb in all of the items constructed for

Experiment 3.

There were 16 animal names and 16 adjectives repeated 8 times for the test items and 8 times for the control items. There were 8 verbs and 8 adverbs, which were repeated 16 times throughout the test. The sentences were matched for number of words (11 for the test items and 8 for the control items), and all lexical items were controlled for the number of syllables: the mean number of syllables for the NPs was 1.94, and it was 2.19 for the adjectives, 2.13 for the verbs and 3 for the adverbs. For the frequency, imageability, and age of acquisition of the lexical items, we used an English database (Bird, et. al., 2001).

A female native speaker read the stimuli in a soundproof speech booth. The sentences were recorded as a whole with normal prosody (yet in a slower pace), segmented into phrases, and each segment was saved as a waveform file. A tone was added at the end of the last segment in each sentence to mark the end of the sentence. The stimuli were presented and controlled by an HP-Laptop. We used a button-box to gather the responses and the e-prime software (Schneider, Eschman, and Zuccolotto, 2002) to measure and record the reaction times (RTs) (i.e., the time between the onset of the phrase and button-press).

4.6.1.4 Procedure

Each participant was tested individually in a quiet room. They were asked to press a button to listen to the segments on their own pace until they completed each sentence. They were also required to answer a comprehension question upon completion of each sentence in order to prevent strategy formation, conscious processing, or mechanical pressing of the push-button. This also ensured that they were listening to the sentences for meaning.

Child participants were told the following story at the beginning of the task: In this game we have two friends: This is Ayşe and this is Ali. Ayşe is a girl who has lots of short stories about different animals and Ali is one of her friends listening to her. You know what...Ayşe is very shy to speak. She needs your help to tell her stories. She stops speaking if you don't help her. How will you help her? All you need to do is to press the blue button in order to make sure she keeps speaking properly until the end of each story. How will you know the story has ended? You will hear a gong tone after each story. Let us see one example to see how it goes, now we will press the button together, right? Here it goes. (Here the experimenter provides one sample demonstration for the child.) If you stop pressing the button she will stop telling her story, if you press the button too fast you may not be able to understand what she is saying. Shall we try one more to see how it is? (Here the child is provided with another

demonstration to see what happens when the button press is too slow or too fast). So you have to arrange your own pace to get the stories right (Here the child is asked to try one sample listening by pressing the button). When the child gets the logic behind the self-paced listening task, the experimenter goes on to tell the following story: Remember, it is not only you who is listening to Ayşe's stories. Ali is also there listening to them, but poor guy sometimes has difficulty understanding the stories because he is daydreaming. He keeps asking questions at the end of each story. Your task is 1- to help Ayşe speak and tell her stories by pressing the blue button; and 2- to help Ali understand the stories by answering his questions. You need to understand all the details about the story to answer all of Ali's questions. We will have some trials now, are you ready?

The task was presented to the child participants as a repeated-measures design: all child participants took each of the two sessions at a minimum of one-week intervals. It was presented to the adult group as a between-group design: each adult participant completed only one session (i.e., each session of the test was performed by a different adult participant).

Data Trimming

As the data derived from this task was enormous, we used a program, which was written in Python to handle the data trimming without any unseen errors the alternative manual analysis might have caused.[1]

The program eliminated all lines (sentences) with incorrect responses to make sure each participant was paying close attention to the task and fully comprehending the sentences (10 % of the data is eliminated due to errors). It calculated the residual RTs for each segment by measuring the length of each segment (segment duration) and subtracting each raw RT from the segment duration. It also eliminated every response that is above 3000 for adults (3.2 % of the data) and above 5000 for children (around 10.3 % of the data). After eliminating the extreme values and extreme negative values, the program detected the outliers and replaced them with the mean RT for each subject and each condition.

4.6.2 Results

The results from the control items (i.e., processing of word order) will be presented in Section 4.7 in order to maintain the coherence of the present chapter.

For the test items, a repeated-measures ANOVA was conducted for each segment with Group (Children, Adults) as a between-subjects factor and RC-Type (Subject, Object) as a

[1] I thank Umut Özge for writing this program that made the data analysis much easier.

within-subjects factor. In (116), we repeat a pair of sample test items to remind the content of each segment.

(116) *Subject RC*

	Segment 1	/ Segment 2	/ Segment 3
GAP$_i$	NP-ACC	/ V-(y)An	/ NP-NOM$_i$
t$_i$	Haylaz goril-i	/ hızlıca it-en	/ güçlü aslan$_i$
t$_i$	naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM$_i$

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

(117) *Object RC*

Segment 1		/ Segment 2	/ Segment 3
NP-GEN	GAP$_i$	/ V-DIK-AGRPOSS	/ NP-NOM$_i$
Haylaz goril-in	t$_i$	/ hızlıca it-tiğ-i	/ güçlü aslan$_i$
naughty gorilla-GEN	t$_i$	/ hard push-DIK-3sgPOSS	/ strong lion-NOM$_i$

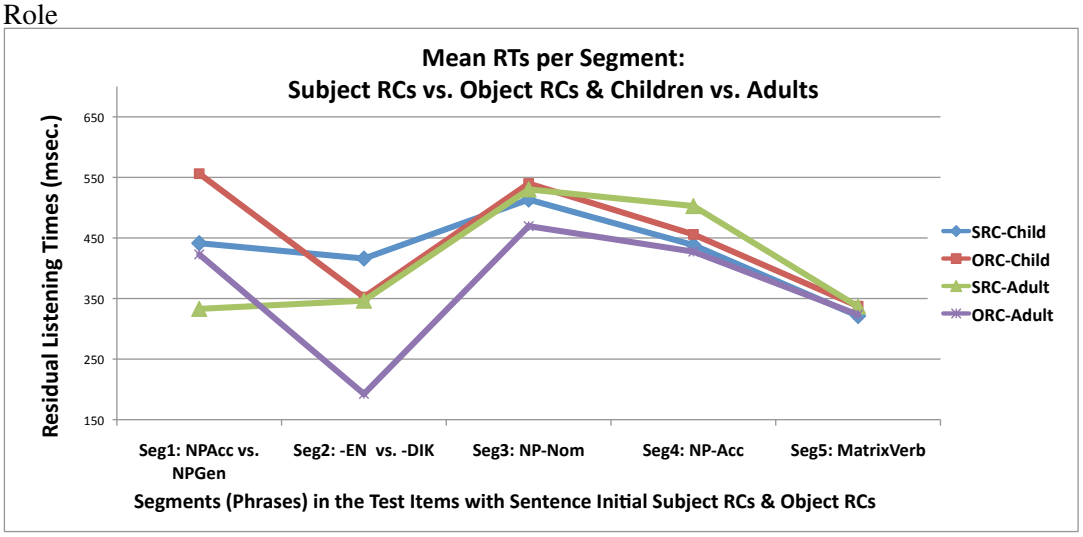
Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

Figure 4.1 displays the RTs children and adults show at each segment in subject RCs and object RCs with the subject role in the matrix clause.

Segment 1 compared sentence-initial accusative NP with sentence-initial genitive NP in subject and object RCs. The ANOVA revealed a significant effect of RC-Type F (1, 68) = 33.97, $p < .001$. The pairwise comparisons revealed that this was due to the significantly shorter RTs after the accusative NP in subject RCs (Children: M = 441 ms., SD = 169; Adults: M = 332 ms., SD = 169) compared to the genitive NP in Object RCs (Children: M = 556 ms., SD = 184; Adults: M =422 ms., SD = 183). That is, sentence-initial NP-ACC elicited significantly shorter RTs than sentence-initial NP-GEN in both groups. There was also a significant effect of Group F (1,68) = 8.58, $p < .05$. According to the pairwise

Figure 4.1: Segment-by-Segment RTs in Subject RCs and Object RCs with Subject Matrix Role



comparisons, children showed longer RTs (M = 498 ms.) than adults (M = 386 ms.). The analysis did not reveal any interaction between RC-Type and Group F (1,68) = .85, $p < .1$ (Figure 4.1).

The next segment (Segment 2) investigated the difference between -(y)An and -DIK participles. The effect of RC-Type was significant F (1, 68) = 26.70, $p < .001$. The pairwise comparisons showed that this was due to significantly faster RTs in object RCs, where relativization is formed by -DIK participle (M = 280 ms., SE = 22.49), compared to subject RCs, where relativization is formed by -(y)An participle (M = 381 ms., SE = 25.01). Similarly to Segment 1, the effect of Group was significant F (1,68) = 5.92, $p < .05$. Pairwise comparisons showed that children were slower (M = 384 ms.) than adults (M = 278 ms.) in Segment 2, too. And there was no RC-Type by Group interaction in this segment F (1,68) = 3.66, $p < .05$ (Figure 4.1).

For Segment 3, there was no significant effect of RC-Type F (1, 68) = .35, $p > .1$ or Group F (1, 68) = .13, $p > .1$; and there was no interaction between the two F (1, 68) = 3.58, $p > .05$ (Figure 4.1).

For Segment 4, there was no significant effect of RC-Type F (1, 68) = 2.58, $p > .1$ or Group F (1, 68) = .53, $p > .1$. However, the ANOVA revealed a significant interaction between the two F (1, 68) = 5.79, $p < .05$. Pairwise comparisons indicated that children showed longer RTs after the relativized NP that is the subject of the matrix clause (i.e., that is

marked with the nominative case) in object RCs (M = 455 ms., SE = 33.69) compared to the same segment in subject RCs (M = 438 ms., SE = 45.30) but adults did not show a similar pattern (Figure 4.1).

4.6.3 Discussion

We were interested in evaluating the filler-gap models of dependency formation in children and adults. To do this, we tested subject and object RCs exemplified in (118) and (119) in an auditory-moving window paradigm.

(118) *Subject RC*

	Segment 1	/ Segment 2	/ Segment 3
GAP$_i$	NP-ACC	/ V-(y)An	/ NP-NOM$_i$
t$_i$	Haylaz goril-i	/ hızlıca it-en	/ güçlü aslan$_i$
t$_i$	naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM$_i$

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

(119) *Object RC*

Segment 1		/ Segment 2	/ Segment 3
NP-GEN	GAP$_i$	/ V-DIK-AGRPOSS	/ NP-NOM$_i$
Haylaz goril-in	t$_i$	/ hızlıca it-tiğ-i	/ güçlü aslan$_i$
naughty gorilla-GEN	t$_i$	/ hard push-DIK-3sgPOSS	/ strong lion-NOM$_i$

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü$_i$.
slow elephant-ACC	/ kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

The results did not reveal any filler-gap effects but revealed a clear effect of morphosyntax. In Segment 1, processing of the sentence-initial genitive case compared to the accusative case was more costly both for children and adults; however, the processing of the possessive-agreement morphology in Segment 2 was significantly facilitated after the processing of the

sentence-initial genitive NP. This indicated that children behaved like adults in processing morphosyntactic dependencies in an incremental and predictive fashion in a head-final language, which is a novel finding. Also, the results showed that there was no facilitation at the processing of the predicate relativized by -(y)An following between sentence-initial accusative NP. This might be due to a processing strategy that tries to attach each NP to its subcategorizer as soon as possible, which is in line with Gibson (1998). We will show in Section 4.7 that this reasoning might indeed be right. Of course, it might simply be less probable to find a relativized verb following a sentence-initial accusative NP compared to a matrix verb. This is an issue for future research.

In Segment 3, the participants did not show a significant difference between subject and object RCs. However, children showed longer RTs in object RCs compared to subject RCs in Segment 4, which was the only difference between children and adults. This pattern might be due to the fact that the object RC had a subject role in the matrix clause, in line with Sheldon's (1974) Parallel Function Hypothesis. We will investigate this issue further in Chapter 6.

Table 4.2 presents the summary of the processing patterns presented by the children and adults.

The present results suggest that the filler-gap accounts of dependency formation cannot make correct predictions for the critical segments (i.e., Segment 1 and 2) for reasons summarised below.

Table 4.1 that presents the summary of the predictions of the filler-gap models for the processing patterns for each segment and each RC-Type is repeated here as Table 4.3.

The gap-as-a-last resort strategy is ruled out because it predicted the parser to analyse a string as if it was a simple declarative sentence and posit a gap if any string input did not conform to its expectations. Accordingly, it predicted longer RTs in Segment 1 in subject RCs compared to object RCs and it predicted longer RTs in Segment 2 in object RCs compared to subject RCs with the following reasoning. The sentence-initial NP-ACC should have indicated that there was a missing subject NP prior to it, so the parser was expected to recover the subject 'pro' right after hearing the NP-ACC. In object RCs, on the other hand, the parser was not expected to posit a gap until Segment 2 since the sentence-initial NP-GEN could have been a part of an untransformed declarative sentence (e.g., a possessive phrase).

Gap-as-a-first-resort strategy also fails to capture the present data. It predicted that the parser would posit a gap in the first position with local ambiguity. Both sentence-initial NP-ACC and NP-GEN are ambiguous since both constituents could be followed in multiple ways. This means the parser should have posited a gap at this point (i.e., at Segment 1) so no RT

Table 4.2: Summary of the Processing Patterns for Each Segment from Children and Adults. '>' indicates longer RTs in the former compared to the latter, '<' indicates shorter RTs in the former compared to the latter, and '=' indicates the RTs for the former and the latter do not differ statistically. 'SR' refers to Subject RCs and 'OR' refers to Object RCs.

Results	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Segment 5**
Results from children	SR < OR	SR > OR	SR = OR	SR < OR	SR = OR
Results from adults	SR < OR	SR > OR	SR = OR	SR = OR	SR = OR

differences should have been observed in Segment 1. Likewise, now that the incoming input was in line with the gap created after the first NP in both structures, the remaining segments should have been processed with equal ease.

Lexical expectation model is also ruled out for the following reason. It predicted that the parser would wait until a noun phrase was complete to posit a gap. Since NP-ACC is a complete NP, the parser should have immediately posited a gap. On the other hand, since NP-GEN is part of a composite NP, it needs its head to be a full-NP. This is why, the parser was supposed to wait until it received the relativized verb to posit a gap. That is, the lexical expectation model predicted longer RTs in Segment 1 in subject RCs compared to object RCs and it predicted longer RTs in Segment 2 in object RCs compared to subject RCs.

As for the Active filler and trace reactivation strategies, both rely on the filler to postulate a gap. These strategies did not predict any differences between subject RCs and object RCs until the filler in Segment 1.

One major problem for the filler-gap models is the fact that they cannot not provide an incremental measure for the processing of Turkish RCs.

The processing cost is determined by the number of lexical items between the filler and the gap in the Linear Distance Hypothesis, by the number of intervening referential NPs between the filler and the gap in the Argument Crossing Accounts, and by the number of structural nodes in the Structural Distance Hypothesis. In all cases, processing is based on the detection of the filler and the gap. Given that gaps precede their fillers in Turkish RCs, the parser has two choices for detecting the gap and assigning the filler an interpretation: it either has to apply one of the gap-based heuristics (e.g., gap-as-a-first-resort, gap-as-a-last-resort, or lexical activation strategies); or it has to wait until the filler that usually appears

Table 4.3: Summary of the predictions of the Filler-Gap Strategies for each segment in subject RCs and object RCs in Experiment 3a.
'>' indicates longer RTs in the former compared to the latter and '=' indicates the RTs for the former and the latter do not differ statistically. 'SR' refers to Subject RCs and 'OR' refers to Object RCs.

RC-Type	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Segment 5**
Subject RC	NP-ACC	V-(y)An	NP-NOM	NP-ACC	Verb
Object RC	NP-GEN	V-DIK-3sgPOSS	NP-NOM	NP-ACC	Verb
Model	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Segment 5**
Gap-as-a-last-resort	SR > OR	SR = OR	SR = OR	SR = OR	SR = OR
Gap-as-a-first-resort	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR
Lexical expectation	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR
Active Filler	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR
Trace Reactivation	SR = OR	SR = OR	SR = OR	SR = OR	SR = OR

clause finally and recover the gap position via reanalysis (as suggested by the Active Filler or Trace Reactivation Hypotheses). The gap-based option secures an incremental processing while the filler-based option has to assume a head-dependent parsing. However, the gap-based accounts are usually considered unintuitive since they cannot secure an incremental processing in head-initial languages. The same holds true for the filler-based accounts in head-final languages. Thus, these accounts seem to be unable to offer a unified mechanism or strategy that could equally be successful in head-initial and head-final languages.

The online data reported above show that neither the gap-based not the filler-based strategies are tenable. This might lead one to propose another filler-gap strategy for the cases where gaps precede the fillers but we will refrain from doing this because offering a distinct mechanism for each phenomenon (i.e., assuming a different processing strategy while dealing with fronted -wh words, displaced NPs, pros, and the like) would not be parsimonious as well as reducing the generalisability and plausibility of these accounts.

Actually, the proponents of filler-gap accounts also agree that this is not a desirable option from a scientific point of view. For instance, Clifton and Frazier suggest that the data is so prolific that it becomes harder to capture the facts with a simpler and monolithic perspective:

> Different processes are responsible for identifying and dealing with different types of gaps. While a simple, monolithic, answer to the question of how sentences with fillers and gaps are processed would seem preferable to the complex and incomplete answer we have given, we believe that the data have driven us to our position. We trust further research will permit this position to be replaced by more elegant and deeper account of the processing of sentences with filler and gaps (Clifton & Frazier, 1989; p.311).

Clifton and Flores D'Arcais (1989) begin their paper urging that we need a "theory of gap filling, not a theory based just on the properties of English". We restate this insightful caution as follows: We need a simpler theory of parsing not a theory based just on a single phenomenon like gap-filling. In the following chapter, we will argue that assuming a strictly lexicalist and monotonic processor that is augmented by a multiple constraint-satisfaction mechanism would be one straightforward way of explaining the present processing facts from Turkish children and adults.

4.7 Experiment 3b: The Effect of Word Order on the Processing of Turkish Relative Clauses

In Experiment 3a, reported in Section 4.6 we used simple sentences in different configurational orders as our control items. Although this might seem irrelevant to the processing of RCs, the results from the word order items will help us formulate a better interpretation of our test items.

We wanted to investigate whether the OV ordering has a processing advantage compared to the SV ordering. This is motivated by the fact that constituent orderings reflected in subject and object RCs are different. The object appears in the preverbal position in subject RCs (e.g., 'Kedi-yi it-en köpek' - 'Cat-ACC push-(y)An dog', 'the dog that is pushing the cat') whereas it is sent to post verbal position in object RCs (e.g., 'Kedi-nin it-tiğ-i köpek' - 'Cat-GEN pus-DIK-POSS3sg', the dog that the cat is pushing'). Kükürt (2004) suggested that the OV ordering in subject RCs might be providing a better cue to single out the object in subject RCs. To test this hypothesis, we compared the processing of OVS structures with the processing of SVO structures. If the pre-verbal ordering of the object facilitates comprehension in subject RCs, OVS structures should be processed faster than SVO structures.

Secondly, we wanted to test whether the SVO and OVS orders have processing advan-

tage over SOV and OSV orders. This is motivated by Gibson's (1998) Syntactic Prediction Locality Theory. According to this, the number of syntactic heads in a grammatical sentence determines the processing cost. This account is different from the filler-gap accounts as it does not necessarily focus on the displaced items and their gap positions while assigning an interpretation to a constituent but on any surface lexical item and its head. It is similar to these accounts only in that it proposes a complexity metric on the basis of the distance between the lexical items (might be fillers or canonical items) and their heads. When the integration of two syntactic heads can be established locally, processing cost will be less than when new discourse entities are introduced between the two heads. According to this, what is costly is to integrate the new lexical item into the existing structure. For a simple intransitive sentence 'John died', for instance, the minimal number of head items for a grammatical sentence is two: head noun for the subject 'John' and the head verb for the predicate 'died'. Two issues are crucial here: 1- when the category of the target lexical item is easily integrated into the possible syntactic structure, the activation level is high. 2- it is likely that the lexical activations decade as the new words (i.e., new discourse entities) intervene between the incomplete structure and its head; so it is difficult to store these incomplete dependencies when they are not local. Thus, more memory and processing resources are required when the distance between a lexical item and its head is longer, and when the intervening lexical items introduce a new discourse entity.

4.7.1 Method

4.7.1.1 Participants

The same participants reported in section 4.6.1 completed this task.

4.7.1.2 Materials and Design

The test items were presented in a auditory moving-window/self-paced-listening task. See section 4.6.1 for more details.

The test stimuli were presented as the control items in the previous experiments and they consisted of 128 non-complex sentences divided equally in four different word-order variations (SOV, OSV, OVS, SVO) (see 120).

(120) a. *SOV*

Haylaz goril güçlü aslan-ı hızlıca it-ti dün sabah

naughty gorilla strong lion-ACC hard push-PAST yesterday morning

'Naughty gorilla pushed (hard) the strong lion yesterday morning.'

b. *OSV*

Haylaz goril-i güçlü aslan hızlıca it-ti dün sabah

naughty gorilla-ACC strong lion hard push-PAST yesterday morning

'The strong lion pushed the naughty gorilla yesterday morning.'

c. *SVO*

Haylaz goril hızlıca it-ti güçlü aslan-ı dün sabah

naughty gorilla hard push-PAST strong lion-ACC yesterday morning

'Naughty gorilla pushed (hard) the strong lion yesterday morning.'

d. *OVS*

Haylaz goril-i hızlıca it-ti güçlü aslan dün sabah

naughty gorilla-ACC hard push-PAST strong lion yesterday morning

'The strong lion pushed the naughty gorilla yesterday morning.'

4.7.1.3 Procedure

The procedure was the same as described in section 4.6.1.

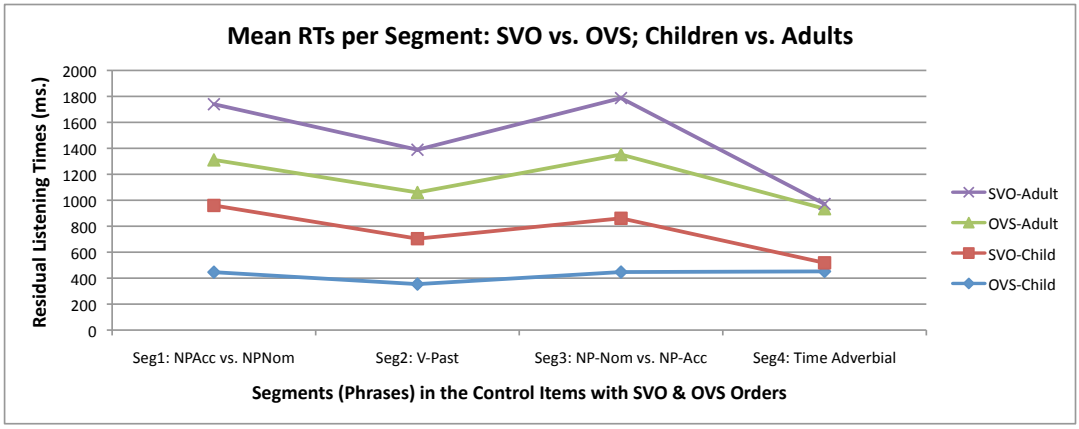
4.7.2 Results

To see the effect of the location of the object, we conducted a repeated-measures ANOVA with the Group (Children, Adults) as between subject factor and the Location of the object (Preverbal/OVS vs. Postverbal/SVO) as a within-subjects factor.

Figure 4.2 displays the RTs in each segment in SVO versus OVS orders in children and adults.

The first segment compared the RTs between the sentence-initial accusative versus nominative NP. The analysis revealed a significant difference between the first segments of the OVS and SVO structures $F(1, 68) = 14.06$, $p < .001$ (see Figure 4.2). According to this, sentence-initial NPs with the accusative case are processed faster than sentence-initial NPs with the nominative case for children (OSV: M = 446 ms., SD = 177; SVO: M = 514 ms., SD = 181) and for adults (OSV: M = 351 ms., SD = 158; SVO: M = 429 ms., SD = 213). The effect of Group was also significant $F(1, 68) = 5.21$, $p < .05$. Pairwise comparisons

Figure 4.2: Segment-by-Segment RTs in SVO vs. OVS Orders



showed that children were significantly slower in processing this segment compared to adults (Children: M = 480 ms.; Adults: M = 390 ms.). The analysis did not reveal any significant interaction between the Location of the Object and the Group, $F(1, 68) = 5.21$, $p < .05$.

The second segment tested the processing of the predicate when it is preceded by an accusative or a nominative NP. This was not significant $F(1, 68) = .91$, $p > .1$; neither was the effect of Group $F(1, 68) = .05$, $p > .1$ (see Figure 4.2). Also, there was no interaction between the two $F(1, 68) = .53$, $p > .1$. This indicated that the processing of the predicate was not influenced by whether the preceding NP is accusative or nominative.

The third segment presented the missing argument after the predicate: it was a nominative NP in OVS and an accusative NP in SVO. The ANOVA showed a significant difference between the two arguments $F(1, 68) = 7.71$, $p < .05$ (see Figure 4.2). According to this, the accusative NP was processed faster following an SV structure (M = 425 ms., SE = 23.07) than the nominative case following an OV structure (M = 469 ms., SE = 24.66). This might be pointing to the fact that an OV structure is more likely to be considered to be a complete structure compared to an SV structure. In this segment, there was no effect of Group $F(1, 68) = .52$, $p > .1$.

The final segment with the time adverbial (e.g., 'dün sabah', yesterday morning) did not elicit a significant difference between the structures $F(1, 68) = 1.56$, $p > .1$. However, the effect of Group was significant in this segment $F(1, 68) = 40.53$, $p < .001$ (see Figure 4.2).

Figure 4.3 displays the total RTs in SOV, SVO, OSV, and OVS orders in children and adults.

As for the total RTs between the OVS and SVO structures, the ANOVA did not reveal a

Figure 4.3: Total RTs in SOV, SVO, OSV, and OVS Orders

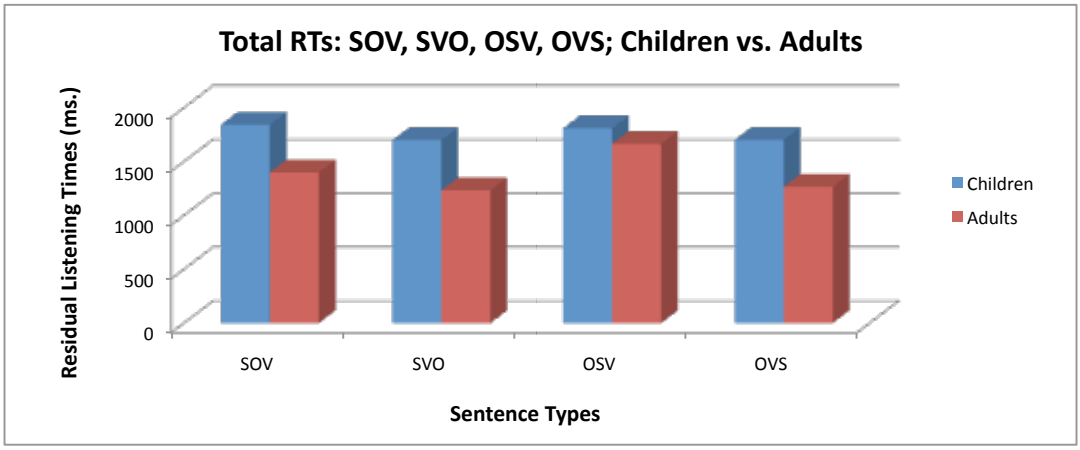
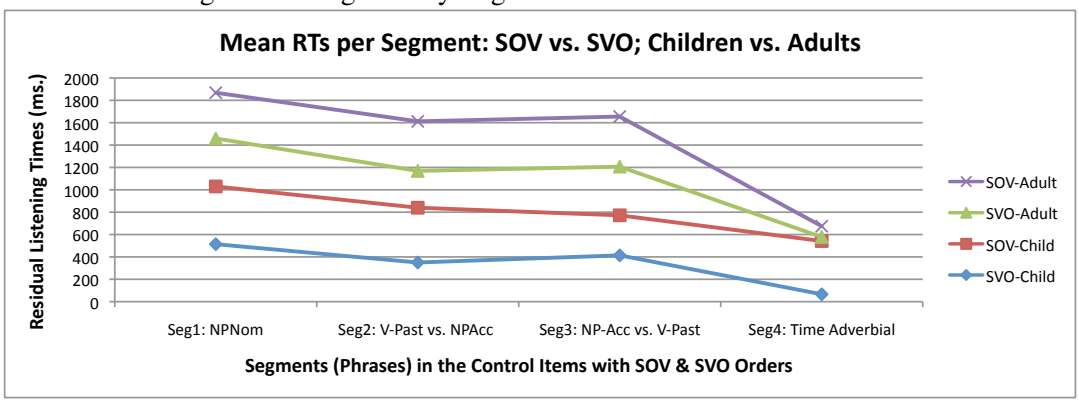


Figure 4.4: Segment-by-Segment RTs in SOV vs. SVO Orders



significant difference between these sentences F (1, 68) = .16, p > .1 while the effect of Group was significant F (1, 68) = 8.97, p > .05.

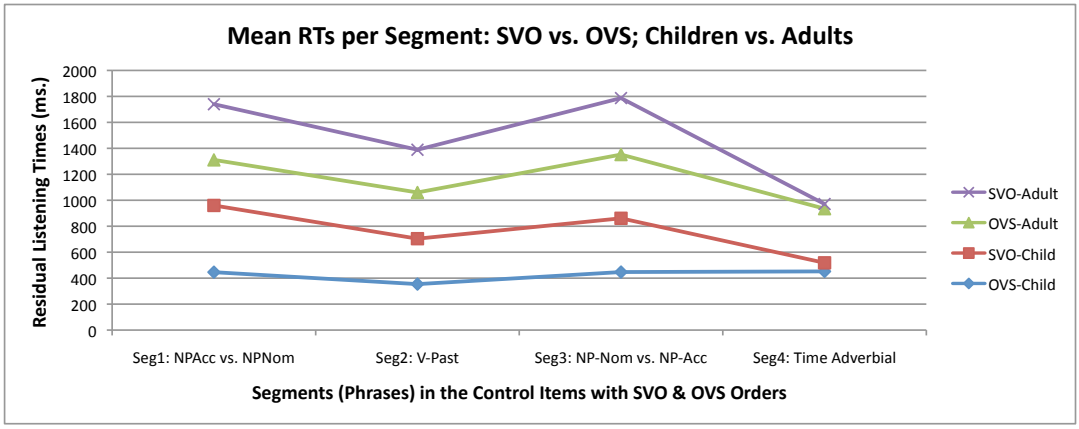
Next, to test the effect of the location of the predicate, we conducted a repeated-measures ANOVA with the Verb-Location (sentence-medial vs. sentence-final) as a within-subjects factor for SOV versus SVO and OSV versus OVS structures.

Figure 4.4 displays the RTs in each segment in SOV versus SVO orders in children and adults.

Figure 4.5 displays the RTs in each segment in OSV versus OVS orders in children and adults.

For Segment 1, the difference between the SOV and SVO was not significant F (1, 68) = .33, p > .1 (see Figure 4.4); however, the difference between OSV and OVS was significant F (1, 68) = 11.97, p < .001 (see Figure 4.5). According to this, an accusative NP was processed

Figure 4.5: Segment-by-Segment RTs in OSV vs. OVS Orders



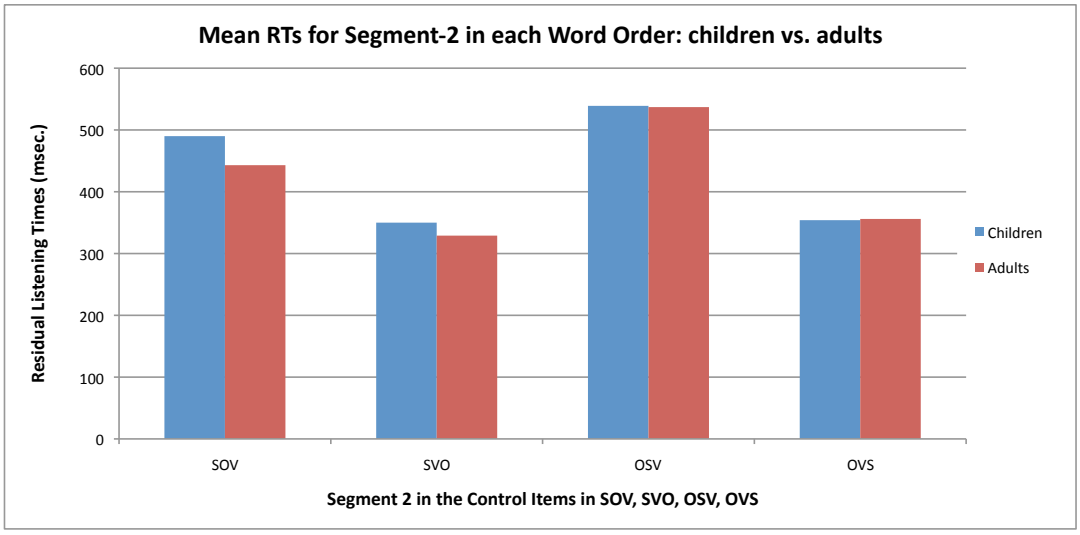
faster when it preceded the verb (Children: M = 446 ms., SD = 177; Adults: M = 351 ms., SD = 158) compared to when it preceded the subject (Children: M = 485, SD = 174; Adults: M = 416 ms., SD = 218).

Figure 4.6 displays the RTs at the critical segment (Segment 2) in SOV versus SVO and OSV versus OVS orders in children and adults.

For Segment 2, the difference between SOV and SVO was significant $F(1, 68) = 42.68$, $p < .001$ (see Figure 4.4). The same was true for the difference between OSV and OVS structures $F(1, 68) = 42.05$, $p < .001$ (see Figure 4.5). According to this, the second segment in SVO (Children: M = 350 ms., SD = 152; Adults: M = 329 ms., SD = 224) and OVS (Children: M = 354 ms., SD = 151; Adults: M = 356 ms., SD = 198) was processed faster than the one in SOV (Children: M = 490 ms., SD = 176; Adults: M = 443 ms., SD = 237) and OSV (Children: M = 539 ms., SD = 180; Adults: M = 537 ms., SD = 365). We take this to indicate that structures presenting the predicate after the first argument are likely to be processed faster than those that present another NP after the first argument (see Figure 4.6).

For Segment 3, the difference between the SOV and SVO was not significant $F(1, 68) = .85$, $p > .1$ (see Figure 4.4). The same was true for the difference between the OSV and OVS, $F(1, 68) = 1.72$, $p > .1$ (see Figure 4.5). The effect of Group was not significant in the former group of sentences while it was significant as far as the OSV and OVS sentences were considered $F(1, 68) = 4.11$, $p < .05$. Pairwise comparisons indicated that children were faster than adults in this segment (Children: M = 401 ms.; Adults = 504 ms.). In addition, there was a significant interaction between the Sentence Type and Group $F(1, 68) = 5.52$, $p < .05$. Pairwise comparisons revealed that the children performed faster in OSV (M = 354 ms.,

Figure 4.6: RTs at Segment 2 in SOV vs. SVO and OSV vs. OVS Orders



SE = 45.14) compared to OVS (M = 447 ms., SE = 34.88) whereas the difference in those sentences did not reach significance in adults.

For Segment 4, which presented the adverbial, the difference between SOV and SVO was significant F (1, 68) = 6.79, p < .05 (see Figure 4.4). And, the same was true for the difference between OSV and OVS F (1, 68) = 3.93, p < .05 (see Figure 4.5). According to the pairwise comparisons, adverbial was processed faster in SVO (M = 227 ms.) compared to SVO (M = 286 ms.); and in OVS (M = 259 ms.) compared to OSV (M = 310 ms.). For both groups of sentences, the effect of Group was also significant (SOV vs. SVO: F (1, 68) = 36.92, p < .001; OSV vs. OVS: F (1, 68) = 22.49, p < .001. This was due to the fact that children performed significantly slower (Adverbial in SOV and SVO: children = 447 ms.; adults = 67 ms.; Adverbial in OSV and OVS:children = 440 ms.; adults = 129 ms.).

Finally, a similar ANOVA conducted for the total RTs revealed a significant difference between SOV and SVO, F (1, 68) = 11.39, p = .001 and the same was true for the difference between OSV and OVS, F (1, 68) = 19.74, p < .001. Both children and adults performed faster in structures which locate the predicate right after the first argument as compared to the ones presenting it after the second argument (Children SOV: M = 1841 ms.,SD = 656; SVO: M = 1698, SD = 641; Adults SOV: M = 1398 ms., SD = 744; SVO: M = 1232 ms., SD = 702 and Children OSV: M = 1808 ms.,SD = 631; OVS: M = 1701, SD = 614; Adults OSV: M = 1664 ms., SD = 908; OVS: M = 1265 ms., SD = 674) (see Figure 4.3).

4.7.3 Discussion

In this experiment, we first compared the SVO and OVS orders to see whether the preverbal location of the object enhanced processing. The results from the first segment showed that both children and adults preferred sentence-initial accusative NP to a nominative one, which is interesting since it does not conform to the canonical word order in Turkish. We will speculate at this point that accusative case is a more frequent or preferred case marking on sentence-initial NPs in Turkish due most probably to the high probability of subject-drop.

Moreover, the results from the second and the third segment provided some insights about the present asymmetry between the nominative and accusative case markings. The second segment, which is the simple predicate in past tense was processed equally well after the nominative and accusative NP. However, the participants showed longer RTs in the third segment in OVS compared to SVO -after the nominative NP compared to the accusative one. This indicates that the OV-structure is more likely to be considered as a full sentence compared to the SV-structure. This asymmetry is interesting because although Turkish allows the drop of both subject and object arguments, we presume that subject-drop is more common than object-drop. Given these observations, Kükürt (2004) might actually be right in arguing that the OV ordering in subject RCs contribute to its better processing.

Secondly, we compared the orders which presented either another argument or a verb in the second segment, namely SOV vs. SVO and OSV vs.OVS orders. There was no difference between the first segments of SOV and SVO structures but the first segment of the OVS structure was processed faster than that of the OSV structure. We do not have a definitive answer for the cause of this. As for the second segment, we found that structures presenting the predicate after the first argument (i.e., SVO and OVS) were processed faster than those presenting another NP after the first argument (i.e., SOV and OSV). The RTs from the third segment in those structures showed that children's RTs were longer in SVO and OVS as compared to SOV and OSV. Thus, children did not expect to find another argument after the predicate in SV and OV structures; most probably they took these structures as full sentences with argument-drops. The total RTs for these structures confirmed that SVO and OVS structures that locate the predicate right after the first argument are processed faster than the SOV and OSV structures that locate two arguments before the predicate. It is important to note that the SVO order was processed faster than the SOV order, despite the fact that the latter is the canonical word order in Turkish. This issue needs a more detailed investigation, which is beyond the scope of this work.

This is in line with Gibson's syntactic prediction locality theory which assumes that the processor tries to attach every NP to its predicate as soon as possible and that the processing cost gets smaller in line with the number of NPs before the predicate. It takes the number of NPs waiting to receive a theta-role as an important factor increasing the processing load and it takes the predicate/subcategorizer as the point where the hypotheses or predictions generated are confirmed or dis-confirmed. The processing of word order variations in Turkish seems to be in line with this hypothesis.

4.8 Summary

In this chapter, we used an auditory moving-window task to investigate the online processing of Turkish RCs as well as simple sentences in various word orders. We addressed the issue of filler-gap strategies in structures presenting the gap prior to the filler. The data did not reveal the filler-gap effects but revealed an effect of morphosyntax both in children and adults.

We also tested simple sentences in various word orders and showed that an OV structure was more likely to be interpreted as a full sentence compared to an SV structure. Furthermore, we showed that the orders that present the verb as the second lexical item (i.e., SVO and OVS) were processed faster than the orders presenting an NP as the second lexical item (i.e., SOV and OSV). We suggested this might be reflecting the parser's tendency to attach to a subcategorizer as locally as possible (a la Gibson, 1998).

CHAPTER 5

INCREMENTAL PROCESSING WITH COMBINATORY CATEGORIAL GRAMMAR

5.1 Introduction

In Chapter 4, we reviewed the major filler-gap accounts of dependency formation and showed that they could not predict the processing facts observed in the parsing of Turkish RCs by children and adults. The pattern reported in Experiment 3a revealed that Turkish children and adults did not show filler-gap effects when processing RCs. We further argued that the filler-based accounts did not guarantee an incremental processing in head-final languages. This poses doubts about the psychological plausibility and generalisability of these hypotheses.

Turkish is one of the languages that offer clear morphological cues and we believe that these cues should be a vital part of interpretation assignment. Previous processing literature strongly suggests that parsing in head-final languages should be as incremental and as predictive as it is in head-initial languages (e.g., Kamide & Mitchell, 1999; Kamide, Scheepers, & Altmann, 2003; Aoshima, Phillips, & Weinberg, 2004). Data from Experiment 3a in Chapter 4 clearly illustrate that this is indeed true both for children and adults. They were able to use the morphemes (a) to rapidly assign an interpretation to the existing structure and (b) to predict eagerly what kind of structure might follow at each point in the interpretation process.

Thus, it appears that we need a model where the processor immediately assigns an interpretation to each incoming string and forms expectations as to how the upcoming strings could be interpreted. In other words, the data clearly illustrate that parsing should be both incremental and predictive. As we have mentioned before, we use the term 'predictive' to refer to the 'eagerness' of the parser to create expectations about the upcoming structures. With phrase structure grammars based on a traditional notion of constituency, 'predictive process-

ing' could be realised only by 'top-down parsing algorithms'[1] or a combination of 'top-down and bottom-up algorithms'. In this chapter, we will assume that the processor has access to a highly lexicalized grammar that is monostratal (i.e., having a single level of representation) and monotonic (i.e., not allowing structure changing operations at any level of processing; in other words, the properties of the higher nodes simply involve the properties of the daughter nodes and nothing else) and see whether a strictly 'bottom-up parsing algorithm'[2] could capture the data reported in Experiment 3a without extra need for parsing heuristics or strategies.

Steedman (2000), shows that this is automatically realised if we relax our definition of *constituency* so that almost every leftmost string receives a semantic interpretation. We will argue that a model of processor that is using a Combinatory Categorial Grammar (CCG) (Steedman (2000)) and a morphemic lexicon (Bozşahin, 2002) meets these requirements and captures the present data in a simpler and more parsimonious manner. We will also present another processing model by Vasishth and Kruijff (2001) that uses a combination of a top-down and bottom-up algorithm and a combinatory grammar (CG). We will demonstrate that it also successfully explains the pattern reported in Experiment 3a.

5.2 Background: Combinatory Categorial Grammar(CCG)

Psycholinguistic studies have provided strong evidence that 'competence grammars are surface oriented, constraint-based, and strongly lexicalist' Sag and Wasow (2008, p. 2). In other words, grammatical and semantic information is directly revealed by each word or each morpheme (i.e., surface form) that becomes available in the course of an processing an utterance. Thus, each lexical item can be partially interpreted and integrated into the incoming strings that combine with the existing ones with the help of concatenative rules that are operative at surface level. This indicates that competence grammar should be compatible with performance facts and both processes should inform one another. Competence grammars are suggested to be constraint-based, which indicates that there is no order of operation between the elements of interpretation assignment (e.g., first syntax then semantics or first syntax then morphology) but multiple constraints pertaining to lexical, grammatical, semantic and

[1]An example of a top-down parsing might be to generate the mother node of an utterance and construct the parse tree from the mother node towards the daughter nodes. That is, it involves hypothesizing a top-most structure -Sentence- and its possible nodes -NP & VP- and then locating the left-most input in the parse tree in line with the hypothesized grammar rule.

[2]A bottom-up algorithm starts with the terminal nodes and tries to build more complex structures by combining thses.

discourse-related information all operate simultaneously as soon as they become available. This also indicates that no operation could modify or destroy the already available representation (i.e., monotonicity). Furthermore, the competence grammars are shown to be highly lexicalized in that each lexical item carries syntactic and semantic information as to how this particular item could be combined with other items. Thus, much linguistic information (e.g., grammatical category, valency, argument and thematic role requirements, grammatical information) is made available by individual words (for a more extensive and accessible summary see Sag & Wasow, 2008).

CCG constitutes an example for the grammar architectures displaying all these features.[3]

First, in CCG the surface forms are decorated with the necessary syntactic and semantic information that respectively subsumes information pertaining to intonation and information structure. This ensures a one-to-one correspondence between syntactic and semantic rules. This is why, the requirement for extra layers of representation between the surface forms and semantic representation is rendered unnecessary (i.e., it is monostratal). All the grammatical information relevant to interpretation are defined at the logical form, which is the only representational level.

In CCG, any relation to conceptual structure must be direct and this is achieved through syntactic types[4], logical form[5], and semantic types [6]of the lexical items.

In addition, the grammar is monotonic so there is no structure-changing operations (e.g., transformations or movement) among the components of the grammar.

A more radical consequence of this monotonic and monostratal theory is the one that alters the traditional meaning of *constituency* together with the notions of dominance and command in the Surface Structure. The Surface Structure is replaced by surface syntactic derivation that not only determines the Logical Form compositionally but also determines the Intonation Structure in accordance with the Information Structure. That is, the surface syntactic derivation actually equals to the derivation of the Information Structure, which yields

[3]see Borsley and Börjars (2009) for introductory chapters about other constraint-based lexicalist theories, which might provide equally plausible alternatives for the interpretation of the present data.

[4]Syntactic types include primitive types such as S, N, or NP; or complex types such as $S\backslash NP$, that takes an argument of type 'NP' on its left and returns an object of type 'S' or NP_{GEN}/NP, that takes an argument of type 'NP' on its right and returns an object of type 'NP' with the feature of the genitive marking

[5]Logical form is the semantic representation of an expression in a logical language

[6]Each individual object has a semantic type that determines its properties and the ways in which it can combine with other types. Types might refer to an individual or an entity, i.e., 'e' or to a truth value. Both 'e' and 't' are primitive types whereas the combination of these leads to a complex type as in 'e $\rightarrow$ t ', which refers to the type of functions from entities to truth values.

non-traditional surface constituencies. This is best illustrated in coordination, where coordinated units are not always traditional constituents. For instance, the fragment *Cem likes* in (121) is not considered a legitimate constituent in phrase structure grammars, while it receives a full interpretation in CCG.

(121) [Cem likes] and [Deniz feeds] the cats.

A similar effect is observed in (122) (Steedman, 2000, p. 18) where the fragment such as *the flowers sent for* receives a semantic interpretation while in accounts adopting traditional notion of constituency the fragment has to be combined into a legitimate constituent to receive an interpretation. Thus, there should be no interpretation before the disambiguating word *patient* in (122).

(122) [The flowers sent for] and [chocolates given to] the patient could not help reduce his anxiety.

