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The SpeeCHain Perspective: Prosody-Syntax Interface in Spontaneous Spoken Hebrew

THESIS SUBMITTED FOR THE DEGREE "DOCTOR OF PHILOSOPHY"

BY

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Lists

i. List of abbreviations

C	Continuous (boundary tone)
CE	Continuous Elongated boundary tone
CF	Continuous Fall boundary tone
CN	Continuous Neutral boundary tone
CR	Continuous Rise boundary tone
CRF	Continuous Rise-Fall boundary tone
CoSIH	Corpus of Spoken Israeli Hebrew
F2F	Face-to-Face dialogues
F	Fragmented (truncated) intonation unit
IU	Intonation unit
IH	Israeli Hebrew
POS	Part of speech
TEL	Telephone conversations
T	Terminal (boundary tone)
TQ	Terminal Question boundary tone

ii. List of Part-of-Speech abbreviations

The Part of Speech annotation is based on the List of Standard Abbreviations in the Leipzig Glossing Rules (<http://www.eva.mpg.de/lingua/resources/glossing-rules.php>).

1.	ACC	Accusative marker (Acc.)
2.	ACC-PRON	Acc. with pronominal suffix
3.	ADJ	Adjective
4.	ADV	Adverb
5.	AUX	Modal lexeme (auxiliary)
6.	BE	Inflectional forms of the lexeme [haja] 'be'
7.	CONJ	Conjunction
8.	DEF	Definite article [ha] 'the'
9.	DM	Discourse marker
10.	EXT	Existentials [jeS] 'there is' and [en] 'there is not'
11.	IMP	Imperative verbal form
12.	INF	Infinitive
13.	MOD	Modifier and quantifier
14.	N	Noun
15.	N-POSS	Possessive suffixes attached to a nominal
16.	AL	Negation lexeme ([?al] 'don't)
17.	LO	Negation lexeme ([lo] 'no')
18.	NUM	Numeral expression
19.	PN	Proper noun
20.	POLITE	Polite interjections, e.g., [bevakaSa] 'please'

21.	POSS	Possessive particle [Sel] 'of'
22.	POSS-PRON	Possessive particle [Sel] 'of' with pronominal suffix
23.	PREP	Preposition
24.	PREP-DEF	Preposition with Definiteness marker
25.	PREP-PRON	Preposition with pronominal complement suffix
26.	PRON	Pronoun
27.	PRP	Personal-pronoun
28.	PTCP	Active participle
29.	Q	Wh-word, question word
30.	SUB	Subordinate particle [Se] 'that'. Both for complement and relative pronoun
31.	V	Verb (either prefix or suffix conjugation)
32.	ZE	Demonstrative Pronoun [ze] 'this'

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Abstract

The purpose of this research is to investigate a particular structural aspect of speech: The segmentation of speech into intonation units. In general, segmentation of spoken language into speech units is accomplished via prosody - the rhythm and melody of speech. This research focuses on how speech is segmented by prosodic boundary tones, which are prosodic break patterns that mark the structure of speech by providing cues as to how a word string should be segmented, as well as whether an utterance is interrogative and whether there has been a change in topic. Prosodic boundary tones are realized by prosodic features: Fundamental frequency (f_0), duration, intensity, and non-speech events, such as pauses. To this effect, the present research provides a link between the acoustic realization and the linguistic interpretation of boundary tones.

The segmentation of speech into intonation units allegedly encompasses three types of prosodic units above the *prosodic word* level: the *phonological phrase*, the *intonational phrase* and the *utterance*. The *prosodic hierarchy* demonstrates that prosodic units are relevant only when they are linked to other layers of speech, i.e. to phonemes, syllables, words, phrases and utterances. This study mainly focuses on the relationship between the syntagmatic layer and the prosodic layer of spontaneous spoken Hebrew. The initial premise of this research was that prosody is crucial to the evaluation of any language processing hypotheses, as the information revealed by prosodic patterning cannot always be extracted from the segmental string alone. In the present research, prosody is used as a major knowledge source for evaluating a processing hypothesis of fluent spontaneous speech on the intonation unit level. A second premise is that prosodic units are not necessarily parallel to syntactic structures, thus the goal is not to define prosodic boundaries in relation to syntactic boundaries, but first to determine the prosodic intonation unit boundaries and then to analyze their location with respect to the syntactic environment.

The research was motivated by the fact that analyses of the intonation unit level system of Hebrew are scarce. Although all languages utilize rising and falling tones and durational variations of segments, the function of these elements varies between

languages. Hence, researchers of prosody agree on the cross-linguistic differentiation between prosodic forms and functions. The goal of this research is to provide a comprehensive description of the prosodic boundary patterns of Israeli Hebrew (IH) in the hope that this will contribute to the overall study of prosodic patterning.

The initial stage of the research was to identify patterns for determining both perceptual and acoustic characteristics of prosodic boundaries. The next stage involved a linear analysis of the prosodic boundary tone and the part-of-speech (POS) dependencies between the words on either side of the boundary. This process resulted in a categorization that enables an analysis of patterns found and can contribute to the understanding of the prosodic-syntactic interface in spontaneous Hebrew in particular, and in spoken language in general.