Finally, the integration of the intonation and discourse information structure into the grammar and the flexible notion of constituency brings with it a system that is more aligned with the parsing techniques. In this system, interpretation assignment is possible to every unit that might traditionally be considered as a *fragment*. This way, the idea that the processor uses the structures specified in the competence grammar in full transparency, in line with the Competence Hypothesis of Bresnan and Kaplan (1984) is more directly endorsed without any requirement of extra parsing mechanisms or strategies.

This standpoint is in stark contrast with the tradition that strictly dissociates the knowledge of grammar and use of this knowledge (e.g., Chomsky, 1965). According to the competence-performance distinction, the competence grammar constitutes a very idealized system so it may not reflect the nature of performance; and one could only understand the nature of language processing mechanisms within the limits of one's knowledge about the competence grammar. Yet, this implies that such an idealised notion of linguistic knowledge is hardly testable and falsifiable, hence not strictly endorsed by the mainstream psycholinguistic work. Therefore, recent lexicalized theories of grammar assume a greater link between the linguistic competence and performance. This provides a ground for testing the available grammar architectures and for attaining psychologically plausible models.

In line with this, Steedman (1989, 2000) proposes a stricter version of the Competence Hypothesis. According to this, the processor directly uses the constituents licensed by the competence grammar. Actually, it *only* uses the competence grammar as its sole mechanism

without the requirement of any extra universal or language-specific parsing heuristics except for an automaton, an algorithm, and an oracle. Steedman and Baldridge (2006) summarize the issue as follows:

> Minimum apparatus besides competence grammar that is required for processing consists of the characteristic automaton for the relevant class of grammars (including its possibly limited working memories), a minimal algorithm for applying the rules, and some memory for building interpretable structure. Any extra apparatus such as rule-orderings or "strategies," covering grammars, and the like, is otiose [unnecessary].

On the other hand, psycholinguistic studies have long been trying to show that the processor applies certain parsing strategies that are universally available for all human language users. Some of these strategies that have been shown to capture the facts regarding the processing of structurally complex sentences in various languages are the Filler-Gap Strategies (Wanner & Maratsos, 1978; Fodor, 1978; Clifton & Frazier, 1989; and Frazier et al., 1989); the Parallel Function Hypothesis (Sheldon, 1974); and the Canonical Sentence Schemas (Bever, 1970; Slobin & Bever, 1982). So far, we have tested the Filler-Gap Strategies in the processing of Turkish RCs in children and adults but could not find the filler-gap effects predicted by various proposals. In the remaining of the present chapter, we will provide a possible plausible analysis of our data using CCG. In the next chapters, we will also address the question as to whether the strategies suggested by Parallel Function Hypothesis and the Canonical Sentence Schemas are employed by Turkish speaking children and adults.

In what follows, we will summarise the components of a language processor as described in Steedman (2000) in order to provide a basis for the processing model we will adopt in interpreting the data from Experiment 3a.

5.2.1 Components of a language processor

A language processor is usually assumed to be functionally composed of three components: a grammar, an algorithm, and an oracle (Steedman, 1993, Steedman, 2000).

5.2.1.1 Grammar

The grammar offers the well-formedness rules that could combine constituents to derive other possible constituents. We will assume that the language processor has as its grammatical component a lexicalized grammar offered in the CCG.

CCG lexicon and rules

CCG comprises a radically lexicalized grammar and a set of combinatory rules. The categorial lexicon is composed of functions encoding information about the type and directionality of their arguments and the type of their results. Each category also includes a logical form associated with the syntactic category.

The notation for the syntactic category is ':=' and the one for the logical form is ':'. The resulting type or range is displayed as the leftmost element; if a function category expects its arguments on its right, a rightward-combining functor (X/Y) is used and if it expects them on the left, a leftward-combining functor $(X\backslash Y)$ is used. In (X/Y) or $(X\backslash Y)$, for instance, X is the resulting type or the range and Y is the argument type. It is important to note that both X and Y could be function categories. For instance, a transitive verb *love* is a function from an object NP into functions from a subject NP into S. Its syntactic category and semantic type are shown in (123).

(123) $love := (S\backslash NP)/NP : \lambda x \lambda y.love' xy$

In addition to the lexicon, there are combinatory rules that enable functors such as (123) to combine with their arguments. We simply list these rules below without going into the details as to why we need them (see Steedman, 2000 and Steedman & Baldridge, 2006 for detailed information).

The functional application rules (forward application rule: '$>$'; backward application rule: '$<$') enable functions to combine with arguments of the appropriate type and position. Informally stated, this rule expects Y on its right in (124a) and on its left in (124b) to be X in its resulting state.

(124) *The functional application rules:*

a. $X/Y \quad Y \quad \Rightarrow \quad X$ $(>)$

b. $X\backslash Y \quad Y \quad \Rightarrow \quad X$ $(<)$

The functional composition rules (forward composition rule: '$>$ **B**'; backward composition rule: '$<$ **B**') allow strings that are not traditionally accepted to be constituents to be formed. This rule enables the composition into functions of more than one arguments. This could be simplified as follows: If X is a result that will be realised when it receives Y on its right in (125a) or on its left in (125b), and if Y is something that is expecting to combine with

Z, then these two can be taken to be something that expects Z to become X. However, the rule has to preserve the direction in which it expects its arguments.

(125) *The functional composition rules:*

a. $X/Y \quad Y/Z \quad \Rightarrow \quad X/Z$ (> **B**)

b. $Y\backslash Z \quad X\backslash Y \quad \Rightarrow \quad X\backslash Z$ (< **B**)

Type-raising turns arguments into functions that take them as arguments (forward type-raising rule: '> **T**'; backward type-raising rule: '< **T**'). When arguments are re-written as functions, they could easily compose with other functions.

(126) *The type-raising rules:*

a. $X \quad \Rightarrow \quad T/(T\backslash X)$ (> **T**)

b. $X \quad \Rightarrow \quad T\backslash(T/X)$ (> **T**)

Function composition and type-raising ensure that almost every left-most string becomes a legitimate constituent and this means that a purely bottom-up processor could be both left-to-right incremental and predictive (or eager) at the same time (Sturt & Lombardo, 2005). Sturt and Lombardo (2005) show that a traditional phrase structure grammar would only yield a right-branching analysis that cannot ensure incrementality (especially in head-final languages) whereas flexible constituency in CCG dispenses with this issue in most of the cases.

In order to minimize the expressive power of these combinators, there a number of principles that are assumed to be universal. It is these principles in this account that constitute the Universal Grammar. We will assume that these principles are already available to children and adults.

(127) *The Principle of Adjacency* Combinatory rules may only apply to finitely many phonologically realized and string-adjacent entities (Steedman & Baldridge, 2006, p. 20).

(128) *The Principle of Consistency* All syntactic combinatory rules must be consistent with the directionality of the principal function (Steedman & Baldridge, 2006). This rule prevents the generation of such rules as $X\backslash Y \quad Y \quad \Rightarrow \quad X \qquad (<)$ because *Y* was supposed to appear on the left not on the right.

(129) *The Principle of Inheritance* If the category that results from the application of a combinatory rule is a function category, then the slash type of a given argument in that category will be the same as the one(s) of the corresponding argument(s) in the input function(s) (Steedman & Baldridge, 2006, p. 20). This rule prevents the generation of $X/Y \quad Y/Z \quad \Rightarrow \quad X\backslash Z \quad (>\mathbf{B})$ since *X* expects *Y* on its right and *Y* expects *Z* on its right, *X* cannot expect *Z* on its left.

5.2.1.2 Algorithm

The algorithm is responsible for applying the rules of the grammar in a certain way (e.g., top-down, bottom-up, or a combination of these) to the incoming strings. It applies all possible rules and generates all possible interpretations without paying attention to whether or not they are appropriate for the given context. That is, the algorithm is non-deterministic in that it is blind to possible ambiguities that might arise due to multiple lexical or structural interpretations of an item.

Bottom-up parsers are driven by the words in an utterance; it combines them into larger constituents using the rules of the grammar. There is also a stack that keeps every unit that is waiting to be attached to a larger string and processes them together with the incoming input.

Top-down parsers, on the other hand, starts the processing with the assumption that there is a sentence eventually to be processed. It builds the top-most S node left-to-right by attaching the incoming inputs into the tree as the daughters of the S. This is repeated for each daughter node until there is no more input.

While the bottom-up parsers keep track of the categories waiting to receive an interpretation, top-down algorithms use a stack to keep the expected categories in order to complete the rule. That is, while the former is incremental the latter is predictive. Both algorithms work in a non-deterministic fashion.

A combination of bottom-up and top-down algorithms is also a possibility (see Crocker (1999) for a detailed information on possible psychologically plausible algorithms).

We wish the derivation to be both incremental and predictive in line with the most of the sentence processing literature. In a traditional phrase-structural grammar it would be wise to combine top-down and bottom-up algorithms in addition to some parsing heuristics. Although it is possible to consider various alternative algorithms in CCG as well, now that the competence grammar in CCG could assign an interpretation to every substring in an incremental way, and now that every category inherently includes the type and directionality of

the arguments that are expected, we could assume a chart-based shift-reduce bottom-up algorithm following Steedman (2000). This would also ensure that parsing is eager (predictive) to some extent.

(130) presents the stages of a nondeterministic bottom-up shift-reduce algorithm as described by Steedman (2000).

(130) a. Initialize the stack to the empty stack and make a pointer point to position 0 in the string, before the first word.

b. As long as there are any words left in the string or a combinatory rule can apply to the topmost items on the stack either:

i. Put on the stack (shift) a category corresponding to the word that starts at the pointed-to position, or:

ii. Apply the combinatory rule to the topmost categories on the stack and replace them by its result (reduce).

Once we have a categorial lexicon and combinatory rules that apply incrementally, the bottom-up algorithm inherently has a predictive nature.

(131) presents how a nondeterministic bottom-up shift-reduce algorithm given in (130) processes an example sentence from English. The category of the first word *Alice* already informs the processor that it is a type-raised NP, which means that it will turn into a sentence when it receives a category on its right that expects an NP on its left to become a sentence. It puts this category into the stack and receives the next word, which is the verb *detests* with a category saying that it will become a sentence when it first receives an NP on its right and another NP on its left. Now the algorithm will apply the forward composition rule to combine *Alice* with *detests*. Now the stack has the resulting category: $:= (S/NP)$. It once more shifts to receive the next string, which is another type-raised NP that expects on its left another item that needs to receive an NP on its right to become a sentence. Next, the algorithm applies the backward application rule and reduces the final result, S.

(131) *Alice detests rats.*

i. Shift $Alice := S/(S\backslash NP) : \lambda p.p\ alice'$

ii. Shift $detests := (S\backslash NP)/NP : \lambda x \lambda y.detest' xy$

iii. Reduce $S/NP : \lambda x.detest' x\ alice'$

iv. Shift $rats := S\backslash(S/NP) : \lambda p.p\ rats'$

v. Reduce $S : detest' rats' alice'$

5.2.1.3 Oracle

Even if there is a one-to-one correspondence between syntax and semantics, human language leads to numerous ambiguities. For instance, there might be lexical ambiguities: one lexical item might have more than one meaning (e.g., (a) book = (n.) a bound collection of written or printed pages; (b) book = (v.) to make a reservation). There might also be local syntactic ambiguities: a string of lexical items could be interpreted in several ways until a certain point in an utterance as in *Molloy understood Malone died*. The string composed of the first three items in this sentence (i.e., *Molloy understood Malone*) gives rise to two distinct interpretations: (a) Molloy understood Malone; and (b) Molloy understood that Malone did something; and this ambiguity is resolved only after the verb *died* is encountered. There might be global ambiguities that cannot be resolved unless there is any context supporting either of the interpretations as in *He ate the cookies on the couch*. The possible interpretations of this sentence are as follows: (a) He was on the couch when he was eating the cookies; and (b) The cookies were on the couch and he ate them. Moreover, even the specification of the category of a seemingly straightforward item involves vagueness for the nondeterministic algorithm. That is, the items *The books read* will receive two interpretations regardless of the real-life possibilities of any of the options: (a) The books are doing the reading; (b) Someone else does the reading.

Indeed, assigning an interpretation to a simple string might require a lot of work especially in free word order languages with rich inflection and pro-drop. One clear example for this could be the $NP + GEN$ in Turkish. $NP + GEN$ could be a possessor of a possessive NP as in (132) or a subject in a complement clause as in (133).

(132) Ali-nin kitab-ı kayıp
Ali-GEN book-3SG-POSS lost
'Ali's book is lost.'

(133) Ali-nin kitab-ı al-dığ-ı-nı gör-düm
Ali-GEN book-ACC take-DIK-3SG-POSS see-PAST-1SG
'I saw that Ali took the book.'

Similarly, the $NP + i$ could be an NP marked with the accusative case as in (134) or an NP marked with the possessive and agreement marker as in (135).

(134) Kitab-ı ve defter-i oku-du-m.
Book-ACC and notebook-ACC read-PAST-1SG
'I read the book and the notebook.'

(135) Kitab-ı ve defter-i kayıp.
Book-3SGPOSS and notebook-3SGPOSS lost
'His book and his notebook is lost.'

Despite all these uncertainties, human language processor successfully integrates various types of information and interprets these utterances with considerable ease (sometimes even without realising the ambiguity). Given the fact that human language is highly ambiguous and the algorithms are nondeterministic, we need to assume a further component for a human processor. This will be a filtering mechanism that reduces the ambiguity by offering which interpretations are more likely to be successful in a given situation. This is called the *Oracle*. It could be thought as a mediator between the rules, algorithms, and the real world (i.e., one's experiences) to guide parsing in plausible ways. That is, given an utterance it lists or ranks all the likely categories a string could receive considering various factors. We will assume that the oracle is a kind of constraint satisfaction mechanism that evaluates multiple factors such as the referential context, semantic or knowledge-based plausibility, and the probabilistic information to make parsing more deterministic.

To illustrate, when encountered a string such as *The books read*, the algorithm will automatically generate all possible interpretations that could be derived from these two lexical items. That is, it will offer two interpretations where *read* either gets a past tense verb or a past participle verb interpretation. In the former case *the books* will be interpreted as the agents doing the reading, in the latter they will be the patients being read by some other agent(s). It is the responsibility of the oracle to consider whether each of these interpretations is semantically plausible in the real world so it will guide the processor to entertain the latter possibility over the former.

Also, given the following word marked with a morpheme *kitab-ı* (*book-ı*) the algorithm generates all the possible rules that could combine these two items without considering their likelihood or appropriateness. That is, it generates the options where the NP *kitab-ı* is an $NP + ACC$ and an $NP + 3SG - POSS$. The oracle considers (a) prosody; (b) the probability with which this specific NP (i.e., *kitap*) could combine with the accusative morpheme or the possessive-agreement morpheme; (c) the probability with which either choice appear as the first NP in an utterance; and (d) whether the available context supports one interpreta-

tion over the other to choose one interpretation over the other(s). Let us assume that we have the word *kitab-ı* (*book-ı*) as part of a conversation in (136) versus the one in (137).

(136) A- Sana gönderdiklerimden hangilerini okudun?
'Which items have you read out of the ones I have sent to you?'

B- Kitab-ı ve defter-i oku-du-m; mektup kaldı.
'I have read the book and the notebook but not the letter.'

(137) A- Taşınırken Ali'nin neleri kaybolmuş?
'What belongings of Ali got lost when he was moving?'

B- Kitab-ı ve defter-i kayıp; mektupları duruyor.
'His book and his notebook are missing but his letters are not.'

We simply assume the oracle will assign a higher rank for the NP-ACC interpretation of the word when it is presented within a context given in (136) and it will rank the NP-POSS interpretation higher when it is presented within a context given in (137). Thus, the oracle provides the processor a parsing model in line with the constraints of the grammar and prior evidence. When there is no contextual information, we will assume the oracle will rank the simplest or the most frequent option highest.

We think these examples illustrate that every parse is a task of local ambiguity resolution given the many choices offered by the grammar. However, there are numerous studies in the literature that offer distinct mechanisms for the processing of complex syntax and for the processing of syntactic ambiguity. This surely complicates the issue and limits the generalizability of the theories by usually enforcing extra stipulations and case-by-case analysis of certain phenomena. This in turn reduces the psychological and computational plausibility of these explanations.

5.3 A CCG account of the data from Experiment 3a

This section will provide a CCG account of the results of the experiment reported in Chapter 4. Section 5.3.1 will provide a brief summary of the *combinatory morphemic lexicon* of Bozşahin (2002), which we will use in our analysis. In 5.3.2, the data from Experiment 3a will be summarised and in 5.3.3, an informal interpretation of these results will be provided. Finally, in 5.3.4 the analysis of the data with the morphemic CCG will be presented.

5.3.1 Morphemic lexicon and grammar

Marslen-Wilson (1999) argues that the morpheme rather than the word should be the primary unit of representation in the mental lexicon. He suggests that morphologically complex words should not be stored as unanalysed units but that there must be morphological analysis in the lexicon. In addition, he argues that bound morphemes are represented as separate morphemes in the lexicon. This supports a morphemic view of mental lexicon that involves combinatorial processes that attaches suffixes to stems in a productive way. In this grammar, the mental lexicon is not a static dictionary that includes 'pre-compiled, full-listing' of lexical items but it is a more 'dynamic system' that actively takes part in combinatory operations.

Similarly, Bozşahin (2002) suggests that 'aspects of morphology and syntax collectively contribute to grammatical meaning composition' (p. 146). The morphemes are represented in the lexicon just like words and they behave just like words in the domain of syntax. That is, each morpheme has a syntactic and semantic type as well as the directionality information. According to this view, morphemes specify their attachment preferences just likes words and they can be part of flexible constituency and receive interpretation as soon as they become available in an utterance. Thus, inflectional morphology belongs to syntax (cf., Hankamer, 1989, for whom the left-to-right parsing should be a part of morphological processing).

Bozşahin (2002) shows that CCG provides a unified grammar formalism in which morphemes could be treated as types in the lexicon that have transparent form-meaning correspondence via the combinatory rules. He suggests that this would provide a unified mechanism for the processing of morphemes and words.

We follow Bozşahin (2002) in positing a morphemic lexicon that takes morphemes rather than words as primary units of representation and that assigns morphemes a capacity to actively take part in parsing. Thus, the lexicon is composed of morphemes and words and they both contribute to the compositional meaning. The idea of a morphemic lexicon and morphemic grammar gains more prominence considering the fact that most of the syntactic phenomena are realised through morphemes in highly inflected languages. This means that a certain phenomenon (e.g., relativization) is attributed a syntactic character in one language (e.g., English) while it is attributed a morphological character in another (e.g., Turkish). As also underlined by Bozşahin (2002), the morphemic version of the lexicon and grammar ensures a more unified semantic treatment for the cross-linguistic phenomena such that "the English relative pronouns *that/whom* and the Turkish relative participle *dig-i* would have exactly the same semantics when the latter is granted a representational status in the lexicon"

(p. 148).

Below, in Section 5.3.4, we will argue that a CCG with morphemic lexicon, a bottom-up parsing algorithm, and an oracle that functions as a multiple-constraint satisfaction mechanism could account for the processing facts reported in Experiment 3a. Before this, we will summarise the results from Experiment 3a in 5.3.2, which will be followed by an informal interpretation of the results in 5.3.3.

5.3.2 Summary of the results of Experiment 3a

We presented subject and object RCs as exemplified in (138) in an auditory-moving window task. In this task, test sentences are presented in a phrase-by-phrase fashion and participants listen to the sentences in a phrase-by-phrase fashion at their own pace. The listening times of each segment are compared between the RC-Types, which provides us with information about particular aspects that cause processing difficulty in each structure.

(138) a. *Subject RC*

Segment 1	/ Segment 2	/ Segment 3
NP-ACC	/ V-(y)An	/ NP-NOM
Haylaz goril-i	/ hızlıca it-en	/ güçlü aslan
Naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM$_i$

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü.
slow elephant-ACC	/ kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

b. *Object RC*

Segment 1	/ Segment 2	/ Segment 3
NP-GEN	/ V-DIK-AGRPOSS	/ NP-NOM
Haylaz goril-in	/ hızlıca it-tiğ-i	/ güçlü aslan
naughty gorilla-GEN	/ hard push-DIK-3sgPOSS	/ strong lion-NOM

Segment 4 / Segment 5

NP-ACC / V

yavaş fil-i / öptü.

slow elephant-ACC / kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

Our participants (i.e., both children and adults) showed significantly longer RTs after the first segment in object compared to subject RCs. This means the sentence-initial NP-GEN required longer processing time vis-a-vis sentence-initial NP-ACC. In the second segment, on the contrary, the participants showed longer RTs after subject RCs relative to object RCs. That is, the verb relativized by -(y)An morpheme took longer to process than the one relativized by -DIK. Apparently, V-(y)An was a less expected string after the sentence-initial NP-ACC compared to V-DIK-AGRPOSS after sentence-initial NP-GEN. There was no reaction time differences between the two RCs in the remaining segments for adults. However, children showed longer RTs in object RCs compared to subject RCs in the third segment. That is, NP-NOM after the string with NP-GEN + V-DIK-AGRPOSS took longer to process than NP-NOM after the string with NP-ACC + V-(y)An.

In short, we detected a clear asymmetry between the sentence-initial NP-ACC versus NP-GEN. Importantly, this asymmetry was observed in our off-line experiments, too. In the elicitation task, both children and adults significantly avoided object RCs by omitting the genitive case and replacing the object relativizing morpheme with the subject relativizer. This most probably reflects that they avoid using highly ambiguous morphemes, namely the genitive and the object relativizing morpheme. In addition, both the online experiment and the elicitation task provided some insights about the incrementality of language processing and incremental grammatical encoding in speech production. The online RTs after each phrase in the test items revealed that both children and adults integrated the incoming morphemes and words into the existing structure very rapidly and that they eagerly generated expectations for the incoming structure. Similarly, in their responses for object RCs, both children and adults tended to locate the object noun (that was supposed to be relativized) as the subject of their utterances. In other words, they tended to use conceptually more accessible and morphosyntactically less ambiguous structures, suggesting an incremental encoding.

One way of capturing the processing difference between the accusative case and the genitive case might be to assign a lexical status to these morphemes. This could best be achieved with the morphemic lexicon that considers morphemes as equal to words in terms of their

representation as well as their syntactic and semantic behaviour. Another motivation for choosing morphemic CCG is the fact that it ensures that each morpheme behaves like a word in enabling incremental interpretation assignment as soon as it appears. It is important to note that the participants displayed clear preferences as to what kind of structure should appear following a particular morpheme. This suggests that these morphemes actually have syntactic categories and semantic types just like words and they display preferences for the incoming categories with which they will combine (e.g., genitive morpheme expects to find the feature of agreement on the incoming word).[7]

5.3.3 Informal Interpretation of the data from Experiment 3a

The present results clearly reveal that child and adult speakers of Turkish process language from left to right incrementally as each lexical and morphosyntactic item becomes available.

It is also observed that sentence-initial NP-ACC facilitates processing compared to NP-GEN in the same position. We will argue that the present pattern might be a reflection of an asymmetry between the processing of accusative and genitive morphemes at the sentence-initial position. This asymmetry might be due to several reasons.

First, a sentence-initial NP-ACC seems to be a more complete constituent compared to a sentence-initial NP-GEN. That is, NP-ACC might easily attach to a simple verb to form a sentence whereas NP-GEN is part of a composite structure that needs its head before it could attach to a verb as illustrated in (139). Unlike the NP-ACC (139a), the NP-GEN in (139b) needs at least its head marked with the possessive-agreement morphology (i.e., 'kardeş-i-ni'; 'sibling-3SGPOSS-ACC') before it attaches to a matrix verb.

(139) a. Haylaz goril-i öp-tü-m.
Naughty gorilla-ACC kiss-PAST-1SG
'I kissed the naughty gorilla.'

b. Haylaz goril-in kardeş-i-ni öp-tü-m.
Naughty gorilla-GEN sibling-3SGPOSS-ACC kiss-PAST-1SG
'I kissed the sibling of the naughty gorilla.'

Second, NP-ACC is less ambiguous than NP-GEN under this specific condition because the former only functions as the direct object while the latter could be a possessor in a possessive phrase or a subject in an embedded clause. On the other hand, it might be rightly argued

[7]Many thanks to Cem Bozşahin and Umut Özge, who provided detailed feedback on this chapter.

that NP-ACC might be ambiguously taken as the third person singular possessive marker as in (140a).

(140) a. *Possessive marker*

pro Haylaz goril-i kaybol-muş.

Naughty gorilla-3SGPOSS lose-HEARSAY

'His/her naughty gorilla is said to be lost.'

b. *Accusative marker*

Haylaz goril-i yavaşca öp-en güçlü aslan kaybol-muş.

Naughty gorilla-ACC softly kiss-(y)An strong lion lose-HEARSAY

'The strong lion that softly kissed the naughty gorilla got lost.'

However, we think this option is ruled out (or at least it is less effective) in the test items in question for the following reasons.[8] First of all, the possessor in the possessive phrase is missing in (140a); previously unmentioned NPs do not usually drop. For instance, the sentence in (140a) would be appropriate in a context where the owner of the naughty gorilla has been already introduced (e.g., in a context where the possessor of the naughty gorilla is crying and the speaker is explaining that he is crying because his naughty gorilla have been lost). Yet, it would be considered rather odd to utter this sentence out of the blue. We presume a sentence-initial NP-POSS without a proper context should be rather rare compared to a sentence-initial NP-ACC uttered in the same condition. Thus, the context does not seem to allow the drop of the possessor NP here.

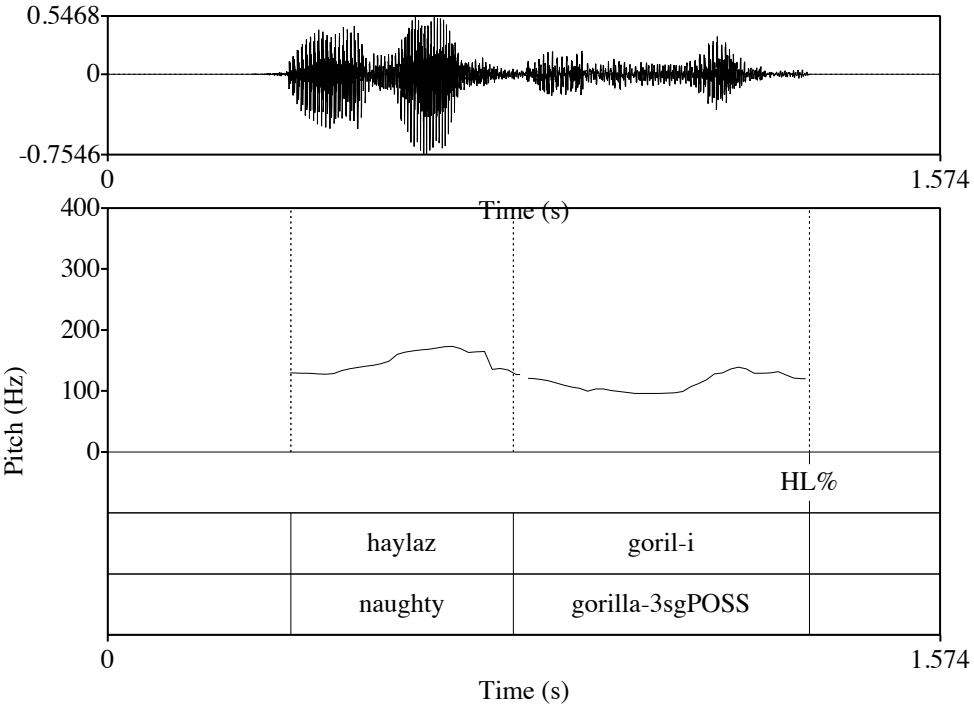
Also, the pitch curves of the first phrase in each of these sentences in (140a) and (140b)[9] have been analysed by Praat Software.[10] As demonstrated in Figure 5.1, the phrase boundary tones of these phrases are distinct. We know that language users highly benefit from the prosodic information of a string when generating expectations for possible interpretations of it.

[8]It is crucial to note at this point that the ambiguity of a certain structure or a certain item depends on many factors. The argument here is that the test conditions in Experiment 3a ensures that the NP-ACC in our test items was not as ambiguous as the NP-GEN in the same condition. This suggests that ambiguity is gradient in nature. That is, two distinct items might be both ambiguous but one might be more ambiguous than the other. Furthermore, the ambiguity depends on the convergence of an array of factors. An item might be more ambiguous when it appears within a certain sentence, in a certain context, and with a certain prosody.

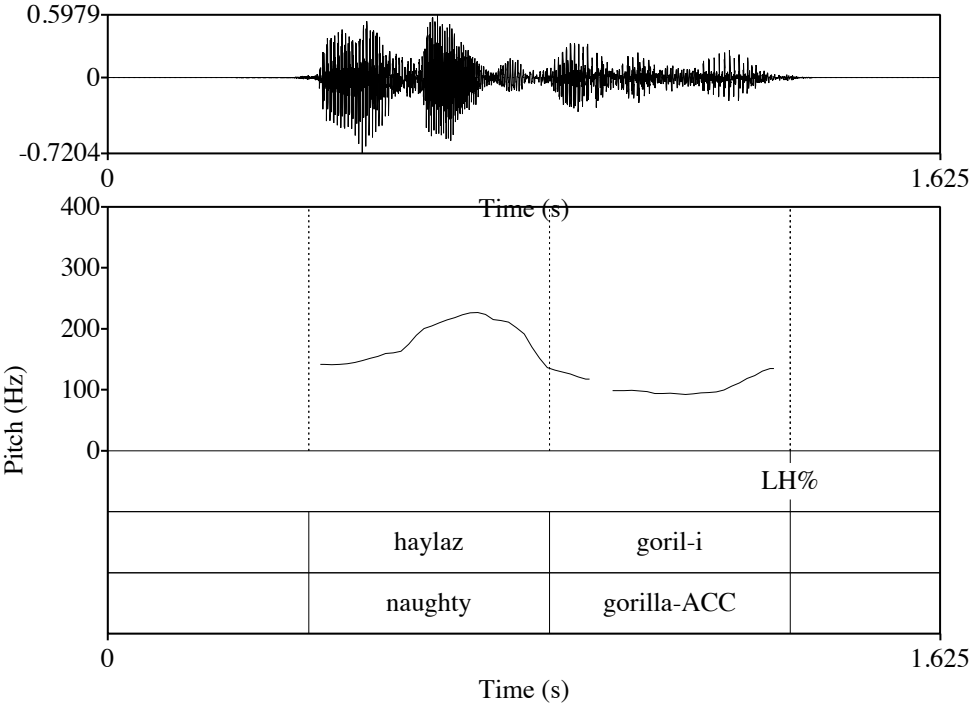
[9]Among these examples, the one in (140a) was not among the test items. This is why, this sentence was constructed to be compared with the example in (140b), which was a sentence selected from the test items in Experiment 3a reported in Chapter 3.

[10]`http://www.fon.hum.uva.nl/praat/`

Figure 5.1: (a) Pitch Contour of NP-POSS in (140a); (b) Pitch Contour of NP-ACC in (140b)



(a)



(b)

We interpret the increased RTs at Segment 2 in subject RCs compared to object RCs as an effect of *surprisal* (a la Hale, 2001) upon hearing the relativized verb after NP-ACC but not after NP-GEN. Most probably, the parser ranked the option of a matrix verb after the NP-ACC higher than the option of a relativized verb whereas it predicted the upcoming possessive agreement morphology on the upcoming string upon hearing the NP-GEN. That is, we suggest the asymmetry between *-(y)An* and *-DIK* in Segment 2 might be stemming from the particular strings preceding these relativized verbs (i.e., Segment 1).

For Segment 1 and 2, both children and adults presented exactly the same pattern of processing: Longer RTs after *NP-GEN* compared to *NP-ACC* and longer RTs after *V-(y)An* compared to *V-DIK-AGRPOSS*. This points to two seemingly conflicting but in fact complementary arguments. On one hand, the genitive morpheme seems to be one source of processing difficulty in object RCs because it takes time to work out its possible functions and ways of integrating it into the possible upcoming strings. On the other hand, children at the ages of 5-8 already have access to the probabilistic and structural constraints the genitive morpheme imposes on the structure building, as the processing of the *NP-GEN* facilitated the processing of the next segment with the relativized verb (*V-DIK-AGRPOSS*). This illustrates that genitive and possessive agreement morphemes act as a composite structure in processing; put informally, their acquisition and processing seem to come as a package. Note that our production data fully complement this view: whenever our participants started their sentence with the genitive NP they completed the structure correctly with the *V-DIK-AGRPOSS*. That is, they either used *(NP-GEN & V-DIK-AGRPOSS)* string correctly or avoided the structure altogether (see Chapter 3.3).

This brings us to the conclusion that the genitive case is a complex but a salient case marker. It is late acquired, it is probably less frequent than the accusative case, it has multiple functions, and it requires extra morphosyntactic marker. However, once its correct function is activated during processing, it acts as a facilitator for the processing of its dependant strings (i.e., the possessive-agreement morphology).

Finally, in the third segment, unlike adults, children showed longer RTs in object as compared subject RCs. It is possible that this reflects a spill-over effect from Segment 2. Also, this might be due to the difference between the RC-role and the matrix role of the RC as stated in Sheldon's (1974) Parallel Function Hypothesis. It suggests that structures are processed better when their matrix role is the same as their embedded role. Thus, subject extracted RCs should be better performed when they function as the subject of the matrix clause compared to when they function as the object of the matrix clause. The same should

hold for object RCs. We will evaluate this hypothesis in Chapter 6.

5.3.4 CCG interpretation of the data from Experiment 3a

Below, we will provide a morphemic CCG account for the result summarised above. In (141) the category information of some of the morphemes we will need are listed as specified in Bozşahin (2002).

(141) Accusative marker '-i' := $N_{acc}\backslash N$
Genitive marker 'in' := $N_{gen}\backslash N$
Subject relativizer '(y)An' := $(N/N)\backslash(S\backslash NP_{nom})$
Object relativizer 'diği' := $(N/N)\backslash(S\backslash NP_{case=obl})$

Considering our informal analysis, it seems that we need to capture the basic difference between the processing of sentence-initial NP-ACC versus NP-GEN in the morphemic CCG analysis of our data.

Given the assumptions regarding the grammar, algorithm and oracle, we will suggest this could be best handled within the domain of oracle. The algorithm automatically generates all possible interpretations of a string; it is the oracle that ranks the alternative analyses considering the contextual or probabilistic information and guides the processor to select from the options. We will simply assume that the oracle follows the reasoning we have just outlined in section 5.3.3 regarding the interpretive options the sentence-initial NP-ACC and NP-GEN induce. We will suppose that the oracle proceeds along the following stages provided in (142):

(142) Given a particular string X in a particular position in an utterance and given the categorical options and grammatical operations available for this string, assign a higher rank for the options that assign the string the most plausible interpretation considering the following information:

a) Referential context;

b) Intonation and prosody;

c) Probability with which the string appears with a particular category in a particular position;

d) When there is no information suggesting the contrary, give a higher rank for the option that attaches the input string to its subcategorizer in a most local way.

Let us see how these steps could be realised in our test items. The processor receives an NP-ACC as its initial input and generates all possible structural options this NP can be combined into. The language specific information used here resides in the lexicon. On its right, it could receive a transitive verb that waits to be attached to an accusative NP on its left so that it becomes a sentence with subject pro-drop as in (143).

(143)

Kadın-ı woman-ACC	vur-du. shoot-PAST
$S/(S\backslash NP_{ACC})$	$(S\backslash NP_{ACC})$

$$\overline{S/(S\backslash NP_{ACC}) \quad (S\backslash NP_{ACC})}^{>}$$

$$S$$

'pro shot the woman.'

It could receive a nominative marked NP that waits to be attached to a verb, which in turn requires two arguments (an accusative NP and a nominative NP) on its left to become an OSV sentence as in (144).

(144)

Kadın-ı woman-ACC	hırsız burglar-NOM	vur-du. shoot-PAST
$S/(S\backslash NP_{ACC})$	$(S\backslash NP_{ACC})/S\{\backslash NP_{NOM}, \backslash NP_{ACC}\}$	$S\{\backslash NP_{NOM}, \backslash NP_{ACC}\}$

$$\overline{\overline{S/(S\backslash NP_{ACC}) \quad (S\backslash NP_{ACC})/S\{\backslash NP_{NOM}, \backslash NP_{ACC}\}}^{<\mathbf{B}} \quad S\{\backslash NP_{NOM}, \backslash NP_{ACC}\}}^{>}$$

$$S$$

'The burglar shot the woman.'

Alternatively, it could receive a relativized verb that waits an accusative NP on its left to become a relative clause, as in(145).

(145)

Kadın-ı woman-ACC	vur shoot	-AN -(y)An	hırsız burglar-NOM
$(S\backslash NP_{NOM})/(S\backslash NP_{NOM}\backslash NP_{ACC})$	$(S\backslash NP_{NOM})/NP_{ACC}$	$(N/N)\backslash(S\backslash NP_{NOM})$	N

$$\overline{\overline{\overline{(S\backslash NP_{NOM})/(S\backslash NP_{NOM}\backslash NP_{ACC}) \quad (S\backslash NP_{NOM})/NP_{ACC}}^{>} \quad (N/N)\backslash(S\backslash NP_{NOM})}^{<} \quad N}^{>}$$

$$N$$

Of course, these possibilities are not the only options available. Each string introduces numerous structural possibilities for the processor to generate, we only listed two simple and one more complex option as an illustration.

Now, let us see the steps followed by the oracle upon encountering sentence-initial NP-ACC and NP-GEN.

We will argue that it must rank the option where the NP-ACC was followed by a simple matrix verb higher than the option where it was followed by a relativized verb on the following grounds:

a. *Contextual information*

There was no visual or sentential context preceding or accompanying the sentences so the oracle has to accommodate the best possible interpretation that could be uttered in a null-context situation. Particularly, there was no contextual information suggesting that the sentence-initial NP-ACC would be followed by a relativized verb.

b. *Prosodic information*

The present data have been derived from an auditory-moving window task. The sentences were uttered as a whole with natural prosody and they were cut into segments so the prosodic breaks were clearly detectable. As the Praat analysis demonstrates in Figure 5.2, the NP-ACC followed by a simple verb as in (146a) does not have a distinct boundary tone compared to the one followed by a relativized verb as in (146b).[11] This indicates that NP-ACC in our data was ambiguous between a direct object in a matrix clause or an object of an RC. Thus, it appears that the parser did not rule out one interpretation over another on the basis of prosodic information here.

(146) a. *NP-ACC followed by a matrix verb*

Haylaz goril-i yavaşca öp-tü güçlü aslan dün gece.
Naughty gorilla-ACC softly kiss-PAST strong lion last night
'The strong lion softly kissed the naughty gorilla last night.'

b. *NP-ACC followed by a relativized verb*

Haylaz goril-i yavaşca öp-en güçlü aslan kaybol-muş.
Naughty gorilla-ACC softly kiss-(y)An strong lion lose-HEARSAY
'The strong lion that softly kissed the naughty gorilla got lost.'

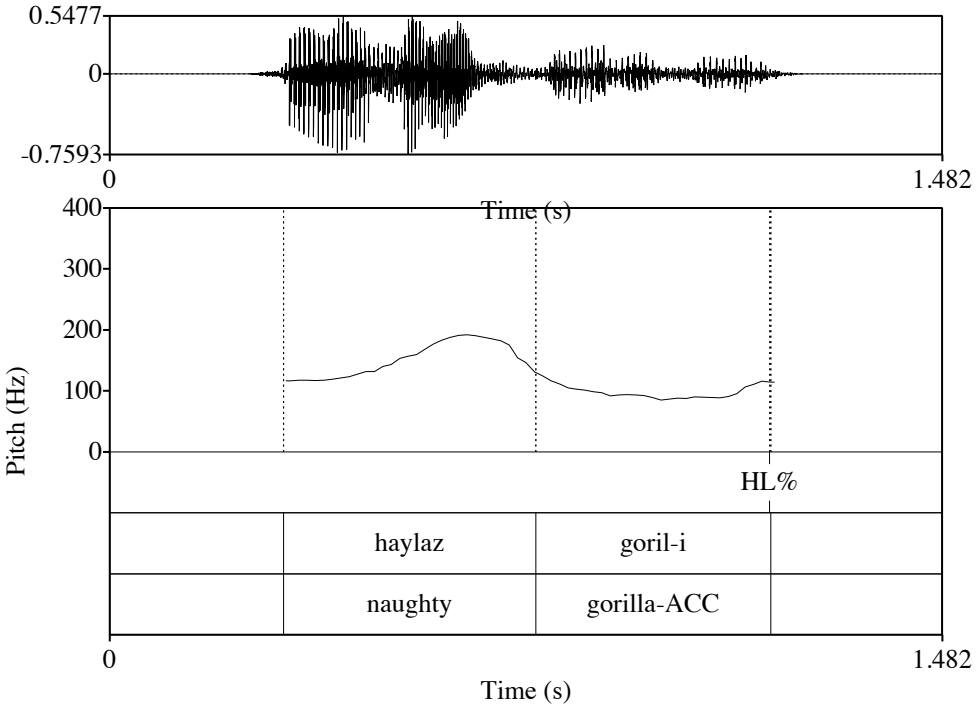
On the other hand, as we have illustrated in (Figure 5.1), the sentence-initial NP-ACC and NP-3SGPOSS had distinct intonation patterns so the ambiguity of the 'NP-i' between accusative and the possessive-agreement morpheme is ruled out. Even if the parser considered the option of the NP-i as a possessed NP, it must have resolved this ambiguity until it reached the boundary tone. Thus, the option of NP-ACC is ranked higher.

c. *Probabilistic Information*

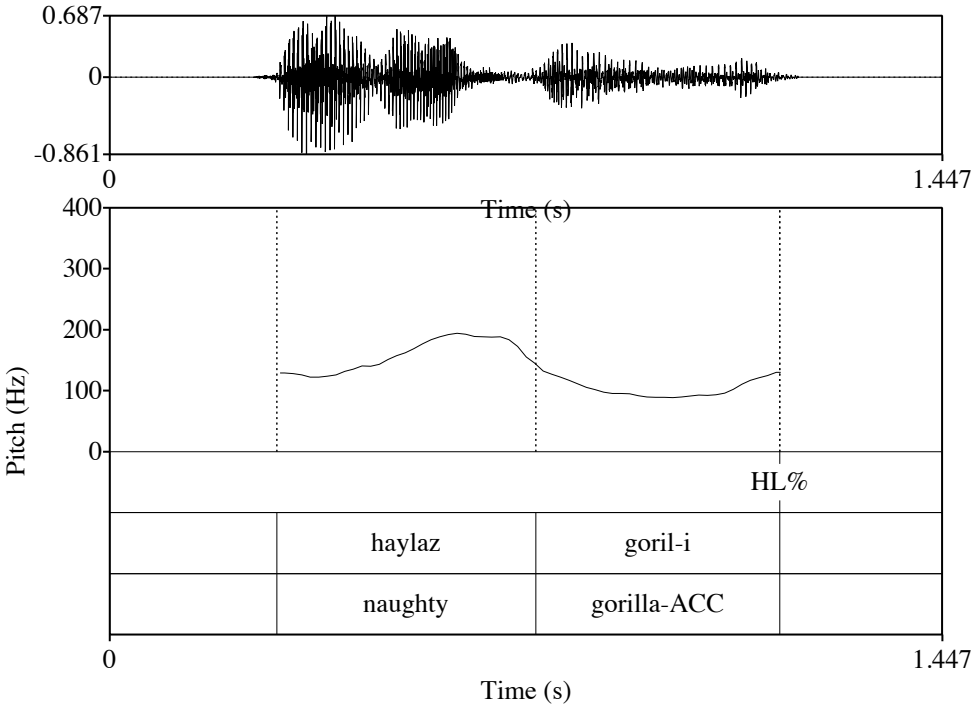
We conjecture that ACC-NP is more frequently followed by a matrix verb as compared

[11] Both of the sentences in (146a) and (146b) were taken from the test items used in Experiment 3a and 3b, reported in Chapter 3.

Figure 5.2: (a) Pitch Contour of NP-ACC Followed by a Matrix Verb; (b) Pitch Contour of NP-ACC Followed by a Relativized Verb



(a)



(b)

to a relativized verb. However, we do not have the necessary corpus information to validate this at the moment.

d. *Local attachment preferences*

The results from the word order items (presented in Chapter 4.7) demonstrate that the ACC-NP followed by a matrix verb is indeed ranked higher: The second segment of an OVS and SVO sentences were processed faster than the ones in OSV and SOV orders. We interpret this as the processor's tendency to combine the available string to its subcategorizer as locally as possible (a la Gibson, 1998) unless the referential context imposes other requirements.

As for the NP-GEN, we do not have contextual and frequency information. Below, we will show that sentence-initial NP-GEN predicted the incoming relativized verb better than sentence-initial NP-ACC.

a. *Contextual information*

There was no contextual information supporting any of the possible interpretations of NP-GEN.

b. *Prosodic information*

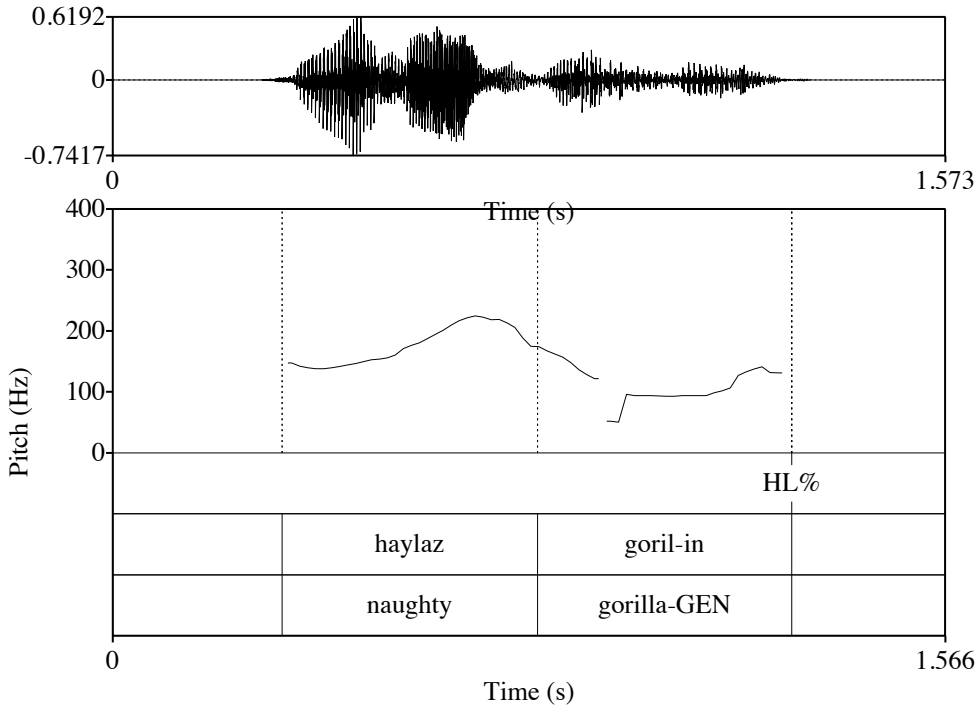
As the Praat analysis demonstrates in Figure 5.3, the prosody of the sentence-initial NP-GEN cannot reveal whether it will be followed by an embedded verb, as in (147a), or a possessed NP, as in (147b), since both have similar boundary tones.[12] This is in line with our prediction that NP-GEN is ambiguous between its two roles, namely possessor of a possessive phrase and subject of an embedded sentence. The fact that prosodic information did not favour one interpretation over another might have contributed to the increased processing time after sentence-initial NP-GEN.