A unique contribution of the present research concerns the corpus. An initial premise was that the research goal can only be achieved by analyzing spontaneous speech. Thus, 19 audio segments from 19 recordings were selected from the Corpus of Spoken Israeli Hebrew (CoSIH). The recordings are of authentic Israeli Hebrew everyday conversations. Each dialogue consists of conversations between one core speaker and various interlocutors with whom the speaker interacted on that day. Almost every core speaker uses both speech channels – either face-to-face dialogues or telephone conversations. The corpus consists of 31,760 word-tokens (over 6 hours of speech). All recordings were manually transcribed according to SAMPA (Speech Assessment Methods Phonetic Alphabet) and annotated for boundary tone types and POS (for words surrounding the boundary tones).

The approach of the prosodic annotation process imposes two main types of Intonational Unit boundary tones that can be defined according to the communicative value of intonation: Terminal (T-) boundary tones and Continuous (C-) boundary tones. A boundary tone was annotated as Terminal when the surface intonation signaled that the speaker had "nothing more to say". Terminal boundaries were evident, for example, in statements and questions. A boundary tone was annotated as Continuous whenever the final tone of the intonation unit signaled "more to come". Continuous boundary

tones were further divided into five sub-sets: Continuous-Rising (CR) tone, Continuous-Falling (CF) tone, Continuous Rising-Falling (CRF) tone, Continuous-Neutral (CN) tone (level tone), and Continuous Elongated (CE) tone (elongated level tones). In order to define the five C-boundaries, it was necessary to identify the phonological structure of the unit that carries the final boundary tone. This was done by first conducting two pilot studies on smaller corpora (Silber-Varod and Kessous 2008; Silber-Varod 2010). One of the outcomes in these studies was a new definition, or a new approach, to a well-known phenomenon of hesitation disfluencies. As a result, this phenomenon was removed from its canonical research framework as a type of speech disfluency (amongst repetitions, false starts, etc.), mostly referred to as 'filled pauses', and was set as a type of rhythmic pattern of speech, i.e., a boundary tone pattern. This boundary tone was mentioned earlier as one of the Continuous boundary patterns, since its perceptual interpretation signals "more to come"; its most prominent prosodic feature is its excessive duration, therefore I called it a Continuous Elongated (CE) boundary tone.

Thus, the present research focuses on the Continuous boundary tone interface with POS. This interface was defined by the type of the C-boundary in relation to the syntactic dependency between the POS on either side of the boundary tone – where the word preceding the boundary is the word that actually carries the C-boundary tone, while the word following the boundary begins a new intonation unit. Several regularities were observed concerning the prosodic-syntactic interface at C-boundaries: The results show that while all types of C-boundary tones split weak dependencies, the Continuous Elongated (CE) boundary tone is unique in that it is the most likely to occur between words with stronger levels of syntactic dependency.

Continuous boundary tones were observed to split four types of dependency relationships. These are outlined below and ranked from the weakest to the strongest dependency. The unique status of CE tones is clearly evident in the results.

- **No dependency**: The weakest type of dependency is of course when a C-boundary does not split a syntactic dependency, that is, when the word carrying the tone and the following word are not in any direct syntactic relationship (not

in the same syntactic phrase or clause). This type is common to four C-boundaries: CN, CR, CRF, and CF. Nonetheless, when the C-boundary follows a Discourse Marker, also considered a "no dependency" type, the boundary is typically a CE boundary.

- **Coordinate structure dependencies:** Coordinate structure dependencies occur between a conjunction and the adjacent syntactic structures (from increments to sentences). There are two types of interface of coordinate structure dependencies, each of which dictate a different effect on the type of C-boundary. The C-boundary is more likely to occur prior to the conjunction in the case of CN, CR, CRF, and CF boundaries, but to follow the conjunction in the case of CE boundaries.
- **Subject-predicate dependency:** These dependencies are more likely to be split by a CE boundary than any other.
- **Intra-phrasal dependency:** This is the "strongest" type of dependency that can be broken by a C-boundary. Again, the CE boundary tone is the most likely to occur.

A perspective that explains the role of the Continuous boundary tones in general and the phenomenon of continuous elongation in particular is next described, suggesting that the CE boundary phenomenon can be explained as a tension between the prosodic and syntactic strata of language – speakers express this tension by elongating the boundary tone and thus expose this tension to the listener. The tension is between a prosodic break (two intonation units: one that ends with the CE tone and the following intonation unit) and the syntactic continuity. This tension occurs in ~40% of C-boundaries and is what enables both the speaker and the listener to process spontaneous speech. This tension, it is claimed, clarifies the structural role of prosody in speech. This interface is modeled as the "speeCHain perspective", a model that focuses on the chaining of prosodic units to one another and, through this, subsequently chaining the syntactic units systematically.