(147) a. *NP-GEN followed by a relativized verb*

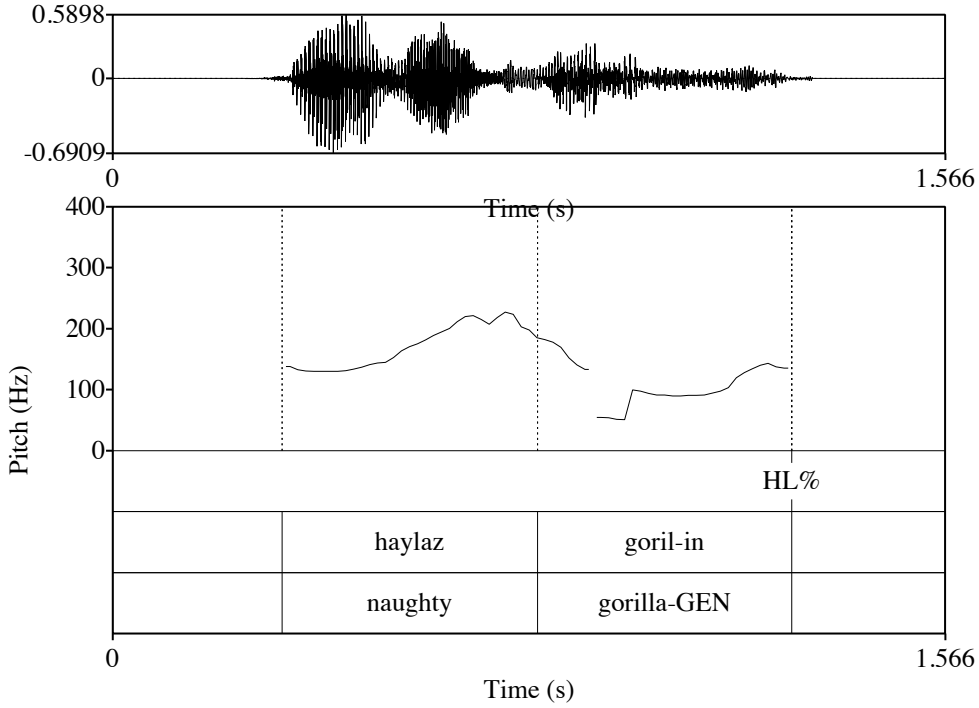
Haylaz goril-in hızlıca it-tiğ-i güçlü aslan
naughty gorilla-GEN hard push-DIK-3sgPOSS strong lion-NOM
yavaş fil-i öptü.
slow elephant-ACC kiss-PAST
'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

[12]The sentences in (147a) was taken from the test items used in Experiment 3, reported in Chapter 3; but since there was no test items similar to (147b), this sentence was constructed in order to provide the present comparison.

Figure 5.3: (a) NP-GEN Followed by a Relativized Verb; (b) NP-GEN Followed by a Possessed NP



(a)



(b)

b. *NP-GEN followed by a possessed NP*

Haylaz goril-in minik kardeş-i-ni tatlıca öp-tü-m.

Naughty gorilla-GEN sweet sibling-3SGPOSS-ACC softly kiss-PAST-1SG

'I softly kissed the sweet sibling of the naughty gorilla.'

c. *Probabilistic Information*

We do not have information about whether an NP-GEN is more frequently followed by a possessed NP or an embedded verb. However, we know that children learn the possessor function of the genitive case earlier than its subject function Ketrez and Aksu-Koc (2009). This may be indicating that a genitive NP is more frequently followed by a possessed NP than by an embedded verb in adult language.

d. *Local attachment preferences*

The only possibility for the sentence-initial NP-GEN to attach to its subcategorizer in the next segment is to receive an embedded verb nominalised or relativized by -DIK and marked with possessive-agreement morphology. Now that the prosody informs the parser not to expect a possessed NP, the only option seems to attach the genitive NP to an embedded verb.

(148) a. Kedi-nin süt-ü

Cat-GEN milk-Poss3sg

'The cat's milk'

b. Kedi köpeğ-in tavşan-ı ısır-dığ-ı-nı gör-dü.

Cat-NOM dog-GEN rabbit-ACC bite-DIK-Poss3sg-ACC see-Past

'The cat saw that the dog bit the rabbit.'

c. Köpeğ-in ısır-dığ-ı tavşan kaç-tı.

Dog-GEN bite-DIK-Poss3sg rabbit run-Past

'The rabbit that the dog bit ran away'

Table 5.1 and Table 5.2 list the steps followed by a bottom-up shift-reduce parser using a morphemic CCG to handle the input in a subject RC and object RC in a morpheme-by-morpheme fashion. The first column shows the current state of the stack and the second column shows the operation parser applies. There are two possible operations: 1- The parser receives the input and puts it into the stack, which is the *shift* operation; 2- It tries to combine the available strings in the stack using the appropriate rule of the grammar, which is the *reduce* operation.

Table 5.1: Morphemic CCG Analysis of a Subject RC with a Bottom-up Shift-reduce Algorithm

	Stack	Operation
1	$[\emptyset]$	shift 'kadın' (woman)
2	$[N]$	shift '-ı' (-ACC)
3	$[N, NP_{ACC}\backslash N]$	reduce '$<$'
4	$[NP_{ACC}]$	reduce'$>$ **T**'
5	$[S\backslash NP_{NOM}/(S\backslash NP_{NOM}\backslash NP_{ACC})]$	shift 'öp' (kiss)
6	$[S\backslash NP_{NOM}/(S\backslash NP_{NOM}\backslash NP_{ACC}), (S\backslash NP_{NOM}\backslash NP_{ACC})]$	reduce '$>$'
7	$[S\backslash NP_{NOM}]$	shift '-EN' (SubjRelMorph)
8	$[S\backslash NP_{NOM}, (N/N)\backslash(S\backslash NP_{NOM})]$	reduce '$<$'
9	$[N/N]$	shift 'adam'(man)
10	$[(N/N), N]$	reduce '$>$'
11	$[N]$	

In Table 5.1, the parser takes the first lexical item and puts it into the stack as a first step. In Step 2, it receives the accusative morpheme. In Step 3, the stack has two items (i.e., woman and -ACC), which could be combined with the *backward application rule*, '$<$'. In Step 4, the stack has an NP-ACC and it is type-raised with the *forward type-raising rule*; i.e., '$>$ **T**'. In Step 5, the stack has a type-raised NP-ACC and a verb is encountered. In Step 6, the NP-ACC and the verb is combined with the *forward application rule*; i.e., '$>$'. In Step 7, the stack has the $[S\backslash NP_{NOM}]$ and the subject relativizing morpheme '(y)An' is recognised. In Step 8, $[S\backslash NP_{NOM}]$ and the relativizing morpheme are immediately combined with the *backward application rule*; i.e., '$<$'. In Step 9, there is $[N/N]$ in the stack and a new lexical item with the category of N (i.e., man) is encountered. In Step 10, $[N/N]$ and [N] is combined with the *forward application rule*; i.e., '$>$'. Step 11 shows the current state of the stack: it has a relativized noun that could further be type-raised and combined with new strings.

In Table 5.2, the parser takes the first lexical item and puts it into the stack as a first step. In Step 2, it receives the genitive morpheme. In Step 3, the stack has two items (i.e., woman and -GEN), that are combined with the *backward application rule*, '$<$'. In Step 4, the stack has an NP-GEN and it could be type-raised and become $[T/(T\backslash NP_{GEN3sg})]$ but here it is displayed as NP-GEN for the sake of simplicity. In Step 5, the stack has an NP-GEN

Table 5.2: Morphemic CCG Analysis of an Object RC with a Bottom-up Shift-reduce Algorithm

	Stack	Operation
1	$[\emptyset]$	shift 'kadın' (woman)
2	$[N]$	shift '-ın' (-GEN)
3	$[N, NP_{GEN3sg}\backslash N]$	reduce '$<$'
4	$[NP_{GEN3sg}]$	shift 'öp' (kiss)
5	$[NP_{GEN3sg}, S\backslash NP\backslash NP]$	shift '-düğ ' (ObjRelMorph)
6	$[NP_{GEN3sg}, (S\backslash NP\backslash NP), ((N/N)\backslash NP)\backslash(S\backslash NP\backslash NP)]$	reduce '$<$'
7	$[NP_{GEN3sg}, (N/N)\backslash NP]$	shift '-ü'
8	$[NP_{GEN3sg}, (N/N)\backslash NP, (N/N)\backslash NP_{GEN3sg}\backslash(N/N)\backslash NP]$	reduce '$<$'
9	$[NP_{GEN3sg}, (N/N)\backslash NP_{GEN3sg}]$	reduce '$<$'
10	$[N/N]$	shift 'adam' (man)
11	$[(N/N), N]$	reduce '$>$'
12	$[N]$	

and a verb is encountered. In Step 6, object relativizing morpheme is encountered and it is combined with the verb via the *backward application rule*, '$<$'. In Step 7, the stack has an NP-GEN and a relativized verb; and a possessive marker with the third person agreement '-ü' appears. In the next step, i.e., Step 8, possessive-agreement morpheme is combined with the relativized verb through *backward application rule*, '$<$'. In Step 9, the relativized verb with the possessive-agreement marker is combined with the NP-GEN with the *backward application rule*, '$<$'. And in Step 10, there is $[N/N]$ in the stack and a new lexical item with the category of N (i.e., man) is encountered. In Step 11, $[N/N]$ and [N] is combined with the *forward application rule*; i.e., '$>$'. Step 12 shows the current state of the stack: it has a relativized noun that could further be type-raised and combined with new strings.

Thus, it seems that a highly lexicalized (even a morpheme-based) grammar that is guided by a multiple constraint satisfaction mechanism could capture the processing facts from Turkish children and adults. This suggests that both children and adults have an access to an incremental parsing mechanism and that the differences in their processing rates seem to be due to some other factors rather than qualitative differences in the parsing mechanisms. Below, we will present a processing model that uses CCG and test whether it could propose a plausible

account of our data.

5.4 Another CCG model: Processing as abduction and deduction

Given the present results, we will now present a sentence processing model by Vasishth and Kruijff (2001) (henceforth, V&K model). It is an incremental model that is based on abductive-inference. The model assumes that each argument (i.e., NP) triggers abductive inferences that lists possible schemas that link this argument into a function (i.e., verbal category) in order to form a grammatical sentence. This is defined as abduction in this model. Abduction is based on a predictive (top-down) processor that uses every available information at each point to form hypotheses about the possible structures to entertain. The processor has a direct access to the grammar (G), which is assumed to be a categorial grammar (CG). In CG, the information as to how the functional categories could combine with their arguments is projected directly from the lexicon. The processor next evaluates these abductive hypotheses upon encountering a verb; that is, it tries to compose (i.e., link) the predicate with the available arguments. This is called deduction. Both abduction and deduction incur processing cost: "The account of processing complexity arises from the number of hypotheses currently active, and how difficult it is to match them against the functional categories of observed words (p.186)." The abduction cost increases in line with the number of NPs that need to be stored in memory, number of functions that need to be generated, and number of hypotheses formulated in line with the input. In addition to this, there is an integration cost arising from the mismatch between the hypothesized functions and the available predicates. This mismatch is considered to be a natural consequence of the left to right depth first search since processing requires constant evaluation and revision of hypotheses with each incoming input. Vasishth and Kruijff (2001) state that their model is similar to that of the surprisal in Hale's (2001) model: the processing cost increases whenever an unexpected phenomenon is observed given the present arguments or whenever a highly expected phenomenon is refused in line with the incoming material. They also underline that it also shares certain features with Gibson's complexity metric that increases in line with the incoming discourse referents that need to be stored in memory and with the shift-reduce algorithm and the Earley processor.

Vasishth and Kruijff (2001) show that their algorithm could account for the Japanese data in Gibson (1998), Nakatani, Babyonyshev, and Gibson (2000), and in Yamashita (1997); for the Dutch data in Kaan and Vasic (2004); for the Dutch and German data in Bach, Brown, and Marslen-Wilson (1986); and for the Hindi data in Vasishth and Kruijff (2001). Below we

will illustrate how the algorithm works by quoting the derivation that accounts for Gibson's (1998) data and then we will list our predictions for the data from Experiment 3.

Gibson (1998) shows that (149a) poses more processing difficulty than (149b).

(149) a. obasan-ga bebiisitaa-ga ani-ga imooto-o izimate-to itta-to omotteiru
aunt-nom babysitter-nom brother-nom sister-acc teased-comp said-comp thinks
'The aunt thinks that the babysitter said that the elder brother teased the younger sister.'

b. bebiisitaa-ga ani-ga imooto-o izimate-to itta-to obasan-ga omotteiru
babysitter-nom brother-nom sister-acc teased-comp said-comp aunt-nom thinks
'The aunt thinks that the babysitter said that the elder brother teased the younger sister.'

The reasoning in the abduction and deduction model is as follows for (149a) and (149b) Vasishth and Kruijff (2001, pp. 193-196):

Step 1:

(150)

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1 = 3	0

Given the first NP-nom (obasan-ga) as an input, the algorithm induces the simplest possible structure which composes this NP with an intransitive verb as shown in f_1. This indicates that this nominative marked NP could be a part of an intransitive sentence when it is composed with an intransitive verb. The total cost for this computation is 3, which is made up of the number of NPs seen so far (1), number of functions abduced (1), the number of hypotheses abduced (1), and the mismatch cost, which is (0) since there have been no new input that requires hypothesis revision.

Step 2:

(151)

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1 = 3	0
NP2-ga	f_2(NP1,NP2)	2+3+2 = 7	0
	f_3(NP1,f_4(NP2))		

The second nominative NP (bebisitaa-ga) points to the possibility for a stative predicate that takes two nominative arguments f_2(NP1, NP2) or for a center embedded construction with two functions (matrix predicate and embedded predicate) f_3(NP1, f_4(NP2)). The cost for abduction at this point is composed of the number of NPs (2), number of functions (3),

and number of hypotheses (2) so the sum is (7) and there is no mismatch cost at this stage. Below, we list the abductive and deductive processes computed with each incoming lexical item until the end of this sentence and their cost providing the explanatory details only at points that is not self-explanatory (see Vasishth & Kruijff, 2001, pp. 193-196 for a detailed information about the application of this algorithm).

Step 3:

(152)

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1 = 3	0
NP2-ga	f_2(NP1,NP2)	2+3+2 = 7	0
	f_3(NP1,f_4(NP2))		
NP3-ga	f_5(NP1,f_6(NP2,NP3))	3+5+2 =10	0
	f_7(NP1,f_8(NP2,f_9(NP3))		

The third nominative NP in Step 3 still presents a local ambiguity as the possibilities for a stative verb as well as for an embedded verb still hold.

Step 4:

(153)

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1 = 3	0
NP2-ga	f_2(NP1,NP2)	2+3+2 = 7	0
	f_3(NP1,f_4(NP2))		
NP3-ga	f_5(NP1,f_6(NP2,NP3))	3+5+2 =10	0
	f_7(NP1,f_8(NP2,f_9(NP3))		
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1 = 8	0

With the insertion of the fourth NP marked in the accusative case, the prediction for the embedded construction is confirmed so the processing cost at this point decreases compared to Step 3. That is, the number of hypotheses in Step 3 was 2 whereas it reduces to 1 in Step 4 with the incoming accusative NP.

Step 5:

(154)

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1 = 3	0
NP2-ga	f_2(NP1,NP2)	2+3+2 = 7	0
	f_3(NP1,f_4(NP2))		
NP3-ga	f_5(NP1,f_6(NP2,NP3))	3+5+2 =10	0
	f_7(NP1,f_8(NP2,f_9(NP3))		
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1 = 8	0
V3	f_{10}(NP1,f_{11}(NP2,V3(NP3,NP4)))	4+2+1 = 7	2

Unlike the previous steps, Step 5 presents the deepest verb, which is a transitive verb. Now the algorithm tries to match this verb with the valency frame of each available function (i.e., number of arguments a verb could take) in the hypothesis space. It tries to match f_{10}, f_{11}, f_{12} but only the valency frame of f_{12} matches with the input verb; so this step causes mismatch cost of (2), increasing the total cost to (9) (i.e., 7 for the abduction cost and 2 for the mismatch cost).

Step 6:

(155)

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1 = 3	0
NP2-ga	f_2(NP1,NP2)	2+3+2 = 7	0
	f_3(NP1,f_4(NP2))		
NP3-ga	f_5(NP1,f_6(NP2,NP3))	3+5+2 =10	0
	f_7(NP1,f_8(NP2,f_9(NP3))		
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1 = 8	0
V3	f_{10}(NP1,f_{11}(NP2,V3(NP3,NP4)))	4+2+1 = 7	2
V2	f_{10}(NP1,V2(NP2,V3(NP3,NP4)))	4+1+1 = 6	1

In Step 6, V2 matches with the second available function, namely f_{11}, which incurs mismatch cost of (1) and the total cost is 7 here (i.e., 1 resulting from the failure in f_{10} and 6 due to the abduction cost).

In Step 7, the verb immediately matches with the first available function, which completes the parse. The overall cost for this sentence is 48 (3+7+10+8+9+7+4). Below is the derivation for the (149b), which has a lower total cost (i.e, 38) than (149a).

Step 7:

(156)

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1 = 3	0
NP2-ga	f_2(NP1,NP2)	2+3+2 = 7	0
	f_3(NP1,f_4(NP2))		
NP3-ga	f_5(NP1,f_6(NP2,NP3))	3+5+2 =10	0
	f_7(NP1,f_8(NP2,f_9(NP3))		
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1 = 8	0
V3	f_{10}(NP1,f_{11}(NP2,V3(NP3,NP4)))	4+2+1 = 7	2
V2	f_{10}(NP1,V2(NP2,V3(NP3,NP4)))	4+1+1 = 6	1
V1	V(NP1,V2(NP2,V3(NP3,NP4)))	4+0+0 = 4	0

(157)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-ga	f_1(NP1)	1+1+1 = 3	0
2	NP2-ga	f_2(NP1,NP2)	2+3+2 = 7	0
		f_3(NP1, f_4(NP2))		0
3	NP3-o	f_5(NP1,f_6(NP2,NP3))	3+2+1 =6	0
4	V3	f_5 (NP1,V3(NP2,NP3))	3+1+1 = 5	1
5	V2	f_7(x,V2(NP1,V3(NP2,NP3)))	4+1+1 = 6	0
6	NP4-ga	f_7(NP4,V2(NP1,V3(NP2,NP3))	4+1+1 =6	0
7	V1	V1(NP4, V2(NP1,V3(NP2,NP3))	4+0+1 = 5	0

Let us now see how the V&K model works for Turkish RCs exemplified in (158) and (160). Let us first focus on how the first two segments would be processed since we detected significant differences between subject and object RCs in those segments.

This model assumes that the processor tries to attach each argument to its subcategorizer as soon as possible and it tries to project as little arguments as possible to keep the processing cost small (a la Gibson, 1998).

Similarly, we could simply assume that the parser considers the number of constraints a lexical or morphological item has to satisfy and the number of roles or functions[13] it might receive in different structures. We conjecture that the processing cost of an item increases in

[13]Note that the term *function* means *predicate* or *verb* in V&K's terms, here we use it to indicate possible *role(s)* a lexical item could receive (i.e., NP-GEN could be the subject of an embedded clause, possessor of a possessive phrase while NP-ACC could only have the object role, and so on). We will use the term *role* to avoid confusion.

line with the number of its roles. That is, the parser generates all likely roles of an item upon encountering it and ranks these roles according to some criteria (e.g., frequency, referential context, prosody, etc.); on the other hand, when a lexical item has a unique role, the parser ranks the simple structure in which this item might appear. To illustrate, upon hearing the sentence-initial genitive NP, the parser ranks each of its roles (i.e., a possessor or a subject). Upon hearing the accusative NP in the same position, since it has a single role, the parser generates only one hypothesis and ranks higher the structure where NP-ACC is followed by a matrix verb.[14].

Tracking the abduction process for Turkish subject and object RCs, for the first step (i.e., first NPs in (158) and (160)), the first accusative NP could receive a transitive matrix verb on its right to form a sentence with subject-drop, as exemplified in (143) so this constitutes the first step in this abduction process with the cost of 3 (as illustrated in (159)).

(158) Kadın-ı vur-an hırsız polis-i it-ti
woman-ACC shoot-(y)An burglar-NOM policeman-ACC push-PAST
'The burglar that shot the woman pushed the policeman.'

(159) *Step 1 in the derivation of a subject RC:*

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-acc	f_1(NP1)	1+1+1 = 3	0

(160) Kadın-ın vur-dug-u hırsız polis-i it-ti
woman-GEN shoot-DIK-3sgPOSS burglar-NOM policeman-ACC push-PAST
'The burglar that the woman shot pushed the policeman.'

(161)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-gen	f_1(NP1,NP2)	2+3+2 = 7	0
		f_3(f$_2$(NP1,NP2))		

In (160), the genitive NP could appear in two possible roles, namely a possessor in a possessive NP as in f_1(NP1,NP2) or a subject in an embedded clause as in f_3(f$_2$(NP1,NP2)) so the parser generates two hypotheses. In the former case, the NP-GEN could attach to a matrix verb when it receives its head noun (i.e., possessed NP), whereas in the latter case it requires two verbs (i.e., f_3 and f_2 or a matrix verb and an embedded verb) to be a complete

[14]Both of the assumptions above lead to the same result so they both capture the present data: sentence-initial NP-ACC is processed faster than sentence-initial NP-GEN

sentence. At this step, the abduction cost for this segment is 7 (2 NPs + 2 functions + 2 possible hypotheses). Thus, as far as the first segment is concerned, the model predicts that the genitive NP in the object RC should lead to longer RTs than the accusative NP in the subject RC, which is in line with our data.

However, the cost for the second segment in the subject RC is predicted to be more than the same segment in the object RC with the following reasoning. Hearing the verb relativized with -(y)An as its second input, the processor fails to fulfil its hypothesis generated in the first step because it expected a matrix verb following the NP-ACC but it received an embedded verb. This leads to a mismatch cost of 1. In addition, it generates a revised hypothesis. Now the required construction should be a function that takes an RC as its argument so the construction should have at least two NPs. This leads to the abduction cost of 4 (2 NPs + 1 function + 1 hypothesis), hence a total cost of 5 (4 abduction cost + 1 mismatch cost) (as demonstrated in (162)).

(162)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-acc	f_1(NP1)	1+1+1 = 3	0
2	V2-(y)An	f_2(V2-(y)An(NP1,x))	2+1+1 =4	1

(163)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-gen	f_1(NP1,NP2)	2+3+2 = 7	0
		f_3(f_2(NP1,NP2))		
2	V2-dik-3sgPoss	f_3(V2-dik-3sgPoss(NP1,x))	2+1+1 = 4	0

As for the relativized predicate with -DIK, the processor successfully composes the genitive NP with the relativized predicate as its subject f_3(V2-dik-3sgPoss(NP1,x)). The abductive cost for this is 4 (2 NPs + 1 function + 1 hypothesis). Also, in contrast to the subject RC there is no mismatch cost in this segment since the parser had generated this option as one of its hypotheses in Step 1, as demonstrated in (163). Thus, the second segment in the object RC (i.e., V-DIK-3sgPoss) should have shorter RTs than the one in the subject RC (i.e., V-(y)An), which is again supported by our data.

For Step 3, since there are two possible hypotheses as a continuation for both of the RCs: it could either be the subject of an intransitive function (i.e., f_3(V2-(y)An(NP1,NP2)) and f_4(V2-dik-3sgPoss(NP1,NP2))) or it could be the subject of a transitive function that also requires to take another NP as its object (i.e., f_4(V2-(y)An(NP1,NP2), x) and f_5(V2-dik-3sgPoss(NP1,NP2), x)). Projecting three possible NPs, two functions, and two hypotheses, this segment has the abduction cost of 7 for both RC-Types, hence no RT differences are predicted (as illustrated in (164) and (165)).

(164)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-acc	f_1(NP1)	1+1+1 = 3	0
2	V2-(y)An	f_2(V2-(y)An(NP1,x))	2+1+1 =4	1
3	NP2-nom	f_3(V2-(y)An(NP1,NP2))	3+2+2 = 7	0
		f_4(V2-(y)An(NP1,NP2), x)		

(165)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-gen	f_1(NP1,NP2)	2+3+2 = 7	0
		f_3(f_2(NP1,NP2))		
2	V2-dik-3sgPoss	f_3(V2-dik-3sgPoss(NP1,x))	2+1+1 = 4	0
3	NP2-nom	f_4(V2-dik-3sgPoss(NP1,NP2))	3+2+2 = 7	0
		f_5(V2-dik-3sgPoss(NP1,NP2), x)		

In Step 4, hearing the next accusative NP confirms the hypothesis that the RC is a part of a transitive verb so the parser now has a third NP and it expects to find a matrix verb (i.e., f_5(V2-dik-3sgPoss(NP1,NP2), x)). This has the cost of 5 (3 NPs + 1 function + 1 hypothesis). Finally, in Step 5 the parser finds the matrix verb. The cost of this final step is 3 (3 NPs + 0 function + 0 hypothesis).

(166)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-acc	f_1(NP1)	1+1+1 = 3	0
2	V2-(y)An	f_2(V2-(y)An(NP1,x))	2+1+1 =4	1
3	NP2-nom	f_3(V2-(y)An(NP1,NP2))	3+2+2 = 7	0
		f_4(V2-(y)An(NP1,NP2), x)		
4	NP3-acc	f_5(V2-(y)An(NP1,NP2), NP3)	3+1+1 = 5	0
5	V1	V1(V2-(y)An(NP1,NP2), NP3)	3+0+0 = 3	0

(167)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-gen	f_1(NP1,NP2)	2+3+2 = 7	0
		f_3(f_2(NP1,NP2))		
2	V2-dik-3sgPoss	f_3(V2-dik-3sgPoss(NP1,x))	2+1+1 = 4	0
3	NP2-nom	f_4(V2-dik-3sgPoss(NP1,NP2))	3+2+2 = 7	0
		f_5(V2-dik-3sgPoss(NP1,NP2), x)		
4	NP3-acc	f_5(V2-dik-3sgPoss(NP1,NP2), NP3)	3+1+ 1= 5	0
5	V1	V1(V2-dik-3sgPoss(NP1,NP2), NP3)	3+0+0 = 3	0

The V&K model correctly predicted that the first segment in the object RC would be more costly than the one in the subject RC and that the opposite would be true for the second segment.

5.5 Summary

In this chapter, we provided a comprehensive analysis of the RC processing data reported in Chapter 4 using two processing models. The first model assumed a processor using a strictly lexicalist grammar, a bottom-up parsing algorithm, and an oracle as a constraint satisfaction mechanism. The second model assumed a processor using a strictly lexicalist grammar, a combination of top-down and bottom-up algorithm and a processing metric for prediction and hypothesis testing. We showed that both models could account for the data by securing incremental parsing.

CHAPTER 6

PARALLEL-FUNCTION HYPOTHESIS

6.1 Introduction

In the previous chapters, we investigated the filler-gap accounts and showed that Turkish speakers did not show filler-gap effects in their interpretation or encoding of Turkish RCs. We also provided two lexicalist models augmented by a constraint satisfaction mechanism and argued that these models could explain the data without extra need for universal or language-specific processing strategies.

In this chapter, we aim to provide a cross-linguistic assessment of another strategy, namely Sheldon's (1974) Parallel Function Hypothesis. According to this, children use a strategy that assigns the same role to the co-referential NPs as their matrix clauses. That is, it predicts that a complex NP that appears in an embedded clause is processed more easily when it has the same grammatical role both in the matrix and embedded clause. Sheldon (1974) suggests that this is a heuristic that is used only by children due to their limited syntactic competence.

As far as RCs are concerned, it predicts better performance in structures where the relativized head has the same grammatical role in the embedded clause and in the matrix clause. That is, a subject RC with the subject role (SS) or an object RC with the object role (OO) in the matrix clause should yield shorter RTs (hence better performance) in processing than a subject RC with the object role (OS) and an object RC with the subject role (SO), respectively. Taking the role-determinants as the determining strategy in processing, the Parallel Function Hypothesis predicts the children to show the following processing hierarchy {SS > OS} and {OO > SO}, where '>' indicates better performance in an off-line comprehension task.[1] It predicts that this should be the pattern observed in all languages regardless of its

[1]Here '<' is used to indicate 'a better performance in the former compared to the latter.' The notation used in the off-line tasks is based on the better performance while in the present on-line task, the results are reported on

typological characteristics. In this respect, it is predicted to be a universal heuristic for the parsing of complex structures that involve embedded clauses.

The Parallel Function Hypothesis has been shown to work well for English (e.g., Sheldon, 1974; and Grober, Beardsley, & Caramazza, 1978) but it has also received criticism (e.g., Hamburger & Crain, 1982; and Correa, 1982). Similarly, its cross-linguistic plausibility have been questioned (Hakuta, 1981 for Japanese; MacWhinney, 1989 for Hungarian; Özcan, 1997 for Turkish). One common feature of the data from cross-linguistic studies is that they come from morphologically rich languages with variable word-order. Hakuta (1981) underlines that word-order has a deeper effect on processing in Japanese; MacWhinney (1989) argues that parallel roles facilitate comprehension only for the subject role and relates this to the prominence of the subject perspective; and Özcan (1997) reports that the parallel roles do not facilitate comprehension of RCs in Turkish children. However, all of these studies, except for MacWhinney (1989) that uses the reading time measures for the whole sentences, are based on the data from off-line studies. They surely provide important insights into the general tendencies in those languages. Yet, these studies cannot single out the cause for the underlying pattern in those complex structures since a particular pattern could be due to a reason other than non-parallel roles in both clauses. Therefore, this hypothesis is revisited here with an on-line study that compares children's performance with that of adults. The aim is to show a moment-by-moment processing of each phrase in Turkish RCs with or without parallel roles in the RC and the matrix clause.

Considering each of the English sentences with an RC in (168), one notices that there is a confounding effect of embedding: while the subject RC with the subject role (SS) is a centre-embedding, the subject RC with the object role is a right-branching structure; similarly, the object RC with the subject role is a centre-embedding whereas the object RC with the object role is a right-branching structure.

(168) a. [The burglar [that shot the woman]] pushed the policeman. (SS)

b. The policeman pushed [the burglar [that shot the woman.]] (OS)

c. [The burglar [that the woman shot]] pushed the policeman. (SO)

d. The policeman pushed [the burglar [that the woman shot.]] (OO)

the basis of RTs in each segment. Thus, '<' is used to indicate shorter RTs in the former compared to the latter. In other words, shorter RTs in the on-line tasks is thought to reflect better performance. However, since these two notations seem conflicting, a brief explanation about the relevant notation will be provided whenever necessary.

Being a flexible word-order language with clear case-marking cues, Turkish allows an evaluation of the Parallel Function Hypothesis without the confounding effect of type of embedding. All sentences in (169) present the RC as the first NP (henceforth: sentence-initial RCs), the order of lexical items is exactly the same in all sentences, but the case morphemes on the NPs indicate that the word order is SOV in SS and SO while it is OSV in OS and OO.

(169) a. [[Kadın-ı vur-an] hırsız] polis-i it-ti (SS)
woman-ACC shoot-(y)An burglar-NOM policeman-ACC push-PAST
'The burglar that shot the woman pushed the policeman.'

b. [[Kadın-ı vur-an] hırsız-ı] polis it-ti (OS)
woman-ACC shoot-(y)An burglar-ACC policeman-NOM push-PAST
'The policeman pushed the burglar that shot the woman.'

c. [[Kadın-ın vur-duğ-u] hırsız] polis-i it-ti (SO)
woman-GEN shoot-DIK-3sgPOSS burglar-NOM policeman-ACC push-PAST
'The burglar that the woman shot pushed the policeman.'

d. [[Kadın-ın vur-duğ-u] hırsız-ı] polis it-ti (OO)
woman-GEN shoot-DIK-3sgPOSS burglar-ACC policeman-NOM push-PAST
The policeman pushed the burglar that the woman shot.

To test Sheldon's (1974) hypothesis, we designed an on-line task using the auditory-moving window paradigm, which we described in Chapter 4. We used the test items as exemplified in (170) and (171). The segments that inform us about the effect of role functions are Segment 3 and Segment 4. These segments should be informative about the effect of RC-role with the help of clear case markings they have. If the Parallel Function Hypothesis is a universal strategy, we should get the following pattern both for Segment 3 and Segment 4: OO < SO, and SS < OS (i.e., shorter RTs in OO compared to SO; and shorter RTs in SS compared to OS in Segment 3 and Segment 4).

(170) a. *SS: Subject RC with the subject matrix role*

Segment 1	/ Segment 2	/ Segment 3
NP-ACC	/ V-(y)An	/ NP-NOM
Haylaz goril-i	/ hızlıca it-en	/ güçlü aslan
naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM

Segment 4 / Segment 5

NP-ACC / V

yavaş fil-i / öptü.

slow elephant-ACC / kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

b. *OS: Subject RC with the object matrix role*

Segment 1 / Segment 2 / Segment 3

NP-ACC / V-(y)An / NP-ACC

Haylaz goril-i / hızlıca it-en / güçlü aslan-ı

naughty gorilla-ACC / hard push-(y)An / strong lion-ACC

Segment 4 / Segment 5

NP-ACC / V

yavaş fil / öptü.

slow elephant / kiss-PAST

'The slow elephant kissed the strong lion that pushed the naughty gorilla.'

(171) a. *SO: Object RC with the subject matrix role*

Segment 1 / Segment 2 / Segment 3

NP-GEN / V-DIK-AGRPOSS / NP-NOM

Haylaz goril-in / hızlıca it-tiğ-i / güçlü aslan

naughty gorilla-GEN / hard push-DIK-3sgPOSS / strong lion-NOM

Segment 4 / Segment 5

NP-ACC / V

yavaş fil-i / öptü.

slow elephant-ACC / kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

b. *OO: Object RC with the object matrix role*

Segment 1 / Segment 2 / Segment 3

NP-GEN / V-DIK-AGRPOSS / NP-ACC

Haylaz goril-in / hızlıca it-tiğ-i / güçlü aslan-ı

naughty gorilla-GEN / hard push-DIK-3sgPOSS / strong lion-ACC

Segment 4 / Segment 5

NP-NOM / V

yavaş fil / öptü.

slow elephant / kiss-PAST

'The slow elephant kissed the strong lion that the naughty gorilla pushed.'

6.2 Experiment 3c: The Parallel Function Hypothesis in the Processing of Turkish Relative Clauses in Monolingual Children and Adults

6.2.1 Method

6.2.1.1 Participants

The same participants reported in section 4.6.1 completed this task.

6.2.1.2 Materials and Design

The test items were presented as part of Experiment 3a reported in Chapter 4. We fully crossed RC-Type (Subject vs. Object RCs) and RC-Role in the matrix clause (Subject vs. Object) in a 2X2 design in an auditory moving-window paradigm described in Chapter 4. The whole test stimuli consisted of 64 sentences divided equally among four sentence types (Subject RCs with the subject role in the matrix clause -SS-, Subject RCs with the object role in the matrix clause -OS-, Object RCs with the object role in the matrix clause -OO-, and Object RCs with the subject role in the matrix clause -SO-). The task was divided into four sessions consisting of 32 test items and 32 control items (64 items in total per session). Control items consisted of 128 non-complex sentences divided equally in four different word-orders (SOV, OSV, OVS, SVO) (see Chapter 4 for the interpretation of the results from the control items).

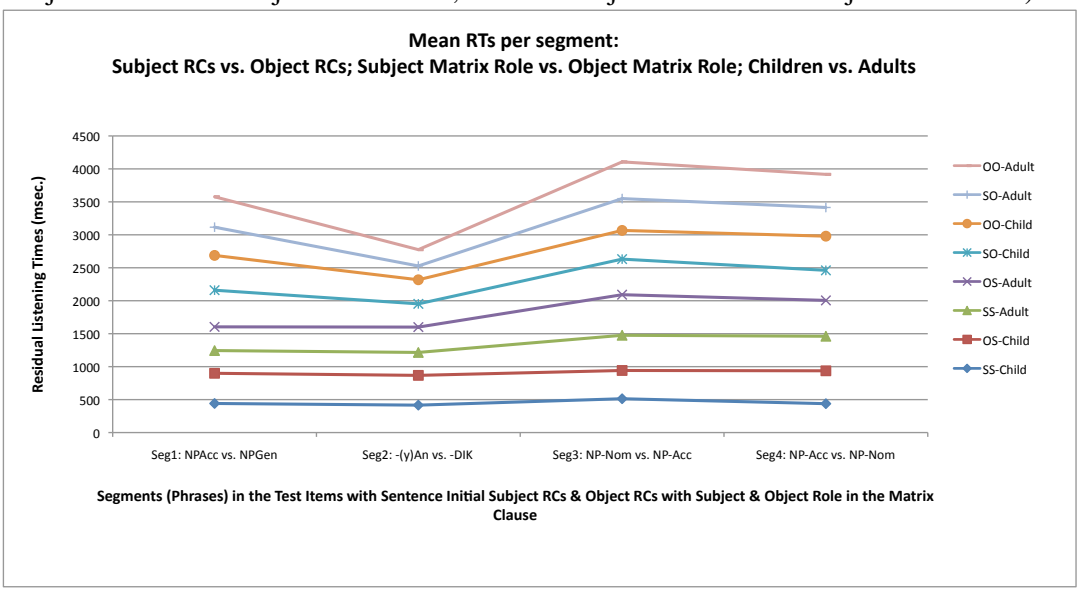
See section 4.6.1 for more details.

6.2.1.3 Procedure

The procedure was the same as described in section 4.6.1.

Figure 6.1: Segment-by-Segment RTs in Sentence-initial RCs with Subject and Object Matrix Role.

(OO: Object RC with the object matrix role; SO: Object RC with the subject matrix role; OS: Subject RC with the object matrix role; and SS: Subject RC with the subject matrix role)



6.2.2 Results

The analysis of the first two segments was reported in Chapter 4.

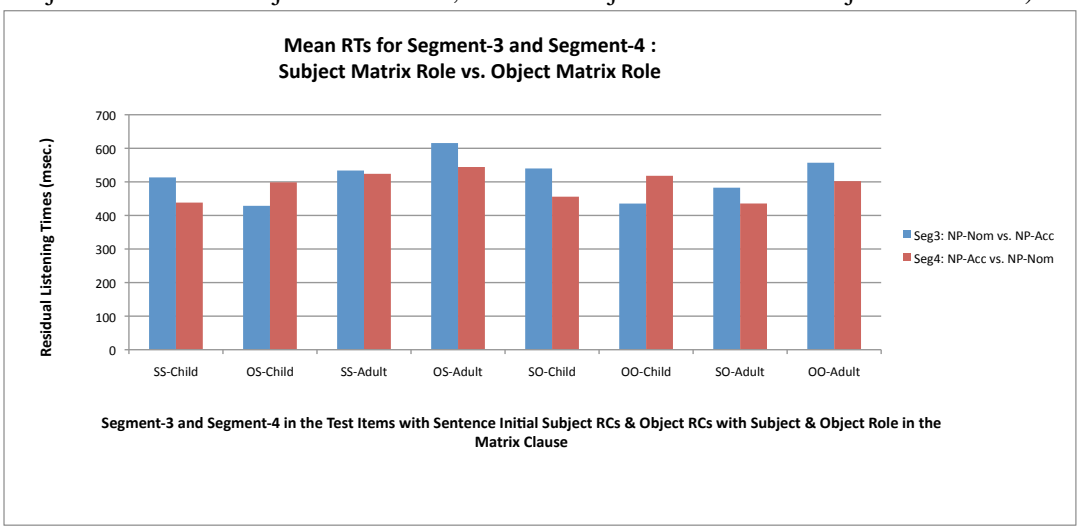
Figure 6.1 displays the RTs in each segment in the test items used to test the Parallel Function Hypothesis.

For the critical segments (i.e., Segment 3 and Segment 4), we conducted a repeated-measures ANOVA test with Group (Children, Adults) as a between-subjects factor and RC-Type (Subject, Object) and RC-Role (Subject, Object) as a within-subjects factors.

Figure 6.2 displays the RTs at the critical segment in the test items used to test the Parallel Function Hypothesis.

For Segment 3, the ANOVA did not reveal an effect of RC-Type $F(1, 68) = 1.02$, $p > .1$; RC-Role $F(1, 68) = .16$, $p > .1$. There was no interaction between RC-Type and Group $F(1, 68) = 3.58$, $p > .05$ but the interaction between RC-Role and Group was significant $F(1, 68) = 18.23$, $p < .001$. Pairwise comparisons with Bonferroni correction indicated that this interaction was due to the fact that the children showed shorter RTs when the relativized NP has the object role whereas the adults showed shorter RTs when the relativized NP has the

Figure 6.2: RTs at Critical Segments (i.e., Segment 3 and Segment 4) in Sentence-initial RCs with Subject and Object Matrix Role.
(OO: Object RC with the object matrix role; SO: Object RC with the subject matrix role; OS: Subject RC with the object matrix role; and SS: Subject RC with the subject matrix role)



subject role in the matrix clause (RC with Subject Role: Children = 526 ms. Adults = 508 ms.; RC with Object Role: Children = 432 ms. Adults = 586 ms.) (see Figure 6.2).

To sum up, the performance in Segment 3 indicates that the children performed faster when the RC (regardless of its type) was in the object role whereas the adults performed faster when the RC was in the subject role.

We analysed the results in Segment 4 to see whether or not the same pattern will be repeated here, too. There was no effect of RC-Type $F(1, 68) = 2.25$, $p > .1$, but the effect of RC-Role was significant $F(1, 68) = 15.25$, $p < .001$. According to this, RCs with the subject matrix role led to shorter RTs than RCs with the object matrix role. There was no effect of Group $F(1, 68) = .23$, $p > .1$, or no interaction between RC-Type and RC-Role $F(1, 68) = .60$, $p > .1$; RC-Type, RC-Role and Group $F(1, 68) = .51$, $p > .1$. Thus, children and adults showed the same pattern in this segment (see Figure 6.2).

However, the interaction between RC-Type and Group was significant $F(1, 68) = 7.22$, $p < .05$. According to the pairwise comparisons, children performed significantly faster in subject RCs (468 ms.) compared to object RCs (486 ms.) but adults performed faster in object RCs (468 ms.) compared to subject RCs (534 ms.).

6.2.3 Discussion

We tested SS, OS, SO, and OO structures to evaluate the Parallel Function Hypothesis, which predicted the following processing pattern {SS < SO} and {OO < OS} (i.e., shorter RTs or better performance in SS compared to SO and in OO compared to OS in Segment 3 and Segment 4) from child participants.

The pattern we derived from children was {OS < SS} and {OO < SO} in Segment 3, and {SS < OS} < {SO < OO} in Segment 4. For adults on the other hand, we had {SO < OO} and {SS < OS} for both segments. This indicates that the Parallel Function Hypothesis does not make correct predictions for the present data. The present results support Hakuta (1981), MacWhinney (1989), and Özcan (1997) regarding the fact that parallel roles did not facilitate comprehension in languages typologically different from English. However, due to differential techniques and test items we cannot fully compare our results with those studies. We will specifically address the perspective put forth in Hakuta (1981) in the next section, where we manipulate the effect of the position of the RC (RC as the first NP vs. RC as the second NP). As for Özcan (1997), she showed that the Parallel Function Hypothesis could not provide an explanation for the pattern displayed by Turkish children but she did not suggest an alternative account for this hypothesis. At this stage, MacWhinney's (1989) perspective account needs closer attention before we proceed with the detailed elaboration of our data.

6.2.3.1 Perspective Hypothesis, MacWhinney (1977, 1982)

MacWhinney and Pleh (1988) argue that Sheldon's hypothesis works more explicitly for subject role than object role. That is, they suggest that both subject RCs and object RCs are performed better when they appeared as the subject of the matrix clause. They base their argument on MacWhinney's (1977) perspective hypothesis (PH), which asserts that humans tend to take the perspective of agents rather than patients and they tend to avoid perspective shift as much as possible. So the sentences starting with the active subject perspective and those that allow lesser amount of perspective shift are easier to process.

The prediction of the PH changes in line with the language in question. For English, it predicts SS < {OO, OS} < SO; and it predicts SS < OS and OO < SO for Turkish. The reasoning behind this prediction is this: the object RC starts with the subject perspective (i.e., *NP-GEN*) so it must have an advantage over the subject RC that starts with the object perspective (i.e., *NP-ACC*). We assume that the relativizing morpheme on the embedded verb in each RC-Type also enables persective shift. For instance, the subject relativizer *-(y)An*

enables the parser to focus on the agent while the object relativizer *-DIK+3sgPOSS* enables the parser to focus on the theme. Examples in (172) display the points that involve perspective shift.[2] According to this, the object RC with the object role in the matrix clause in (172a) should have an advantage over the object RC with the subject role in (172b) as the former shifts perspective once whereas the latter does so for twice before the critical segment (i.e., Segment 3). Similarly, the subject RC with the subject role in (172c) has one perspective shift while the subject RC with the object role in (172d) has two before Segment 3. If the criteria specified here for determining the perspective shift is correct, the Perspective Hypothesis expects the following pattern for Turkish RCs: $SS < OS$ and $OO < SO$, which is similar to the expectations of the Parallel Function Hypothesis.

(172) a. *OO*

Goril-in	it-tiğ-i	aslan-ı	fil	öp-tü
Gorilla-GEN	push-DIK-3sgPOSS	lion-ACC	elephant-NOM	kiss-PAST
Subject ⇒	Object	Object ⇒	Subject	(2 shifts)

'The elephant kissed the lion that the gorilla pushed.'

b. *SO*

Goril-in	it-tiğ-i	aslan	fil-i	öp-tü
Gorilla-GEN	push-DIK-3sgPOSS	lion-NOM	elephant-ACC	kiss-PAST
Subject ⇒	Object ⇒	Subject ⇒	Object	(3 shift)

'The lion that the gorilla pushed kissed the elephant.'

c. *SS*

Goril-i	it-en	aslan	fil-i	öp-tü
Gorilla-ACC	push-(y)An	lion-NOM	elephant-ACC	kiss-PAST
Object ⇒	Subject	Subject ⇒	Object	(2 shifts)

'The lion that pushed the gorilla kissed the elephant.'

d. *OS*

Goril-i	it-en	aslan-ı	fil	öp-tü
Gorilla-ACC	push-(y)An	lion-ACC	elephant-NOM	kiss-PAST
Object ⇒	Subject ⇒	Object ⇒	Subject	(3 shifts)

'The elephant kissed the lion that pushed the gorilla.'

The present data from Turkish children and adults do not give support for neither of the hypotheses. The data from adults indicated that they preferred the RC to be the subject of

[2]The perspective shift in these examples is indicated by an arrow ('⇒').

the matrix clause (SS < OS and SO < OO in Segment 3 and 4). The children's data, on the other hand, was more complex in that their RTs for the critical segment indicated that they preferred the RC to be the object of the matrix clause (OS < OS and OO < SO) whereas their RTs in the next segment (i.e., Segment 4) showed exactly the opposite pattern (SS < SS and OO < SO). Thus, children showed a different performance from adults in Segment 3 but they showed the same performance in Segment 4.

Three issues need elaboration at this point:

1. Why do adults tend to locate each RC as the subject of the matrix clause?
2. Why do children show a differential pattern in Segment 3 and 4?
3. Why do children present a pattern that is different from adults in Segment 3?

6.2.3.2 Why do adults tend to locate each RC as the subject of the matrix clause?

One explanation regarding the first issue might be as follows: In all these sentences, the RC appears at the sentence-initial position. Sentence-initial NPs are more likely to be the subjects in Turkish in line with the canonical word order (i.e., SOV) so adults might be locating each RC as the subject of the matrix clause in these sentences. That is, [RC]OV might be the configuration our participant are projecting in these structures. This is actually in line with Hakuta (1981), who showed that surface configurational properties of sentences had a more powerful effect than parallel roles in Japanese, which is a variable word order language. With a number of off-line comprehension and production tasks, Japanese participants were reported to show strong effect of word order both in sentences where the RC appeared as the first or the second NP. In the next experiment (in Section 6.3), we will manipulate the position of the RC in the matrix clause in order to find out the effect of word order and the location of the RC on the processing of these sentences.

6.2.3.3 Why do children show a differential pattern in Segment 3 and Segment 4?

As for the finding that children showed differential performance in Segments 3 and 4, we will conjecture that this might be due to their inability to use available prosodic cues in locally ambiguous structures. When prosodic cues are disregarded, Segment 2 in both RC-Types is actually a point of local ambiguity. That is, the relativized verbs could attach directly to a matrix clause as a headless RC as in (173a) and (174a) or they could attach to the RC-head as in (173b,c) and (174b,c).

(173) Segment 1 / Segment 2 / . . .
Haylaz goril-i / hızlıca it-en /. . .
Naughty gorilla-ACC / hard push-(y)An / . . .

a. *Headless RC*
. . . / Segment 3 / Segment 4
. . . / güçlü aslanı / öp-tü.
. . . / strong lion-ACC / kiss-PAST
'The one that pushed the naughty gorilla kissed the strong lion.'

b. *SS*
. . . / Segment 3 / Segment 4 / Segment 5
. . . / güçlü aslan / yavaş fil-i / öp-tü.
. . . / strong lion / slow elephant-ACC / kiss-PAST
'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

c. *OS*
. . . / Segment 3 / Segment 4 / Segment 5
. . . / güçlü aslanı / yavaş fil / öp-tü.
. . . / strong lion-ACC / slow elephant / kiss-PAST
'The slow elephant kissed the strong lion that pushed the naughty gorilla.'

(174) Segment 1 / Segment 2 / . . .
Haylaz goril-in / hızlıca it-tiğ-i / . . .
Naugt gorilla-GEN / hard push-DIK-3sgPOSS / . . .

a. *Headless RC*
. . . / Segment 3 / Segment 4
. . . / güçlü aslan-ı / öp-tü.
. . . / strong lion-ACC / kiss-PAST
'The one that the naughty gorilla pushed kissed the strong lion.'

b. *SO*
. . . / Segment 3 / Segment 4 / Segment 5
. . . / güçlü aslan / yavaş fil-i / öp-tü.
. . . / strong lion / slow elephant-ACC / kiss-PAST
'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

c. *OO*

... / Segment 3 / Segment 4 / Segment 5

... / güçlü aslan-ı / yavaş fil / öp-tü.

... / strong lion-ACC / slow elephant / kiss-PAST

'The slow elephant kissed the strong lion that the naughty gorilla pushed.'

As we will discuss below, we predict that children might have ignored the prosodic cues in the test items and attached the segments up to the relativized verb directly to the matrix clause without waiting for the head noun. That is, they took these strings as headless RCs as exemplified in (173a) and in (174a). Moreover, they formed expectations in line with this for the incoming segments (i.e., segments 3 and 4). Hamburger's (1980) observation that children acquire headless RCs before full RCs provides support for our prediction here. It is highly probable that early acquired phenomena are also easier to process.

Our interpretation for the children's responses in segment 3 and 4 is as follows.

As underlined before in Chapter 2, a headless RC in Turkish gets its case marking right after the relativized predicate as exemplified in (175).

(175) a. Ali-(y)i öp-en gel-di.

Ali-ACC kiss-(y)An-NOM come-PAST

'The one who kissed Ali came.'

b. Ali-(y)i öp-en-i gör-dü-m.

Ali-ACC kiss-(y)An-ACC see-PAST-1SG

'I saw the one who kissed Ali.'

c. Ali-(y)i öp-en-in anne-si gel-di.

Ali-ACC kiss-(y)An-GEN mother-3SGPOSS come-PAST

'The mother of the one who kissed Ali came.'

d. Ali-nin öp-tüğ-ü gel-di.

Ali-GEN kiss-DIK-3SGPOSS-NOM come-PAST

'The one who Ali kissed came.'

e. Ali-nin öp-tüğ-ü-nü gör-dü-m.

Ali-GEN kiss-DIK-3SGPOSS-ACC see-PAST-1SG

'I saw the one who Ali kissed.'

f. Ali-nin öp-tüğ-ü-nün anne-si gel-di.
Ali-GEN kiss-DIK-3SGPOSS-GEN mother-3SGPOSS come-PAST
'The mother of the one who Ali kissed came.'

Not having an overt case marking after the relativized verb, the RCs might have been taken as the subject of the matrix clause. Below is a CCG analysis for a headless RC that is the subject of a transitive verb (176).[3] We will simply assume this is the expected structure (although a headless RC could be followed in many different ways as we outlined above).

(176)

Goril-i	it-en	aslan-ı	öptü
gorilla-ACC	push-(y)An	lion-ACC	kiss-PAST
$T/(T\backslash NP_{ACC})$	$(NP/NP)\backslash NP_{ACC}$	NP_{ACC}	$(S\backslash\ NP_{NOM})\backslash NP_{ACC}\}$
(NP/NP) <			$S\backslash NP$ <
NP HRC			
S <			

'The one that pushed the gorilla kissed the lion.'

Given the assumption that the structure until the relativized verb is interpreted as a headless RC, we will analyse whether the V&K model predicts the processing cost correctly. The test sentences are repeated as (177) and (178) below and the derivation of each of these structures are given in (179) and (180), respectively.

(177) *OS: Subject RC with the object matrix role*

Segment 1	/ Segment 2	/ Segment 3
NP-ACC	/ V-(y)An	/ NP-ACC
Haylaz goril-i	/ hızlıca it-en	/ güçlü aslan-ı
naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-ACC

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil	/ öptü.
slow elephant	/ kiss-PAST

'The slow elephant kissed the strong lion that pushed the naughty gorilla.'

[3]We assume a rule (indicated by HRC) that captures the omission of the RC head.

(178) *SS: Subject RC with the subject matrix role*

Segment 1	/ Segment 2	/ Segment 3
NP-ACC	/ V-(y)An	/ NP-NOM
Haylaz goril-i	/ hızlıca it-en	/ güçlü aslan
naughty gorilla-ACC	/ hard push-(y)An	/ strong lion-NOM

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü.
slow elephant-ACC	/ kiss-PAST

'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

We will explain the analysis from Segment 3 onwards (i.e., after the relativized verb) assuming that the strings until this point had been taken as a headless RC by children. In (179), the parser encounters NP-ACC in Segment 3 and ranks higher the option of a headless RC that takes its object argument on its right as exemplified in (176). The processing cost for Segment 3 is 4 in (179): 2 NPs (i.e., a headless RC in the subject role and NP-ACC in the object role) + 1 function (i.e., relativized verb) + 1 hypothesis (i.e., it expects to receive its matrix verb) = 4 abduction cost + 0 mismatch cost).

(179) *Derivation for the subject RC with the object matrix role*

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-acc	f_1(NP1)	1+1+1 = 3	0
2	V2-(y)An	f_3(V2-(y)An(NP1)),x)	2+1+1 = 4	1
3	NP2-acc	f_4(V2-(y)An(NP1)NP2)	2+1+1 = 4	0
4	NP3-nom	f_5(V2-(y)An(NP1,NP2),NP3)	3+1+1 = 5	1
5	V1	V1(V2-(y)An(NP1,NP2),NP3)	3+0+0 = 3	0

In (180), on the other hand, Segment 3 is NP-NOM so the parser has to revise its hypothesis and recover that the strings until the relativized verb have not actually been a headless RC. This means a mismatch cost of 1 so the processing cost in this segment (i.e., Step 3) is 6: 3 NPs (i.e., object in the RC, RC Head, and object in the matrix clause) + 1 function (i.e., relativized verb) + 1 hypothesis (i.e., it expects a matrix verb) = 5 abduction cost and 1 mismatch cost (i.e. the nominative NP after the relativized verb indicates that the structure should not be a headless RC). This correctly predicts that Segment 3 in (179) will be processed faster than the one in (180).

(180) *Derivation for the subject RC with the subject matrix role*

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-acc	f_1(NP1)	1+1+1 = 3	0
2	V2-(y)An	f_3(V2-(y)An(NP1)),x)	2+1+1 = 4	1
3	NP2-nom	f_4(V2-(y)An(NP1,NP2),x)	3+1+1 = 5	1
4	NP3-acc	f_5(V2-(y)An(NP1,NP2),NP3)	3+1+1 = 5	0
5	V1	V1(V2-(y)An(NP1,NP2),NP3)	3+0+0 = 3	0

Now, in Segment 4, the parser expects a matrix verb in (179) because it is not yet clear that the structure is not actually a headless RC. When the parser encounters an NP-NOM in Segment 4, it has to revise its analysis and realise that the structure until this point was actually a full RC. This means a mismatch cost of 1 so the total cost for this segment in (179) is 6: 3 NPs (i.e., object of the RC, RC Head, and object of the matrix clause) + 1 function (i.e., relativized verb) + 1 hypothesis (i.e., it expects to receive a matrix verb) + 1 mismatch cost. In (180), on the other hand, the parser has already aligned its hypothesis with the fact that the structure up to the previous segment had been a full RC with the subject role in the matrix clause so it now expects a matrix object. The next segment is indeed an NP-ACC, so it will process this segment without any mismatch cost. That is, the cost in this segment is 5 (i.e., 3 NPs + 1 function + 1 hypothesis). Again, this is in line with the data with longer RTs in (179) compared to (180) in Segment 4.

The same expectations with the same reasoning apply for the object RCs, too: longer RTs in (183) compared to (181) in Segment 3 and longer RTs in (181) compared to (183) in Segment 4. It can be seen that the cost for step 3 in (184) is 6 while it is 4 in (182) and the cost for step 4 in (182) is 6, while it is 5 in (184). This is exactly the piece of finding revealed from the children's data.

(181) *OO: Object RC with the object matrix role*

Segment 1	/ Segment 2	/ Segment 3
NP-GEN	/ V-DIK-AGRPOSS	/ NP-NOM
Haylaz goril-in	/ hızlıca it-tiğ-i	/ güçlü aslan-ı
naughty gorilla-GEN	/ hard push-DIK-3sgPOSS	/ strong lion-ACC

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil	/ öptü.
slow elephant	/ kiss-PAST

'The slow elephant kissed the strong lion that the naughty gorilla pushed.'

(182) *Derivation for the object RC with the object matrix role*

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-gen	f_1(NP1,NP2)	2+3+2 = 7	0
		f_3(f$_2$(NP1,NP2))		
2	V2-dik-3sgPoss	f_3(V2-dik-3sgPoss(NP1)),x)	2+1+1 = 4	1
3	NP2-acc	f_4(V2-dik-3sgPoss-(NP1)NP2)	2+1+1 = 4	0
4	NP3-nom	f_5(V2-dik-3sgPoss(NP1,NP2),NP3)	3+1+1 = 5	1
5	V1	V1(V2-dik-3sgPoss(NP1,NP2),NP3)	3+0+0 = 3	0

(183) *SO: Object RC with the subject matrix role*

Segment 1	/ Segment 2	/ Segment 3
NP-GEN	/ V-DIK-AGRPOSS	/ NP-NOM
Haylaz goril-in	/ hızlıca it-tiğ-i	/ güçlü aslan
naughty gorilla-GEN	/ hard push-DIK-3sgPOSS	/ strong lion-NOM

Segment 4	/ Segment 5
NP-ACC	/ V
yavaş fil-i	/ öptü.
slow elephant-ACC	/ kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

(184) *Derivation for the object RC with the subject matrix role*

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-gen	f_1(NP1,NP2)	2+3+2 = 7	0
		f_3(f$_2$(NP1,NP2))		
2	V2-dik-3sgPoss	f_3(V2-dik-3sgPoss(NP1)),x)	2+1+1 = 4	1
3	NP2-nom	f_4(V2-dik-3sgPoss(NP1,NP2),x)	3+1+1 = 5	1
4	NP3-acc	f_5(V2-dik-3sgPoss(NP1,NP2),NP3)	3+1+1 = 5	0
5	V1	V1(V2-dik-3sgPoss(NP1,NP2),NP3)	3+0+0 = 3	0

Whether or not children are indeed assigning the headless RC interpretation to the string up to the relativized verb is a topic of further research. However, if this reasoning is true, we could argue that children behaved just like adults in assigning the sentence-initial RC the subject role in line with the SOV order.

6.2.3.4 Why do children present a pattern that is different from adults?

The results showed that children's performance in Segment 3 did not match that of adults and we argued that they might have perceived the string up to Segment 3 as a headless RC. One

possible explanation for this pattern could be the weak prosodic cues in the auditory-moving window task and weak prosodic processing in children. In other words, it might be partly due to the confounding factors related to the auditory moving window task, and it might also be due to children's limited sensitivity to prosodic cues. Below, we will consider each view in turn:

Prosody in the auditory-moving window task

Although there are other techniques (e.g., eye-tracking, ERPs) that are more powerful in preserving the prosody, the auditory-moving window paradigm has also been shown to be sensitive to prosodic measures. For instance, F. Ferreira et al. (1996) shows that this technique could successfully be used to investigate the use of prosody during parsing. Similarly, Waters and Caplan (2001) argue that the auditory moving window paradigm is as natural as other available techniques.

In natural speech, prosodic phrases are uttered as one unit and are never separated from each other. Prosodic phrasing in the examples in (185) are shown with '{}'. For instance, in RCs, the relativized predicate and the head noun should constitute a prosodic phrase when the head noun is not dropped as shown in (185a). In headless RCs, on the other hand, the first NP and the relativized verb are read as a prosodic unit as in (185b). When the prosodic phrasing and the actual structure does not match, the structure becomes odd as in (185c). Here, the prosodic phrasing wrongly indicates that the structure is a headless RC when actually it is an RC with the head noun.

(185) a. *Full RC*

{Aslanın {tekmelediği ayı}} kaçtı.

Lion-GEN {kick-DIK-Poss3sg bear} run-PAST.

'The bear the lion kicked ran away.'

b. *Headless RC*

{Aslanın tekmelediği} ayıyı kovaladı

{Lion-GEN kick-DIK-Poss3sg} bear-ACC chased

'The one that the lion kicked chased the bear.'

c. *Full RC Ungrammatical*

*{Aslanın tekmelediği} ayı kaçtı.

{Lion-GEN kick-DIK-Poss3sg} bear run-PAST

*'The one that the lion kicked the bear ran away.'

In the auditory-moving window task, we wanted to measure the participant's processing time after each phrase so we presented the sentences in segments. Also, in order to secure a natural prosody, we placed an adjective preceding each NP (e.g., naughty gorilla) and an adverb preceding each verb (e.g., hard kick-(y)An) as shown in (186).

(186) a. *Full RC*

{Güçlü aslanın} / {hızlıca tekmelediği} / {zavallı ayı} / {kaçtı}.
{Strong lion-GEN} {hadr kick-DIK-Poss3sg} {poor bear} {run-PAST.}
'The poor bear the strong lion kicked hard ran away.'

b. *Headless RC*

{Güçlü aslanın} / {hızlıca tekmelediği} / {zavallı ayı-yı} / {kovaladı}
{Strong lion-GEN} {hadr kick-DIK-Poss3sg} {poor bear-ACC} {chased}
'The one that the strong lion kicked hard chased the poor bear.'

In this way, we avoided the unnatural separation of the relativized verb and the head so the segment divisions (shown with '/') corresponded to the pattern of natural prosodic phrasing. To illustrate, the original prosodic phrasing supporting the full RC interpretation was preserved as illustrated below in Figure 6.3a and Figure 6.3b, which presents the Praat analyses of our test items with full RCs compared to sample sentences with headless RCs, respectively.[4] These figures show that the boundary tone of the relativized verb in a full subject RC used in our experiment, as shown in Figure 6.3a, was perceptually distinct from the boundary tone of the relativized verb in a headless RC, as shown in Figure 6.3b. The same holds true for the object RCs as displayed in Figure 6.4.

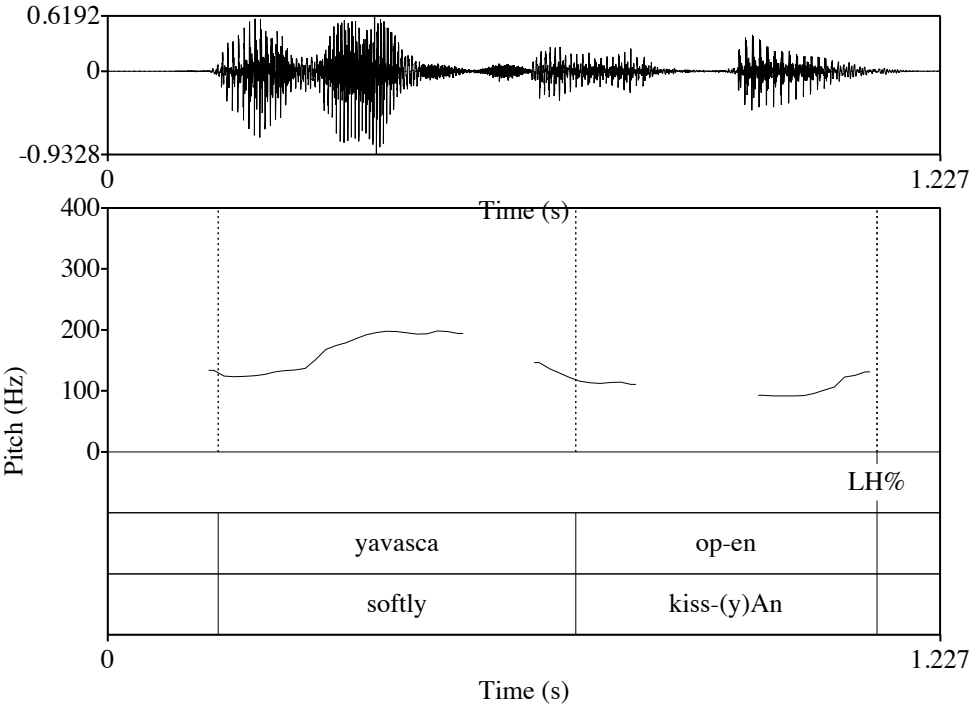
Thus, it appears unlikely that the present pattern is due to the nature of the auditory moving-window task. Moreover, it is crucial to note that only the child participants showed a strong bias for the headless RC interpretation here. A possible cause for the differences between children and adults might be due to children's limited sensitivity to prosodic cues. It might be the case that the children failed to detect the prosodic cues marking that the full RC reading is attempted in those structures. We will discuss this in the following section.

Children's sensitivity to prosodic cues

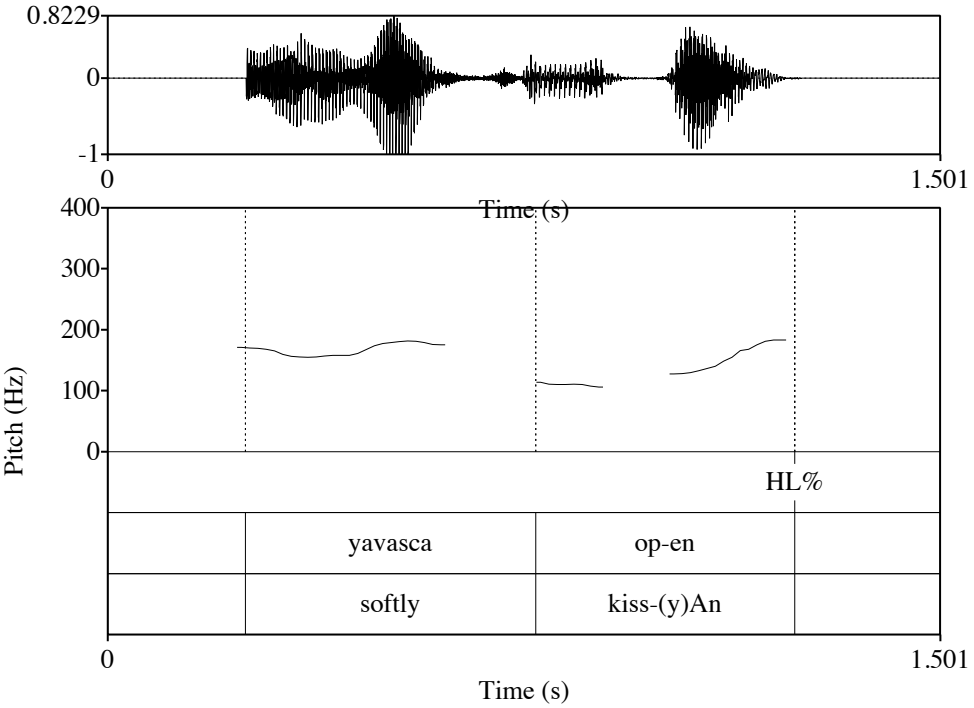
We conjecture that our child participants might have shown limited or delayed sensitivity for the prosodic cues, indicating that the head of the RC will follow in the next segment.

[4]The sample sentence in Figure 6.3b was not a part of the stimuli. It was constructed to provide a comparison with the full RC in Figure 6.3a.

Figure 6.3: (a) Pitch Contour of the Relativized Verb of a Full Subject RC (b) Pitch Contour of the Relativized Verb of a Headless Subject RC

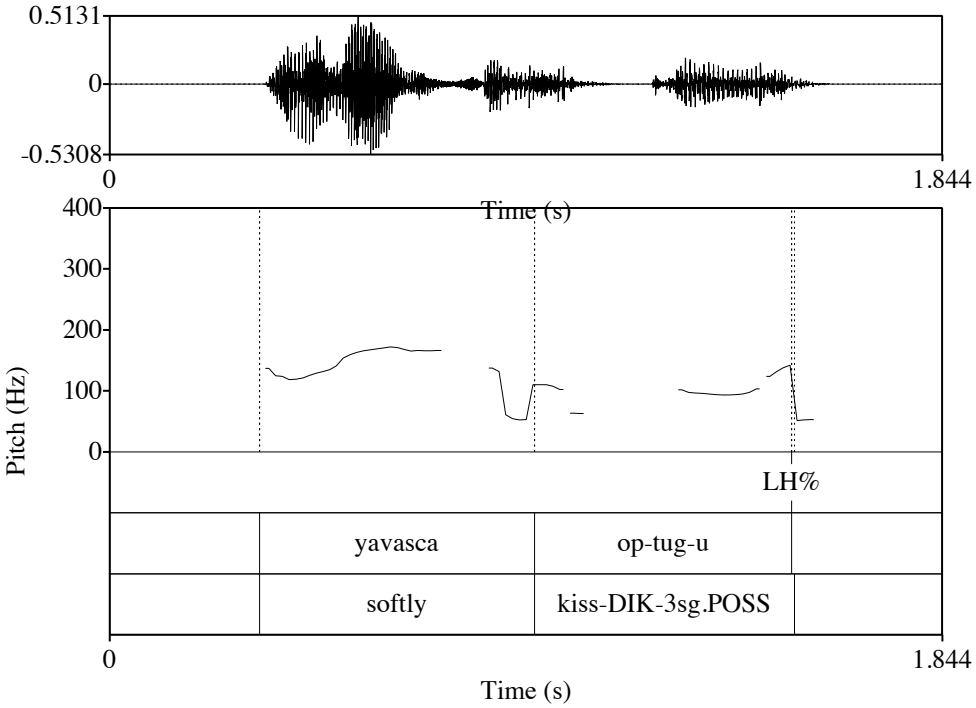


(a)

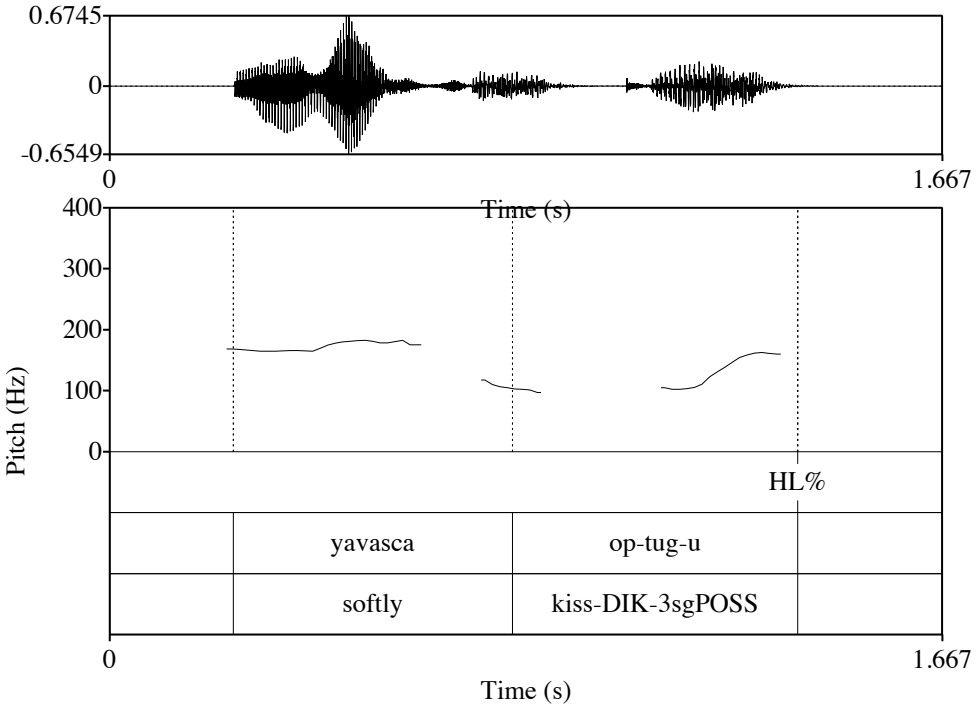


(b)

Figure 6.4: (a) Pitch Contour of the Relativized Verb of a Full Object RC (b) Pitch Contour of the Relativized Verb of a Headless Object RC



(a)



(b)

Indeed, children have been reported to be less sensitive to prosodic cues (Snedeker & Trueswell, 2003; Choi & Mazuka, 2003). These studies show that children rely more on lexical cues while assigning interpretation to strings that are locally or globally ambiguous.

However, considering the studies showing that infants start using the prosodic cues to segment speech into words as early as 6 months old (Jusczyk & Krumhansl, 1993; Morgan, 1996; and Johnson & Jusczyk, 2001; among others), one needs to be cautious while making strong conclusions without enough data. For the moment, it is sufficient to say that children might be showing a delayed effect of the local ambiguity at the point of relativized verb by showing a bias for the headless RC interpretation.

Thus, we leave the question as to whether this is actually due to children's limited sensitivity for the prosodic cues for future work. Moreover, whether adults would select the headless RC interpretation over the full RC interpretation in cases with zero prosodic cues (e.g., in a reading task) is another issue that needs to be examined. We leave these questions for further research that directly manipulates the effect of prosody and context on the interpretive tendencies of Turkish-speaking children and adults in locally ambiguous RCs.

6.3 Experiment 3d: When do Turkish-Speaking Adults Assign a Subject Role to a Relative Clause?

In the previous experiment, we found that adults preferred assigning the sentence-initial RCs the subject role; however, since we did not manipulate the location of the RC in the matrix clause we could not clarify whether this was due to the effect of the canonical word order or due to another factor.

We conducted another self-paced listening experiment only with the adult participants to investigate why parallel roles did not aid comprehension for Turkish speakers and to find out whether the canonical word-order information provides stronger cues for parsing than the role determinants in Turkish.

The Parallel Function Hypothesis predicted that SS structures would be performed better than OS structures; and OO structures would be performed better than SO structures regardless of the variation in the RC-Location or Word-Order.

Hakuta (1981) provided data against this hypothesis from Japanese. Testing all four variation, namely SS, OS, SO, and OO in SOV and OSV order as in (187) and (188), respectively in an act-out task, he found that SS and SO sentences were easier when they were presented

in the SOV order whereas OS and OO were easier when they were presented in OSV order. In addition to this, the participants did not benefit from the case markings on the NPs both within the RC and within the matrix clause. This led him to argue that the word order determines whether an RC would be perceived as the subject or object of the sentence and that configurational information has priority over the morphosyntactic cues in processing.

(187) a. [SubRC] N_{NOM} N_{ACC} V (SS)

b. [ObjRC] N_{NOM} N_{ACC} V (SO)

c. N_{NOM} [SubRC] N_{ACC} V (OS)

d. N_{NOM} [ObjRC] N_{ACC} V (OO)

(188) a. N_{ACC} [SubRC] N_{NOM} V (SS)

b. N_{ACC} [ObjRC] N_{NOM} V (SO)

c. [SubRC] N_{ACC} N_{NOM} V (OS)

d. [ObjRC] N_{ACC} N_{NOM} V (OO)

On the other hand, MacWhinney and Pleh (1988) claimed that parallel role strategy worked only for the subject role as it constituted the human perspective, in line with MacWhinney (1977), who locates the 'subject' category on perceptual grounds in a manner similar to Ertel (1974). According to them, the subject functions as the anchoring point in a construction of an utterance. Thus, sentences are tended to be constructed and perceived from the subject or 'ego' perspective.

If this tendency were true, one would expect that speakers would assign the RCs the subject role regardless of its location in the sentence. Indeed, this was how MacWhinney and Pleh (1988) interpreted their RC data from Hungarian.

In this experiment we will focus on the effect of word order to test the hypotheses by Hakuta (1981) and MacWhinney (1977).

6.3.1 Method

6.3.1.1 Participants

Only the adult participants reported in section 4.6.1 completed this task. We did not test the child participants as their results in the previous experiment suggested that we control for the

local ambiguity and prosody after the relativized predicate to successfully test the effect of parallel roles, which exceeds the scope of the present study.

6.3.1.2 Materials and Design

Similar to the previous study, we crossed the RC-Type (Subject vs. Object) and RC-Role in the matrix clause (Subject vs. Object) in an auditory moving-window task. In the previous experiment, all RCs appeared sentence-initially whereas in the present one they appeared as the second NP (henceforth: sentence-medial RCs) as illustrated in (189) and (190) below.

(189) a. *SS: Subject RC with the subject matrix role*

Segment 1 / Segment 2 / Segment 3
NP-ACC / NP-ACC / V-(y)An
Yavaş fil-i [[haylaz goril-i / hızlıca it-en]
slow elephant-ACC naughty gorilla-ACC / hard push-(y)An

Segment 4 / Segment 5
NP-NOM / V
güçlü aslan] / öp-tü.
strong lion-NOM / kiss-PAST
'The strong lion that pushed the naughty gorilla kissed the slow elephant.'

b. *OS: Subject RC with the object matrix role*

Segment 1 / Segment 2 / Segment 3
NP-NOM / NP-ACC / V-(y)An
Yavaş fil / [[haylaz goril-i / hızlıca it-en]
slow elephant / naughty gorilla-ACC / hard push-(y)An

Segment 4 / Segment 5
NP-ACC / V
güçlü aslan-ı] / öp-tü.
strong lion-ACC / kiss-PAST
'The slow elephant kissed the strong lion that pushed the naughty gorilla.'

(190) a. *SO: Object RC with the subject matrix role*

Segment 1	/ Segment 2	/ Segment 3
NP-ACC	/ NP-GEN	/ V-DIK-AGRPOSS
Yavaş fil-i	/ [[haylaz goril-in	/ hızlıca it-tiğ-i]

Slow elephant-ACC / naughty gorilla-GEN / hard push-DIK-3sgPOSS

Segment 4	/ Segment 5
NP-NOM	/ V
güçlü aslan]	/ öptü.

strong lion-NOM / kiss-PAST

'The strong lion that the naughty gorilla pushed kissed the slow elephant.'

b. *OO: Object RC with the object matrix role*

Segment 1	/ Segment 2	/ Segment 3
NP-NOM	NP-GEN	/ V-DIK-AGRPOSS
Yavaş fil	/ [[haylaz goril-in	/ hızlıca it-tiğ-i]

slow elephant / naughty gorilla-GEN / hard push-DIK-3sgPOSS

Segment 4	/ Segment 5
NP-ACC	/ V
güçlü aslan-ı]	/ öptü.

strong lion-ACC / kiss-PAST

'The slow elephant kissed the strong lion that the naughty gorilla pushed.'

The test stimuli consisted of 64 RCs that appeared as the second NP in the matrix clause and that were divided equally among four sentence types (Subject RCs with the subject role in the matrix clause -SS-, Subject RCs with the object role in the matrix clause -OS-, Object RCs with the object role in the matrix clause -OO-, and Object RCs with the subject role in the matrix clause -SO-). Only the adult participant participated in this experiment.

See section 4.6.1 for more details.

6.3.1.3 Procedure

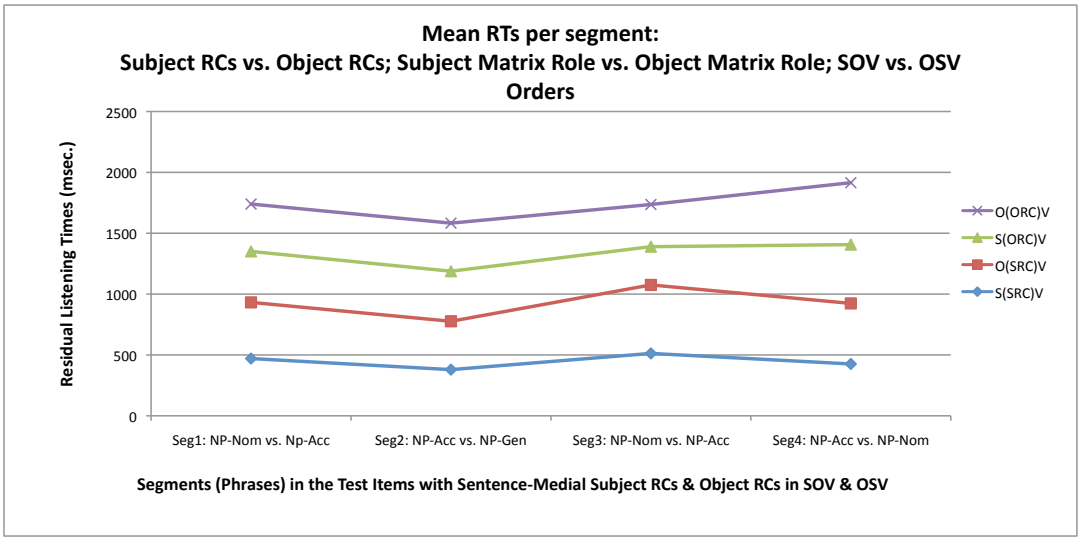
The procedure was the same as described in section 4.6.1.

6.3.2 Results

Segment 4 was the critical segment revealing the effect of the matrix role of the RC. However, we need to provide the analysis for all segments to see how each segment was processed

Figure 6.5: Segment-by-Segment RTs in Sentence-medial RCs with Subject and Object Matrix Role.

(O(ORC)V: Object + Object RC with the subject matrix role + Verb; S(ORC)V: Subject + Object RC with the object matrix role + Verb; (O(SRC)V: Object + Subject RC with the subject matrix role + Verb; S(SRC)V: Subject + Subject RC with the object matrix role + Verb



incrementally from the first segment onwards.[5]

Figure 6.5 displays the RTs in each segment in the items with the sentence-medial subject RCs and object RCs with the subject role and the object role in the matrix clause.

In Segment 1, to find out whether sentence-initial NP-Nominative and NP-Accusative are processed differently, we conducted a repeated measures ANOVA, with the Case-Marking (Nominative vs. Accusative) as within-subject factors for each RC-Type separately. According to this, there was no effect of case marking (nominative or accusative case) on the processing of sentence-initial NPs neither for subject RCs $F(1, 33) = .05$, $p > .05$ or object RCs $F(1, 33) = 1.41$, $p > .05$ (see Figure 6.5).

In Segment 2, we compared the processing of accusative versus genitive case on the second NPs. In these structures, the first NP was either the subject or the object of the matrix clause and the second NP was the first NP of the RC (i.e., accusative-NP or genitive-NP). A repeated-measures ANOVA was conducted with the RC-Type (Subject/Object) and Case-

[5]In the previous experiment in Section 6.2, we focussed only on the critical segments because the results regarding the first two segments were already reported in Chapter 4.

Marking (Accusative/Genitive) as within-subject factors. There was no effect of RC-Type F (1, 33) = .52, p > .52, no effect of Case-Marking F (1, 33) = .00, p > .05, and no interaction between the two F (1, 33) = 1.01, p > .05(see Figure 6.5).

In Segment 3, the predicate relativized with -(y)An or -DIK was presented. The repeated-measures ANOVA with the RC-Type (Subject/Object) and RC-Role (Subject/Object) as within-subject factor revealed a significant effect of RC-Type F (1, 33) = 40.18, p < . 001. According to the pairwise comparisons the participants showed longer RTs after the predicates relativized with -(y)An (537 ms.) compared to the ones relativized with -DIK (330 ms.). There was no effect of Case-Marking F (1, 33) = .92, p > .05; and no interaction between the RC-Type and Case-Marking F (1, 33) = .07, p > . 05 (see Figure 6.5).

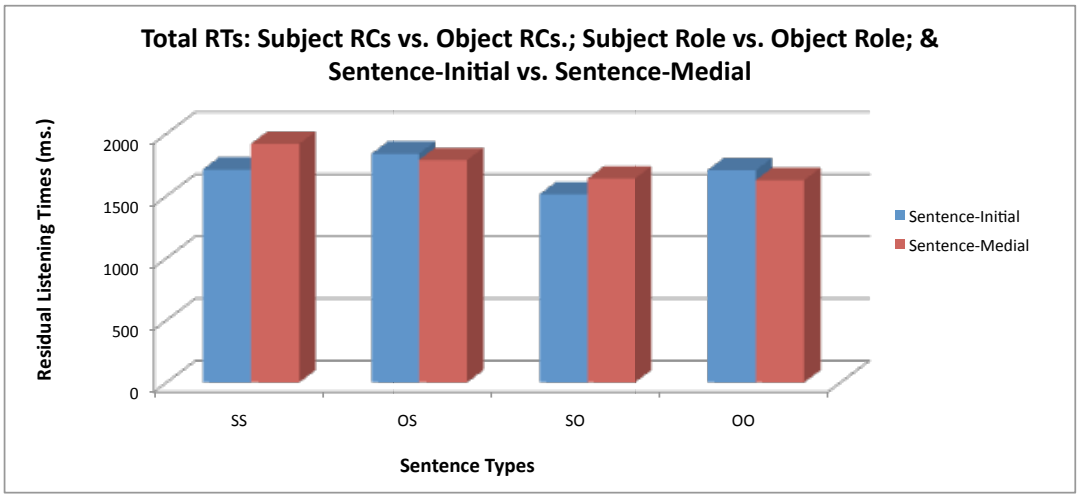
The critical segment (i.e., Segment 4) presented the RC head. The case marking cues on these head nouns revealed their role in the matrix clause. We conducted a repeated-measures ANOVA, with the RC-Type (Subject/Object) and RC-Role (Subject/Object) as within-subject factors for this segment. This revealed a significant effect of RC-role F (1,35) = 4.91, p < .05. Pairwise comparisons indicated that participants showed shorter RTs if the RC was marked in the accusative case compared to the nominative case, which demonstrates that Turkish speakers expect the sentence-medial RC to be in the object role since the RC appears as the second NP in the matrix clause. Recall that the same adult participants showed shorter RTs if the RC was marked in the nominative case compared to the accusative case when it appeared sentence-initially,(i.e., they expected the sentence initial RC to be in the subject role). Thus, the pattern presented in the experiment reported in Section 6.2 was (SS < OS) & (SO < OO) whereas it was (OS < SS) & (OO < SO) in the present experiment. Also, the statistics did not reveal a significant effect of RC-Type or an interaction between the RC-Type and the RC-Role (see Figure 6.5).

Finally, to see whether the effect of the position of the RC (sentence-initial vs. sentence-medial) would be reflected in the total RTs, we conducted a separate repeated-measures ANOVA for each RC-Type from the two experiments with the RC-Role (Subject/Object) and RC-Location (Sentence-Initial vs. Sentence-Medial) as a within-subjects factor.

Figure 6.6 displays RTs adults show at the critical segment (i.e., Segment 4) in sentence-initial versus sentence-medial subject RCs and object RCs with the subject role and the object role in the matrix clause.

The pattern revealed for both RC-Types was exactly the same: we did not find an effect of RC-Role (subject RCs: F (1, 33) = .002, p > .05; object RCs: F (1, 33) = 2.39, p > .05) or RC-Location (subject RCs: F (1, 33) = 3.02, p > .05; object RCs: F (1, 33) = .14,

Figure 6.6: RTs at Critical Segment (i.e., Segment 4) in Sentence-initial vs. Sentence-medial RCs with Subject and Object Matrix Role.
(OO: Object RC with the object matrix role; SO: Object RC with the subject matrix role; OS: Subject RC with the object matrix role; and SS: Subject RC with the subject matrix role)



p > .05) but we found a significant interaction between the two (subject RCs: F (1, 33) = 2.27, p < .05; object RCs: F (1, 33) = 5.32, p < .05). The pairwise comparisons with Bonferroni correction indicated that this interaction was due to the fact that RCs (both subject and object) with the subject role were performed better when they appeared at the sentence-initial position while the RCs with the object role were performed better when they appeared as the second NP (i.e., sentence-medial): SS-SentenceInitial (M = 1712 ms.; SD = 853) < SS-SentenceMedial (M = 1918 ms.; SD = 949), OS-SentenceInitial (M = 1838 ms.; SD = 918) > OS-SentenceMedial (M = 1788 ms.; SD = 793); SO-SentenceInitial (M = 1512 ms.; SD = 738) < SO-SentenceMedial(M = 1639 ms.; SD = 816), OO-SentenceInitial (M = 1706 ms.; SD = 728) > OO-SentenceMedial(M = 1627 ms.; SD = 765). This confirmed once more that the participants took the word-order into consideration when creating their expectations as to whether the RC will receive a subject or an object role.

6.3.3 Discussion

Results from the first segment did not reveal a significant difference between the sentence-initial NP-Nominative and NP-Accusative. This indicates that both NPs both with zero marking and with the accusative case are processed equally well when they appear as the first NP

in a sentence.

As for the second segment, we found no difference between the processing of accusative versus genitive case when each appeared on the second NP in a sentence. It has been underlined in Experiment 3a in Chapter 4 that sentence-initial genitive NP required longer RTs than sentence-initial accusative NP. The present findings suggest that the processor considers the position of each structure while interpreting it. Note that the NP in Segment 2 (i.e., NP-ACC in subject RCs and NP-GEN in object RCs) is preceded either by a nominative or accusative NP. This might have led the parser to rank the subject role of the genitive case higher than its possessor role more quickly than it did in Experiment 3a (i.e., the cases where NP-GEN appeared sentence-initially). Similarly, the processing time for the accusative marked object of the RC in Segment 2 seem to have increased when the preceding NP was also marked in the accusative case. This might have decreased the difference between the accusative and genitive case that was observed in Experiment 3a. This means morphosyntactic and configurational information complement each other to guide the interpretation assignment.

On the other hand, longer RTs after the predicate relativized with -(y)An compared to -DIK in Segment 3 confirms our finding in Experiment 3a in Chapter 4. Here too, the accusative case was less able to guide the parser to expect a relativized verb compared to the genitive case (for more discussion, see Section 5.3.3 and 5.3.4).

RTs in the critical segment (i.e., Segment 4) demonstrated that participants tended to assign the object role to the RCs that appeared as the second NP in the matrix clause. In Experiment 3c in Section 6.2, our adult participants interpreted sentence-initial RCs as the subject of the matrix clause. This indicates that the parser takes into account the position of the RC in the matrix clause while assigning it a role. When a relativized NP appears as the first NP in the matrix clause, it is more likely to receive the subject role; when it appears as the second NP, it tends to receive the object role.

Thus, the results from the critical segment (i.e., Segment 4) are in line with the pattern displayed in Hakuta's off-line act-out task. Thus, word-order cues seem to be guiding interpretation better than the parallel-role cues in languages with variable word order such as Turkish and Japanese.

However, Hakuta also claims that configurational features of Japanese provide better contribution to parsing compared to morphosyntactic cues. Indeed, there was an initial NP with the nominative or accusative case (i.e., subject or object of the matrix clause) preceding the RCs in our sentence-medial RCs. Had these cues been as effective as word order in guiding the role assignment, the findings would have revealed no effect of RC-Role. To illustrate,

having heard an NP-ACC sentence-initially, the participants should have formed an expectation for another NP that is in the subject role and they should have assigned the RC a subject role. Similarly, having heard a sentence-initial nominative NP, the participants should have predicted a second NP with the accusative case and they should have assigned the RC the object role. This was not observed neither in Hakuta's nor in our experiment.

Nevertheless, we think that the conclusion that word order is a better determinant than morphosyntax is too broad a generalization with the following reasoning. In Chapter 8, we will show that children benefit from the accusative case as a reliable cue to assign the object role. However, as it will be clear, we kept the length of our test sentences very short in the task in Chapter 8 to limit the number of propositions and extra arguments. In the present experiment, on the other hand, the participants dealt with more complex structures consisting of two propositions and four arguments. Each sentence-initial NP was followed by another NP and a relativized verb as shown in (191). The same was true for Hakuta's experiments.