Acknowledgments

In recent years, my dissertation has been a priority, but of course, in life, a person always has several priorities at once. Due to life's challenges and their consequences, my dissertation could not always come first. At any rate, it is now complete. I have finished, I am elated, but not alone. Indeed, I could not have succeeded without the invaluable support of others. Without these supporters, especially the select few I'm about to mention, I might not have reached this moment.

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1 Introduction

Spoken language is the primary mode of communication between humans, and therefore understanding spoken language is an essential basis for developing linguistic theories. As human listeners, we bring many sources of information to the interpretation of an utterance, including syntax, semantics, prosody, our knowledge of the world and the conversational context. Of these, the present research investigates speech prosody aspects. Prosody is the information gleaned from the timing and melody of speech (Shriberg, Stolcke, Hakkani-Tür, and Tür 2000). However, the timing and melody of speech convey several types of information – linguistic (e.g., unit organization) as well as para-linguistic (e.g., intentions) and even non-linguistic (e.g., emotional state). The present research deals with prosodic patterns that interface with linguistic structures. Such interfaces are achieved by providing the link between acoustic realization and linguistic interpretation of an utterance. The interfaces can be studied because prosody provides clues as to how to segment a speech string, which element is in focus, whether a point is in question, and whether there has been a change in topic.

The core question of my research within these varied functions of prosody and interfaces with other linguistic aspects is the role of prosody in the segmentation of speech into prosodic units and its interface with syntax. Thus, prosody is used in this research as a major knowledge source, providing information not available from the segmental string alone for evaluating language processing hypotheses.

Despite the fact that prosody provides such important information, it has rarely been investigated with respect to its interface with syntax in spontaneous Hebrew. Current Hebrew speech research involves only constrained domains where the information provided by prosody is often peripheral in comparison with the phonological, syntactic and semantic aspects of speech. The current research takes the "prosody first" approach, which views prosody as the main cue of speech segmentation and according to which analysis of speech should be performed. Besides books dedicated to prosodic analysis that have appeared since the beginning of the 1980s, the approach is already in use in large scale projects such as C-Oral-ROM (Cresti and

Moneglia 2005); found in conferences dedicated to prosody (SPRoSIG's *Speech Prosody* conferences)[1] and studies carried out using automatic tools, such as ANALOR – Analyse de l'oral, a tool for semi-automatic annotation of French prosodic structures (Avanzi, Lacheret-Dujour, and Victorri 2008).

The database used for the present research is one of spontaneous spoken Israeli Hebrew (IH) of adult speakers. "Recent research has found that spontaneous speech, notably conversational speech, is very different from other spoken varieties, to the extent that it calls for special research" (Izre'el 2010, 56-57). Sentences given to informants in a lab, or a lecture read from a manuscript, do not establish the entire spectrum of prosodic patterns found in spontaneous speech. For example, "Unlike read or laboratory speech, spontaneous speech contains high rates of disfluencies (e.g., repetitions, repairs, filled pauses, false starts)" (Shriberg 2001, 153). Furthermore, read speech maintains syntactic structures and unit segmentation, e.g., phrases and sentences, similar to the orthographic input. Thus, although such research undoubtedly contributes to the prosodic analysis, it is limited as it deals with only one type of prosodic 'package', one that spontaneous speech does not.

The key stages involved in the present research for the study of prosody-syntax analysis are the following: the definition of perceptually identified prosodic patterns and analysis of the given syntagmatic axis in the environment of these prosodic patterns. Specifically, the identification of intonation unit boundary tones, leaning on previous studies that dealt with their acoustic correlates; Part-of-Speech annotation of the words before and after the prosodic boundary; and the establishment of an analysis on the interface between these boundary tones and the syntactic dependencies at this syntagmatic axis.

1.1 Overview of the dissertation

The dissertation is organized as follows: Chapter 2 discusses the theoretical issues related to prosody in general and to intonation unit boundary tones in particular (§2.1).

[1] http://aune.lpl.univ-aix.fr/projects/sprosig/

Existing prosodic boundary annotation systems are described briefly (§2.2), and by putting forward the premises of the present research relating to prosody (§2.3), I will present the fundamental distinction between intonation unit boundaries, the two main dichotomous categories: Terminal and Continuous.

Chapter 3 deals with theoretical approaches related to the prosody-syntax interface. Two main approaches will be discussed: *prosodic phonology* (§3.1) and independent studies that share the priority of prosodic structures on syntactic analysis conventions when dealing with speech analysis (§3.2), mainly spontaneous speech analysis (§3.3). In §3.3, which is dedicated to studies of spontaneous speech, not necessarily prosody driven, that have contributed to the re-evaluation of spontaneous speech research, I present non-spontaneous examples from IH (§3.3.1-§3.3.2) and other languages (§3.3.3) that provide evidence for the phenomenon of excessive lengthening that is commonly perceived as hesitation disfluency.

Chapter 4 raises the research questions that emerge from the empirical evidence presented in §3.3.1-§3.3.4.