(191) a. NP$_{ACC}$ [NP$_{ACC}$ V-(y)An] NP$_{NOM}$ V

b. NP$_{NOM}$ [NP$_{ACC}$ V-(y)An] NP$_{ACC}$ V

c. NP$_{ACC}$ [NP$_{GEN}$ V-DIK-3SGPOSS] NP$_{NOM}$ V

d. NP$_{NOM}$ [NP$_{GEN}$ V-DIK-3SGPOSS] NP$_{ACC}$ V

In these structures the processor is expected to assign a role for the relativized NP that is preceded by two other NPs. It has to keep these NPs and one relativized verb in memory before assigning a role to the relativized NPs. Therefore, we suggest the participants' inability to use the case marking cues on the sentence-initial NPs might be related to the extra processing cost due to the number of arguments in these structures. It appears that the word order cues were more prominent because of the length in this experiment.

Moreover, it is important to note that our child participants did not assign the first NP the agent role in our off-line comprehension task in Chapter 3 and Chapter 8. The reasoning we follow is that the children did not use the word order cues most probably due to the genitive case that appeared on the sentence-initial NPs. That is, the fact that the genitive case is ambiguous between a possessor and a subject might have diminished the effect of the word order and prevented the participants to attach this NP the subject role.

This brings us to the conclusion that the processor uses every information eagerly and incrementally as much as competing constraints allow. The position of a lexical item, the

context in which it appears, its prosody and many other factors seem to shape the way it is being processed. It is only when the multiple unambiguous cues successfully converge that the flow of processing is smooth and problem-free.

6.4 Summary

In this chapter, we presented two experiments to test the Parallel Function Hypothesis, according to which the processing of a complex structure would be easier when the syntactic role of the NP in the embedded clause is the same in the matrix clause, compared to the cases when it has different roles in each clause. Children attended only the first of these experiments (i.e., Experiment 3c). The data from this experiment did not support the Parallel Function Hypothesis but showed that adults assigned the RC a subject role when it appeared as the first NP in the sentence. Children showed the same pattern one segment later than adults. We conjectured that this difference between children and adults could be due to slower processing speed in children compared to adults or due to their limited sensitivity to prosodic cues.

In Experiment 3d, the adults tended to assign the RC the object role when the RC appeared as the second NP in the sentence. We discussed these results in the light of the Parallel Function Hypothesis and Perspective Hypothesis and showed that neither received support. Instead, we argued that the participants focused on the order of NPs while assigning them a role in complex sentences with several arguments, which is in line with Japanese data from Hakuta (1981).

CHAPTER 7

PROCESSING OF GENITIVE-POSSESSIVE AGREEMENT MORPHOLOGY

7.1 Introduction

In Kükürt (2004), we attributed the difficulty in the comprehension of object RCs to the genitive-possessive agreement morphology. We suggested that adults with Broca's aphasia and children might be having difficulty in processing the agreement marker following the object relativizing morpheme -DIK.

Our elicitation task in Chapter 3.3 revealed that children avoided using the object RCs in their utterances. We showed that they mostly omitted the genitive case and the possessive-agreement morpheme in their erroneous utterances. They replaced the genitive case with the nominative case and they replaced -DIK-3SGPOSS with -(y)An. However, we also underlined that whenever they started their utterance with the genitive morpheme, they completed the structure in a grammatical way.

Similarly, in Chapter 4, we reported that the processing of the sentence-initial genitive NPs required longer listening times compared to the sentence-initial accusative NPs. We showed that the processing of the object relativizing morpheme and possessive-agreement morphology was accelerated once the genitive case was processed. However, in our auditory moving-window task, our participants were free to adjust their pace while listening to the sentences. This might have ensured the processing of the genitive case, which in turn facilitated the processing of the possessive-agreement morphology. Thus, we still do not know whether the genitive case and the possessive agreement morphology are processed with ease in the course of natural speech stream. The aim of the present experiment is to test the effect of possessive agreement morphology on the processing of RCs.

7.2 Experiment 4: Genitive-Possessive Agreement Morphology in the Processing of Turkish Relative Clauses in Monolingual Children and Adults

7.2.1 Method

7.2.1.1 Word Monitoring Task

We employed a word-monitoring task based on Marslen-Wilson and Tyler (1980). The task presents stories consisting of two sentences. The first sentence functions as a contextual lead-in and the second sentence involves the critical item with the genitive-possessive agreement morpheme. In half of these items the possessive agreement morphology is omitted, rendering the sentences ungrammatical. In this task, participants are required to monitor for a word specified (both visually and orally) at the beginning of each story and press a pre-specified button as soon as they hear this word in the story. The location of these critical words is instructive in evaluating the on-line processing of the target structure. They appear right after the target item that is either grammatical or ungrammatical and the program measures the time from the onset of the word until the button-press. The idea behind the task is that it takes longer for participants to detect the target word when it appears after the ungrammatical structure compared to the grammatical one. That is, if the participants have no problems in processing the genitive-possessive agreement morphology, they should have no difficulty detecting the ungrammaticality caused by the missing agreement morphology by showing longer RTs after the target word in ungrammatical versions compared to the grammatical ones. However, if there is no reaction time difference between the grammatical and ungrammatical condition, this would indicate that they fail to detect the missing morpheme.

7.2.1.2 Participants

36 child participants that took part in the previous experiments successfully completed this task, and 36 undergraduate students from the Middle East Technical University participated as a control group. Please see the method section of Chapter 3, where we provide information about the participants.

7.2.1.3 Materials and Design

There were two structures we wanted to test, namely object RCs and possessive NPs. We wanted to see whether children at the age of 5-8 were sensitive to the ungrammaticalities arising due to the omission of the possessive agreement morphology in those structures.

The experimental stimuli consisted of 36 stories divided equally among two sentence types, namely the object RCs and possessive NPs. Each item was presented in a story made up of two sentences as exemplified in (192). The first sentence served as a lead-in that set the context and introduced the characters. The second sentence presented the test items. The test items included a critical point with the specific linguistic item to be tested (i.e., agreement morphology). In half of the sentences, we omitted the possessive-agreement marker, as exemplified in (192b, d), which caused an ungrammaticality. Each critical item was followed by a target word and participants were told to monitor for this word while listening to the stories. Four of the stories from each condition were followed by a comprehension question related to the lead-in or the critical part of the story to make sure the participants were paying attention to the task.

(192) a. *Object RC-Grammatical*
Target Word: Ayı
Lead-in: Ormandaki diğer hayvanlar aslanlardan çok korkarlarmış.
'Animals in the forest were really afraid of lions.'
Test sentence: Kral aslanın yanlışlıkla **tekmelediği** bir *ayı* korkudan titremeye başlamış.
'A bear that the king lion kicked by mistake started to shake out of fear.'

b. *Object RC-Ungrammatical*
Target Word: Ayı
Lead-in: Ormandaki diğer hayvanlar aslanlardan çok korkarlarmış.
Test sentence: Kral aslanın yanlışlıkla **tekmeledik** bir *ayı* korkudan titremeye başlamış.

c. *Possessive NP-Grammatical*
Target Word: Kitap
Lead-in: Bir gün aslanlar okulda hızlı okuma yarışmasına katılmışlar.
'One day some lions participated in a fast-reading contest at school'
Test sentence: Kral aslanın yakın **arkadaşı** bir *kitap* kazanmış.
'A close friend of the king lion won a book.'

d. *Possessive NP-Ungrammatical*

Target Word: Kitap

Lead-in: Bir gün aslanlar okulda hızlı okuma yarışmasına katılmışlar.

Test sentence: Kral aslanın yakın **arkadaş** bir *kitap* kazanmış.

There were 18 fillers of various structures and 18 catch trials that did not include a target word. As in the experimental items, filler items and catch trials were distributed over two conditions: grammatical and ungrammatical. There were 10 additional items presented at the beginning of the task as a practice.

The whole task was divided into 2 sessions consisting of 18 test items, 18 fillers and 18 catch items (56 items in total per session). The test was pseudo-randomised so that the items of the same type did not appear consecutively and the grammatical and ungrammatical version of the same item did not appear in the same session. There was at least a two-week interval between each session of the experiment.

Each lead-in sentence ranged between 18-22 syllables and each sentence ranged between 26-44 syllables. In the test items there were 3 critical words: the NP in genitive case, the critical word with the possessive-agreement morpheme, and the target word. We controlled for the location of each critical word. The genitive NP appeared either as a 2nd or 3rd word of each sentence. The critical word with/without the possessive-agreement morphology appeared as the 4th word and the target word systematically appeared as the 7th word. We also controlled for the number of syllables in each critical word. The genitive NP ranged between 2-3 syllables, the word with the critical point ranged between 3-6 syllables, and the target word ranged between 2-5 syllables. In the filler items, the target word appeared in various positions (as the 4th, 8th, or 9th word) to prevent participants from developing a response pattern. In the catch trials, the participants heard and saw a target word at the begining of the story but the story-teller did not use this word in her story. This prevented random button pressing and ensured that participants fully attended to the task.

All of the RCs were restrictive. In all cases, the relativized NP was indefinite and it systematically appeared in the subject role in the matrix clause.

Possessive NPs employed a simple possessor NP + possessed NP structure. Possessor NPs were all common nouns with [+ animate] and [- human] features. All of the possessed NPs had [+ animate] and [+ human] features such as teacher, friend, and sibling.

All of the verbs in the experimental conditions denoted a willingly performed action, which assigns the subject NP the agent role and the object NP the patient role (e.g., it-

push, öp-kiss, kovala-chase, tekmele-kick, gıdıkla-tickle, ısır-bite). All of the nouns in the experimental conditions denoted a concrete, animate, and singular entity (e.g., kedi-cat, maymun-monkey, kuzu-lamb, ördek-duck, tavşan-rabbit, tavuk-chicken, aslan-lion, ayı-bear, fil-elephant, at-horse, deve-camel, and inek-cow).

Finally, all of the target nouns also denoted a concrete, inanimate, and singular entity (e.g., çikolata-chocolate, dondurma-ice-cream, elma-apple, anne-mother, hediye-present, uçurtma-kite, telefon-telephone, and sopa-stick). Some of the NPs appeared in accusative case. Some of the target words in the filler items were plural. Half of the catch trials resembled the test items in that they included an indefinite NP as the 6th or 7th word, preceded by an indefinite marker 'bir' (e.g., bir araba - a car) but they were different from the pre-specified target words. This prevented participants from predicting the appearance of the target word after the indefinite article 'bir' in the test items.

All lexical items were controlled for age of acquisition, imageability, number of syllables, semantic reversibility, and position in the sentence. For the frequency, imageability, and age of acquisition of the lexical items, we used an English database (Bird, et. al., 2001) like we did for our previous experiments.

A female native speaker read the stimuli sentences and a male speaker read the questions in a soundproof speech booth. The stories were recorded with natural prosody and each was saved as a waveform file. The stimuli was presented and controlled by an HP-Laptop. We used a button-box to gather the responses and the e-prime software (Schneider, Eschman, and Zuccolotto2002) to measure and record the reaction times (RTs) (i.e., the time between the onset of the target word and button-press).

7.2.1.4 Procedure

Each participant was tested individually in a quiet room. They were asked to listen to each story to answer the comprehension question and at the same time monitor these stories for a target word that is specified at the beginning of each story. They were told that some of the stories will include the target word and they were required to press a specified button as soon as possible if they hear the word. They were told that they will be scored both on the basis of their responses to the comprehension questions and their detection of target words.

The child participants were told the following story at the beginning of the task: Ayşe is a girl who has lots of short stories about animals in the forest. Ayşe tells these stories to a friend of hers, Ali. Ali sometimes does not remember what happens in the stories and asks

some questions. There are two tasks you need to complete in this game. Your first task is to listen to each story carefully to answer Ali's questions. You need to understand all the details about the story so that you get all your answers correct. Also, Ayşe will tell you a word before each story, she will also show you the picture of this word. Sometimes she will use this target word in her story, sometimes she will not. Your second task is to listen very carefully to find out if the target word will appear in these stories. If you hear the target word in the story, press the yellow button as quickly as possible. Remember some stories do not have the target word. Do not press the button if you don't hear the word and wait for Ali's question. Before the practice items, the children's comprehension of the instructions were checked with these questions: 1- Why do we listen to Ayşe's stories carefully? (To answer Ali's questions.) 2- When do we press the yellow button? (When we hear the target word.) 3- How do we know which word to monitor? (Ayşe tells us which word to monitor and she shows us its picture before each story.) 4- What do we do if Ayşe does not use the word in the story? (We should not press the button and wait for the next story.) Also, they were reminded of the rules during the practice items if necessary.

The whole task, which consisted of 112 items in total was presented to the child participants as a repeated-measures design: all child participants took both sessions at a minimum of two-week interval. And adults completed a between-group design version of the task (i.e., each session of the test was performed by a different adult participant).

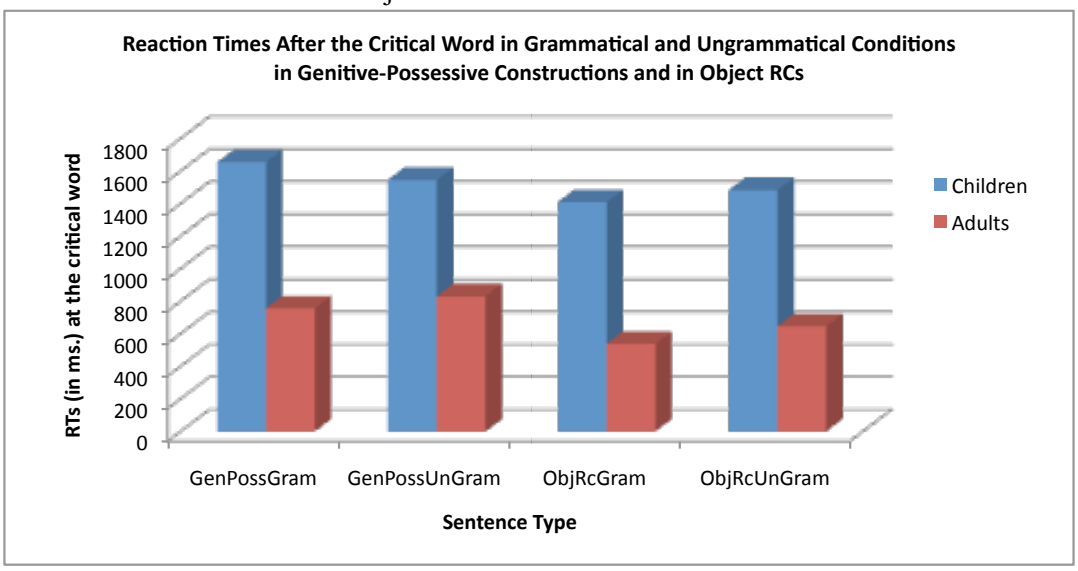
7.2.2 Results

We conducted a repeated-measures ANOVA with the Sentence Type (Possessive NPs and Object RCs) and Grammaticality (Grammatical and Ungrammatical) as a within-subjects factor for each group (adults and children) separately.

Figure 7.1 displays the reaction times after the critical word in grammatical and ungrammatical conditions in the genitive-possessive constructions and object RCs in children and adults.

For adults, the effect of both sentence type $F(1, 35) = 112.10$, $p < .001$ and grammaticality $f(1, 35) = 26.58$, $p < .001$ was significant. Pairwise comparisons with Bonferroni correction showed that the target words were detected more more quickly in object RCs (591 ms.) than in possessive NPs (793 ms.), $p < .001$; and they were detected more quickly in grammatical versions (646 ms.) than in ungrammatical ones (737 ms.), $p < .001$. Finally, there was no interaction between the sentence type and grammaticality $F(1, 35) = 1.17$, $p > .05$. Thus, the

Figure 7.1: RTs at Critical Word in Grammatical and Ungrammatical Conditions in Genitive-Possessive Constructions and Object RCs



effect of grammaticality was consistent both for object RCs (Grammatical: M = 537 ms., SD = 122; Ungrammatical: M = 645 ms., SD = 155) and possessive NPs (Grammatical: M = 756 ms., SD = 145; Ungrammatical: M = 829 ms., SD = 161).

Figure 7.2 displays the reaction times after the critical word in grammatical and ungrammatical conditions in the genitive-possessive constructions in children and adults.

Figure 7.3 displays the reaction times after the critical word in grammatical and ungrammatical conditions in object RCs in children vs. adults.

For children, on the other hand, there was a significant effect of sentence type $F(1, 34) = 11.12$, $p < .05$ while the effect of grammaticality did not reach significance $F(1, 34) = .13$, $p > .05$. The pairwise comparisons showed that children were able to detect the target word more quickly in object RCs compared to possessive NPs. However, the interaction between the sentence type and grammaticality did approach significance $F(1, 34) = 4.39$, $p = .04$. That is, overall the difference between grammatical and ungrammatical sentences was not significant for neither of the sentence types but the children showed slightly longer RTs after the ungrammatical version of the object RCs (Grammatical: M = 1408 ms., SD = 637; Ungrammatical: M = 1482 ms., SD = 610) whereas they showed the opposite pattern in Possessive NPs (Grammatical: M = 1653 ms., SD = 673; Ungrammatical: M = 1545 ms., SD = 579), which caused the interaction between the sentence type and grammaticality.

Figure 7.2: RTs at Critical Word in Grammatical and Ungrammatical Conditions in Possessive NPs.

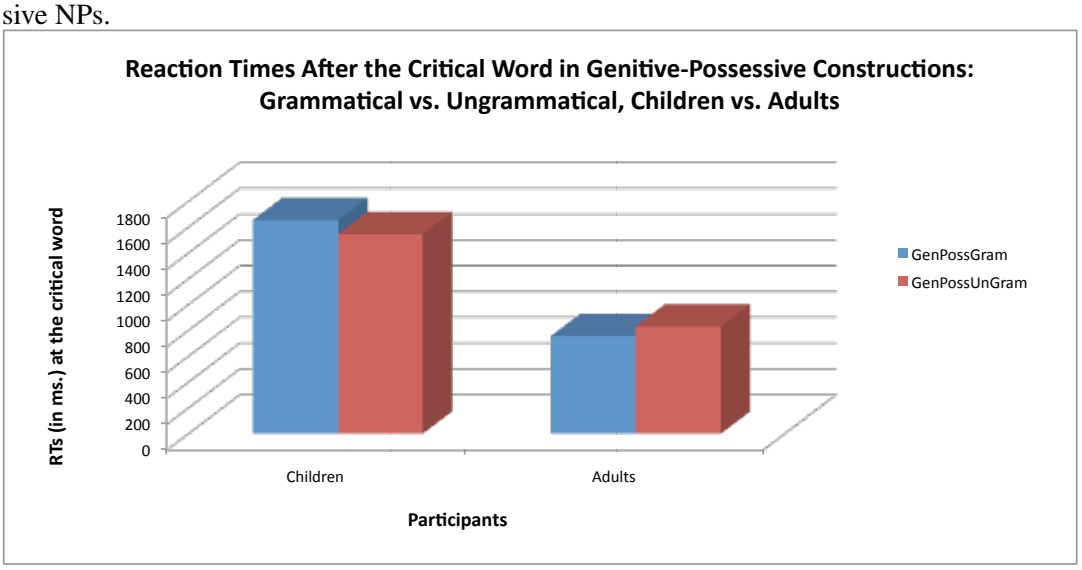
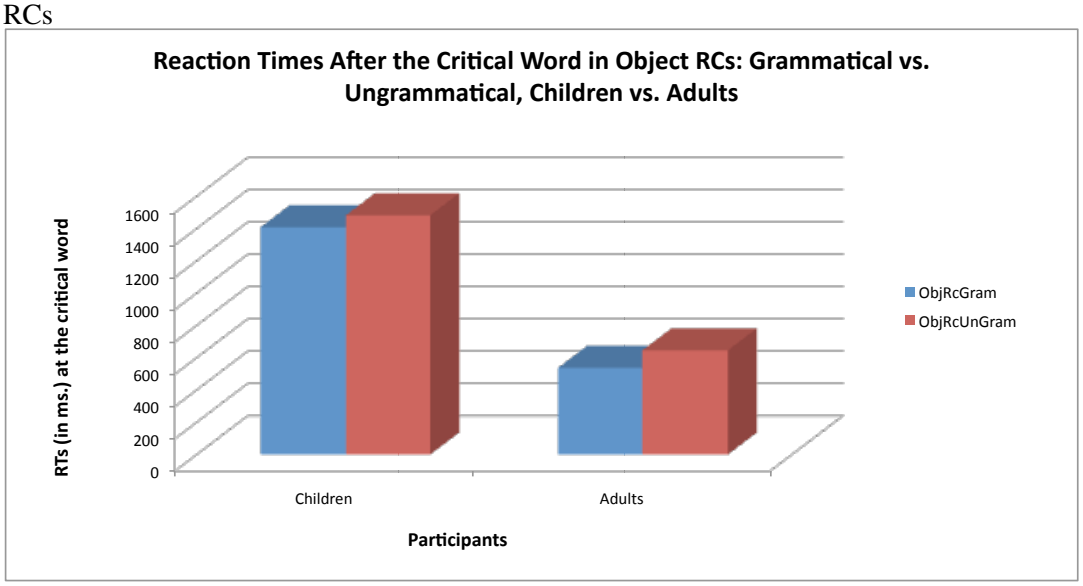


Figure 7.3: RTs at Critical Word in Grammatical and Ungrammatical Conditions in Object RCs



7.2.3 Discussion

The results showed that children did not present similar patterns to adults in the processing of genitive-possessive agreement morphology in object RCs and possessive NPs in a task that presents the test items in a normal speech stream. It took adults longer to press the button after the target word in ungrammatical versions of both structures whereas children did not show this effect. This indicates that while adults were able to detect the ungrammaticalities caused by the missing agreement marker, children were not.

This is fully in line with Kükürt (2004) predictions and our reasoning in Section 7.1. That is, there seems to be an effect of possessive agreement morphology on the problematic processing of object RCs by children.

This difficulty might also be stemming from the genitive case rather than the possessive-agreement morphology. It might be the case that children failed to detect the genitive case in a normal speech stream because the distinction between the accusative case '-i' and the genitive case '-in' might not be fully salient for them. This is also in line with our production task in Chapter 3.3 and our auditory-moving window task in Chapter 4. The former showed that children avoided the object relativizing strategy and rarely used these structures. Yet, they never made errors in possessive-agreement morphology in their utterances once they started their utterances with the genitive case. And, the latter showed that the processing of the sentence-initial genitive case was difficult but once it was successfully processed, the processing of possessive-agreement morphology was significantly facilitated.

Thus, combining the results from the two on-line tasks as well as the production study, it is highly possible that the real-time processing of the genitive case takes time and this prevents children from recognizing the missing agreement morphology in possessive phrases and object RCs.

Of course, further research using finer-grained methods such as the ERPs (i.e., event-related potentials) could provide a greater insights in this issue. The word monitoring task certainly works with adults since it revealed the expected patterns; however when it comes to children's processing, one should always reconsider the task demands. That is why, we suggest the same task is conducted with ERPs. If children are actually able to process the ungrammaticalities in the genitive-possessive agreement morphology, ERPs might provide a more sensitive measure of this (i.e., one should detect a peak in electrical brain activity after the stimulus with ungrammaticality).

Still, all three tasks we have reported so far (i.e., production, auditory-moving window,

and word-monitoring tasks) point towards the same direction: the genitive case, to a great extent, seems to bear the morphosyntactic responsibility for the subject-object asymmetry in Turkish RCs.

7.3 Summary

In this chapter, we tested the effect of genitive-possessive agreement morphology on the processing of object RCs. To do this, we employed two different structures, namely object RCs and possessive-NPs, both of which have genitive-possessive agreement morphology. We used the Word-Monitoring Paradigm that measures the participants online reactions to ungrammaticalities in a sentence. Half of each type of sentences were rendered ungrammatical via the omission of the possessive-agreement morphology and participants were asked to monitor for a target word by pressing the response button as soon as hearing the pre-specified word in the sentence. The prediction was that the RTs to detect the target word would take longer after the ungrammatical version of the sentence compared to its grammatical version. The adults showed the expected pattern of RTs whereas children did not show the effect of grammaticality in these structure. This confirms the effect of genitive-possessive agreement morphology on the processing of object RCs.

CHAPTER 8

STRATEGIES IN THE COMPREHENSION AND PRODUCTION OF TURKISH RELATIVE CLAUSES IN MONOLINGUAL AND BILINGUAL CHILDREN

8.1 Introduction

The findings we have reported so far suggest that the mechanisms children and adults employ in language processing are not qualitatively different from each other. It appears that similar processing constraints (e.g., whether a lexical item is ambiguous or not, whether a lexical item could easily compose with a verb to form a sentence, whether a lexical item is a composite structure, frequency with which a lexical or morphological item appears in certain environments, and so on) seem to influence both children and adults though at different degrees and that they both process (i.e., parse and encode speech) in an incremental manner as soon as each lexical and morphological item become available.

However, the question arises as to why children present significant difficulties in certain structures if they are actually influenced by similar factors to adults. One factor might be children's limited memory span, which put them in disadvantage while processing spoken sentences in real-time (for review see Baddeley, 2003; King and Just, 1991). Similarly, studies show that children have poor executive function abilities (i.e., goal-directedness, mental-flexibility, effective inhibition, and planning), which might also limit children's language abilities (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002; Novick, Trueswell, & Thompson-Schill, 2005; Choi & Trueswell, 2010). Alternatively, children might be relying on reliable cues of their language (e.g., word-order in English and morphosyntax in highly agglutinating languages like Turkish, Japanese, and Korean), hence employ a restrictive repertoire of linguistic cues to guide their parsing commitments (Bates & MacWhinney, 1987).

All these factors might be affecting language processing in certain ways. Our aim in this chapter is not to dissociate between them but it is rather to focus on the strategies monolingual and bilingual children use in their comprehension and production of sentences involving RCs.

Our data so far have revealed that monolingual children display subject preference both in comprehension and production and that they take into consideration both case marking and word order cues to certain degrees in their processing of Turkish RCs. Yet, we have also demonstrated that some morphosyntactic cues take longer to process than others (e.g., genitive versus accusative case) and that the same asymmetry is observed in production, too. That is, children have avoided using the genitive case as a subject case in their responses. On the other hand, certain case marking cues have been shown to be a better guide than word order cues in comprehension while both cue types seem to be utilised by monolingual children in their production.

In this chapter, we will report data revealing the performance of Turkish-English bilingual children who live in London in the off-line tasks reported in Chapter 3 in comparison to Turkish monolingual children. We will explore whether or not bilingual children present similar patterns of performance to their age-matched monolingual peers as far as their first language (i.e., Turkish) is concerned and we will specifically focus on the comprehension and production strategies both monolingual and bilingual children employ. We know that English-speaking children dominantly use word order cues while assigning theta-roles in complex sentences (Bever, 1970). It is not clear whether or not the same is true for Turkish children considering the fact that word order cues might not be as reliable in Turkish as it is in English due to the word order variation (cf., Slobin & Bever, 1982). Furthermore, Turkish provides richer morphosyntactic cues than English. Thus, it might be the case that Turkish children benefit more from the inflectional cues rather than word order cues.

The research about the first language acquisition in children born to families living outside of Turkey has been very limited. Verhoeven and Boeschoten (1986) showed that Turkish-Dutch bilingual children, whose exposure to Dutch starts only after the age of 4, did not significantly differ from their age-matched monolingual peers at the age of 5 in terms of their lexical, morphosyntactic, and pragmatic development of Turkish whereas they showed poorer performance at the age of 7, indicating that their first language development had been influenced from the input they received in Dutch.

In a recent study, Yağmur and Nap-Kolhoff (2010) show that many Turkish-Dutch successive bilingual children have lower scores on the Turkish SALT (Acarlar & Johnston, 2006) compared to monolingual norms. Similarly, Jong, Çavuş, and Baker (2010) report that in an

elicitation task, Turkish-Dutch TD children omit the genitive possessive marker and underlines that the use of the genitive possessive may be undergoing change in Turkish spoken in the Netherlands. Yet, Marinis and Özge (2010) provide data from Turkish-English children who live in London concerning their receptive skills in Turkish using the Turkish Test of Early Language Development (TELD-3-T) (Topbaş & Güven, 2007) and report that Turkish-English bilingual children do not significantly differ from their monolingual peers in terms of their receptive skills although they perform at lower rates.

To our knowledge, there have been no studies systematically investigating the comprehension or production of Turkish RCs in bilingual children with Turkish as their L1. In that respect, this study might provide some insights about the developmental patterns presented by bilingual children in their first language and about language acquisition in general.

8.2 Experiment 5: Strategies in the Comprehension of Turkish Relative Clauses in Turkish Monolingual and Turkish-English Bilingual Children

A great deal of research in child language has focused on the strategies the parser applies to compensate for the difficulties in processing complex structures. For instance, Bever (1970) suggested that English-speaking children use simple heuristics to interpret passive sentences. According to this, they take any 'sequence within a potential internal unit in the surface structure' as 'actor-action-object' (p. 298). In an SOV language this schema would be 'NNV', the first NP being the agent or the subject. We will call this heuristic the Canonical Word Order Strategy.

To test cross linguistic plausibility of the Canonical Word Order Strategy among children, Slobin and Bever (1982) analyzed a variety of languages allowing degrees of freedom in word order and inflection (i.e., English, Italian, Serbo-Croatian, and Turkish), and argued that children internalized the most powerful regularities of their language such as inflection or word order while still making use of canonical sentence schemas whenever the inflectional cues were not available. Later, MacWhinney, Pléh, and Bates (1985) confirmed this pattern for Hungarian showing that processing strategies were chosen depending on the strength of the linguistic cues available and that children tended to assign the first noun the agent role when there was no case marking information. We will call this the Case-Marking Strategy.

Based on her data from typically-developing children and adults with Broca's aphasia,

Kükürt (2004) adopted a language specific approach to account for the asymmetry between subject and object RCs. She proposed two possible heuristics for Turkish speakers, namely the pre-verbal strategy, which selects the NP that is in the pre-verbal position as the patient and the Accusative-Object (Acc-Obj) Strategy, which assigns the patient role to the NP with the accusative case. The former makes the prediction that the preverbal strategy might be the word order strategy Turkish speakers employ as it preserves the OV ordering. We have shown in Chapter 4 that monolingual children consider OV structure as a complete sentence so this might indeed have some effect on the processing of RCs. The latter is in line with the case-marking strategies, yet it points to an asymmetry between the accusative case and the genitive case in Turkish by highlighting that certain case marking cues might pose more processing difficulties compared to others. The experiment in Chapter 4 has revealed that both children and adults process sentence-initial NP-ACC faster than sentence-initial NP-GEN, hence it has provided online support for this idea.

The question we address in this section concerns the grammatical-role assignment strategies among Turkish-speaking monolingual and bilingual children. We will evaluate the the Canonical Word Order Strategy, Case-Marking strategy, and the Acc-Obj strategy in the comprehension of Turkish RCs.

In Turkish, both RC types have non-canonical ordering of lexical items. While the subject RC has OVS (193a), the object RC has SVO ordering (193b) (cf., SOV declarative in (193c)). In this case, if the first NP is taken as the agent as a default strategy, in line with agent-first strategy (e.g., Bever, 1970), we should anticipate better performance in object RCs which hosts a sentence-initial subject NP marked in the genitive case compared to subject RCs hosting an accusative marked NP.

(193) a. *Subject RC:*

Kadın-ı vur-an hırsız

Woman-ACC shoot-(y)An burglar

'The burglar that shot the woman.'

b. *Object RC:*

Kadın-ın vur-duğ-u hırsız

Woman-GEN shoot-DIK-3SG.POSS burglar

'The burglar that the woman shot.'

c. *SOV Declarative:*

Kadın hırsız-ı vur-du

Woman-NOM burglar-ACC shoot-PAST

'The woman shot the burglar.'

On the contrary, if morphological cues provide stronger cues for Turkish speakers and if both the accusative and the genitive case have equal cue strength, we should not find a significant difference between the two RC Types since both have sentence-initial NPs with case marking: sentence-initial accusative NP in subject RCs (193a) correctly marks the object and sentence-initial NP with the genitive case in object RCs (193b) correctly marks the subject in the RC. Indeed, the NP with the genitive case might have a higher chance of being selected as a subject both for its case marking and configuration.

As for the Acc-Obj Strategy, sentences with accusative marked object NPs as in (193a) should lead to a better performance compared to the ones that have null case marking on the object NP as in (193b).

Summarizing, if sentence-initial NPs are selected as the subject, then object RCs should be performed better than subject RCs. If all case-marking cues have equal strength in determining the grammatical roles, there should be no difference between the two RCs since the sentence-initial accusative case in subject RCs marks the object and sentence-initial genitive case marks the subject. However, if the accusative case is a stronger cue than the genitive case, subject RCs should lead to better performance.

To test the canonical-order, case-marking, and Acc-Obj strategies, we varied the structure within which we presented the RCs: we presented the test items either within an imperative sentence or within a question as described in (194).

(194) a. *Object RC presented within an imperative sentence:*

Deve-nin it-tiğ-i at-ı göster.

Camel-gen push-dık-poss3sg horse-acc show

'Show me the horse that the camel is pushing.'

b. *Object RC presented within a question:*

Hangi-si deve-nin it-tiğ-i at?

Which camel-gen push-dık-poss3sg horse

'Which one is the horse that the camel is pushing?'

c. *Subject RC presented within an imperative sentence:*

Deve-(y)i it-en at-ı göster.

Camel-acc push-(y)An horse-acc show

'Show me the horse that is pushing the camel.'

d. *Subject RC presented within a question:*

Hangi-si deve-(y)i it-en at?

Which-3sgPOSS camel- push-(y)An horse

'Which one is the horse that is pushing the camel?'

If the Acc-Obj strategy make correct predictions, then the success rate in object RCs should be higher in imperatives than in questions. This is because in imperatives, the object of the RC (i.e., 'atı', 'horse-ACC') functions as the object of the matrix clause and it is marked in the accusative case, as shown in (194a) above. On the other hand, in questions, the object of the RC (i.e., 'at', 'horse') is the subject of the matrix clause and does not have the accusative case marking, as shown in (194b).

8.2.1 Methods

8.2.1.1 Participants

25 Turkish-English bilingual children aged 5-8 participated in this study.

All children were born to Turkish-speaking families in London (except one child who moved to the UK at the age of 6) and the medium of communication at home was reported to be Turkish since most of the mothers had poor English skills. Although the children lived in the UK, they were not exposed to systematic English until the age of 3;5 when they first attended English nursery. Their age of exposure to English raged between 3;5 and 6. At the time of testing, the children had exposure to English between one and six years.[1] English is the language spoken at school and it is reported to be the primary language for socialization as revealed by the informal interviews with the children and their parents. Children showed clear preference for English and they rated themselves as more proficient in English than in Turkish.

However, in another study (Marinis & Özge, 2010), we tested 10 of the bilingual children participated in the present study (with the mean age of 5;11) using TELD-3-T (Topbaş &

[1]The was only one child, who was not born in the UK. She moved to London at the age of 6 and she was 7 when she took these tests so she had been exposed to English for one year at the time of testing. All the other children were born in the UK and had at least 3 years of exposure to English.

Güven, 2007). This test is adapted from the English assessment TELD-3 (Hresko, Reid, & Hammill, 1999), and it includes the assessment of receptive and expressive language in children between the ages 2;0 to 7;11. The results compared with the ten age-matched monolingual children from the standardization sample of TELD-3-T revealed that although bilingual children showed an overall lower performance, this difference was not statistically significant. Thus, we could tentatively suggest that there are not big differences between monolingual Turkish children and Turkish-English bilingual children who participated in this study in terms of their receptive and expressive language abilities in Turkish.

37 monolingual Turkish children matched in terms of age and mother's education served as a control group.

All children were reported to be neurologically intact with no behavioural, cognitive, or psychological problems, and all children had normal or corrected to normal vision.

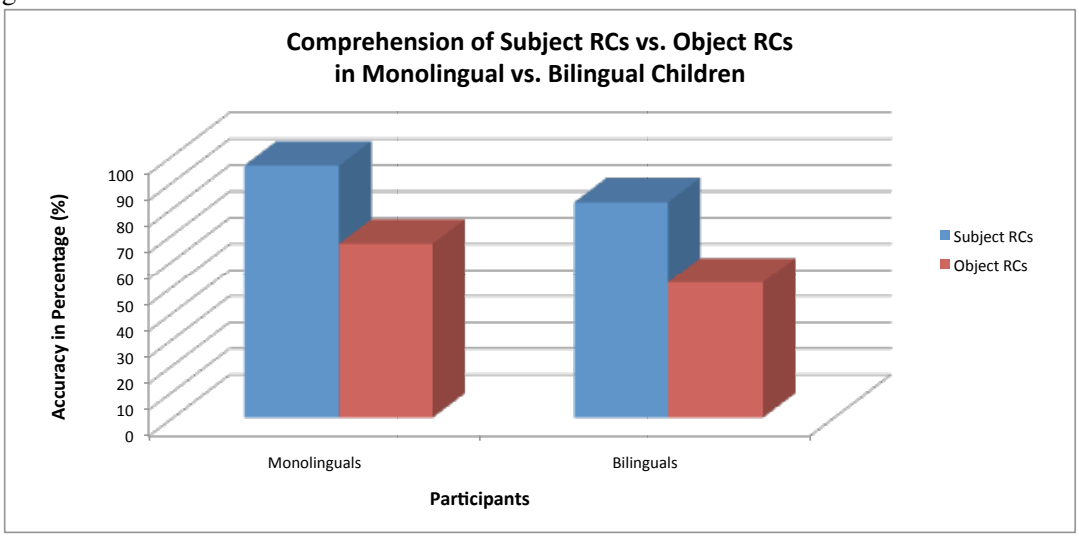
8.2.1.2 Materials and Design

We used the same comprehension task presented in Chapter 3. It consisted of 32 experimental and 28 control items. Two factors were manipulated in the experimental items: relative clause type (RC-Type) and Presentation-Type. In terms of RC-Type, each item was composed of a semantically reversible RC modifying either a subject (subject RC) or an object (object RC). With respect to the Presentation-Type, each RC was presented either within an imperative sentence or within a question. All verbs in the experimental items were transitive. The Presentation-Type served to test the effect of the accusative morpheme on the correct theta-role assignment. If the accusative case provides a cue for the object, then the success rate in object RCs should be higher in imperatives than in questions. This is because in imperatives, the object in the RC is also the object of the main clause and is marked with the accusative case, as shown in (195a) below. On the other hand, in questions, the object in the RC is the subject of the main clause and does not have the accusative marking, as shown in (195b) below.

(195) a. Deve-nin it-tiğ-i at-ı göster.
Camel-GEN push-DIK-3SGPOSS horse-ACC show
'Show me the horse that the camel is pushing.'

b. Hangi-si deve-nin it-tiğ-i at?
Which-3sgPOSS camel-GEN push-DIK-3SGPOSS horse
'Which one is the horse that the camel is pushing?'

Figure 8.1: Rate of Accuracy (%) in Subject RCs vs. Object RCs in Monolingual vs. Bilingual Children



8.2.1.3 Procedure

We applied the same procedure as the one reported in the comprehension task in Chapter 3.

8.2.2 Results

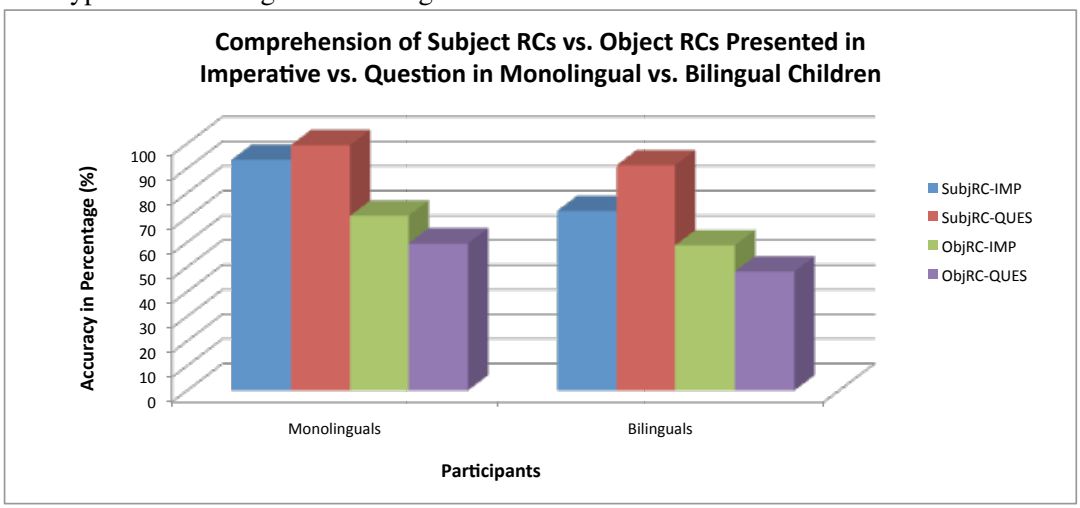
Figure 8.1 displays the accuracy rate displayed by monolingual and bilingual children in subject RCs and object RCs.

To investigate the effect of RC-Type and Presentation-Type on children's comprehension, a mixed repeated-measures ANOVA was conducted with the factors Group (monolinguals, bilinguals) as a between-subjects factor, RC-Type (Subject, Object) and Presentation Type (Question, Imperative) as a within-subjects factor. This showed a significant main effect of RC-Type $F(1, 63) = 67.42$, $p < .001$. According to the pairwise comparisons with Bonferonni correction, all groups performed significantly better in subject RCs ($M = 89.16$) compared to object RCs ($M = 59.30$), $p < .001$. There was no effect of Presentation-Type $F(1,63) = .20$, $p > .1$ and no interaction between RC-Type and Language Group $F(1, 63) = .14$, $p > .1$.

Figure 8.2 displays the accuracy rate displayed by monolingual and bilingual children in each RC type and presentation type.

In addition, there was a significant interaction between RC-Type and Presentation-Type $F(1, 63) = 29.95$, $p < .001$. Pairwise comparisons showed that object RCs showed higher

Figure 8.2: Rate of Accuracy (%) in Subject RCs vs. Object RCs in two Different Presentation Types in Monolingual vs. Bilingual Children



accuracy in imperatives (M = 64.76) than in questions (M = 53.84), whereas subject RCs showed higher accuracy when presented in questions (M = 95.27) than in imperatives (M = 83.05), $p < .001$.

There was also a significant interaction between Presentation-Type and Language-Group $F(1, 63) = 5.28$, $p < .05$. To find out the source of the interaction, we conducted pairwise comparisons using the Bonferroni correction. These showed that monolingual children overall performed better in imperatives (M = 82.07) compared to questions (M = 79.44) while bilinguals performed better in questions (M = 69.67) compared to imperatives (M = 65.74), $p < .05$.

8.2.3 Discussion

We tested Turkish monolingual and Turkish-English bilingual children in their comprehension of Turkish RCs. The results revealed that both groups displayed better performance in subject RCs compared to object RCs and the success rate in each group did not differ significantly.

Regarding the parsing strategies, we were interested in finding out whether Turkish children used the canonical-order or case-marking cues as a heuristic to assign grammatical roles while processing complex structures.

The Canonical Word Order Strategy Hypothesis predicted that children would assign the

first NP the agent role in line with the SOV ordering. However, it is clear from the present results that Turkish children did not use the agent-first tactic as an interpretive strategy in RC comprehension (cf. Bever, 1970). If that had been the case, our participants would have performed better in object RCs, in which the first NP already had the subject role.

The case-marking strategy predicted no significant difference between the two structures since the NPs in both RCs had a case marking. This view predicted that sentence-initial accusative NP in subject RCs would serve as a clear cue to single out the object, and that sentence-initial genitive NP in object RCs would be a strong candidate as the subject both for its linear position as it appeared sentence-initially, and its inflectional marking as it carried a subject case (i.e., genitive case). Yet, while children had no difficulty in assigning the roles in subject RCs, the same did not hold true for object RCs. This verifies the asymmetry in children's access to the case marking cues in Turkish: the accusative case seems to predict the theta-roles better than than the genitive case.

Finally, the Acc-Obj strategy predicted an increased success rate in object RCs when the extracted object has the accusative case. Indeed, object RCs showed higher accuracy in imperatives than in questions, whereas subject RCs showed higher accuracy when presented in questions than in imperatives. This is likely to be due to a facilitatory effect of accusative case marking cues. This strategy could lead to the correct theta-role assignment in object-RCs presented in imperatives, such as in (196a) below. Here the NP_{ACC} is the object of both the RC and the main clause and is marked with accusative from the main verb 'show'.

(196) a. Deve-nin it-tiğ-i at-ı göster.
Camel-gen push-dık-poss3sg horse-acc show
'Show me the horse that the camel is pushing.'

b. Hangi-si deve-nin it-tiğ-i at?
Which-3sgPOSS camel-gen push-dık-poss3sg horse
'Which one is the horse that the camel is pushing?'

We suggest children showed better performance in object RCs presented in the imperative because they were able to use the accusative case in those sentence as a cue marking for the theme or the object. This line of thinking also gains support from longitudinal studies reporting that Turkish children acquire accusative case morphology before the age of two while genitive case on the embedded subjects appears at a later age (e.g., Aksu-Koç & Slobin, 1985; Ketrez & Aksu-Koc, 2009). It also receives support from experimental and computational studies showing that the accusative case morphology provides a reliable marker while

clustering verb types in Turkish child language Ural, Yüret, Ketrez, Koçbaş, and Küntay (2009).

However, we found the opposite performance in subject RCs: children showed better performance when the subject RCs were presented within questions compared to when they were presented within imperatives. When a subject RC is presented in a question, as in (197a) below, there is one NP-ACC, which is unambiguously the object. On the other hand, when it is presented within an imperative sentence, as shown in (197b) below, there are two NPs marked with the accusative case: the first one is the object in the RC and the second one is the object in the matrix clause. The fact that there were more than one NPs in the accusative case may have increased the level of ambiguity in subject RCs presented within imperative sentences.

(197) a. Hangi-si deve-yi it-en at?
Which-3sgPOSS camel-acc push-yan horse
'Which one is the horse that is kicking the camel?'

b. Deve-yi it-en at-ı göster.
Camel-acc push-yan horse-acc show
'Show me the horse that is pushing the camel'

Here the effect of Presentation-Type provided evidence for possible strategies used by children when they comprehend RCs, which is a novel finding. In languages with strict word order like English, word-order seems to provide an important cue for theta-role assignment. In agglutinating languages, such as Hungarian (MacWhinney & Pleh, 1988), Japanese (Hakuta, 1981), Serbo-Croatian (Slobin & Bever, 1982), and Turkish (Slobin, 1986; Kükürt, 2004), case marking and morphological cues seem to facilitate theta-role assignment more successfully than word order cues. Thus, cue reliability appears to differ from one language to another. Yet, unlike previous studies, we demonstrated in this experiment that the broad differentiation between morphological and word order cues might not always be sufficient to capture certain behavioural data and the differences observed between languages. One example is the lower performance in subject RCs presented within imperative sentences. The accusative case might be a very straightforward cue to mark the object in Turkish but when there are two accusative NPs within the same structure, its strength might be decreasing. Similarly, even if Turkish provides clear morphosyntactic cues, the parser might be benefiting more from the word order cues compared to case marking cues when the number of

arguments increases in a structure, as we have demonstrated in Chapter 6. Hence, we suggest that there is actually a further competition between the cues and constraints within each language so the cue reliability is not constant across structures and it is influenced by other available cues in a grammatical structure.

Also, the fact that both monolinguals and bilinguals showed a similar effect of the accusative case and that bilingual children did not overwhelmingly use word order cues might be indicating that they do not show the effect of transfer from their L2 (i.e., English) in terms of the comprehension strategies. Of course, their performance in English should also be tested to see whether they would transfer from Turkish to English. We leave the investigation of our bilingual children's performances in Turkish and English RCs from the perspective of transfer for future research.[2]

Finally, there was a significant interaction between Language-Group and Presentation-Type. This indicates that monolingual children performed better in imperatives whereas bilingual children showed a better performance in questions. We do not have a definitive answer for this but we think this might be due to the following: In structures that puts the question word earlier as in (196a) and (197a), it is clear from the start that the participants are required to point to one of the animals in the context. That is, the message is located right at the beginning in those sentences. However, in the imperative conditions (i.e., (196b) and (197b)) the participants have to keep their attention constant to hear the imperative verb that appears sentence finally and to carry out the instructions (i.e., whether they will 'point to', 'hit', or 'colour' the animals). Bilingual children were more successful in questions and monolingual children were more successful in imperatives. This pattern might be a reflection of a tendency in bilingual children to expect the message (i.e., the verb or the question word) at sentence-initial positions in a manner reflecting the head-initial nature of their L2. In other words, monolingual Turkish children might be more accustomed to hearing the verb or the message in sentence-final positions whereas the bilingual ones expected them earlier in a sentence. We are not sure whether to consider this as an effect of transfer but we believe it is a serious possibility given that the placement of the head in the two languages is one of the major typological differences between Turkish and English. Apparently more research is necessary to clarify this issue.

[2]Many thanks to Belma Haznedar for her insightful comments about this issue.

8.3 Experiment 6: Strategies in the Production of Turkish RCs in Turkish Monolingual and Turkish-English Bilingual Children

Experiment 5 demonstrated that both monolingual and bilingual children showed a better performance in subject RCs compared to object RCs and that they benefited from the accusative morpheme more than the genitive morpheme when assigning theta-roles to the referents in RCs.

In Experiment 6, we will investigate the bilingual children's performance in the production of Turkish RCs. Our aim in this chapter is to analyse both monolingual and bilingual children's errors to investigate whether bilingual children present similar patterns to monolingual children and whether they make errors that are not observed in their monolingual peers. In addition, we will use children's errors to gain some insights about language acquisition in general.

8.3.1 Method

8.3.1.1 Participants

The same monolingual and bilingual children reported in Experiment 5 in Section 8.2.1.1 participated in this study.

8.3.1.2 Materials and Design

The same elicitation materials reported in Chapter 3 were used in this study.

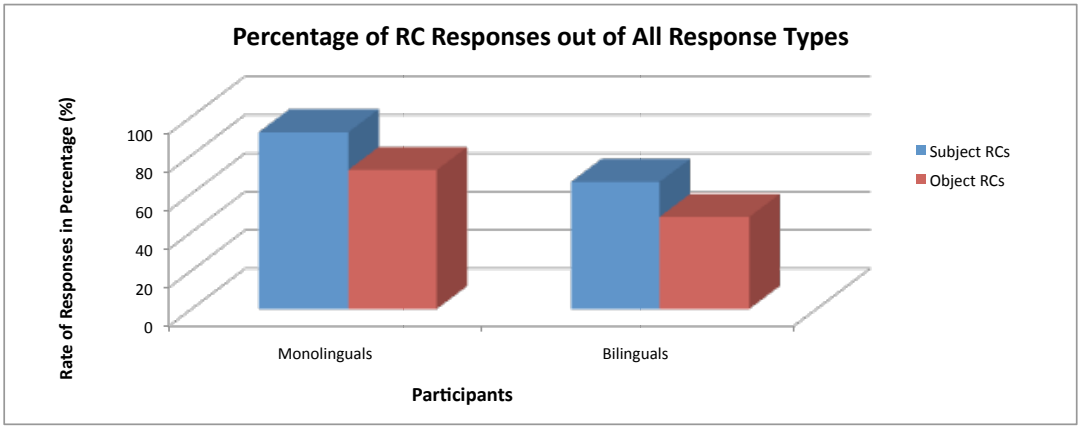
8.3.1.3 Procedure

The procedure was also the same as the production task reported in Chapter 3.

8.3.2 Results

A repeated-measures ANOVA with the factors Group (monolingual children, bilingual children) and RC-Type (Subject, Object) was conducted to see to what extent the participants used RCs (both grammatical and ungrammatical) compared to other response types. This revealed a significant effect of RC-Type $F(1, 63) = 49.65$, $p < .001$ since all groups used more subject ($M = 80.76$; $SD = 28.50$) than object RCs ($M = 61.75$; $SD = 31.73$). The effect

Figure 8.3: Rate of all RC Responses out of all Responses (%) in Monolingual vs. Bilingual Children



of Group was also significant F(1, 63) = 15.47; p < .001. According to this, the monolingual children significantly used more RCs (M = 82.07) compared to the bilingual ones (M = 56.96). And there was no Group by RC-Type interaction F (1, 63) = .06; p > .1.

Figure 8.3 displays the rate of responses that include grammatical and ungrammatical RCs out of all other responses in monolingual and bilingual children for each RC type.

Figure 8.4 displays the rate of responses that include grammatical RCs out of all RCs in monolingual and bilingual children for each RC type.

To investigate possible differences between the two RC Types on the rate of grammatical RCs out of all RC responses, we conducted a similar ANOVA. This showed a main effect of RC-Type F (1, 63) = 154.25, p < .001 but no effect of Group F (1, 63) = 3.00, p < .05 or no interaction between Group and RC-Type F (1, 63) = .25, p > .1.

Both bilingual and monolingual children used similar strategies such as avoidance strategies we have exemplified in Chapter 3 such as conjoined sentences (e.g., 198), passives (e.g., 199), and structures with perspective shift (e.g., 200). They also used reversal errors (e.g., 201), non-pragmatic responses (e.g., 202), and non-adult responses (e.g., 203). Different from monolingual children, bilingual children used simple sentences as exemplified in (204).

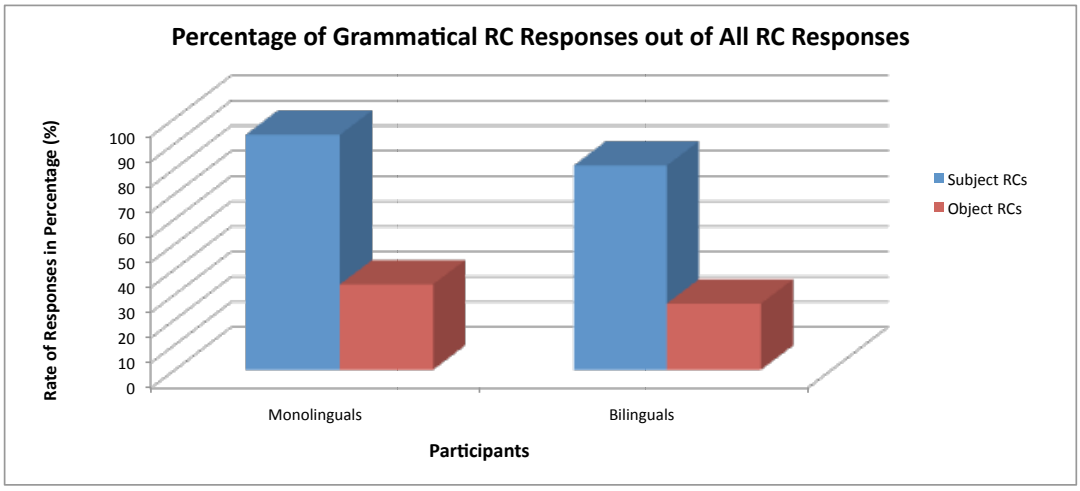
(198) *Conjoined Clauses*

Ördek öp-müş ya o fare

duck kiss-EV.COP-3sg you know that's the mouse

'The mouse, the one that the duck has apparently kissed.'

Figure 8.4: Rate of Grammatical RCs out of all RC Responses (%) in Monolingual vs. Bilingual Children



(199) *Passive Voice*

Gıdık-lan-an kuzu

tickle-PASS-(y)An lamb

'The lamb that is being tickled.'

(200) *Perspective Shift*

a. Ördek-ten kaç-an fare

duck-ABL run-(y)An mouse

'The mouse that is running away from the duck.'

b. Kravat tak-an deve ineğ-i koval-ıyor

Tie wear-(y)An camel cow-acc cahse-prog

'The camel wearing a hat is chasing the cow.'

c. *Prepositional Phrases*

Öp-en kedi-nin yan-ın-da-ki

Kiss-(y)An cat-GEN next-POSS3sg-dat-rel

'The one that is next to the cat that is kissing.'

(201) *Reversal Errors*

Koyun-u it-en inek

Sheep-ACC push-(y)AN cow

'The cow that is pushing the sheep.'

(202) *Non-Pragmatic Responses*

Tavşan o-nu sev-er-ken

Rabbit he-ACC stroke-AOR-CV

'While the rabbit was stroking him.'

(203) *Non-Adult Responses*

a. İnek o-nu ısır-an kuzu

cow he-ACC bite-(y)AN lamb

b. İnek kuzu-(y)u ısır-an kuzu

cow lamb-ACC bite-(y)AN lamb

c. İnek ısır-an kuzu

cow bite-(y)AN lamb

d. İneğ-in kuzu-(y)u it-tiğ-i kuzu

cow-GEN sheep-ACC push-DIK-3SG.POSS lamb

'The lamb that the cow bit the lamb.'

(204) *Simple Sentences*[3]

a. İnek koyun-u it-iyor

cow sheep-ACC push-PROG-3sg

'The sheep is pushing the cow.'

b. Köpek öpü-yor fare-(y)i

dog mouse-ACC kiss-PROG-3sg

'The dog is kissing the mouse.'

(205) *Other Responses*[4]

a. it-tir-en kedi-yi köpek

push-CAUS-(y)An cat-ACC dog

b. kedi köpeği öp-ü-yor köpek

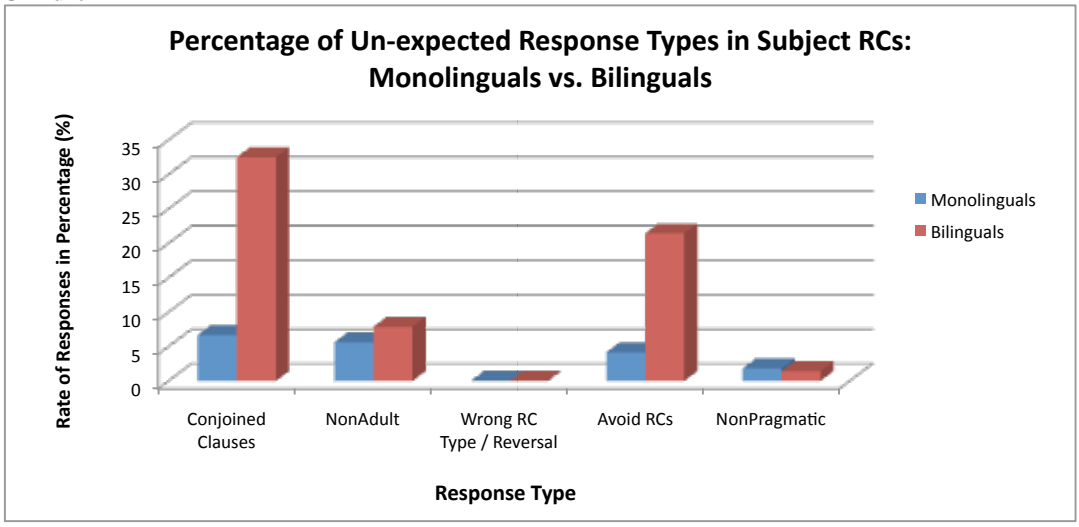
cat dog-ACC kiss-PROG dog

'The dog that the cat is kissing the dog.'

[3]Note that the word order is sometimes SVO, as in (204b), which might be reflecting the canonical order of English. But more research is needed in order to verify this.

[4]These responses were uttered very randomly (i.e., once or twice).

Figure 8.5: Rate of Unexpected Responses (%) in Subject RCs in Monolingual vs. Bilingual Children



c. Ayı kovala-yan aslan-ı
Bear chase-(y)An lion-ACC
'The lion such that the bear is chasing him.'

Figure 8.5 displays the rate of unexpected response types in monolingual and bilingual children for subject RCs.

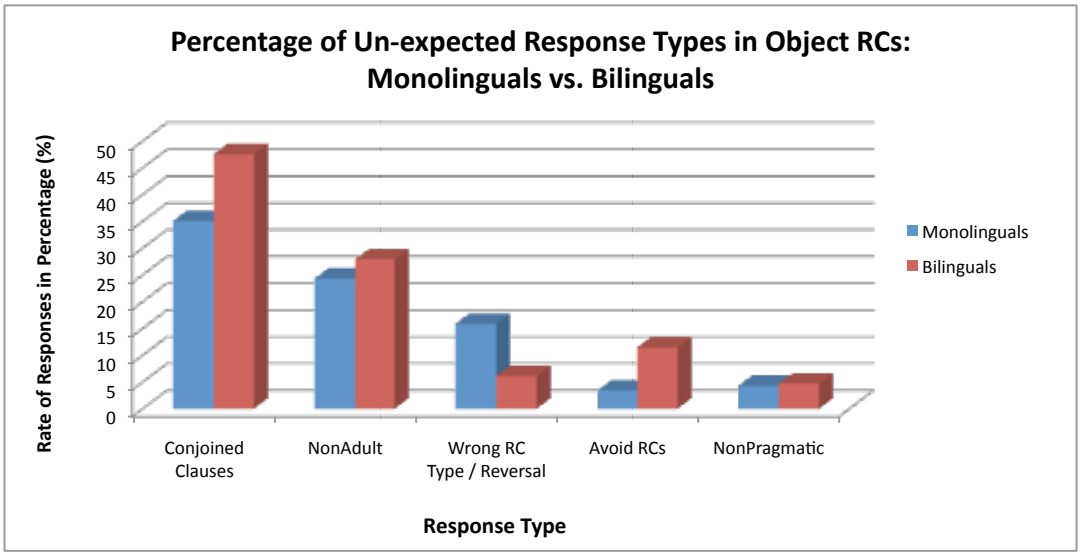
Figure 8.6 displays the rate of unexpected response types in monolingual and bilingual children for object RCs.

We next analysed the rate of each response type in each RC-Type separately. See Section (3.3) for a detailed explanation of the response types.

For subject RCs, we conducted a mixed repeated-measures ANOVA with Response-Type (avoidance, conjoined clauses) as a within-subjects and Group (monolinguals and bilinguals) as a between-subjects factors. This revealed a main effect of Group $F(1, 63) = 47.55$, $p < .001$ but no effect of Response Type $F(1, 63) = 2.22$, $p > .1$ or no interaction between RC-Type and Response Type $F(1, 63) = .87$, $p > .1$.

For object RCs a similar ANOVA was conducted with Response Type (reversal, non-adult, conjoined clause; avoidance) and Group (monolinguals and bilinguals). The effect of Response Type $F(3, 189) = 25.04$, $p < .001$ and Group $F(1, 63) = 6.29$, $p < .05$ was significant but there was no interaction between the two $F(3, 189) = 2.39$, $p > .05$. Pairwise comparisons with Bonferroni correction showed that there were significantly more conjoined

Figure 8.6: Rate of Unexpected Responses (%) in Object RCs in Monolingual vs. Bilingual Children



clauses than reversal errors; more reversal errors than perspective shift responses; more avoidance responses than non-adult responses; and more conjoined clauses than perspective shift responses. Also, the rate of errors made by monolinguals (M = 19.63) was smaller than bilinguals (M = 23.21).

8.3.3 Discussion

We tested Turkish-English bilingual children in their production of Turkish RCs and compared them with Turkish monolingual children. The results showing the rate of RCs (both grammatical and ungrammatical) out of all responses indicated that both groups showed similar patterns by producing more RCs for subject RCs than object RCs. The analysis also revealed that monolingual children overall used a greater number of RCs compared to bilinguals.

A similar analysis for the use of grammatical RCs out of all RC-responses showed that while the asymmetry between subject and object RCs was preserved, the difference between monolinguals and bilinguals disappeared. This might be suggesting that bilingual children used more avoidance strategies and monolingual children used more strategies that involve RCs, albeit with incorrect form. It appears that monolingual children are more flexible to attempt to use object relativization compared to bilinguals and that they make mistakes while

trying out alternative ways of expressing their message whereas bilinguals more conservatively preferred simpler and correct structures to replace object RCs.

Indeed, the response analysis for subject RCs showed that bilingual children used conjoined clauses and other avoidance strategies significantly more often than monolinguals.The same holds true for object RCs: bilinguals used more avoidance strategies than monolinguals.

Also, both groups of children used more avoidance strategies than all other response types. This indicates that children preferred avoiding the structures they were unsure about rather than making mistakes.

Comparing the two RC types, children used more avoidance strategies in object RCs compared to subject RCs and they did not use non-adult responses or reversal errors in subject RCs. This implies that subject RCs are acquired earlier than object RCs.

In the following section, we will discuss the nature of children's non-adult responses from in relation to language acquisition.

8.3.3.1 What do the non-adult responses reveal about language acquisition?

In this section, a closer investigation of children's non-adult responses will be provided since they might provide some insights about the state of the child's grammatical knowledge and the nature of language acquisition process in general. In this section, we will show that children do not produce these erroneous utterances outside the possibilities of their experiences and outside the possibilities of their competence grammar.

In all of the non-adult responses, the children tended to adapt *-(y)An* as an object relativizing morpheme. This type of response is certainly not part of a mere reversal error as it is accompanied by consistent changes. For instance, the genitive case on the first NP is usually omitted as in (206b). This pattern shows that *-(y)An* is a better choice as a relativizing participle and the bare nominative case is a better choice as a subject marker.

(206) a. *Target:*

Köpeğ-in kovala-dığ-ı kedi

dog-gen chase-DIK-Poss3sg cat-null

'The cat that the dog was chasing'

b. *Response:*

Köpek kovala-yan kedi

dog-NOM chase-(y)An cat-NOM

Could we say that children have not acquired *-DIK* even at the ages of 5-8? Although it seems to be true that Turkish children acquire structural means of generating subject RCs (i.e., the use of *-(y)An* morpheme and the accusative case) earlier than the means of generating object RCs (i.e., the use of *-DIK* morpheme, genitive case, and possessive-agreement morphology), looking at the present data, we do not wish to argue that our participants at this age range (5-8) have not acquired the latter yet, since they had significantly higher number of correct responses compared to their non-adult responses. We rather want to claim that they reflect the frequency and consistency of the input they receive from their language community.

Importantly, *NP1-NOM verb-(y)An NP2-NOM* exists in the adult grammar with different meanings. It appears as a subject RC with an intended meaning *'Dogs (or the dog) that chase(s) cats* as in (207), where 'kedi', 'cat' is an incorporated object.

(207) Kedi kovala-yan köpek-ten nefret ed-er-im
Cat-NOM chase-(y)An dog-ABL hate make-PRES-1SG
'I hate dogs chasing cats.'

It also appears as an object RC in cases with *generic or incorporated subjects* in Barker, Hankamer, and Barker et al.'s (1990) term and *semi-subjects* in Haig's (1997) term as shown in (208a), in which case the version with *-DIK* is also possible when the subject is a specific or non-generic NP as in (208b).[5] These examples imply that children do not randomly generate these *errors* as a pure over-generation but they produce utterances for which there is positive evidence in the environment so these structures are allowed by adult grammar albeit with different meanings.

(208) a. Arı sok-an kız
bee-NOM sting-(y)An girl-NOM
'The girl whom a bee stung'

[5]The issue of whether these sentences should be considered subject incorporation or conditions of case stripping is not relevant to our discussion here; see Haig (1997) for further discussion. What is at issue here is the fact that children are exposed to these cases and they have to work out the meanings and constraints attached to these structures and they have to differentiate between the cases where the genitive case, -DIK participle, and possessive-agreement morphology should be used and the cases where the genitive case can be omitted and -(y)An can replace -DIK.

b. Arı-nın sok-tuğ-u kız
Bee-GEN sting-DIK-3SGPOSS girl
'The girl whom the bee stung'

Another modification they make while utilizing *-(y)An* as an object-relativizing morpheme is to insert a pronoun or full *NP-ACC* in the extraction site in addition to keeping the subject NP in the nominative case as in (209b).

(209) a. *Target:*
Köpeğ-in kovala-dığ-ı kedi
dog-gen chase-DIK-Poss3sg cat-null
'The cat that the dog was chasing'

b. *Response:*
*Köpek o-nu / kedi-yi kovala-yan kedi
*dog-NOM 3sgPRON-ACC / cat-ACC chase-(y)An cat-NOM
'The cat that the dog is chasing the cat/him"

The response in (209b) is not comparable to a possible RC with a resumptive pronoun in English. What an English-speaking child would do is to construct the RC correctly except for adding a resumptive pronoun as in (210).

(210) a. *Target:*
'The man that the dog was chasing"

b. *Response:*
'The man$_i$ that the dog was chasing him$_i$"

Similarly, the structure in (209b) is not akin to the object RC with a resumptive pronoun that is observed in adult Turkish, where *kendisi* refers to the relativized (head) noun, as exemplified in (211a)(for information on Turkish resumptive pronoun see Meral (2006) and Göksel and Kerslake (2005)). Here, *'kendisini'* is grammatical as a resumptive pronoun while the personal pronoun *'onu'* is not (211b).

(211) a. Köpeğ-in kendi-si-ni$_i$ kovala-dığ-ı adam$_i$
dog-gen kendi-3sg-ACC chase-DIK-Poss3sg man-NOM
'The cat that the dog was chasing him"

b. *Köpeğ-in o-nu$_i$ kovala-dığ-ı adam$_i$
*dog-gen Pron3sg-ACC$_i$ chase-DIK-Poss3sg man-NOM$_i$
'The cat that the dog was chasing him"

Moreover, as we have illustrated in (209b), the child is not only adding a pronoun but also changing the relativizing participle and the case marking. Again, the adult grammar exemplifies the instances of object RCs with a resumptive pronoun *kendisi* and with *-(y)An* rather than *-DIK* as in (212a). Here too, *'onu'* instead of *'kendisini'* is not possible (212b). Thus, it appears that these errors somehow reflect the input children receive. Also, although we are not aware of any work on children's resumptive pronouns in Turkish, the fact that children use the personal pronoun *'o'* instead of the resumptive pronoun *'kendisi'* hints that *'kendisi'* as a resumptive pronoun may not be appearing until late in Turkish-speaking children. In a study by Gürel (2002) on the acquisition of the binding properties of overt pronominals 'o', 'kendisi' (as a reflexive pronoun), and null pronoun in adult L2 learners in comparison to the performance of L1 speakers with language attrition, it is shown that the binding properties of 'kendisi' and null pronoun are learned earlier than the overt pronoun 'o' and that L2 learners show similar performance to L1 speakers with language attrition. Gürel (2002) relates this to the effect of transfer from English. According to this, 'kendisi' as a reflexive pronoun is acquired early so it seems to be a topic of further research to investigate the acquisition of 'kendisi' as a resumptive pronoun in L1 and L2 child language.

(212) a. Kendisi-ni köpek ısır-an adam
Himself-ACC dog-NOM bite-(y)An man-NOM
'The man$_i$ whom the dog bit him$_i$"

b. *O-nu köpek ısır-an adam
*3sgPron-ACC dog-NOM bite-(y)An man-NOM
'The man$_i$ whom the dog bit him$_i$"

Additionally, the location of the pronoun in children's object RCs does not conform to the standard position of the resumptive pronoun. Note that the location of *'kendisi'* is constrained in that it should precede the RC since the relativized predicate *ısıran* (*bite-(y)An*) and the subject *köpek* (*dog-NOM*) form a sort of subject incorporation *köpek ısır-an* and cannot be separated, thereby rendering (213) ungrammatical. However, this rule is an exception in this case most probably due to the subject incorporation and the use of -(y)An as an object-relativizing suffix. Once there is no subject incorporation, the resumptive pronoun *'kendisi'*

should appear in the extraction site as in (211a) above. Thus, it is highly probable that children are conforming to the normal case of resumption, where the resumptive pronoun appears in the extraction site as in (211a).

(213) *köpek kendi-si-ni$_i$ ısır-an adam$_i$
*dog-NOM kendi-3sg-ACC$_i$ bite-(y)An man-NOM$_i$
*'The man$_i$ whom the dog him$_i$ bit"

Thus, it appears that children have already discovered that there are distinct strategies for subject and object relativization given that they do not merely use subject RCs instead of object RCs. They use -(y)An both as a subject and an object-relativizing participle, which is indeed possible in some cases in adult grammar. They make consistent changes while adopting -(y)An as an object relativizer. Whenever they use -(y)An as an object-relativizing suffix, they omit the genitive morpheme, which is in fact quite a reasonable change as there is no instance of -(y)An with the genitive subject. Of course, these changes are not grammatical so they still need to disentangle the exact difference between *-(y)An* and *-DIK*. Similarly, they sometimes attempt to use a resumptive pronoun but they cannot come up with the correct pronoun and they make mistakes in the correct location of the resumption. Indeed, the location of the resumptive pronoun is not fixed in adult grammar, either. Thus, it appears that children's errors reflect the degree of ambiguity in the input they are exposed to. In other words, they tend to use structures for which the environment provides positive evidence.

We also contend that children's non-adult responses reflect the possible structures that are permissible in the competence grammar. We know that children's incorrect utterances might exist as grammatical structures in other languages (Crain, 1991, Crain & Thornton, 1998, Crain & Pietroski, 2001). For instance, as we have displayed above, both monolingual and bilingual children omitted the genitive case on the subject NP in object relativization and used -(y)An instead of -DIK (the example is repeated here in 214).

(214) a. *Target:*
Köpeğ-in kovala-dığ-ı kedi
dog-gen chase-DIK-Poss3sg cat-null
'The cat that the dog was chasing'

b. *Response:*
Köpek kovala-yan kedi
dog-NOM chase-(y)An cat-NOM

We know that -(y)An relativizer is used both in subject and non-subject extraction in some Turkic languages as shown in (215) (examples are from Johanson & Csató, 1998). All these examples resemble child response in (214b) in that they lack the genitive case on the subject, they are relativized by the participle -(y)An, and there is no possessive-agreement morphology on the relativizer or on the head.

(215) a. *Azerbaijanian*

men ac-an gapi

I-NOM open-(y)An door-NOM

'The door I have opened'

b. *Uzbek*

men yaz-yan kitab

I-NOM write-(y)An book-NOM

'The book I have written'

c. *Tatar*

sin kör-gen kese

you-NOM see-(y)An man-NOM

'The man you have seen'

d. *Chuvash*

ese yulak-an yulaz

you-NOM sing-(y)An song-NOM

'The song you are singing'

e. *Kirghiz*

men jeg-en et

I-NOM eat-(y)An meat-NOM

'The meat I have eaten'

f. *Uyghur*

men ogu-yan kitap

I-NOM read-(y)An book-NOM

'The book I have read'

These examples illustrate that child grammar does not overgenerate such structures but their errors remain within the possibilities of their competence grammar. This is in line with the Continuity Hypothesis suggesting that children form hypotheses within the boundary of

the Universal Grammar (e.g., Crain, 1991; Crain & Thornton, 1998; Poeppel & Wexler, 1993; Hyams, 1992; among others).[6]

Crain and Pietroski (2001) (among others) argue that children could display structures that are non-existent in their native language and these constructions might actually exist in other languages which children have never received input from. Our data support the view that children's errors might be grammatical in other languages. However, these constructions are at the same time the ones for which there is certain evidence in the linguistic environment but with different functions or meanings. In our data, we have not detected any constructions that are never available in children's input language.

To illustrate, our child participants did not produce errors where they combined genitive case with the -(y)An relativizer (e.g., 216) even though similar structures can be observed in Turkmen language as shown in (217).

(216) *Köpeğ-in kovala-yan kedi
dog-gen chase-(y)An cat-3sgPOSS

(217) *Turkmen*
men-in al-an kitab-im
I-GEN buy-(y)An book-1sgPOSS
'The book I have bought'

In addition, children did not produce sentences having genitive case on the subject of the RC but lacking the possessive-agreement marker or vice versa. We presume such errors are less likely to occur but it would be interesting to investigate whether they are observed in early child language in Turkish or in other Turkic languages. On the other hand, we know from the data reported in Hermon et al. (2007) that children do produce sentences with missing

[6]It is maintained by certain versions of the Continuity Hypothesis that children's utterances could present deviations from the input language only insofar as adult languages differ from each other. That is, all the errors children make should exist at least in one language of the world. The Continuity Hypothesis further claims that available adult languages differ from each other only in certain parameters (Crain & Pietroski, 2001; among others). We would like to underline, however, that the view that a common innate grammatical apparatus lies in all languages does not necessarily require the parameter setting approach to be true. It fully depends on what kind of grammatical mechanism a theory assumes. Some of the lexicalist approaches seem to obviate any necessity for the parameters. The reasoning goes as follows: if the lexicon is loaded with the grammatical information each lexical item requires and if children acquire the lexicon but not the rules of the grammar, there should not be any need for parameters and subset principles (Steedman, 2009). We leave the exploration of different accounts of language acquisition for future research since our studies have not been designed to directly address these questions.

genitive case when there is an intervening element between the RC subject (i.e., 'kız', 'girl') and the relativized verb with the possessive-agreement (i.e., 'atla-dığ-ı', 'jump-3sgDIK') as in the example in (218b) (cf., the grammatical version in (218a)).

(218) a. *Grammatical Utterance:*

Kız-ın üstünden zıpla-dığ-ı çocuk

girl-GEN top-3.SG-ABL jump-3sgDIK child

'The child over the top of whom the girl is jumping'

b. *Child's Utterance:*

*Kız üstünden atla-dığ-ı çocuk

girl top-3.SG-ABL jump-3sgDIK child

c. *Intended Utterance:*

Kız üstünden atlı-yor çocuğ-un.

girl top-3.SG-ABL jump-PROG child-GEN

'The girl is jumping over the top of the child.'

We predict this might be due to the fact that children cannot keep in memory the bare NP (i.e., 'kız', 'girl') with which they start their utterance until it is linked to its head, which is presumably supposed to be a matrix verb as in (218c) and they continue with a relativized verb (i.e., 'atla-dığ-ı', 'jump-3sgDIK'). Most probably, this results from the intervening lexical item (i.e., 'üstünden', 'top-3.SG-ABL') between the sentence-initial NP and its head.

A similar pattern is observed in our online comprehension experiment in Chapter 7, which was testing the grammatical violations in the genitive and possessive-agreement morphology in object RCs and possessive phrases. Children failed to detect the omission of the possessive-agreement morphology on the head (i.e., on the relativized verb or on the possessed NP). In these structures, the head and its genitive marked subject were intervened by an extra lexical item (e.g.,'yanlışlıkla', 'by mistake' in (219a and 219b). or 'yakın', 'close' in (219c and 219d). Thus, the intervening element might have put extra load preventing the children from detecting the ungrammaticality.

(219) a. *Object RC-Grammatical*

Kral **aslanın** yanlışlıkla **tekmele-diğ-i** bir *ayı* korkudan titremeye başlamış.

'A bear that the king lion kicked by mistake started to shake out of fear.'

b. *Object RC-Ungrammatical*

Kral **aslanın** yanlışlıkla **tekmele-dik** bir *ayı* korkudan titremeye başlamış.

c. *Possessive NP-Grammatical*

Kral **aslanın** yakın **arkadaş-ı** bir *kitap* kazanmış.

'A close friend of the king lion won a book.'

d. *Possessive NP-Ungrammatical*

Kral **aslanın** yakın **arkadaş** bir *kitap* kazanmış.

Actually, agreement errors are not limited to child language, which is in line with our reasoning here. Adults might make such errors when the intervening element between the head and its dependent item is large enough. For instance, in a recent interview on a news channel, the deputy prime minister of Turkey Cemil Çiçek uttered an ungrammatical sentence, where he omitted the genitive case on the subject of the complement clause but located the agreement marker on the nominalised verb as illustrated in (220).[7] The grammatical version of the sentence is given in (220a), where the subject of the complement clause 'terrorist organisation' is marked with the genitive case and the nominalised verb is encoded with the '-ME' complementiser and possessive-agreement morphology (i.e., 'sürdür-me-si', 'endure-ME-3sgPOSS'). In Çiçek's version (220b), the possessive-agreement marker on the embedded verb appears without the genitive case on the subject. We presume he began his utterance with a plan of an utterance with a matrix verb, as in(220c) but he forgot the beginning of his sentence and continued with an embedded verb. This is very much similar to the error reported in Hermon et al. (2007), which we displayed in (218).

(220) a. *Grammatical Utterance:*

Hiçbir terör **örgütü-nün** dış destek olmadan

No terrorist **organisation-GEN** international support without

varlığını **sürdür-me-si** mümkün değil.

existence-3sgPOSS **endure-COMPL-3sgPOSS** possible not

'It is not possible for a any terrorist organisation to endure its existence without international support.'

b. *Çiçek's Utterance:*

*Hiçbir terör **örgütü** dış destek olmadan

No terrorist **organisation-NOM** international support without

varlığını **sürdür-me-si** mümkün değil.

existence-3sgPOSS **endure-COMPL-3sgPOSS** possible not

[7]Note that this error can be observed only on the video as the corrected version of the sentence has been written on the news-script on 25th May2010 at http://www.ntvmsnbc.com/id/25099215/.

c. *Intended Utterance:*

Hiçbir terör **örgütü** dış destek olmadan

No terrorist **organisation-NOM** international support without

varlığını **sürdür-e-mez**.

existence-3sgPOSS **endure-ABIL-NEG**

'No terrorist organisation can endure its existence without international support.'

Thus, our child participants were always consistent with the utterances they produced. Furthermore, the changes that rendered their speech ungrammatical could never be considered odd in that they seemed to comply with the regularities of their language. That is, they replaced the highly ambiguous and less frequent items with more reliable and frequent ones (e.g., nominative instead of genitive, -(y)An instead of -DIK), hence they mirrored the problematic and probabilistic aspects of adult grammar. In this respect, our data seem to favour a perspective combining the effect of the Universal Grammar as well as child's experiences. One might argue that the present results could be purely the result of probabilistic regularities rather than a combination of innate grammar and experience. Our data cannot dissociate between these factors. Apparently, more research is needed with younger children to answer this question.

Finally, every child in our group produced at least one grammatical object RCs, which points to one critical observation about the nature of language acquisition in general: children do not learn the language in an all or none fashion. It takes time for a child to fully internalise the full command of a lexical or morphological item and it seems that the probabilistic nature of the input influences this process, which is in line with theories underlining the statistical aspects of language acquisition (e.g., Steedman, Kwiatkowski, & Hockenmaier, 2008; Yang, 2002; Trueswell & Gleitman, 2007; Buttery, 2003; Siskind, 1996; and Saffran et al., 1996; among others).

To sum up, the children's errors have led us to make two observations:

1. Child language mirrors the environmental input in that their errors tend to reflect the process of hypothesis testing and assigning correct interpretations to mostly ambiguous strings.

2. Child language mirrors the grammatical apparatus they possess in that their errors are always within the limits of their competence grammar.

These observations indicate that children's errors could be considered as instances of approximations toward the adult grammar, which reflect children's incomplete hypotheses and limited experience with language. As we have illustrated, their linguistic repertoire is full of ambiguous input that needs to be correctly analysed. Naturally, not all of the hypotheses they generate from their experiences reflect the correct form-meaning matchings of their language. However, they never construct structures that are out of the scope of their grammar so their *errors* are indeed processable on the part of an adult speaker. Thus, children's task seems to be to correctly sort out a very complex input and to match which lexical/morphological items can be used to express which meanings and it is quite explicit in the present data that it takes children considerably long to do so.

8.4 Summary

In Experiment 5, we investigated whether Turkish-English successive bilingual children would present similar patterns to their age-matched Turkish monolingual children in terms of their comprehension of Turkish RCs and in terms of the comprehension strategies. We used the same sentence-referent matching task reported in Chapter 3 and showed that bilingual children, just like their monolingual peers, had difficulty in object RCs. Regarding the comprehension strategies, we compared the canonical-order strategy or NNV strategy of Bever, 1970, the case marking strategy and the Acc-Obj Strategy. To do this we varied the type of sentence in which the RC appeared: each RC appeared either within a question or within an imperative sentence. Success rate in object RCs were higher in imperatives than in questions, which indicated that the accusative marking on the object of the matrix clause (and the object of the RC) guided theta-role assignment better than the genitive case that in on the subject of the RC. Similarly, the participants did not show an effect of the canonical-order strategy since they did not tend to assign the first NP the agent role in none of the structures. In other words, the results suggested that children benefited from the accusative case to detect the theme in complex sentences, hence the Acc-Obj strategy received support over two other strategies. Also, the asymmetry between the sentence-initial accusative NP and sentence-initial genitive NP that was reported in the on-line experiment was once more confirmed in this experiment. However, one difference between monolingual and bilingual children was that while the former performed better when the RC appeared in an imperative sentence, the latter performed better when the structure appeared within a question. To put it differently, Turkish speakers performed better when the message (or the head) of the sentence appeared in the sentence-

final position whereas Turkish-English speakers performed better when the message appeared sentence-initially. We conjectured that this might be a sign of transfer since the head appears sentence-final position in Turkish while it appears earlier in the sentence in English. Thus, children might be reflecting their expectation as to where the head of the sentence that carries the message would appear.

In Experiment 6, the production of Turkish RCs in the same bilingual and monolingual children was tested with the elicitation task reported in Chapter 3. The results suggested that both groups produced more subject RCs than object RCs; while the monolingual group used a greater number of RCs. The rate of grammatical RCs out of all RC-responses confirmed the subject-object asymmetry but eliminated the effect of Group. According to this, bilingual children used a greater number of avoidance responses compared to monolinguals. We related this to the possibility that bilingual children were more conservative with the structure they chose whereas monolinguals were more flexible to use RCs despite with errors. The interpretation of children's ungrammatical responses indicated that they produce errors within the possibilities of their experiences with the input as well as within the boundaries of their competence grammar.

CHAPTER 9

DISCUSSION

9.1 Introduction

The thesis has provided a comprehensive analysis of the acquisition and processing of Turkish RCs by combining offline comprehension and production experiments and online processing experiments. We have documented that the subject-object asymmetry that has been reported for other languages and in some acquisition studies in Turkish has indeed been observed in the comprehension, production, and processing of Turkish RCs. In all our experiments, the subject RCs were processed significantly better than object RCs by children. We have also showed that the convergence of multiple factors such as complex morphosyntax, ease to attach to a verb, word order regularities, and the degree of ambiguity in the lexical items contribute to this asymmetry.

In addition, we reviewed some of the mainstream accounts regarding the strategies in language processing. Among these were the Filler Gap Accounts, the Parallel Function Hypothesis, and Canonical Word Order Strategy. We evaluated these theories in the light of our data and suggested that none of these could fully capture the processing facts the thesis presents. Instead, we promoted a processing account that uses a highly lexicalized grammar, a bottom-up parsing algorithm, and a mechanism that evaluates multiple sources of information in line with the parsing model of a specific language along the same lines with Steedman (1989; 2000); and another processing model by Vasishth and Kruijff (2001) that uses a highly lexicalized grammar, a combination of a top-down and a bottom-up algorithm, and a complexity metric inspired by Gibson (1998) and Hale (2001).

We also reported that the children (aged 5-8) and adults showed similarity in terms of parsing morphosyntactic and lexical elements in an incremental fashion. Finally, data from bilingual children in comparison to the monolingual children suggested that they presented

the similar subject-object asymmetry in their comprehension and production of RCs and that they used similar strategies.

Below, in Section 9.2 we provide a brief summary of the experimental findings in each chapter, and in Section 9.3 we will discuss what these findings imply in terms of (a) acquisition and processing of Turkish RCs; (b) development of parsing abilities in a head-final language; (c) mechanisms and strategies in human language processing; and (d) language acquisition. Finally, in Section 9.4, we will list the limitations of this study and try to use these to offer a direction for future research.

9.2 Summary of the Findings

9.2.1 Experiment 1 and Experiment 2

In Chapter 3, we reported two off-line experiments to test the comprehension and production of Turkish RCs in monolingual children and adults.

In Experiment 1, we tested monolingual children and adults in their comprehension of Turkish RCs. The results showed that children performed significantly poorer in object RCs vis-a-vis subject RCs, which is in line with most of the previous studies about the comprehension of Turkish RCs. The experiment also revealed that children also showed a poorer performance than adults only in terms of the comprehension of object RCs. A similar pattern was observed in the analysis comparing the performance of the younger children to the older ones. That is, younger children's comprehension of object RCs was significantly more problematic than that of older children whereas their performance did not differ in terms of subject RCs. Thus, we observed a developmental pattern from younger to older children on one hand, and from children to adults on the other, with respect to their comprehension of object RCs but not of subject RCs.

In Experiment 2, we presented a novel elicitation task to test the production of Turkish RCs in the monolingual children and adults. The subject-object asymmetry observed in the comprehension task was also observed in this experiment. Considering the rate of responses that involve RCs (both grammatical and ungrammatical), both children and adults showed a significant drop in the use of object RCs compared to subject RCs. In other words, both children and adults avoided object RCs and replaced them with different structures such as conjoined clauses, lexical substitutions, passives, and so on. One reason for this tendency might be the fact that the meaning in an object RC could be expressed with passives as well.

Yet, the fact that children did not use as many sentences with passive voice as adults might be indicating that object RCs posed certain difficulties for children. The analysis comparing the rate of grammatical RCs out of all responses revealed that children produced significantly more ungrammatical RCs than adults, who made only minimal errors. This points to a clear difference between children and adults: adults may be avoiding object RCs because there are structurally and conceptually more accessible choices available to them (Bock & Warren, 1985), whereas children seem to have difficulty in generating the correct structure in their utterances. We analysed the children's ungrammatical or non-adult responses and observed that all had one common feature: avoiding the genitive case and the object relativizing morpheme -DIK. We took this as an indication of the effect of morphosyntax along similar lines to Slobin (1986). Children also used resumptive pronouns or full resumptive NPs in the extraction site in object RCs but not in subject RCs. We interpreted this as a support for the effect of canonical word order that places the object in the pre-verbal position. Combining the results, we suggested that the subject-object asymmetry in Turkish RCs could not depend on a single cause but must be arising as a result of combination of multiple factors.

In Chapter 3, we also reviewed the Filler-Gap Accounts, namely the Linear Distance Hypothesis, the Structural Distance Hypothesis, and the Argument Crossing Account. The Filler-Gap Accounts attribute the difficulty to the increased memory or processing cost arising during the integration of the fillers with the gaps. The Linear Distance Hypothesis assumes that the processing resources increase in line with the number of intervening elements between the filler and the gap. As far as Turkish RCs are concerned, it predicts the subject RCs to be more difficult than object RCs since the former has an NP and a relativized verb between the gap and the filler while the latter had only the relativized verb. The Structural Distance Hypothesis, on the other hand, takes the number of structural nodes between the filler and the gap as a main source of processing cost. The Structural Distance Hypothesis predicts object RCs to be more difficult than subject RCs since the number of structural nodes is greater in the former. Finally, the Argument Crossing Account relates the processing cost to the number of referential elements between the filler and the gap. Thus, it expects subject RCs to be more difficult since it has a referential NP between the gap and the filler. According to this, only the Structural Distance Hypothesis received support from the results reported in the comprehension and production experiments. However, in the same chapter we addressed the question of how the parser should detect the gap before detecting the filler in Turkish RCs, where the gap precedes its head. We underlined that this issue should be clarified in order for the Structural Distance Hypothesis to get supported. Moreover, we underlined that the

children's ungrammatical responses documented in the elicitation task might be indicating an effect of morphosyntax apart from (or rather than) the cause explained by the Structural Distance Hypothesis.

9.2.2 Experiment 3a and Experiment 3b

In Experiment 3a in Chapter 4, we conducted an online comprehension study using a phrase-by-phrase self-paced listening paradigm that measures the segment-by-segment RTs after each phrase in complex sentences that locate the RCs with the subject matrix role sentence-initially to tease apart the effect of morphosyntax and the filler-gap effects on the processing of Turkish RCs.

The main issue regarding the Filler-Gap Accounts was to understand whether Turkish children and adults show filler-gap effects in structures that present the gap prior to the filler (i.e., whether or not their RTs would increase upon detecting the gap and the filler). We analysed the data with respect to the major filler-gap strategies, that have been suggested in the literature, such as the Gap-as-a-last-resort, the Gap-as-a-first-resort, the Lexical Expectation, the Active-Filler, and Trace Reactivation strategies. Yet, the results did not show a filler-gap effect while showing a clear effect of morphosyntax. That is, the participants presented longer RTs after the sentence-initial NP with the genitive case in comparison to the one with the accusative case. This confirmed the morphosyntactic asymmetry between a sentence-initial accusative NP and a sentence-initial genitive NP.

We related this to the following factors: a) Having multiple form-function mappings, the genitive morpheme is more ambiguous than the accusative morpheme. b) Since Turkish allows subject pro-drop very frequently, a sentence-initial NP-ACC could locally attach to a verb and form a sentence while an NP-GEN is a part of a composite constituent requiring its possessive-marked head before attaching to a matrix verb (a la Gibson, 1998). c) Based on the fact that children acquire the accusative morpheme earlier than the genitive morpheme (Ketrez & Aksu-Koc, 2009), it is highly possible that sentence-initial accusative NP is more frequent than sentence initial genitive NP.

The analysis also revealed that once the genitive NP in the object RC was processed, the processing of the relativized predicate with the agreement morphology in the next segment was facilitated. On the other hand, the participants did not display a similar effect at the relativized predicate in subject RCs. That is, they did not show a facilitatory effect upon hearing the predicate relativized by -(y)An after the sentence-initial NP-ACC. With the same

reasoning as above, we suggested that the participants must have expected to find a simple predicate rather than a relativized one following the NP-ACC to form a simple sentence as locally as possible. In other words, the parser must have ranked the option of a relativized verb after a genitive NP higher than the option of a relativized verb after an accusative NP.