Chapter 5 is devoted to the corpus, which consists of two types of discourse: face-to-face and telephone conversations. All conversations were taken from the Corpus of Spoken Israeli Hebrew – CoSIH database. The transcription conventions are presented in (§5.1). Since transcriptions are the consequence of theoretical and methodological considerations, several linguistic issues are described in this chapter, among them the decision to dedicate a single file to each speaker; that is, to analyze each speaker's continuum separately (§5.1.1); the phonemic inventory of Spoken Israeli Hebrew (§5.1.2); and the minimal syntactic unit transcribed and analyzed (§5.1.3). I then present preliminary results concerning the types versus tokens ratios in order to illustrate the decisions made about the transcription conventions (§5.1.4).

Chapter 6 defines the prosodic boundary tones according to which the speech was segmented and annotated. The boundary tones in spontaneous Israeli Hebrew are introduced in §6.1. This section is divided into five sub-sections: §6.1.1 is dedicated to *terminal boundary tones*; §6.1.2 is dedicated to *continuous boundary tones*; §6.1.3

presents the issue of perceptual annotation; and §6.1.4 is dedicated to a short discussion of the pause parameter as a cue to intonation unit boundaries in spontaneous Israeli Hebrew. In §6.1.5, an example of prosodic labeling is presented as well as preliminary results concerning the intonation units and the boundary inventory in the two databases (§6.1.5.1-§6.1.5.2). The second part of chapter 6 is dedicated to the phonetic realization of continuous boundary tones (§6.2). From this section on, only C(ontinuous)-boundaries are discussed, since, unlike T(erminal)-boundaries, it is assumed that C-boundaries are not parallel to syntactic sentence boundaries. This assumption makes the C-boundaries a distinct domain for prosody-syntax research.

Section 6.2 is divided into five sub-sections, each dedicated to one C-boundary, from the most frequent C-boundary – CE (§6.2.1), to CN (§6.2.2), CR (§6.2.3), CRF (§6.2.4) and the least frequent – CF (§6.2.5). §6.2.1 is exceptional in the sense that it presents a profound definition of the CE (Continuous Elongation) boundary tone. The definition of the CE tone begins with a discussion of the existing terminology for the phenomenon (e.g., *filled pauses*) (§6.2.1.1). In §6.2.1.2, the three realizations of the CE boundary tone in spontaneous IH are introduced. Only then do I turn to the phonetic characteristics of the CE tone (§6.2.1.3). Chapter 6 ends with a discussion of syllable durations in various prosodic environments (§6.2.6) and in fluent (non-boundary syllables) speech. This is the only quantitative measurement carried out on all the C-boundaries, and even in this case, the measurements were carried out only on two recordings and not on the entire corpus. These results are presented because the definition of CE depends on the durational threshold.

Chapter 7 discusses the methodological procedure of the syntagmatic analysis. An introduction to linear (*n*-gram) analysis is presented in §7.1. I then explain how it is implemented in the present research (§7.2), with regard to POS (Part of Speech) annotation and the integration of C-boundary annotation into the syntagmatic axis. Hence, the *n*-gram analysis in the present research consists of both POS and C-boundary sequences, which are called *trigrams*, since each sequence consists of three parts: POS before the C-boundary, the C-boundary itself, and the POS following the C-boundary.

The chapter also includes a brief survey of the implementation of *n*-gram analysis on spontaneous IH (§7.2.1).

Chapter 8 is dedicated to the results of the research and is divided into three sections according to the *n*-grams discussed. §8.1 reports the results (in terms of occurrence and probability) for POSs that *precede* C-boundaries; §8.2 reports the results for POSs *following* C-boundaries; and §8.3 reports the results for POSs on both sides of the C-boundaries; i.e., what seem to be syntactic *dependencies* over C-boundaries. In §8.4, there is specific reference to the dominant dependencies over each of the C-boundaries. These four parts of chapter 8 are mainly concerned with POS and C-boundary sequences. §8.5 provides a closer look at specific cases and brings more evidence of the implications of the POS results on the different POS distributions preceding C-boundaries. Thus, §8.5 is divided according to the three main POS groups, which reflect the three strengths of dependencies over C-boundaries, mainly CE. Chapter 8 ends with an interim summary of the results.

Chapter 9 presents the analysis. Since the results relate to dependencies between POSs, or words, across C-boundaries, I try to explain them through Dependency Grammar (DG) – a syntactic theory that does not refer to prosody, and indeed, no prosodic-syntactic interface has ever been studied according to this theory. The main concern of chapter 9 is to find a syntactic approach that can deal with the elongation phenomenon and that is able to classify the elongated POSs. DG rests on three terms: *head*, *dependent* and *dependency*, which are introduced in §9.1. These terms are mentioned in an attempt to find the common feature of a POS that carries the CE boundary tone (i.e., an elongated POS). In §9.2, the elongated phenomenon is explained through head-dependent notions, and in §9.3, I try to show that the elongated elements also share the fact that they are function words. In §9.4, I try to explain the fact that elongated POSs are actually enclitics in intonation unit final position. This encliticization is demonstrated through the Hebrew definite article [ha] 'the'. In §9.5, I turn to an analysis of the following POS and present theories, such as the *Complexity Hypothesis* to explain the results. In §9.6, I suggest new terms for the elongated POSs that carry the CE

boundary tone and for the POS following the CE boundary. The notion underlying these terms comes from the pronominal approach (Blanche-Benveniste, Delofeu, Stefanini, and Van Den Eynde 1984). Chapter 9 ends with a suggestion for a new perspective on the prosody-syntax interface (§9.8), which is relevant to the entire set of C-boundaries. I call this perspective "The speeCHain perspective," with a capital CH, since this typography reflects the tension between prosody and syntax in speech, for which I have provided evidence.

2 Prosody

The primary, and by far the most frequent use of language, is communication. Communication as investigated in the present research is achieved through the spoken medium, i.e., speech. Speech sounds are on two levels: the segmental level and the suprasegmental level. While the segmental level refers to phonemes, i.e., phones, and their incorporation into words and utterances in a given language; the suprasegmental sound patterns are "a vocal effect which extends over more than one sound segment in an utterance, such as a pitch, stress or juncture pattern" (Crystal 2008, 446). According to McQueen and Cutler (2010), listeners make use of suprasegmental patterns first and foremost to parse speech into words: "the central knowledge store for speech perception is the mental lexicon, that is, our stored representations of words" (ibid., 489). Nonetheless, the present research focuses on a higher organizational level than words, the segmentation of speech into speech units on the intonation level.

During speech, speakers articulate a sequence of speech segments (vowels and consonants), but their organization (regrouping and delimitation) is accomplished via suprasegmental features, such as duration (and rhythm, in consequence), fundamental frequency (f_0), and intensity. Pauses, which cannot be categorized as speech sounds, are also studied within the framework of prosodic organization since they participate in the demarcation of speech units (Cruttenden 1997, 30; Dankovičová, Pigott, Wells, and Peppe 2004, 18). The term *supra-segmental* implies a hierarchy of speech units. Indeed, according to the *prosodic hierarchy* (Selkirk 1984; a model of the hierarchy is also found in Gussenhoven 2004, 124), segments, and segments features, are at the bottom of the (abstract) hierarchy and suprasegmental units are gradually composed of smaller units in this hierarchy. An abstract model of the *prosodic hierarchy* is in (1). A concrete example of this hierarchy is presented in §3.1.

(1) The *prosodic hierarchy* (simplification of the illustration in Fletcher 2010, 529)

Highest Unit	Utt	Utterance
	IP	Intonational Phrase
	PhP	Phonological Phrase[2]
	PrWd	Prosodic Word
	Ft	Foot
	σ	Syllable
Lowest Unit	μ	Mora

This bottom-up *abstract* hierarchy, which imposes prosodic characteristics (units) onto segments, is not in harmony with the *articulation* process of segmental and prosodic features (Fox 2000, 4-5). In other words, prosodic features can be seen primarily as the result of laryngeal or subglottal activity. Tone and intonation are controlled by laryngeal muscles and accentual features are attributed to the respiratory muscles. Segmental features are primarily associated with the supralaryngeal component (except the voiced-unvoiced feature). Thus, "we could consider prosodic features to be similarly more fundamental, in the sense that segmental features involve the modification of an air-stream which is already specified for prosodic features" (Fox 2000, 4). This insight stresses the distinction between segmental and prosodic features, which obliges us to consider the nature and organization of the phonological structure of which such features can be said to be a part. In other words, prosody organizes structures that measure chunks of speech into countable units of various sizes (Fletcher 2009, 523).

The suprasegmental features can be best represented on interdependent levels of prosodic structures (Fox 2000, 9), namely through the *prosodic hierarchy* (see (1) above and discussion in §3.1). Lexical stress, for example, is realized in Israeli Hebrew on the word level (see the IH phonemic inventory in §5.1.2), while the prominent syllable is realized on a higher level of the *prosodic hierarchy* – it is a prosodic cue which signals the important word in an utterance. Intonation contours, which are signaled by external and internal prosodic cues (Cruttenden 1997, 29-35), are thus both a grouping process

[2] Selkirk (1995, 5, footnote 6) notes that "the question of how many levels of phrasing there are in the universal Prosodic Hierarchy turns out not to be relevant to the prosodic analysis of function words."

(i.e., integration of smaller units into a larger unit) and a delimitation process (i.e., separating linguistic units from one another). Eventually, although the delimitation of prosodic units in general (e.g., syllable, prosodic word) and of intonation units in particular, is achieved via suprasegmental features, a prosodic unit on a given prosodic level may be more emergent than the others. For example, production of the smallest units, the syllables, is more prominent in carefully spoken slow speech, while in rapid conversational speech, listeners may directly perceive the sequence of IUs (Vaissière 1991, 110).

2.1 The Intonation Unit and its boundaries

The prosodic unit that is the focus of the present research is the *Intonation Unit* (IU). This term is essentially parallel to what in the *prosodic hierarchy* (see (1) above) is called an *intonational phrase*. The reason for not using the term *intonational phrase* is mainly because the word *phrase* has a solid syntactic definition (Luraghi and Parodi 2008, 152-154), and the unit I am concerned with is a strictly prosodic one.