Experiment 3b reported the RTs from simple sentences with four different word orders, namely SOV, SVO, OSV, and OVS. The aim in this experiment was to test the effect of word order on the processing of RCs. We specifically investigated the following questions: (a) Is the OV ordering that is observed in subject RCs processed better than SV ordering that appears in object RCs? (b) Does the number of NPs (i.e., discourse entities, a la Gibson, 1998) have any effect on parsing? That is, is there a processing difference between structures that locate the verb right after the first NP (e.g., SVO and OVS) compared to the ones that have another NP before the structure is attached to a verb (e.g., SOV and OSV)? Regarding the first question, the comparisons between OVS and SVO sentences suggested that the participants considered the OV structure as a full sentence compared to the SV structure. We took this to indicate that subject pro-drop is more expected than object pro-drop in Turkish. We also argued that the fact that OV ordering is processed faster might also be contributing to the better performance in subject RCs, which have an underlying OV ordering. Regarding the second question, both SV and OV structures were processed faster than SO and OV, respectively. This was in line with Gibson (1998). This was also in line with our explanation regarding the asymmetry between subject RCs and object RCs in the first segment (i.e., NP-ACC vs. NP-GEN) and in the second segment (i.e., relativized verb following an NP-ACC vs. an NP-GEN) in Experiment 3a.

9.2.3 Experiment 3c and Experiment 3d

In Experiment 3c, we tested the predictions of the Parallel Function Hypothesis, which predicts that the processing of a complex structure should be easier when the syntactic role of an NP in an embedded clause is the same as its role in the matrix clause, compared to the cases when it has different roles in each clause. According to this, a subject RC with the subject role in the matrix clause should be processed better than a subject RC with the object matrix role; and an object RC with the object matrix role should be processed better than an object RC with the subject role in the matrix clause. We investigated the online processing of sentences with sentence-initial RCs with subject and object matrix role with an auditory moving-window task.

The results revealed that adults showed faster RTs at the critical segments when the RC had the subject role regardless of the RC-Type. Children, on the other hand, showed a different performance in each of the two critical segments (i.e., Segment 2 and Segment 3). In Segment 3 that hosts the relativized NP (the head NP), they showed faster RTs when both of the RCs had the object role compared to when they had the subject role; whereas in Segment 4, hosting the object of the matrix clause, they showed faster RTs when both of the RCs had the subject role. Thus, children showed the same performance as adults only in Segment 4. This indicates that the Parallel Function Hypothesis was not supported by the present results.

In the same chapter, we discussed the issue of why adults expected the RC to have the subject matrix role regardless of the RC-Type, and why children showed a different pattern from adults in Segment 3. Regarding the first question, noting that all RCs appeared sentence-initially, we suggested that the participants might be reflecting the effect of canonical word order of Turkish (SOV), assigning the sentence-initial NP the subject role. Regarding the question as to why children expected the RC to have the object matrix role in Segment 3, we hypothesized that children might have interpreted the relativized predicate in Segment 2 as a headless RC with the subject matrix role (since it did not have any case marking on it), so they might have expected to find an object NP in Segment 3. We further analysed the prosodic patterns in our test items to see if they provided the necessary cues indicating that the structure was not a headless RC. Analysing the sounds with Praat Software, we found that there was a clear prosodic difference between a headless RC and a full RC at the end of the relativized predicate. This led us to suggest that children might have had difficulty detecting the prosodic cues in the test items, which is an issue that requires further investigation.

In Experiment 3d, we investigated the processing of sentences with sentence-medial RCs by the adult participants only. The results from the critical segment confirmed the prediction made in the previous experiment as to why adults showed faster RTs at the critical segment in sentences with sentence-initial RCs with the nominative case. When the RC appeared as the second NP (i.e., sentence-medial RCs), the participants tended to perform better in the critical segment when the RC had the accusative marking regardless of its type. Thus, they tended to locate the sentence-initial RC as the subject of the matrix clause (i.e., as in Experiment 3c) while locating the sentence-medial RC as the object of the matrix clause. Another finding in this experiment was that the asymmetry observed in sentence-initial NP-ACC versus sentence-initial NP-GEN disappeared when they were preceded by another NP (i.e., either an NP-NOM or NP-ACC). We took this to indicate that the position of a morphosyntactic or lexical item in the sentence and the structures preceding it —most probably in addition to

other factors such as context and prosody— influence the ease with which it is processed.

9.2.4 Experiment 4

In Experiment 4, we used the word-monitoring paradigm to test the children's and adults' sensitivity to the ungrammaticalities arising from the omission of the possessive-agreement morphology in object RCs and possessive NPs. The logic behind this paradigm is that the participants should need longer listening times upon encountering an ungrammaticality.

According to this, the adults displayed increased RTs at the critical point in ungrammatical sentences, indicating that they detected the ungrammaticalities whereas children did not show any difference between the grammatical and ungrammatical version of the items.

We argued that this might be confirming the effect of genitive-possessive agreement morphology on the processing of object RCs. However, we also noted that the present pattern conflicted with the results from Experiment 3a, where the processing of the segment with the possessive-agreement morpheme was facilitated after the processing of the genitive NP in the preceding segment. We suggested that the children might have had difficulty recognizing the genitive case in the word-monitoring task when the sentence was uttered at a normal speech rate and that this might have affected their processing of the possessive-agreement morphology. Thus, this finding might be due to the task demands in the word-monitoring task rather than the problems in the processing of possessive-agreement morphology. This issue requires further research.

9.2.5 Experiment 5 and Experiment 6

In Experiment 5, we investigated whether Turkish-English bilingual children would present similar patterns to their age-matched Turkish monolingual peers in terms of their comprehension of Turkish RCs and in terms of the strategies they used. We used the same sentence-referent matching task reported in Chapter 3 and showed that the bilingual children, just like their monolingual peers, had difficulty in object RCs. Regarding the comprehension strategies, we compared the Canonical Word Order strategy (or NNV strategy) of Bever's (1970) the Case Marking Strategy, and the Acc-Obj Strategy. To do this, we varied the type of the sentence in which the RC appeared: each RC appeared either within a question or within an imperative sentence. Success rate in object RCs were higher in imperatives than in questions, which indicated that the accusative case on the object of the matrix clause (and the object of the RC) guided the theta-role assignment better than the genitive case. Also, the participants

did not seem to show an effect of the canonical word order since they did not assign the first NP the agent role in any of the structures. Instead, the results suggested that the children benefited from the accusative case in detecting the theme in complex sentences.

It is crucial to note that Slobin and Bever (1982) reported that Turkish children showed an effect of word order when there were no case marking cues; and Demiral et al. (2008) showed that Turkish-speaking adults showed a tendency to assign the first NP the agent role when it had no case marking. Thus, we might have obtained the present results due to the cue-competition in our test items, namely the competition between the sentence-initial accusative NP and the sentence-initial genitive NP. In our experiment, the children did not assign the agent role to the first NP when it had the accusative case, which is fully expected given the fact that the accusative is the object marker in Turkish. Yet, an interesting finding in this experiment was that the children also did not assign the first NP the agent role when it had the genitive case, which is the subordinate subject case in Turkish. This indicates that the children was not able to use this case marking cue most probably because the genitive marker could also function as a possessor suffix. This is in line with the longitudinal studies showing that the possessor function of the genitive case is acquired earlier than its subject function (e.g., Ketrez & Aksu-Koc, 2009). Another support for this comes from the asymmetry between the sentence-initial accusative NP and sentence-initial genitive NP reported in Experiment 3a.

One difference between monolingual and bilingual children in this experiment was that while the former performed better when the RC appeared in an imperative sentence, the latter performed better when the structure appeared within a question. To put it differently, Turkish speakers performed better when the message (or the head) of the sentence appeared in the sentence-final position whereas Turkish-English speakers performed better when the message appeared sentence-initially. We conjectured that this might be a sign of transfer since the head appears in the sentence-final position in Turkish while it appears earlier in the sentence in English. This issue needs further research.

In Experiment 6, the production of Turkish RCs in the bilingual and monolingual children was tested with the elicitation task reported in Chapter 3. The results suggested that both groups produced more subject RCs than object RCs; while the monolingual group used a greater number of RCs. The rate of grammatical RCs out of all RC-responses confirmed the subject-object asymmetry but eliminated the effect of Group. According to this, bilingual children used a greater number of avoidance responses compared to monolinguals. We related this to the possibility that bilingual children were more conservative with the structure they chose whereas monolinguals were more flexible to use RCs albeit with errors. The in-

terpretation of children's ungrammatical responses indicated that they produced errors within the possibilities of their experiences with the input language as well as within the boundaries of their competence grammar.

9.3 Conclusions

The thesis attempted to provide a comprehensive analysis of the processing and acquisition of Turkish RCs. The research questions that have been formulated in the Chapter 1) will be revisited in the following sections to provide a summary of our conclusions.

9.3.1 Conclusions about the Processing and Acquisition of Turkish Relative Clauses

The research questions regarding the processing and acquisition of Turkish RCs were as follows:

- Are subject RCs acquired earlier and processed better than object RCs in Turkish?
- How could we account for the asymmetries that might be observed between subject and object RCs in Turkish?
- Do Turkish monolingual and Turkish-English bilingual children show similar patterns in their comprehension and production of Turkish RCs?

The off-line and on-line experiments in this study complemented each other in documenting a clear processing asymmetry between subject RCs and object RCs. According to this, subject RCs are processed better than object RCs.

The comprehension data from the monolingual and bilingual children in the sentence-referent matching task demonstrated that both groups had a poor comprehension of object RCs than subject RCs. That is, they could not assign the correct theta-roles to the referents described in an object RC whereas they did not display any problems in subject RCs.

The fact that they also performed equally well in non-reversible object RCs (i.e., the structures where one of the referent is human or animate whereas the other referent is inanimate; e.g., 'Show me the ice-cream the boy is eating') in the control items suggest that the nature of lexical items provided semantic and pragmatic cues to choose the reasonable or logical argument as the agent of the activity (e.g., 'The boy must be eating the ice-cream as the opposite is not plausible in a real world'). Some researchers insightfully argue that the processing load

resulting from the presence of the same type of arguments (i.e., animate NPs) in a structure is the reason for the difficulty in object RCs (e.g., Arnon, 2005). This must certainly have an effect on processing, as various studies confirm that the number and the nature of arguments influence the success in parsing (e.g., Gibson, 1998). However, the type of ungrammatical responses children produced in their utterances in the elicitation task casts doubts on the proposal that the mere difficulty resides in semantic plausibility. In this task, children tended to omit the genitive case, and they tended to replace the object relativizing morpheme -DIK with the subject relativizer -(y)An, indicating a clear effect of morphosyntax.

Similar morphosyntactic errors were also documented by a previous study on the production of RCs (Özcan, 2000). The present study is novel in that it complements these results with online experiments that reveal about the moment-by-moment processes children employ. The online results from the monolingual children mainly reflected the pattern displayed by monolingual and bilingual children in the off-line tasks. In Experiment 3a, monolingual children and adults spent longer times processing the sentence-initial genitive case. As for the simple items with various word orders, they showed a clear preference for the OVS order that is observed in subject RCs (in comparison to the SVO order that is observed in object RCs). They showed a preference for the OVS and SVO orders that place the verb earlier in comparison to the OSV and SOV orders that place an extra argument before the verb. In Experiment 4, children, but not adults, failed to detect the ungrammaticalities arising from the missing possessive agreement morphology in possessive NPs and object RCs.

Some features of object RCs posed difficulty for adults, too. For instance, the genitive case was avoided in production; the same was true for the object relativizer. Similarly, sentence-initial NPs with the genitive case took longer to process than sentence-initial NPs with the accusative case in the auditory moving-window experiment. This may be due to the fact that these structures are not used in adult spoken language frequently, which is in line with several studies showing that object RCs are less frequent than subject RCs (Slobin, 1986 and Haig, 1997). Thus, the statistical nature of the input influences the production and processing, hence acquisition. Yet, it seems to be an important question to investigate why these structures are less frequent. The present findings argue for the possibility that lexical or morphological items (1) that have greater number of functions (Bates & Goodman, 1997, MacWhinney, 1999), hence a greater amount of ambiguity; (2) that depend on other units to receive a proper interpretation (e.g., the genitive case requires its head with the possessive-agreement marker to receive full interpretation); (3) that cannot locally attach to a verb (e.g., an NP with genitive marking needs its head before attaching to a verb) (Gibson, 1998) tend

to be less frequent and more problematic both for production and processing.

One issue regarding ambiguity needs emphasis here. It is certain that almost all units of language pose ambiguity in certain respects. However, we argued that ambiguity should be a gradient feature like most other aspects of language (e.g., grammaticality or acceptability). That is, whether and to what degree a structure is ambiguous seems to depend on many factors such as the structure within which it appears, its location in a sentence, its prosody, the context, and so on. This suggests that a structure that is highly ambiguous in one setting might be less ambiguous in others.

Taken together, these findings strongly suggest that there is not a single cause for the asymmetry that is in question here: factors pertaining to morphosyntax, word-order, semantics, plausibility, prosody, context, and other cognitive factors converge to render object RCs a harder structure to process and acquire.

9.3.2 Conclusions about the Development of Language Processing in Head-Final Languages and Mechanisms and Strategies in Human Language Processing

The research questions with regard to the development of language processing in head-final languages were as follows:

- To what extent do Turkish adults benefit from morphosyntactic information in an incremental and predictive manner?
- What do the comprehension and production data from children and adults reveal about the development of sentence processing abilities and language acquisition processes in general?
- What is the cross-linguistic validity of the processing strategies offered for typologically different languages?

There have been very limited research investigating the development of online language processing mechanisms in children acquiring head-final languages (e.g., Choi & Trueswell, 2010). The studies, which come mostly from English-speaking children, suggest that even if children and adults show continuity in terms of their parsing mechanisms, there is a clear developmental path children follow in some respects (Trueswell & Gleitman, 2007). For instance, it has been suggested that children depend mostly on verbs while they process spoken

utterances (Snedeker & Trueswell, 2004, Thothathiri & Snedeker, 2008). Importantly, this finding implies that children acquiring a head-final language that presents the verb in the sentence-final position should postpone interpretation until the verb appears. This, in turn, would indicate that these children do not parse utterances incrementally or their parsing is head-dependent. Previous research has shown that in head-final languages although the verb appears sentence finally, adults parse utterances incrementally and predictively on the basis of a number of locally available cues (Kamide & Mitchell, 1999; Kamide, Altmann, & Haywood, 2003).

The present study suggests that the incrementality and predictivity observed in adult processing is also available for the case of children acquiring a head-final language.

It has been argued that speakers tend to start their utterance with conceptually more accessible and simple structures (Bock & Warren, 1985). This has been attributed to the idea that spoken utterances are formulated incrementally, where people do not generally formulate all of their utterances but mould their message into the structure with which they started their sentence (V. S. Ferreira & Dell, 2000). The fact that our participants tended to start their utterance with the subject perspective when constructing object RCs gives support incrementality. Also, Experiment 3a demonstrated that both child and adult participants showed an effect of morphemes at each segment, suggesting that they were able to incorporate the morphological cues into the existing structure incrementally as well as predicting the upcoming lexical and morphosyntactic material. Although children showed similarity to adults in terms of incremental processing, their performance was significantly slower than that of adults. Similarly, they showed a different pattern from adults in the processing of the RC role in the matrix clause. We related this to their limited sensitivity to the prosodic cues while interpreting ambiguous utterances, which is in line with Snedeker and Trueswell (2003) and Choi and Mazuka (2003)).

The present work also investigated three proposals offered as universal strategies the human processor employs while interpreting utterances. The first one is the Filler-Gap Strategies, which take the distance between the filler and the gap as the main source of processing difficulty. The second one is the Parallel Function Hypothesis that is proposed to be used by children while interpreting NPs in complex structures on the basis of their grammatical role. The third one is the Canonical Word Order Strategy arguing that the human parser tends to take the canonical word order as their schema to interpret the utterances in complex structures. Turkish speakers did not show the effects predicted by these strategies. It appears that certain sources of information (e.g., word order, case marking) that may be proved to yield

successful results in certain cases might not be as successful in other cases depending on their weight in relation to other factors (e.g., the number of lexical items, the level of ambiguity, the type of linguistic items, frequency, the strength of the linguistic cues, and the like). That is, language processing seems to be a product of a dynamic interplay of many different (linguistic and nonlinguistic) factors.

In line with this, we argued that a model of a language processor that uses a highly lexicalized grammar, a bottom-up parsing algorithm, and a mechanism that evaluates multiple sources of information in line with the parsing model of a specific language along the same lines with Steedman (1989; 2000); and a model by Vasishth & Kruijff (2001) that uses a highly lexicalized grammar, a combination of a top-down and a bottom-up algorithm, and a complexity metric inspired by Gibson (1998) and Hale (2001) can account for the present data in a straightforward manner.

9.4 Limitations and Ideas for Further Studies

Below, we list the questions that have not been addressed in this thesis as the main limitations of this study. We provide some ideas as to how certain areas are planned to be investigated as a part of our future research program.

- In the comprehension task, in addition to the semantically reversible sentences (i.e., both referents are animate and they could both be agent and patient; e.g., a dog and a cat) we also employed semantically non-reversible sentences (e.g., a boy and an apple). The results suggested that children showed an effect of semantic reversibility and they used the semantic cues to assign correct theta-roles to the referents in the sentence. One question we have not addressed was whether or not the same pattern would be observed in production. Research suggests that children's early RCs involve semantically reversible structures where the agent and the patient is straightforwardly derived from the context (e.g., 'the book I read', 'the ball mummy holds') (Arnon, 2010 and Diessel & Tomasello, 2000). As a future work, we intend to address this issue to see whether children's production is facilitated with the type of lexical items they are required to use in their responses.

- In the production task, our elicitation cards required a shift of perspective from patient to agent when eliciting an object RC. More specifically, the elicitation question (e.g., which lion is wearing a hat?) attracted the participants' attention to the patient and

required to form an RC that modifies the patient (i.e., 'the lion that the bear is kissing is wearing a hat'). In most of the cases, our participants tented to locate the patient (i.e., the lion) as the subject of their utterance (e.g., 'the lion that is being kissed' or 'the lion that is wearing the hat is kissing the bear'). We suggested that the perceptual factors (i.e., the fact that our elicitation card required a shift of perspective from patient to agent in object RCs while requiring no perspective shift in subject RCs) might be adding to the difficulty of producing object RCs. We intend to test the tenability of this factor using an eye-tracking paradigm. Children's gaze fixations on the referents in the elicitation card should inform us whether children have difficulty shifting their perspective from the dominant referent to the less dominant one in a visual scene.

- Another question regarding the production task was to what extent our participants planned their message and encoded it grammatically before they begin their utterance. In other words, to what extent was their utterance formulation incremental? The fact that they located the patient as the subject of the sentence and the fact that they used less ambiguous morphological markings (nominative rather than genitive; -(y)An rather than -DIK) might be indicating that their speech formulation is incremental. However, this issue needs closer examination with appropriate experimental materials and paradigms.

- The online auditory moving-window task in Experiment 3a revealed no filler-gap effects but it revealed some asymmetries in the processing of certain morphemes when they appeared in certain location. We used two accounts using a lexicalized grammar (morphemic CCG and V&K Model) and showed that they could ensure incremental and predictive processing without extra algorithms or parsing strategies. We assumed that contextual, perceptual, lexical and syntactic factors as well as the probabilistic ones should be considered by the processor in determining a particular parsing choice. We did not use any frequency measures or we did not test the suggested proposals using a computational parsing model. The integration of a probabilistic framework that considers the probabilities of certain lexical/grammatical choices following certain items in a wide-coverage parsing model would provide us with important means to test our hypotheses as well as granting the plausible implementation of these models. One such model is suggested by Morgan, Keller, and Steedman (2010). For future work, we intend to gather the probabilities of certain lexical and morphological items (i.e., the probability with which a sentence-initial NP-GEN is followed by a relativized verb

compared to a possessed NP with possessive agreement morphology) from the METU Turkish spoken corpus that is in preparation (Ruhi & Karadaş, in press) to test whether a computational parser would yield similar results we report from children and adults in this study.

- Experiment 3a also showed that child speakers of a head-final language at the ages of 5 to 8 parse spoken utterances as incrementally and as predictively as adults, though with lower processing speed. This is the first study showing that children of a head-final language use every available information rapidly and eagerly without waiting for the verb just like the adults in head-final and head-initial languages. This is in line with adult processing literature showing that the mechanism to parse head-final languages is not verb-based but it is as incremental as parsing in head-initial languages (e.g., Kamide & Mitchell, 1999; Kamide, Altmann, & Haywood, 2003). However, this finding contrasts with the studies showing that children largely depend on the subcategorization frames of the verb in their parsing routines (e.g., Snedeker & Trueswell, 2003, 2004; and references therein). In the future work, we aim to investigate whether younger children acquiring a head-final language would show similar patterns to the age group we tested (i.e., 5-8 year-olds) in terms of using each available morpheme and lexeme for incremental interpretation.

- Experiment 3c showed that Turkish-speaking adults tended to locate the sentence-initial RC in the subject role in line with the SOV word order, whereas the children showed the expected pattern one segment later than the critical segment. We suggested that this might be due to the spill-over effect children showed because of their slower-processing speed compared to adults. Alternatively, we suggested that this might be due to children's limited ability in detecting the prosodic cues at the site of local ambiguities. We underlined that the relativized verb in Turkish might function as the head in cases where the modified NP is dropped (i.e., headless RC). We showed that our test items displayed prosodic cues indicating that the modified NP would be introduced in the next segment and we argued that children might not have realised this due to their limited sensitivity to prosodic cues in ambiguity resolution and they might have mistaken the relativized verb as the head with the subject matrix role. We showed that the V&K Model could explain the data in line with this reasoning; however, the present study is not conclusive about whether or not this pattern is due to children's slow processing or due to their failure in integrating the prosodic cues in their parsing. We aim

to investigate this issue with a study explicitly designed to test the role of prosody in children's attachment preferences in Turkish RCs. More specifically, we aim to test whether Turkish-speaking children tend to assign the relativized verb the head role despite the prosodic cues favoured the full RC interpretation.

- As for the Turkish-English bilingual children, we provided the off-line comprehension and production data in their Turkish. As future work, we intend to report their comprehension and production of English RCs with regard to the literature about bilingualism and the effect of transfer from their Turkish to English (i.e., from the dominant language to the less dominant one or vice versa). We also intend to report data from English-speaking monolingual children to compare the performance patterns in Turkish-English bilingual children in their processing of English RCs.

- Turkish-English bilingual children performed less successfully both in comprehension and production compared to Turkish monolingual children (despite showing the same subject-object asymmetry). We conjecture that this might be due to the fact that they do not receive any formal input (i.e., literacy education or instruction) in Turkish language (a la Cummins, 1980, 2000). We intend to compare Turkish-English bilingual children that receive academic input both in English and Turkish to those that receive education only in English to test whether there is any effect of academic input on the success rate of their linguistic processing in both languages.

- Finally, the informal interviews with Turkish-English children and their families revealed that they do not prefer communicating in Turkish with their Turkish-English bilingual friends and that they spoke Turkish only when they have to communicate with family members who do not speak English. This might be indicating their preferences in their identity construction as an English speaker only and that this might be related to their lower perception of the native community compared to the British culture. Future work should investigate the effects of sociolinguistic factors on bilingual language processing and the process of native language acquisition and attrition.

References

Abney, S. (1991). Parsing by chunks. In R. Berwick, S. Abney, & C. Tenny (Eds.), *Principle-based parsing* (pp. 257–278). Tübingen: Kluwer Academic Publisher.

Acarlar, F., & Johnston, J. R. (2006). Computer-based analysis of Turkish child language: clinical and research applications. *Journal of Multilingual Communication Disorders*, *4*(2), 78–94.

Adani, F. (2009). Rethinking the acquisition of relative clauses in Italian: towards a grammatically based account. *Journal of Child Language*, *doi: 10.1017/S0305000909990250*, 1–25.

Adani, F., Lely, H. K. J. van der, Forgiarini, M., & Guasti, M. T. (2010). Grammatical feature dissimilarities make relative clauses easier: A comprehension study with Italian children. *Lingua*, *120*(9), 2148–2166.

Aksu-Koç, A. A., & Slobin, D. I. (1985). The acquisition of Turkish. In D. I. Slobin (Ed.), *The crosslinguistic study of language acquisition: Vol. 1, the data* (pp. 839–880). Hillsdale, NJ: Erlbaum.

Altmann, G. (1988). Ambiguity, parsing strategies, and computational models. *Language and Cognitive Processes*, *3*(2), 73–97.

Altmann, G. (2001). The language machine: Psycholinguistics in review. *British Journal of Psychology*, *92*(1), 129–170.

Altmann, G., & Steedman, M. (1988). Interaction with context during human sentence processing. *Cognition*, *30*(3), 191–238.

Anderson, V. A., Anderson, P., Northam, E., Jacobs, R., & Mikiewicz, O. (2002). Relationships between cognitive and behavioral measures of executive function in children with brain disease. *Child Neuropsychology*, *8*(4), 231–240.

Aoshima, S., Phillips, C., & Weinberg, A. (2002). Active filler effects and reanalysis: A study of Japanese Wh-scrambling constructions. *University of Maryland Working Papers in Linguistics*, *12*, 1–24.

Aoshima, S., Phillips, C., & Weinberg, A. (2004). Processing filler-gap dependencies in a head-final language. *Journal of Memory and Language*, *51*(1), 23–54.

Arnon, I. (2005). Relative clause acquisition in Hebrew: Towards a processing-oriented account. In A. Brugos, M. R. Clark-Cotton, & S. Ha (Eds.), *Proceedings of the Twenty-ninth Boston University Conference on Language Development* (p. 37-48). Somerville, MA: Cascadilla Press.

Arnon, I. (2010). Rethinking child difficulty: the effect of NP type on children's processing of relative clauses in Hebrew. *Journal of Child Language*, *37*(1), 27–57.

Aydın, O. (2007). The comprehension of Turkish relative clauses in second language acquisition and agrammatism. *Applied Psycholinguistics*, *28*(02), 295–315.

Aygen, G. (2003). Extractability and the nominative case feature on tense. In S. Özsoy, D. Akar, M. Nakipoğlu-Demiralp, E. E. Erguvanlı-Taylan, & A. Aksu-Koç (Eds.), *Studies in Turkish Linguistics: Proceedings of the 10th International Conference in Turkish Linguistics* (pp. 81–94). Istanbul: Boğaziçi University Press.

Bach, E., Brown, C., & Marslen-Wilson, W. (1986). Crossed and nested dependencies in German and Dutch: A psycholinguistic study. *Language and Cognitive Processes*, *1*(4), 249–262.

Baddeley, A. (2003). Working memory: Looking back and looking forward. *Nature Reviews Neuroscience*, *4*(10), 829–839.

Bangalore, S., & Joshi, A. (1999). Supertagging: An approach to almost parsing. *Computational Linguistics*, *25*(2), 237–265.

Barker, C., Hankamer, J., & Moore, J. (1990). Wa and ga in Turkish. In K. Dziwirek, P. Farrell, & E. Mejias-Bikandi (Eds.), *Grammatical Relations: A Cross-Theoretical Perspective* (pp. 21–43). Stanford: CSLI Publications.

Bates, E., & Goodman, J. C. (1997). On the inseparability of grammar and the lexicon: Evidence from acquisition, aphasia and real-time processing. *Language and Cognitive Processes*, *12*(5/6), 507–584.

Bates, E., & MacWhinney, B. (1987). Competition, variation, and language learning. In B. MacWhinney (Ed.), *Mechanisms of Language Acquisition.* New Jersey: Lawrence Erlbaum Inc. Publishers.

Bever, T. G. (1970). The cognitive basis for linguistic structures. In J. R. Hayes (Ed.),

Cognition and the Development of Language (pp. 279–362). New York: Wiley.

Bird, H., Franklin, S., & Howard, D. (2001). Age of acquisition and imageability ratings for a large set of words, including verbs and function words. *Behavior Research Methods*, *33*(1), 73.

Bock, J. K., & Cutting, J. C. (1992). Regulating mental energy: Performance units in language production. *Journal of Memory and Language*, *31*(1), 99–127.

Bock, J. K., & Warren, R. K. (1985). Conceptual accessibility and syntactic structure in sentence formulation. *Cognition*, *21*(1), 47–67.

Borsley, R., & Börjars, K. (2009). *Non-transformational Syntax*. Oxford: Blackwells.

Bozşahin, C. (2002). The combinatory morphemic lexicon. *Computational Linguistics*, *28*(2), 145–186.

Bresnan, J., & Kaplan, R. M. (1984). Introduction: Grammars as mental representations of language. In W. Kintsch, J. R. Miller, & P. P. G. (Eds.), *Methods and Tactics in Cognitive Science* (pp. 103–135). Hillsdale, NJ: Erlbaum.

Buttery, P. (2003). Computational models for first language acquisition. *CLUK-6, Edinburgh*.

Carlson, G. N., & Tanenhaus, M. K. (1988). Thematic roles and language comprehension. In W. Wilkins (Ed.), *Syntax and Semantics: Vol. 21. Thematic Relations* (Vol. 21, pp. 263–288). San Diago, CA: Academic Press.

Carlson, K., & Clifton, C. (2001). Prosodic Boundaries in Adjunct Attachment. *Journal of Memory and Language*, *45*(1), 58–81.

Carreiras, M., Duñabeitia, J. A., Vergara, M., Cruz-Pavía, I. de la, & Laka, I. (2010). Subject relative clauses are not universally easier to process: Evidence from Basque. *Cognition*, *115*(1), 79–92.

Charniak, E. (1997). Statistical techniques for natural language parsing. *AI magazine*, *18*(4), 33–43.

Chater, N., & Manning, C. D. (2006). Probabilistic models of language processing and acquisition. *Trends in Cognitive Sciences*, *10*(7), 335–44.

Choi, Y., & Mazuka, R. (2003). Young children's use of prosody in sentence parsing. *Journal of Psycholinguistic Research*, *32*(2), 197–217.

Choi, Y., & Trueswell, J. (2010). Children's (in)ability to recover from garden paths in a verb-final language: evidence for developing control in sentence processing. *Journal of Experimental Child Psychology*, *106*(1), 41–61.

Chomsky, N. (1965). *Aspects of the Theory of Syntax*. Cambridge, MA: The MIT Press.

Chomsky, N. (1981). Principles and parameters in syntactic theory. In N. Hornstein & D. Lightfoot (Eds.), *Explanation in Linguistics: The Logical Problem of Language Acquisition* (pp. 32–75). London: Longman.

Chomsky, N. (1995). *The Minimalist Program*. Cambridge, MA: MIT Press.

Clifton, C., & Frazier, L. (1989). Comprehending sentences with long-distance dependencies. *Linguistic Structure in Language Processing*, 273–317.

Cole, P., Hermon, G., & Tjung, Y. (2003). The formation of relative clauses in Jakarta Indonesian: Data from adults and children. *ISMIL*, *7*, 27–29.

Collins, M. J. (1996). A new statistical parser based on bigram lexical dependencies. In *Proceedings of the 34th Annual Meeting on Association for Computational Linguistics* (pp. 184–191). Santa Cruz, California. ACL, 1996: Association for Computational Linguistics.

Collins, M. J. (2003). Head-Driven Statistical Models for Natural Language Parsing. *Computational Linguistics*, *29*(4), 589–637.

Crain, S. (1991). Language acquisition in the absence of experience. *Behavioral and Brain Sciences*, *14*(4), 597–650.

Crain, S., & Fodor, J. D. (1985). How can grammars help parsers. In D. Dowty, K. L., & Z. A. M. (Eds.), *Natural Language Parsing: Psychological, Computational and Theoretical Perspectives* (pp. 94–127). Cambridge, UK: Cambridge University Press.

Crain, S., McKee, C., & Emiliani, M. (1990). Visiting relatives in Italy. In L. Frazier & J. G. De Villiers (Eds.), *Language Processing and Language Acquisition* (pp. 335–356). Dordrecht: Kluwer Academic Publishers.

Crain, S., & Pietroski, P. (2001). Nature, nurture and universal grammar. *Linguistics and Philosophy*, *24*(2), 139–186.

Crain, S., & Steedman, M. (1985). On not being led up the garden path: the use of context by the psychological parser. In L. Kartunnen, D. Dowty, & A. Zwicky (Eds.), *Natural Language Parsing: Psychological, Computational, and Theoretical Perspectives* (pp. 320–358). Camridge, UK: Cambridge University Press.

Crain, S., & Thornton, R. (1998). *Investigations in Universal Grammar: A guide to Experiments on the Acquisition of Syntax and Semantics*. Cambridge, MA: MIT Press.

Crocker, M. W. (1999). Mechanisms for sentence processing. In S. Garrod & P. M. (Eds.), *Language Processing* (pp. 191–232). East Sussex, UK: Psychology Press.

Csató, É. (1996). A typological review of relative clause constructions in some Turkic languages. In *Current Issues in Turkish Linguistics: Proceedings of the Fifth International*

Conference on Turkish Linguistics. (pp. 28–32). Ankara: Hitit Yayınevi [copyright London: SOAS].

Cuetos, F., & Mitchell, D. C. (1988). Cross-linguistic differences in parsing: restrictions on the use of the late closure strategy in Spanish. *Cognition*, *30*(1), 73–105.

Cuetos, F., Mitchell, D. C., & Corley, M. M. B. (1996). Parsing in different languages. In C. M., J. García-Albea, & Sabastián-Gallés (Eds.), *Language Processing in Spanish* (pp. 145–189). Mahwah, NJ: Lawrence Erlbaum Associates.

Cummins, J. (1980). The cross-lingual dimensions of language proficiency: Implications for bilingual education and the optimal age issue. *Tesol Quarterly*, *14*(2), 175–187.

Cummins, J. (2000). *Language, Power, and Pedagogy: Bilingual Children in the Crossfire*. UK: Multilingual Matters Ltd.

Demiral, S. B. I., Schlesewsky, M., & Bornkessel-Schlesewsky, I. (2008). On the universality of language comprehension strategies: Evidence from Turkish. *Cognition*, *106*(1), 484–500.

De Vincenzi, M. (1996). *Test di comprensione delle frasi interrogative soggetto/oggetto in Italiano*. Roma, Italia: Istituto di Psicologia del CNR.

Diessel, H. (2004). *The Acquisition of Complex Sentences*. Cambridge, UK: Cambridge University Press.

Diessel, H. (2005). Competing motivations for the ordering of main and adverbial clauses. *Linguistics*, *43*(3), 449–470.

Diessel, H., & Tomasello, M. (2000). The development of relative clauses in spontaneous child speech. *Cognitive Linguistics*, *11*(1/2), 131–152.

Dittmar, M., Abbot-Smith, K., Lieven, E., & Tomasello, M. (2008). German children's comprehension of word order and case marking in causative sentences. *Child Development*, *79*(4), 1152–1167.

Erkman-Akerson, F. (1998). Genitival subjects in Turkish relative constructions. In L. Johanson, E. A. Csato, & V. Locke (Eds.), *The Mainz Meeting: Proceedings of the Seventh International Conference on Turkish Linguistics, August 3-6, 1994* (p. 285). Wiesbaden: Harrassowitz Verlag.

Ertel, S. (1977). Where do the subjects of sentences come from. In S. Rosenber (Ed.), *Sentence Production: Developments in Research and Theory* (pp. 141–167). Hillsdale, NJ: Lawrence Erlbaum.

Fernald, A., Swingley, D., & Pinto, J. P. (2001). When half a word is enough: Infants can recognize spoken words using partial phonetic information. *Child Development*, *72*(4),

1003–1015.

Ferreira, F. (2002). Syntax in language production: an approach using tree-adjoining grammars. In L. Wheeldon (Ed.), *Aspects of Language Production* (pp. 291–330). Cambridge, MA: MIT Press.

Ferreira, F., Anes, M. D., & Horine, M. D. (1996). Exploring the use of prosody during language comprehension using the auditory moving window technique. *Journal of Psycholinguistic Research*, *25*(2), 273–290.

Ferreira, F., & Clifton, C. (1986). The independence of syntactic processing. *Journal of Memory and Language*, *25*(3), 348–368.

Ferreira, F., & Engelhardt, P. E. (2006). Syntax and production. In M. J. Traxler & M. A. Gernsbacher (Eds.), *Handbook of Psycholinguistics* (pp. 61–91). San Diego, California: Academic Press.

Ferreira, V. S., & Dell, G. S. (2000). Effect of ambiguity and lexical availability on syntactic and lexical production. *Cognitive Psychology*, *40*(4), 296–340.

Fodor, J. D. (1978). Parsing strategies and constraints on transformations. *Linguistic Inquiry*, *9*(3), 427–473.

Frazier, L. (1979). *On Comprehending Sentences: Syntactic Parsing Strategies.* Dissertations Collection for University of Connecticut.

Frazier, L., Flores d'Arcais, A., & Giovanni, B. (1989). Filler driven parsing: A study of gap filling in Dutch. *Journal of Memory and Language*, *28*(3), 331–344.

Frazier, L., & Rayner, K. (1982). Making and correcting errors during sentence comprehension: Eye movements in the analysis of structurally ambiguous sentences. *Cognitive Psychology*, *14*(2), 178–210.

Friedmann, N., Belletti, a., & Rizzi, L. (2009). Relativized relatives: Types of intervention in the acquisition of A-bar dependencies. *Lingua*, *119*(1), 67–88.

Friedmann, N., & Novogrodsky, R. (2004). The acquisition of relative clause comprehension in Hebrew: a study of SLI and normal development. *Journal of Child Language*, *31*(3), 661–681.

Garrett, M. F. (1988). Processes in language production. *Linguistics: The Cambridge Survey*, *3*, 69–96.

Gass, S. (1980). An investigation of syntactic transfer in adult second language learners. In R. Scarella & S. Krashen (Eds.), *Input in Second Language Acquisition* (pp. 132–141). Rowley, MA: Newbury House.

Gibson, E. (1998). Linguistic complexity: Locality of syntactic dependencies. *Cognition*,

68(1), 1–76.

Göksel, A. (2007). Morphology and Syntax Inside the Word: Pronominal Participles of Headless Relative Clauses in Turkish. In G. Booij, L. Ducceschi, B. Fradin, E. Guevara, A. Ralli, & S. Scalise (Eds.), *Proceedings of the Fifth Mediterranean Morphology Meeting* (pp. 47–72). University of Bologna.

Göksel, A., & Kerslake, C. (2005). *Turkish: A Comprehensive Grammar*. New York: Routledge.

Goodluck, H. (1978). *Linguistic principles in children's grammar of complement subject interpretation*. MA: Graduate Linguistic Student Association, University of Massachusetts.

Goodluck, H., & Tavakolian, S. (1982). Competence and processing in children's grammar of relative clauses. *Cognition*, *11*(1), 1–27.

Grober, E. H., Beardsley, W., & Caramazza, a. (1978). Parallel function strategy in pronoun assignment. *Cognition*, *6*(2), 117–33.

Güngördü, Z., & Engdahl, E. (1998). A relational approach to relativization in Turkish. In G. G. J. K. Bouma & R. T. Oehrle (Eds.), *Proceedings of the Joint Conference on Formal Grammar, Head-Driven Phrase Structure Grammar, and Categorial Grammar* (pp. 125–133). Saarbrucken, Germany.

Gürel, A. (2002). *Linguistic Characteristics of Second Language Acquisition and First Language Attrition: Turkish Overt versus NuIl Pronouns*. Unpublished doctoral dissertation, McGill University, Montréal.

Gutierrez, J. M. (2010). Comprehension of Relative Clauses in L1 Basque. In K. Franich, K. M. Iserman, & L. Keil (Eds.), *Proceedings of the 34th Annual Boston University Conference on Language Development.* MA, USA: Cascadilla Press.

Haig, G. (1997). Turkish relative clauses: A tale of two participles. *Turkic Languages*, *1*, 184–209.

Haig, G. (1998). *Relative Constructions in Turkish*. Wiesbaden: Harrassowitz Verlag.

Hakuta, K. (1981). Grammatical description versus configurational arrangement in language acquisition: the case of relative clauses in Japanese. *Cognition*, *9*(3), 197–236.

Hale, J. (2001). A probabilistic Earley parser as a psycholinguistic model. In *Proceedings of the Second Meeting of the North American Chapter of the Association for Computational Linguistics on Language Technologies 2001 - NAACL '01* (pp. 1–8). Morristown, NJ, USA: Association for Computational Linguistics.

Hamburger, H. (1980). A deletion ahead of its time. *Cognition*, *8*(4), 389–416.

Hamburger, H., & Crain, S. (1982). Relative acquisition. In S. Kuczaj (Ed.), *Language development: Syntax and Semantics, Vol I* (pp. 245–274). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hankamer, J. (1989). Morphological parsing and the lexicon. In W. Marslen-Wilson (Ed.), *Lexical Representation and Process* (pp. 392–408). Cambridge, MA: The MIT Press.

Hankamer, J., & Knecht, L. (1976). The role of the subject/non-subject distinction in determining the choice of relative clause participle in Turkish. *Harvard Studies in Syntax and Semantics*, *2*, 197–219.

Hawkins, J. A. (1999). Processing complexity and filler-gap dependencies across grammars. *Language*, *75*(2), 244–285.

Hermon, G., Öztürk, Ö., & Kornfilt, J. (2007). Acquisition of relative clauses in Turkish. In *Interdisciplinary Approaches to Relative Clauses (Rel 07), University of Cambridge, 13-15 September.*

Hockenmaier, J., & Steedman, M. (2002). Generative models for statistical parsing with Combinatory Categorial Grammar. In *Proceedings of the 40th Annual Meeting of the Association for Computational Linguistics* (pp. 335–342). Association for Computational Linguistics.

Hopper, P. J., & Thompson, S. A. (1984). The discourse basis for lexical categories in universal grammar. *Language*, *60*(4), 703–752.

Hresko, W. P., Reid, D. K., & Hammill, D. D. (1999). *Test of Early Language Development (TELD)*. Austin, TX: PRO-ED.

Hsu, N., Hermon, G., & Zukowski, A. (2009). Young children's production of head-final relative clauses: Elicited production data from Chinese children. *Journal of East Asian Linguistics*, *18*(4), 323–360.

Hyams, N. (1992). A reanalysis of null subjects in child language. In J. Weissborn, H. Goodluck, & T. Roeper (Eds.), *Theoretical Issues in Language Acquisition: Continuity and Change in Development* (pp. 249–267). Hillsdale, NJ: Lawrence Erlbaum.

Jackendoff, R. (2002). *Foundations of Language: Brain, Meaning, Grammar, Evolution*. Oxford: Oxford University Press.

Johanson, L., & Csató, E. A. (1998). *The Turkic Languages*. London: Routledge.

Johnson, E. K., & Jusczyk, P. W. (2001). Word Segmentation by 8-Month-Olds: When Speech Cues Count More Than Statistics. *Journal of Memory and Language*, *44*(4), 548–567.

Johnson-Laird, P. N. (1968). The choice of the passive voice in a communicative task. *British*

Journal of Psychology, *59*(1), 7–15.

Jong, J. de, Çavuş, N., & Baker, A. (2010). Language impairment in Turkish-Dutch bilingual children. In S. Topbaş & M. Yavaş (Eds.), *Communication Disorders in Turkish* (pp. 290–303). Clevedon: Multilingual Matters.

Jurafsky, D. (1996). Universal tendencies in the semantics of the diminutive. *Language*, *72*(3), 533-578.

Jusczyk, P. W., & Krumhansl, C. L. (1993). Pitch and rhythmic patterns affecting infants' sensitivity to musical phrase structure. *Journal of Experimental Psychology*, *19*(3), 627–627.

Kaan, E., & Vasic, N. (2004). Cross-serial dependencies in Dutch: Testing the influence of NP type on processing load. *Memory and Cognition*, *32*, 175–184.

Kamide, Y., Altmann, G., & Haywood, S. L. (2003). The time-course of prediction in incremental sentence processing: Evidence from anticipatory eye movements. *Journal of Memory and Language*, *49*(1), 133–156.

Kamide, Y., & Mitchell, D. C. (1999). Incremental pre-head attachment in Japanese parsing. *Language and Cognitive Processes*, *14*(5), 631–662.

Kamide, Y., Scheepers, C., & Altmann, G. (2003). Integration of syntactic and semantic information in predictive processing: cross-linguistic evidence from German and English. *Journal of Psycholinguistic Research*, *32*(1), 37–55.

Keenan, E. L., & Comrie, B. (1977). Noun phrase accessibility and universal grammar. *Linguistic inquiry*, *8*(1), 63–99.

Keenan, E. L., & Comrie, B. (1979). Data on the noun phrase accessibility hierarchy. *Language*, *55*(2), 333–351.

Kempen, G., & Hoenkamp, E. (1987). An incremental procedural grammar for sentence formulation. *Cognitive Science*, *11*(2), 201–258.

Ketrez, & Aksu-Koc. (2009). Early nominal morphology in Turkish: Emergence of case and number. In U. Stephany & M. D. Voeikova (Eds.), *Development of Nominal Inflection in First Language Acquisition: A Cross-linguistic Perspective* (p. 15-48). Berlin: Mouton De Gruyter.

Kiaer, J. (2005). Incremental Parsing in Korean: at the syntax-phonology interface. In *International Symposium on Korean Linguistics* (Vol. 11).

Kim, Y. J. (1987). *The Acquisition of Relative Clauses in English and Korean: Development in Spontaneous Production*. Unpublished doctoral dissertation, Harvard University, Cambridge, MA.

Kjelgaard, M. M., & Speer, S. R. (1999). Prosodic facilitation and interference in the resolution of temporary syntactic closure ambiguity. *Journal of Memory and Language*, *40*(2), 153–194.

Knecht, L. E. (1985). *Subject and Object in Turkish*. Unpublished doctoral dissertation, Tufts University.

Kornfilt, J. (1984). *Case marking, Agreement, and Empty Categories in Turkish*. Unpublished doctoral dissertation, Harvard University, Cambridge, MA.

Kornfilt, J. (1994). Some remarks on the interaction of case and word order in Turkish: Implications for acquisition. In *Syntactic Theory and First Language Acquisition: Heads, Projections, and Learnability* (pp. 171–201). Hillsdale, NJ: Lawrence Erlbaum.

Kornfilt, J. (1997). *Turkish*. London: Routledge.

Kornfilt, J. (2000). Some syntactic and morphological properties of relative clauses in Turkish. In A. Alexiadou, P. Law, A. Meinunger, & C. Wilder (Eds.), *The Syntax of Relative Clauses* (pp. 121–159). Philadelphia, PA: John Benjamins.

Kükürt, D. (2004). *Comprehension of Turkish relative clauses in Broca's Aphasics and Children*. Unpublished master's thesis, Middle East Technical University, Ankara-Turkey.