Le groupe intonatif (Avanzi & Lacheret-Dujour 2010) is another term used for a minimal prosodic unit within the framework of *périodes intonatives* (Lacheret-Dujour and Victorri 2002). Fox (2000, 288-290) summarizes the various names such units have been called (e.g., *tone group*, *intonation group*, *tone unit*, *intonation phrase*). I adopt the term *intonation unit* here, because it has a prosodic orientation and since "it represents neutrality" (ibid., 288). Given the reservation that *intonation* reflects only the changes in the fundamental frequency (f_0), and does not encapsulate the entire prosodic cue spectrum (e.g., rhythm), it is a familiar term in academic research and for laymen as well. The term has been translated into Hebrew as *hangana* (Laufer 1987). The term *prosody* and its inflectional forms will be used instead of *suprasegmental*.

It is commonly accepted that an IU is a stretch of speech uttered under a single coherent intonation contour (Du Bois, Schuetze-Coburn, Cumming, and Paolino 1993, 47; Chafe 1994, 57-60) or "'whole' intonation patterns" (Cruttenden 1997, 29). "A coherent intonation unit" (Chafe 1994, 60) while easily perceived, is difficult to define in

formal acoustic terms, or through any other internal criteria (e.g., prominence, pitch movements). According to Pierrehumbert and Hirschberg (1990), tunes (i.e., intonation contours) are composed of three aspects: *pitch accents*, *phrase accents*, and *boundary tones*. Wichmann (2000) notes that "in most current models of intonation there are two main elements: first of all that of pitch, and secondly the way spoken language is broken down into 'phrases' and the nature of boundaries between them" (ibid., 10). Thus, whatever terminology is used for the speech units, their identification is defined either by *internal* or *external* cues. Regarding internal cues, Wichmann suggests that tone groups usually contain at least one tone (ibid, 12).

In the present research, a discourse flow is segmented into IUs first by detecting their boundaries; internal criteria are brought into consideration only secondarily (cf. (Cruttenden 1997, 29-30). This practice has been used successfully in transcribing large corpora, such as the *Santa Barbara Corpus of Spoken American English* (Du Bois et al. 1993); the *VerbMobil* project (Batliner, Kompe, Kießling, Mast, Niemann, and Nöth 1998); and *C-ORAL-ROM* (Cresti and Moneglia 2005).

The acoustic cues that are most frequently mentioned with respect to IU boundaries are final lengthening and f_0 change (upward or downward) (Cruttenden 1997, 34). These and other acoustic cues are also mentioned in a brief yet comprehensive summary of the phonetic realization of prosodic phrase boundaries in adult English in Dankovičová et al. (2004, 18-20).

Fox shows that boundary tones are considered primarily in the American structuralists' analyses of intonation: "the most important contours, usually occurring at the end of the utterance, are called *primary contours*" (Fox 2000, 281). For example, fall (.), rise (?) and (¿) occur at the end of the sentence; exclamatory pitch (!) and suspension (,) occur either in combination with these or in non-final position (ibid., 281-282). Still, the American structuralists also require a *beginning point* of the contour, which occurs on a 'heavily stressed syllable' which is more or less the *nucleus* in the British school.

Boundary, or juncture, cues are summarized in Bosker (in press) with respect to IH prosodic research:

The prosodic boundary cues are *final lengthening* (inter alia, Wightman et al. 1992), *domain initial strengthening* (Keating et al. 2003), *assimilation resistance* (Nespor & Vogel 1986), *pitch movements* (Cruttenden 1997:34; Ladefoged 2006), *fast initial speech* ('anacrusis' in Chafe 1994:59 and Cruttenden 1997:32) and *pause* (Cruttenden 1997:30). The occurrence and the prominence of the cues signaling prosodic juncture differs per language.

Research into the acoustic correlates of the IU boundaries in Modern Hebrew, paint a multi-faceted picture. Studies based on elicited speech (Laufer 1987; 1996), suggest the following hierarchy of boundary cues: pitch reset > cross-boundary change of speech rate > pause. An investigation into IUs in spontaneous speech has shown that speech rate should be placed higher in the hierarchy: final lengthening > pitch reset > pauses > fast initial speech (Amir et al. 2004; Izre'el 2009). In a subsequent study fast initial speech is categorized together with final lengthening into a single rhythm cue high up in the hierarchy (Silber-Varod & Amir, working paper). Other studies no longer deal with the initial rush and consider only the left side of the boundary domain, that is - the end of an IU (e.g., Silber-Varod's forthcoming doctoral thesis). The characteristics of the most frequently occurring IU boundary in planned Modern Hebrew speech have been found to include three boundary cues: an 'up-down' pitch reset pattern (i.e., rising tone at the end of an IU and a transition downwards to the onset of the following IU), final lengthening and pause (Silber-Varod & Kessous 2008). (Bosker, personal communication)

Prosodic boundaries, even when well defined in terms of acoustic cues, are linguistically significant only if they have structural and semantic values. This is what Fox (2000, 271-273) implies in his survey on intonation studies, which goes back to 1569. It is evident from his historical background that the rise and fall oscillations of intonation have been documented since the very first studies of intonation. For example, it is said that in 1886, Alexander M. Bell identified five basic types of 'inflections' for English and that he associated meanings with each:

1. A rising tone is prospective, or anticipatory of meaning
2. A falling tone is retrospective, or completive of meaning
3. A mixed or undulating tone is suggestive, or inferential of meaning
4. An approximately level tone is reflective, or suspensive of meaning (Fox 2000, 272)

On the structural aspect, McQueen and Cutler (2010) suggest relations between prosodic boundaries and syntactic structures:

> The suprasegmental patterns of speech encode the prosodic structure in utterances. Even though prosodic and syntactic structures are independently determined ... it has long been known that listeners derive syntactic boundaries, and discourse boundaries too, from phrase-final lengthening and from the f_0 contour. (McQueen and Cutler 2010, 506)

Another important point concerning the decision to define IUs by detecting prosodic boundaries is the acknowledgement that IUs in IH can consist of a boundary tone only, as will be demonstrated below (for example, IUs 7-8 in (15)). This contradicts the British school that defines each tone-group as consisting at least of a *nucleus*, which is the syllable on which the main accent falls. According to the British school, (prosodic) *heads* and *tails*[3] are optional (Fox 2000, 278). This is also the approach of the only comprehensive book ever written on Hebrew intonation (Laufer 1987, 39-40). Nevertheless, "the allocation of pitch features to nuclear tones or to boundaries could, in a sense, be seen as rather arbitrary, a matter of mere notation; since the nuclear tone is the last pitch movement of the intonation unit, the effect is the same whether we treat the end of this movement as a property of the nucleus or of the boundary" (Fox 2000, 304). To conclude, the present research presents IU segmentation in IH according to boundary tones, with the presumption that IU can consist only of a boundary tone,

[3] It should be noted that *tails* in the British school are not directly identified as boundary tones.

when, for example, the segmental content contains monosyllabic interjections such as [e] 'eh', [lo] 'no', [ken] 'yes' (see chapter 3, point 2).

2.2 Annotation systems of prosodic boundary tones – from theory to practice

All theoretical models of intonation are eventually realized as annotation systems since researchers need either to quantify or to explain their theoretical model (Izre'el 2009). An annotation system that is implemented on several languages can thus be helpful in providing "some standard means of comparison" (Wichmann 2000, 10). As mentioned earlier (§2.1), two main elements are usually involved in such intonation models-annotations: the pitch contour and the IU boundaries (ibid., 10-13).

In Du Bois (2006), the classification of intonation boundaries consists of three types of boundary tones/Closures:[4]

- Terminative (.) intonation morpheme signaling finality (period)
- Continuative (,) intonation morpheme signaling continuation (comma)
- Appeal (?) combines with final/continuation: (?.) (?,)

These boundary meanings do not necessarily correspond to the three terminal pitch directions: fall (\), rise (/) and level (–) (Du Bois, Cumming, Schuetze-Coburn, and Paolino 1992, 32-34). While Du Bois et al. (1992, 1993) represent the American School of intonation analysis which emphasizes terminal junctures, Cruttenden (1997, 38-55) and Wichmann (2000) represent the English School, which prefers contour analysis and focuses on nuclear tones.

A similar threefold classification was suggested by Mixdorff and Amir (2002) on Hebrew utterances. Although they did not focus on prosodic boundaries, they applied three terminal characteristics: declaratives (with narrow/broad focus); echo-questions (with narrow/broad focus); and neutral non-terminal (followed by 2-3 phrases).

[4] The truncated intonation unit with aborting projected IU (marked with an em-dash or two hyphens) is not included here.

As will be discussed below (§2.3), this tripartite division of boundary tones is limited, considering the variety of continuous "techniques" that speakers use. Moreover, the differentiation between terminal and appeal boundary tones, although acoustically and linguistically well-defined, is not a dichotomy that is relevant to the present research on the syntax-prosody interface, and therefore these two types will be merged into one category (see §2.3).

A bipartite categorization of IU is suggested by Chafe (1994, 63-64), who suggests that "successful" IUs are either *substantive* or *regulatory*, while the third option is *truncated* (or *fragmentary*). Declaratives, terminatives, questions and other units that "convey substantive ideas of events, states, or referents" are all substantive IUs (Chafe 1994, 63). The *regulatory* category does not apply to declarative, non-terminal, or continuous, etc., but to what "coincides to a large extent with the .... *discourse markers*" (cf. Maschler 2009). It should be noted, however, that Chafe's IU types will not be adopted here.