Kwon, N., Polinsky, M., & Kluender, R. (2006). Subject preference in Korean. In D. Baumer, D. Montero, & M. Scanlon (Eds.), *Proceedings of the 25th West Coast Conference on Formal Linguistics (WCCFL 25)* (pp. 1–14). Somerville, MA: Cascadilla Press.

Lin, C. J. C. (2006). *Grammar and Parsing: A Typological Investigation of Relative-clause Processing*. Unpublished doctoral dissertation, The University of Arizona.

Lin, C. J. C., & Bever, T. G. (2006). Subject preference in the processing of relative clauses in Chinese. In D. Baumer, D. Montero, & M. Scanlon (Eds.), *Proceedings of the 25th West Coast Conference on Formal Linguistics (WCCFL 25)* (pp. 254–260). Somerville, MA: Cascadilla Press.

Love, T., & Swinney, D. (1996). Coreference processing and levels of analysis in object-relative constructions; demonstration of antecedent reactivation with the cross-modal priming paradigm. *Journal of Psycholinguistic Research*, *25*(1), 5–24.

MacDonald, M. C., Pearlmutter, N. J., & Seidenberg, M. S. (1994). Syntactic ambiguity resolution as lexical ambiguity resolution. In C. Clifton, L. Frazier, & K. Rayner (Eds.), *Perspectives on Sentence Processing* (pp. 123–153). Hillsdale, NJ: Lawrence Erlbaum.

MacWhinney, B. (1977). Starting points. *Language*, *53*(1), 152–168.

MacWhinney, B. (1989). Language learning: Cues or rules? *Journal of Memory and*

Language, *28*(3), 255–277.

MacWhinney, B. (1999). *The Emergence of Language*. Mahwah, NJ: Lawrence Erlbaum.

MacWhinney, B., & Pleh, C. (1988). The processing of restrictive relative clauses in Hungarian. *Cognition*, *29*(2), 95–141.

Maratsos, M. P. (1974). Children who get worse at understanding the passive: A replication of Bever. *Journal of Psycholinguistic Research*, *3*(1), 65–74.

Marinis, T. (2003). Psycholinguistic techniques in second language acquisition research. *Second Language Research*, *19*(2), 144–161.

Marinis, T., & Özge, D. (2010). Measuring the language abilities of Turkish-English bilingual children using TELD-3. In S. Topbaş & M. Yavaş (Eds.), *Communication Disorders in Turkish* (pp. 303–314). Clevedon: Multilingual Matters.

Marslen-Wilson, W. (1999). Abstractness and combination: The morphemic lexicon. In S. C. Garrod & M. J. Pickering (Eds.), *Language Processing* (pp. 101–117). East Sussex, UK: Psychology Press.

Marslen-Wilson, W., & Tyler, L. K. (1980). The temporal structure of spoken language understanding. *Cognition*, *8*(1), 1–71.

Marslen-Wilson, W., & Welsh, A. (1978). Processing interactions and lexical access during word recognition in continuous speech. *Cognitive Psychology*, *10*(1), 29–63.

Meral, H. M. (2006). Resumptive pronouns in Turkish. In S. Yağcıoğlu & A. C. Değer (Eds.), (pp. 223–233). Izmir: Dokuz Eylül Yayınları.

Mitchell, D. C., & Brysbaert, M. (1998). Challenges to recent theories of crosslinguistic variation in parsing: Evidence from Dutch. *Syntax and Semantics*, *31*, 313–344.

Mitchell, D. C., & Cuetos, F. (1991). The origins of parsing strategies. In C. Smith (Ed.), *Current Issues in Natural Language Processing* (pp. 1–12). Austin, TX: University of Texas at Austin.

Morgan, J. L. (1996). Prosody and the roots of parsing. *Language and Cognitive Processes*, *11*(1), 69–106.

Nakano, Y., Felser, C., & Clahsen, H. (2002). Antecedent priming at trace positions in Japanese long-distance scrambling. *Journal of Psycholinguistic Research*, *31*(5), 531–571.

Nakatani, K., Babyonyshev, M., & Gibson, E. (2000). The complexity of nested structures in Japanese. In *Poster Presented at CUNY Sentence Processing Conference, UCSD.*

Nice, K. Y. van, & Dietrich, R. (2003). Animacy effects in language production: From mental model to formulator. In H. Tappe & H. Härtl (Eds.), *Mediating Between Concepts and*

Grammar (pp. 101–118). Berlin: Mouton De Gruyter.

Novick, J. M., Trueswell, J., & Thompson-Schill, S. L. (2005). Cognitive control and parsing: Reexamining the role of Broca's area in sentence comprehension. *Cognitive, Affective, & Behavioral Neuroscience*, *5*(3), 263–281.

O'Grady, W. D. (1997). *Syntactic Development*. USA: University of Chicago Press.

O'Grady, W. D., Lee, M., & Choo, M. (2003). A subject-object asymmetry in the acquisition of relative clauses in Korean as a second language. *Studies in Second Language Acquisition*, *25*(03), 433–448.

Osgood, C. E., & Bock, J. K. (1977). Salience and Sentencing: Some Production Principles. In S. Rosenberg (Ed.), *Sentence production: Developments in Research and Theory* (pp. 89–140). Hillsdale, NJ: Erlbaum.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1971). *The Measurement of Meaning*. Urbana: University of Illinois Press.

Özcan, F. H. (1997). Comprehension of relative clauses in the acquisition of Turkish. In K. İmer & E. Uzun (Eds.), *Proceedings of the 8th International Conference on Turkish Linguistics* (pp. 149–155). Ankara.

Özcan, F. H. (2000). Production of relative clauses in the acquisition of Turkish: The role of parallel function hypothesis. In A. Göksel & C. Kerslake (Eds.), *Studies in Turkish and Turkic Languages: Proceedings of the Ninth International Conference on Turkish Linguistics* (pp. 307–313). Munich: Wiesbaden.

Ozeki, H., & Shirai, Y. (2010). Semantic bias in the acquisition of relative clauses in Japanese. *Journal of Child Language*, *37*(1), 197–215.

Özge, D., Marinis, T., & Zeyrek, D. (2009). Comprehension of subject and object relative clauses in monolingual Turkish children. In S. Ay, O. Aydın, I. Ergenç, S. Gökmen, S. İşsever, & D. Peçenek (Eds.), *Proceedings of the Fourteenth International Conference of Turkish Linguistics (ICTL).* Wiesbaden: Harrasowitz Verlag.

Özsoy, A. S. (1994). Relative Clauses in Turkish. In L. Johanson, V. L. É. Á. Csató, A. Menz, & D. Winterling (Eds.), *The Mainz Meeting, Proceedings of the Seventh International Conference on Turkish Linguistics.* Wiesbaden: Harrassowitz Verlag.

Öztürk, B. (to appear). Relativization strategies in Turkish. In *Proceedings of WAFL 2007, MITWPL.* Cambridge: MIT.

Pickering, M., & Barry, G. (1991). Sentence processing without empty categories. *Language and Cognitive Processes*, *6*(3), 229–259.

Pickering, M., Clifton, C., & Crocker, M. W. (2000). Architectures and mechanisms in

sentence comprehension. In M. Pickering, C. Clifton, & M. W. Crocker (Eds.), *Architectures and Mechanisms for Language Processing* (pp. 1–28). Cambridge: Cambridge University Press.

Poeppel, D., & Wexler, K. (1993). The full competence hypothesis of clause structure in early German. *Language*, *69*(1), 1–33.

Pullum, G. K. (1977). Word order universals and grammatical relations. *Syntax and Semantics*, *8*, 249–78.

Rayner, K., Carlson, M., & Frazier, L. (1983). The interaction of syntax and semantics during sentence processing: Eye movements in the analysis of semantically biased sentences. *Journal of Verbal Learning and Verbal Behavior*, *22*(3), 358–374.

Rizzi, L. (1990). *Relativized Minimality*. Cambridge, MA: MIT Press.

Rizzi, L., & Schlonsky, U. (2005). *Strategies of Subject Extraction.* (Ms. Universities of Siena and Geneva)

Ruhi, c., & Karadaş, D. Çokal. (in press). Features for an internet accessible corpus of spoken Turkish discourse. In *Working Papers in Corpus-based Linguistics and Language Education 3*.

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science*, *274*(5294), 1926.

Sag, I. A., & Wasow, T. (2008). Performance-compatible competence grammar. In R. D. Borsley & K. B. (red.). (Eds.), *Non-Transformational Syntax: A Guide to Current Models* (Vol. 3). Oxford: Blackwell.

Sarılar, A., & Küntay, A. C. (in press). Do young learners pick up on relative clause constructions in referential communication? a training study. In E. Erguvanlı-Taylan & B. Rona (Eds.), *Puzzles of language: Essays in honour of Karl Zimmer.* Wiesbaden: Harrassowitz Verlag.

Schachter, J. (1974). An error in error analysis. *Language Learning*, *24*(2), 205–214.

Seidenberg, M. S., & MacDonald, M. C. (1999). A probabilistic constraints approach to language acquisition and processing. *Cognitive Science*, *23*(4), 569–588.

Sekerina, I. A., Fernández, E. M., & Clahsen, H. (2008). *Developmental Psycholinguistics: On-line Methods in Children's Language Processing*. Amsterdam: John Benjamins Publishing.

Sheldon, A. L. (1974). The acquisition of relative clauses in English. *Journal of Verbal Learning and Verbal Behavior*, *13*(3).

Siskind, J. M. (1996). A computational study of cross-situational techniques for learning

word-to-meaning mappings. *Cognition*, *61*(1-2), 39–91.

Slobin, D. I. (1966). Grammatical transformations and sentence comprehension in childhood and adulthood. *Journal of Verbal Learning and Verbal Behavior*.

Slobin, D. I. (1973). Cognitive prerequisites for the development of grammar. In B. Lust & C. Foley (Eds.), *First Language Acquisition: The Essential Readings.* Malden, MA: Blackwell Publishing.

Slobin, D. I. (1986). The acquisition and use of relative clauses in Turkic and Indo-European Languages. In D. I. Slobin & K. Zimmer (Eds.), *Typological Studies in Language, Studies in Turkish Linguistics* (Vol. 8, pp. 273–294). Amsterdam/Philadelphia: John Benjamins.

Slobin, D. I., & Bever, T. G. (1982). Children use canonical sentence schemas: A crosslinguistic study of word order and inflections. *Cognition*, *12*(3), 229–265.

Snedeker, J., & Trueswell, J. (2003). Using prosody to avoid ambiguity: Effects of speaker awareness and referential context. *Journal of Memory and Language*, *48*(1), 103–130.

Snedeker, J., & Trueswell, J. (2004). The developing constraints on parsing decisions: the role of lexical-biases and referential scenes in child and adult sentence processing. *Cognitive Psychology*, *49*(3), 238–99.

Snedeker, J., & Yuan, S. (2008). Effects of prosodic and lexical constraints on parsing in young children (and adults). *Journal of Memory and Language*, *58*(2), 574–608.

Spivey-Knowlton, M., & Sedivy, J. (1995). Resolving attachment ambiguities with multiple constraints. *Cognition*, *55*(3), 227–267.

Steedman, M. (1989). Grammar, interpretation and processing from the lexicon. In W. Marslen-Wilson (Ed.), *Lexical Representation and Process* (pp. 463–504). Cambridge, MA: MIT Press.

Steedman, M. (1993). Categorial grammar. *Lingua*, *90*(3), 221–258.

Steedman, M. (2000). *The Syntactic Process*. USA: MIT Press.

Steedman, M. (2009). Foundations of Universal Grammar in planned action. In M. H. Christiansen, C. Collins, & S. Edelman (Eds.), *Language Universals* (pp. 174–200). USA: Oxford University Press.

Steedman, M., & Baldridge, J. (2006). Combinatory categorial grammar. *Encyclopedia of Language and Linguistics*, *2*, 610–622.

Steedman, M., Kwiatkowski, T., & Hockenmaier, J. (2008). *The statistical problem of language acquisition.* (In preparation)

Stowe, L. A. (1986). Parsing WH-constructions: Evidence for on-line gap location. *Lan-*

guage and Cognitive Processes, *1*(3), 227–245.

Stowe, L. A. (1989). Thematic structures and sentence comprehension. In G. N. Carlson & M. K. Tanenhaus (Eds.), *Linguistic Structure in Language Processing* (pp. 319–357). Springer.

Sturt, P., & Lombardo, V. (2005). Processing coordinated structures: Incrementality and connectedness. *Cognitive Science: A Multidisciplinary Journal*, *29*(2), 291–305.

Swingley, D., Pinto, J. P., & Fernald, A. (1999). Continuous processing in word recognition at 24 months. *Cognition*, *71*(2), 73–108.

Swinney, D., Ford, M., Frauenfelder, U., & Bresnan, J. (1988). *On the temporal course of gap-filling and antecedent assignment during sentence comprehension.* (Unpublished manuscript)

Tanenhaus, M., Spivey-Knowlton, M., Eberhard, K., & Sedivy, J. (1995). The interaction of visual and verbal information in spoken language comprehension. *Science*, *268*, 1632–34.

Taraban, R., & McClelland, J. L. (1988). Constituent attachment and thematic role assignment in sentence processing: Influences of content-based expectations. *Journal of Memory and Language*, *27*(6), 597–632.

Tavakolian, S. (19788). *The Conjoined Clause Analysis of Relative Clauses*. Unpublished doctoral dissertation, UMass Diss.

Tavakolian, S. (1981). The conjoined-clause analysis of relative clauses. In S. Tavakolian (Ed.), *Language Acquisition and Linguistic Theory.* Cambridge, MA: MIT Press.

Tenenbaum, J., Griffiths, T., & Kemp, C. (2006). Theory-based Bayesian models of inductive learning and reasoning. *Trends in Cognitive Sciences*, *10*(7), 309–318.

Thothathiri, M., & Snedeker, J. (2008). Syntactic priming during language comprehension in three- and four-year-old children. *Journal of Memory and Language*, *58*(2), 188–213.

Tomasello, M. (1992). The social bases of language acquisition. *Social Development*, *1*(1), 67–87.

Tomasello, M., Call, J., & Hare, B. (2003). Chimpanzees understand psychological states-the question is which ones and to what extent. *Trends in Cognitive Sciences*, *7*(4), 153–156.

Topbaş, S., & Güven, S. (2007). *Test of Early Language Development (TELD-3): Turkish version*. Eskişehir: DILKOM, Anadolu University.

Traxler, M. J., Pickering, M. J., & Clifton, C. (1998). Adjunct attachment is not a form of lexical ambiguity resolution. *Journal of Memory and Language*, *39*, 558–592.

Trueswell, J. (1996). The role of lexical frequency in syntactic ambiguity resolution. *Journal of Memory and Language*, *35*, 566–585.

Trueswell, J., & Gleitman, L. (2004). Children's eye movements during listening: Developmental evidence for a constraint based theory of sentence processing. In J. M. Henderson & F. Ferreira (Eds.), *The Interface of Language, Vision, and Action: Eye Movements and the Visual World* (pp. 319–346). New York: Psychology Press.

Trueswell, J., & Gleitman, L. (2007). Learning to parse and its implications for language acquisition. In G. Gaskell (Ed.), *Oxford Handbook of Psycholinguistics* (pp. 319–346). Oxford: Oxford University Press.

Trueswell, J., Sekerina, I. A., Hill, N. M., & Logrip, M. L. (1999). The kindergarten-path effect: studying on-line sentence processing in young children. *Cognition*, *73*(2), 89–134.

Trueswell, J., Tanenhaus, M., & Kello, C. (1993). Verb-specific constraints in sentence processing: Separating effects of lexical preference from garden-paths. *Journal of Experimental Psychology*, *19*(3), 528–553.

Trueswell, J., & Tanenhaus, M. K. (1994). Toward a lexical framework of constraint-based syntactic ambiguity resolution. In C. Clifton, L. Frazier, & K. Rayner (Eds.), *Perspectives on Sentence Processing* (pp. 155–179). Hillsdale, NJ: Lawrence Erlbaum.

Tyler, L. K., & Marslen-Wilson, W. (1981). Children's processing of spoken language. *Journal of Verbal Learning and Verbal Behavior*, *20*(4), 400–416.

Tyler, L. K., & Wessels, J. (1983). Quantifying contextual contributions to word-recognition processes. *Perception & Psychophysics*, *34*(5), 409–420.

Underhill, R. (1972). Turkish participles. *Linguistic Inquiry*, *3*(1), 87–99.

Ural, A. E., Yüret, D., Ketrez, F. N., Koçbaş, D., & Küntay, A. (2009). Morphological cues vs. number of nominals in learning verb types in Turkish: The syntactic bootstrapping mechanism revisited. *Language and Cognitive Processes*, *24*(10), 1393–1405.

Vasishth, S., & Kruijff, G. J. M. (2001). Sentence processing as abduction+ deduction. In *Ohio University Department of Linguistics Working Papers in Linguistics* (pp. 183–207). Citeseer.

Wanner, E., & Maratsos, M. (1978). An ATN approach to comprehension. In M. E. Halle, J. E. Bresnan, & G. A. Miller (Eds.), *Linguistic Theory and Psychological Reality* (pp. 119–161). Cambridge, MA: MIT Press.

Waters, G. S., & Caplan, D. (2001). Age, working memory, and on-line syntactic processing in sentence comprehension. *Psychology and Aging*, *16*(1), 128–144.

Yamashita, H. (1997). The effects of word-order and case marking information on the processing of Japanese. *Journal of Psycholinguistic Research*, *26*(2), 163–188.

Yang, C. (2002). *Knowledge and Learning in Natural Language*. USA: Oxford University Press.

Yağmur, K., & Nap-Kolhoff, E. (2010). Aspects of acquisition and disorders in Turkish-Dutch bilingual children. In S. Topbaş & M. Yavaş (Eds.), *Communication Disorders in Turkish* (pp. 269–290). Clevedon: Multilingual Matters.

VITA

Education

September 2004–September 2010: PhD, Middle East Technical University, Department of Foreign Languages Education, Ankara, Turkey. Thesis Title: Strategies and mechanisms in the processing and acquisition of relative clauses in Turkish monolingual and Turkish-English bilingual children.

September 2000–January 2004: MSc, Middle East Technical University, Cognitive Science, Informatics Institute, Ankara, Turkey. MSc Thesis Title: The comprehension of Turkish relative clauses in children and adults with Broca's aphasia.

September 1996–June 2000 BA, Middle East Technical University, Department of Foreign Languages Education, Ankara, Turkey. BA graduation project title: Word Access Strategies in Turkish: A Study on Nouns.

Experience

Research

October 2010–Present: Post Doctoral Research Fellow, Koç University, Department of Psychology, Istanbul-Turkey. Working with Aylin Küntay on the development of parsing abilities in young children acquiring a head-final language.

September 2007–September 2009: Research Assistant, University of Reading, Department of Psychology and Clinical Language Sciences, Reading-UK. Working in Theodoros Marinis's team in an ESRC funded project titled Real-time processing of syntactic information in children with English as a second language and children with specific language impairment.

Teaching

September 2004–September 2007: Instructor, Middle East Technical University, Department of Modern Languages, Ankara-Turkey.

September 2003–May 2004: Instructor, Istanbul Bilgi University, School of English Language, Istanbul-Turkey.

September 2000–September 2002: Instructor, Bilkent University, School of English Language, Ankara-Turkey.

Organizational Duties

September 21–September 22 2010 Co-organization of the Psycholinguistics and Cognitive Science Seminar at the Middle East Technical University Cognitive Science Department, with Deniz Zeyrek.

September 2009–January 2010 Co-organization of Ankara Linguistic Circle Seminars at the Middle East Technical University Cognitive Science Department, with Umut Özge.

Publications

Özge, D. (2010). Do Turkish-speaking children mind the gap in their processing of relative clauses? Paper presented at Cognitive Science Seminars: Psycholinguistics and Cognitive Science, 21-22 September 2010. Middle East Technical University, Ankara.

Özge, D., Marinis, T., and Zeyrek, D. (2010). A conflict between filler-gap accounts and incrementality: Evidence from production and parsing of relative clauses in a head-final language. Poster presented at 16th International Conference on Architectures and Mechanisms for Language Processing (AMLAP 2010), York-UK.

Özge, D. and Marinis, T.(2010). Predictive processing in children acquiring a head-final language: Evidence from Turkish Relative Clauses. Poster presented at 16th International Conference on Architectures and Mechanisms for Language Processing (AMLAP 2010), York-UK.

Özge, D. (2010). What do children's errors in object relative clauses in Turkish reveal about language acquisition Paper presented at The Fifteenth International Conference of Turkish

Linguistics (ICTL 2010), Szeged-Hungary.

Özge, D., Marinis, T., and Zeyrek, D. (2010). Parallel function hypothesis revisited. Paper presented at The Fifteenth International Conference of Turkish Linguistics (ICTL 2010), Szeged-Hungary.

Özge, D., Marinis, T., and Zeyrek, D. (2010). Production of relative clauses in monolingual Turkish children. In Chandlee, J., Franich, K., Iserman, K., and Keil, L., editors, A Supplement to the Proceedings of the 34th Boston University Conference on Language Development (BUCLD, 34).

Özge, D., Marinis, T., and Zeyrek, D. (2009). Comprehension of subject and object relative clauses in monolingual Turkish children. In Ay, S., Aydın, Ö., Ergenç, İ., Gökmen, S., İşsever, S., and Peçenek, D., editors, Proceedings of the Fourteenth International Conference of Turkish Linguistics (ICTL 2008). Wiesbaden: Harrasowitz Verlag.

Marinis, T. and Özge, D. (2010). Measuring the language abilities of Turkish-English bilingual children using TELD-3. In Topbaş, S. and Yavaş, M., editors, Communication Disorders in Turkish in monolingual and multilingual settings, Communication Disorders Across Languages. Multilingual Matters.

Ünal, G., Özge, D., Hohenberger, A., and Marinis, T. (2009). The Turkish Listening Span test: A methodological developmental study on Turkish school children. Poster presented at the XIV European Conference on Developmental Psychology, Lithuania.

Özge, D. (2007a). Comprehension of Turkish relative clauses in children and adults with agrammatic aphasia. Poster presented at the British Aphasiology Society Biennal International Conference, Edinburgh.

Özge, D. (2007b). Regression in child language and aphasia. Paper presented at the Child Language Seminar, Reading, UK.

Özge, D. and Daloğlu, A. (2007). Program evaluation journey: Does continuous change reflect student needs? Paper presented at the Sabancı University School of English Languages International Conference on Foreign Language Education.

Özge, D. and Tekman, G. (2006). Comprehension of Turkish relative clauses in agrammatic Borca's aphasia. Poster presented at the Clinical Aphasiology Conference, Ghent.

Kükürt-Özge, D. (2004b). Türkçe konuşan broka afazili hastalarda ilgi tümcelerini kavrayış biçimleri. Paper presented at the 2nd National Conference on Language and Language Dis-

orders, Eskisehir-Turkey.

Kükürt, D. (2004a). Comprehension of Turkish relative clauses in Broca's Aphasics and children. Master's thesis, Cognitive Science, Middle East Technical University, Ankara-Turkey.

Grants

September 6–September 8 2010: 16th International Conference on Architectures and Mechanisms for Language Processing (AMLAP 2010), grant for academic activities abroad funded by The Scientific and Technological Research Council of Turkey, TUBITAK.

June 2009–May 2013: Member of Experimental Pragmatics network in the UK, Funded by the ESRC.

2009–2013: Member of COST Action IS0804, Language Impairment in a Multilingual Society: Linguistic Patterns and the Road to Assessment; Woking group 6- Executive Functions, Funded by the COST

November 6–November 8 2009 The 34th Annual Boston University Conference on Child Development, BUCLD 34 Paula Menyuk Travel Award.

March 30–April 3 2009: COST Training School in Language Acquisition Methods, travel and expenses grant funded by European Cooperation in Science and Technology, COST.

July 18–July 20 2007: Child Language Seminar, grant for academic activities abroad funded by The Scientific and Technological Research Council of Turkey, TUBITAK.

May 29–June 2 2006: Clinical Aphasiology Conference, CAC Student Travel Fellowship.

Courses and Certificates

30th March–3rd April 2009: COST Training School in Language Acquisition Methods, Centre for General Linguistics (ZAS), Berlin, Germany.

12th June–23rd June 2006: LOT Summer School in Linguistics, Amsterdam, Netherlands.

26th July–31st July 2005: Training the Trainer: a summer course in teacher training, Longman Pearson Education, Bodrum, Turkey.

September 2004–June 2005: In-service Training Program, School of Foreign Languages,

Middle East Technical University, Ankara, Turkey.

September 2000–June 2001: University of Cambridge Course for Overseas Teachers of English, School of English Languages, Bilkent University, Ankara, Turkey.

TURKISH SUMMARY

ANA DİLİ OLARAK TÜRKÇE VE TÜRKÇE-İNGİLİZCE ÖĞRENEN ÇOCUKLARIN İLGİ TÜMLEÇLERİNİ ANLAMA VE İŞLEME MEKANİZMA VE STRATEJİLERİ

Bu tez çalışması, Türkçe ilgi tümleçlerinin işlenmesi (processing) ve edinimi hakkında kapsamlı bir deneysel analiz sunmaktadır. Çalışmada anadili olarak Türkçe öğrenen 5-8 yaş arası tek dilli çocuklarla klasik deneysel yöntemlerin yanı sıra ilk kez sözlü cümlelerde reaksiyon süresini ölçen eş-zamanlı yöntemler kullanılmış ve bu çocukların sözlü dil anlama ve çözümleme (parsing) davranışları yetişkinlerle karşılaştırılmıştır.

Çalışmada ayrıca Londra'da yaşayan ve anadili olarak Türkçe ve İngilizce öğrenen 5-8 yaş arası iki-dilli çocukların ilgi tümleçlerini anlama ve bu yapıları sözlü dilde kullanma yetileri Türkçe konuşan tek-dilli yaşıtları ile eş-zamanlı olmayan yöntemler kullanılarak karşılaştırılmıştır.

Yapılan bir dizi deney sonucunda bazı diğer dillerde de gözlemlenen özne-nesne bakışımsızlığı (subject-object asymmetry) anadili olarak Türkçe öğrenen tek-dilli ve iki-dilli çocukların Türkçe ilgi tümleçlerini anlama ve kullanma davranışlarında da bulgulanmıştır. Çocuklar, bütün deneylerde nesneyi niteleyen ilgi tümleçleriyle karşılaştırıldığında özneyi niteleyen ilgi tümleçlerinde anlamlı bir şekilde daha iyi performans sergilemişlerdir. Ayrıca, tek-dilli çocukların eş-zamanlı deneylerde gösterdikleri bazı davranışların yetişkinlerinkiyle aynı örüntüde olduğu bulgulanmış ve bu örüntülerin özne-nesne bakışımsızlığının morfo-sentaks, eyleme kolay bağlanma, sözcük dizilişindeki düzenlilik, sözcüklerdeki çok-anlamlılık ya da çok-işlevlilikten kaynaklanan muğlaklık, yapıların ve sözcüklerin birlikte kullanılma frekansı gibi bir çok faktörün birleşmesi ile ortaya çıktığına işaret ettiği iddia edilmiştir.

Bu araştırmada, Türkçe ilgi tümleçlerinde özne-nesne bakışımsızlığının sebepleri araştırılırken, alanyazında insanın dil işleme ve çözümleme mekanizma ve stratejileri hakkında İngilizce gibi çok çalışılan diller için önerilen 'Dolgu-Boşluk Varsayımları' (Filler-Gap Hypotheses) (Maratsos, 1974; Wanner ve Maratsos, 1974; Fodor, 1978; Clifton ve Frazier, 1989;

Frazier, Flores d'Arcais ve Giovanni, 1989), 'Koşut İşlev Varsayımı' (Parallel Function Hypothesis) (Sheldon, 1974) ve 'Standart Sözcük Sırası Taktiği' (Canonical Word Order Strategy) (Bever, 1970) gibi belli başlı kuramların hipotezleri de test edilmiş ve bu kuramların bu çalışmada sunulan deneylerin bulgularını açıklamakta yetersiz kaldıkları gösterilmiştir.

Çalışmadaki bulgular Steedman (1989) ve (2000)'de önerildiği gibi sözcüksel (lexicalist) gramer, aşağıdan-yukarı algoritma (bottom-up algoritm) ve bir çeşit çoklu kısıt değerlendirme mekanizması (multiple constraint satisfaction mechanism) varsayan bir dil işleme modeli ve Vasishth ve Kruijff (2001)'de önerildiği gibi sözcüksel gramer, yukarıdan-aşağı (top-down) ve aşağıdan-yukarı algoritmayı birleştiren sol-köşe algoritması (left-corner algorithm) ve Gibson (1998) ve Hale (2001)'den esinlenen yeni bir kompleksite ölçütü (complexity metric) varsayan bir diğer dil işleme modeli kullanılarak açıklanmıştır.

Aşağıda çalışmada yapılan deneyler ve sonuçları kısaca özetlenmiştir.

Deney 1: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası çocuklar ile anadili Türkçe olan yetişkinlerin ilgi tümleçlerini anlama davranışları cümle-gönderge eşleştirme testi (sentence-referent matching task) kullanılarak ölçülmüştür. Buna göre çocuklar özne niteleyen ilgi tümleçlerinde nesne niteleyen ilgi tümleçlerine göre daha yüksek bir başarı gösterirlerken yetişkinler her iki tür tümleçte de yüksek başarı göstermişlerdir. Bu sonuçlar ışığında Çizgisel Uzaklık Hipotezi (Linear Distance Hypothesis), Yapısal Uzaklık Hipotezi (Structural Distance Hypothesis) ve Argüman Çaprazlama Hipotezi (Argument Crossing Account) gibi belli başlı Dolgu-Boşluk Hipotezleri incelendiğinde elde edilen sonucun sadece Yapısal Uzaklık Hipotezi (Structural Distance Hypothesis) tarafından tahmin edildiği belirtilmiştir. Ancak, bu bölümde bu hipotezin geçerli olabilmesi için dil işlemcisinin yapılardaki boşluğu dolgudan önce geldiği durumlarda nasıl bir strateji kullanarak saptadığına ve artımlı çözümlemeyi (incremental parsing) nasıl sağladığına dair bir açıklama yapması gerektiğinin altı çizilmiş ve bunun ancak eş-zamanlı bir yötem kullanılarak test edilebileceği vurgulanmıştır.

Deney 2: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası çocuklar ile anadili Türkçe olan yetişkinlerin ilgi tümleçlerini sözlü olarak kullanma davranışları resim anlatım testi (picture elicitation task) kullanılarak ölçülmüştür. Buna göre hem çocuklar hem yetişkinler özne niteleyen ilgi tümleçleri ile anlatılması gereken resimlerde daha sıklıkla ilgi tümleci kullanırken nesne niteleyen ilgi tümleçleri ile anlatılması gereken resimlerde daha sıklıkla farklı yapılar (bağlı cümleler ya da edilgen yapılar kullanma ya da bakış açısı değiştirme gibi kaçınma stratejileri) kullanmayı tercih etmişlerdir. Kullanılan ilgi tümleçlerinin doğruluk değerleri analiz edildiğinde çocukların özne niteleyen ilgi tümleçlerinde nesne niteleyen ilgi

tümleçlerine göre daha yüksek bir başarı gösterdikleri; buna karşın yetişkinlerin her iki tür tümleçte de az hata yaptıkları anlaşılmıştır. Kullanılan kaçınma stratejileri ve yapılan hatalar incelendiğinde hem çocukların hem yetişkinlerin ismin –in hali ve nesne niteleyen tümleç yapan –DIK eki gibi biçimbirimleri kullanmaktan kaçındıkları, özne ilgi tümleçlerinde boşluğun bulundupu yerde zamir kullanarak Özne-Nesne-Eylem sözcük dizilişini korumaya çalıştıkları, nesneyi cümlelerinde özne olarak kullanarak bakış açısını sürekli öznede tutmaya çalıştıkları gösterilmiş ve ortaya çıkan tablonun tek sorumlusunun dolgu ile boşluk arasındaki yapısal uzaklık olamayacağı, biçimbirimsel, sözdizimsel, kavramsal ve algısal bazı başka etmenlerin de etkisinin değerlendirilmesi gerektiği tartışılmıştır. Bu bölümde ayrıca Yapısal Uzaklık Hipotezi'nin sözlü cümle kurma mekanizmalarının artımlı olduğu varsayımıyla çeliştiği tartışılmıştır.

Deney 3a: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası çocuklar ile anadili Türkçe olan yetişkinlerin ilgi tümleçleri içeren karmaşık cümleleri dinlerken nasıl bir zihinsel süreçten geçtikleri 'kendi hızında parça parça cümle dinleme' (self-paced listening task) kullanılarak ölçülmüştür. Buna göre hem çocuklar hem yetişkinler cümle başındaki isimlerin üzerindeki ismin –in hali ekini ismin –i hali ekine göre daha yavaş işlemişlerdir. Buna karşın ikinci sözcük grubunda duydukları ve –DIK ekinin bulunduğu nesne ilgi tümcesinin alt eylemini –(y)An ekinin bulunduğu özne ilgi tümcesinin alt eylemine göre daha hızlı işlemişlerdir. Bu sonuçlar baş-sonlu ve biçimbirimsel açıdan zengin bir dil olan Türkçe'nin hem çocuklar hem yetişkinler tarafından artımlı bir şekilde çözümlendiğine işaret etmektedir. Alanyazındaki diğer çalışmalar (Kamide ve Mitchell, 1999) bu özelliğin Japon konuşan yetişkinler tarafından da sergilendiğini göstermişlerdir; ancak burada elde edilen sonuçlar baş-sonlu bir dil edinen çocukların da yetişkinlere benzer davrandığını göstermesi bakımından orjinaldir.

Deney 3b: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası çocuklar ile anadili Türkçe olan yetişkinlerin farklı sözcük sırasında verilen basit cümleleri dinlerken nasıl bir zihinsel süreçten geçtikleri 'kendi hızında parça parça cümle dinleme' (self-paced listening task) kullanılarak ölçülmüştür. Bu testte ilk olarak özne ilgi tümleçlerinde görülen Nesne-Eylem dizilişi ile nesne ilgi tümleçlerinde görülen Özne-Eylem dizilişinin bu karmaşık yapıları çözümlemeye olan etkileri Nesne-Eylem-Özne ve Özne-Eylem-Nesne dizilişindeki basit cümleler aracılığıyla incelenmiştir. Buna göre hem çocuklar hem yetişkinler Nesne-Eylem ikilisinden sonra gelen Özne argümanını Özne-Eylem ikilisinden gelen Nesne argümanına göre daha yavaş işlemişlerdir. Bu sonucun katılımcıların Nesne-Eylem ikilisini tam cümle olarak algıladıklarına işaret ediyor olabileceği tartışılmış ve bu Türkçe'de öznesi düşürülmüş cümlelerin sıklıkla kullanılıyor olmasına bağlanmıştır. Ayrıca, bu bulgunun özne ilgi tümleç-

lerinde görülen Nesne-Eylem dizilişinin Kükürt (2004)'te önerildiği gibi bu tür ilgi tümleçlerinin daha kolay işlenmesine bir etkisi olabileceği vurgulanmıştır.

İkinci olaraksa, Özne-Eylem-Nesne ve Nesne-Eylem-Özne gibi eylemi cümle ortasında sunan basit cümleler ile Özne-Nesne-Eylem, Nesne-Özne-Eylem gibi eylemden önce iki argüman sunan basit cümle yapıları karşılaştırılarak Gibson (1998)'in cümle işlemcinin ortaya çıkan argümanları olabildiğince çabuk bir biçimde eyleme bağlama eğilimi olduğunu varsayan 'Sözdizimsel Tahminde Bölgesellik' (Syntactic Prediction Locality) teorisi test edilmiştir. Buna göre hem çocuklar hem yetişkinler eylemin cümle ortasında geldiği Özne-Eylem-Nesne ve Nesne-Eylem-Özne gibi dizilişleri eylemden önce iki argüman bulunan Özne-Nesne-Eylem, Nesne-Özne-Eylem gibi dizilişlere göre daha hızlı işlemişlerdir. Bu bulgunun Gibson (1998)'i destekler nitelikte olduğu tartışılmıştır.

Deney 3c: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası çocuklar ile anadili Türkçe olan yetişkinlerin özne ve nesne ilgi tümlecinin cümlenin öznesi ve nesnesi olduğu cümleleri dinlerken nasıl bir zihinsel süreçten geçtikleri 'kendi hızında parça parça cümle dinleme' (self-paced listening task) kullanılarak ölçülmüştür. Bu deneyde amaç Sheldon'un (1974) 'Koşut İşlev Varsayımı' hipotezini test etmektir. Bu hipoteze göre alt tümcelerin ana tümcedeki rolleri kendi tümcelerindeki rolleri ile çakışıyorsa çözümleme yavaş ve problemli olacak, bu roller arasında bir paralellik varsa çözümleme hızlı ve sorunsuz olacaktır. Bu deneyde yetişkinler her iki tümleç türü ana tümcenin öznesiyse (bu tümleçlerin ana tümcenin nesnesi olduğu durumlarla karşılaştırıldığında) kritik noktadaki parçayı daha hızlı dinlemişlerdir. Buna karşın çocuklar, her iki tümleç de ana tümcenin nesnesi olduğu durumlarda kritik noktada daha hızlı bir performans sergilemiş ve ancak bir sonraki parçada yetişkinlerin gösterdiği performansı yakalayabilmişlerdir. Bu deneyden elde edilen bulgular 'Koşut İşlev Varsayımı'nın beklentilerine uymamaktadır. Yetişkinlerin her iki tür ilgi tümcesini de cümlenin öznesi olarak daha iyi işlemesini, Türkçe'de öznelerin genellikle cümle başında yer almasıyla bağlantılı olarak bu tümleçlerin cümle başında yer almasına bağlanmıştır. Çocuklarınsa benzer davranışı yetişkinlerden daha geç göstermesinin a) çocukların işleme kapasitesinin yetişkinlerden daha limitli olması; b) ya da çocukların bürünsel verileri gözardı ederek ilgi tümlecinin eylemine kadar olan tümce parçacığını ('haylaz gorilin yavaşca öptüğü' gibi) başsız ilgi tümcesi olarak algılamış olabileceği gibi iki farklı sebepten olabileceği tartışılmıştır. Bu deney sonuçları ayrıca MacWhinney'in (1977) 'Bakış Açısı Hipotezi' (Perspective Hypothesis) çerçevesinde de incelenmiş ve bu hipotezin de sonuçları tam olarak açıklayamadığı gösterilmiştir.

Deney 3d: Bu deneyde anadili Türkçe olan yetişkinlerin cümle ortasında kullanılan özne ve nesne ilgi tümlecinin cümlenin öznesi ve nesnesi olduğu cümleleri dinlerken nasıl bir zihinsel süreçten geçtikleri 'kendi hızında parça parça cümle dinleme' (self-paced listening task) kullanılarak ölçülmüştür. Buna göre katılımcılar her iki ilgi tümcesi de cümle ortasında kullanıldığında bu tümceler ana cümlenin nesnesi olduğunda öznesi olduğu durumlara göre daha hızlı işlenmişlerdir. Bu sonuç ise bir önceki deneyde yapılan hipotezi destekler niteliktedir; şöyle ki, ilgi tümleci cümle başında bulunduğu zaman Türkçe sözcük sırasına uygun bir şekilde ana cümlenin öznesi olarak algılanmakta ve cümle ortasında bulunduğunda ana cümlenin nesnesi olarak algılanmaktadır. Bu sonuçların Hakuta'nın (1981) Japonca'da eş zamanlı olmayan deneyler sonucunda sunduğu bulgularla büyük ölçüde örtüşmekte olduğu tartışılmıştır.

Deney 4: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası çocuklar ile anadili Türkçe olan yetişkinlerin özne ilgi tümleci ve iyelik bildiren isimlerde (possessine NPs) iyelik-uyum ekinin kaldırılması ile oluşturulan dilbilgisi dışı cümleleri dinlerken nasıl bir zihinsel süreçten geçtikleri 'kelime izleme' (word-monitoring task) kullanılarak ölçülmüştür. Bu deneyde katılımcıların eğer varolan dilbilgisi hatasını fark etmeleri durumunda bu hatalardan hemen sonra ortaya çıkan kelimeleri izlemede hatasız cümlelerdeki kelimelere göre daha yavaş tepki göstermeleri beklenmektedir. Sonuçlar yetişkinlerin bu davranışı beklenen ölçüde gösterirken çocukların cümleleri işleme hızları arasında anlamlı bir fark bulunmamıştır. Bu bulgular çocukların iyelik-uyum ekindeki hataları fark etmediğine işaret ediyor olabilir. Ancak, Deney 3a'da hem çocukların hem yetişkinlerin ismin –in hali ekinden hemen sonra iyelik uyum eki bulunan ilgi tümleci eylemini anlamlı şekilde hızlı işlemeleri ve Deney 2'de çocukların kendi kurdukları cümlelerde cümlelerine ismin –in hali eki olan bir isimle başladıklarında iyelik uyum ekini her cümlede doğru kullanmaları çocukların aslında cümle başındaki ismin –in hali ekini algılayamamış oldupuna da işaret ediyor olabilir. Dolayısıyla bu deneydeki soruların daha duyarlı metodlar kullanılarak yeniden araştırılması gerektiği vurgulanmıştır.

Deney 5: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası tek dilli çocuklar ile anadili olarak Türkçe ve İngilizce edinen 5-8 yaş arası iki-dilli çocukların Türkçe ilgi tümleçlerini anlama davranışları cümle-gönderge eşleştirme testi (sentence-referent matching task) kullanılarak ölçülmüştür. Buna göre her iki gruptaki çocuklar özne niteleyen ilgi tümleçlerinde nesne niteleyen ilgi tümleçlerine göre daha yüksek bir başarı göstermişlerdir. Bu deney tek-dilli ve iki-dilli çocukların karmaşı cümleleri anlama stratejilerini araştırmış ve hem tek-dilli hem de iki-dilli çocukların benzer şekilde karmaşık cümlelerde ismin –i

hali ekinin kullanıldığı adı nesne olarak algıladıkları gösterilmiştir. Bu deney daha önceki deneylerde ortaya çıkan ismin –i hali ve –in hali arasındaki bakışımsızlığı desteklemiştir çünkü her iki grup da cümle başındaki –in hali bulunan isme özne rolünü yüklememişlerdir. Bu sonuçlar Bever'in 'Standart Sözcük Sırası Taktiği', MacWhinney ve Bates'in (1987) 'Durum Ekleri Taktiği' ve Kükürt'ün (2004) '-in hali nesnedir taktiği' (Accusative-Object) çerçevesinde incelendiğinde, son önerinin tahminlerinin Türkçe konuşan çocukların bulguları tarafından desteklendiği gözlemlenmiştir.

Deney 6: Bu deneyde anadili olarak Türkçe edinen 5-8 yaş arası tek-dilli çocuklar ile anadili olarak Türkçe ve İngilizce edinen 5-8 yaş arası iki-dilli çocukların ilgi tümleçlerini sözlü olarak kullanma davranışları resim anlatım testi (picture elicitation task) kullanılarak ölçülmüştür. Buna göre hem çocuklar hem yetişkinler özne niteleyen ilgi tümleçleri ile anlatılması gereken resimlerde daha sıklıkla ilgi tümleci kullanırken nesne niteleyen ilgi tümleçleri ile anlatılması gereken resimlerde daha sıklıkla farklı yapılar (bağlı cümleler ya da edilgen yapılar kullanma ya da bakış açısı değiştirme gibi kaçınma stratejileri) kullanmayı tercih etmişlerdir. Kullanılan ilgi tümleçlerinin doğruluk değerleri analiz edildiğinde her iki grubun da özne niteleyen ilgi tümleçlerinde nesne niteleyen ilgi tümleçlerine göre daha yüksek bir başarı gösterdikleri anlaşılmıştır. Çocukların yaptığı hatalar incelendiğinde bu hataların yetişkinlerin kullandığı bazı yapılara ve bazı Türki dillerdeki gramer yapılarına benzer olduğu gözlemlenmiş ve çocukların hatalarının deneyimledikleri yapı çeşitlerinden, dildeki genel muğlaklıktan ve varolan kompetans gramer bilgilerinden bağımsız olmadığı tartışılmıştır.

Sonuç:

Bu çalışmada elde edilen bulgular Türkçe konuşan tek-dilli ve iki-dilli çocukların ilgi tümleçlerini sözlü anlama ve sözlü kullanma edimlerinde özne-nesne bakışımsızlığı olduğunu eş-zamanlı olan ve olmayan yöntemlerle bir kez daha göstermiştir. Bu açıdan Türkçe'de daha önce eş-zamanlı olmayan yöntemlerle yapılmış bazı çalışmaların (Slobin, 1986; Özcan, 1997; 2000; Kükürt, 2004; Hermon, Öztürk ve Kornfilt, 2007) bulgularını eş-zamanlı yöntemlerle desteklemiştir.

Bu çalışmaya göre bu tablo morfo-sentaks, eyleme kolay bağlanma, sözcük dizilişindeki düzenlilik, sözcüklerdeki çok-anlamlılık ya da çok-işlevlilikten kaynaklanan muğlaklık, yapıların ve sözcüklerin birlikte kullanılma frekansı gibi bir çok faktörün birleşmesi ile ortaya çıkmaktadır.

Yapılan deneyler hem yetişkinlerin hem de tek-dilli çocukların baş-sonlu bir dil olan Türkçe'yi de artımlı bir şekilde çözümlediklerine işaret etmektedir. Buna göre her biçim-

birimsel öge ortaya çıktığı anda çözümlenmekte ve bu ögelerin birlikte kullanılacağı başka ögeler öngörülmektedir. Bu baş-sonlu çocukların da tıpkı İngilizce gibi dilleri öğrenen çocuklar ve yetişkinler gibi benzer mekanizmaları kullandığına işaret etmektedir. Bu bakımdan Kamide ve Mitchell (1999) ve Kamide, Altmann ve Haywood (2003) gibi çalışmalarla örtüşmektedir.

Bu çalışmada ayrıca bütün dillerin kullandığı tek bir çözümleme stratejisi olmayabileceğine işaret etmekte ve cümle çözümlemenin Steedman (1989) ve (2000)'de önerildiği gibi sözcüksel gramer, aşağıdan-yukarı ve bir çeşit çoklu kısıt değerlendirme mekanizması bir dil işleme modeli ve Vasishth ve Kruijff (2001)'de önerildiği gibi sözcüksel gramer, yukarıdan-aşağı ve aşağıdan-yukarı algoritmayı birleştiren sol-köşe algoritması ve Gibson (1998) ve Hale (2001)'den esinlenen yeni bir kompleksite ölçütü varsayan bir diğer dil işleme modeli kullanılarak artımlı mekanizması korunarak açıklanabileceği gösterilmiştir.