Another coherent framework of intonation is the ToBI (Tone and Break Indices) annotation system (Silverman et al. 1992; Beckman and Hirschberg 1994). This annotation system was derived from Pierrehumbert's (1980) model of intonation in non-linear phonology. This annotation system was designed for use in labeling intonation and prosody in databases of spoken Mainstream American English (MAE_ToBI). A characteristic of the ToBI system relevant to the present discussion is the following emphasized rule:

> The function of a tone also determines its timing relative to the autosegmental projection of consonants and vowels, i.e. a pitch accent is aligned with the segments of the relevant stressed syllable whereas *an edge tone is aligned with the segments at the relevant phrase boundary* [my emphasis, VSV]. There are contrasting High (H) versus Low (L) edge tones at two levels of intonational phrasing, associated with two different degrees of boundary strength: (a) the intermediate phrase and (b) the intonational phrase. (Beckman, Hirschberg, and Shattuck-Hufnagel 2005, cited in Green 2010, 63)

Green (2010) adapted the ToBI system to Hebrew, as ToBI-IH. She created a systematic procedure for transcribing data to describe, compare and contrast the prosodic features of children with developmental disorders (WDD) and those with Autism Spectrum Disorders High Functioning (ASD-HF). Green (2010) identified three types of boundary tones and describes them as follows:

(a) An initial boundary tone '%'

(b) A high boundary tone 'H%'

(c) A low boundary tone 'L%'

> The two final boundary tones combine with the phrase accents in four different combinations i.e. the last intermediate phrase accent (Hp or Lp) combines with the intonational boundary tones to yield the configuration of LpL%, LpH%, HpL% or HpH%. These boundaries appear to have specific pragmatic functions. By analyzing the distribution of these configurations appearing in the (semi-) spontaneous speech and the reading aloud corpus, it is evident that LpL% is the most frequently used boundary tone in Israeli Hebrew. (Green 2010, 76)

Indeed, the ToBI annotation system is a coherent framework to work with; however, it has theoretical disadvantages. According to Fox (2000, 285-286), the Dutch school has rejected "pitch 'levels' (e.g., H and L) as the basic elements of intonation since they reject the view that the speaker primarily intends to hit a particular pitch level" (Fox 2000, 286). The Dutch school sees as the basic unit of intonation the pitch *movement* (e.g., rise, fall). Michaud (2008) rejects the 'Autosegmental-Metrical' methodology since its models of intonation tend to blur the distinction between tonal and intonational phenomena. Even in non-tonal languages such as Hebrew, the idea that tonal intonation is a postulate is a premise I have decided not to accept, based on Michaud (2008), who argues that tonal intonation is a special case, rather than the general rule.

2.3 The communicative value of prosodic boundaries: terminal vs. continuous boundary tones

Since the present research focuses on prosodic boundaries, the prosodic annotation will include a minimal set of tags that symbolize only boundary tones.

A conclusive vs. continuative binary classification of IU boundary tones has been adopted here. Each IU boundary was marked perceptually as either continuous, whenever the final tone of the IU signaled "more to come" or as terminal, when intonation signaled "nothing more to say". Fragmentary (or truncated) IUs are annotated as well, but ignored in the analysis. A full treatment of the boundary tone annotation system is provided in Chapter 6. This dichotomy is frequently implemented when studying prosodic-discourse interfaces (Danieli, Garrido, Moneglia, Panizza, Quazza, and Swert 2004; Cresti and Moneglia 2005; Lacheret-Dujour 2007). There is evidence that the dichotomy between 'final' and 'non-final' patterns goes back to the beginning of the 20th century, and that these patterns reflect the dichotomy between 'conclusive' and 'forward pointing' (Fox 2000, 317). Since the corpus is spontaneous, coding a third type of IU, the truncated (or fragmentary) IU (Chafe 1994) which is characteristic of spontaneous speech, was inevitable. Nevertheless, the truncated IUs were not taken into consideration in the prosody-syntax analysis (see chapter 7).

The binary classification of terminal vs. continuous boundary tones is influenced by Brazil's (1997) binary dichotomy of *proclaiming* tone (P) vs. *referring* tone (R). Brazil classifies these as two different tones on the basis of their prosody as well (Brazil 1997, 68), although he says that this opposition is more abstract and less accurate regarding their phonetic realization. His definition is that the P tone (mostly a fall tone) is realized when the speaker articulates *new* information that the listener doesn't already know. On the other hand, the R tone (mostly a fall-rise tone) is articulated when the speaker is presenting something that is already 'common ground'.

Three notions in Brazil's P/R opposition (Brazil 1997, chapters 4-5) are important to the present research:

Speaker-hearer relations: Brazil expresses the P/R opposition (or P/R system) in communicative terms. He assigns communicative importance to the two tones. His opposition emphasizes the message aspect of speech where given and new information are combined.

Speech process: The P/R opposition has a role in the process of continuous speech. Brazil (1997, 73-74) represents the R tone unit graphically as a loop – an excursion into the common ground – which ends where it began. The P tone unit, on the other hand, constitutes a movement towards greater convergence – a step forward in the information-exchanging process that a speaker has initiated. The P tone unit is represented by a straight arrow which symbolizes "increments which add up to what the listener is 'told'" (Brazil 1997, 74). Brazil gives the following example:[5]

Speaker A asks Speaker B: "What will you do on your day off?"

Speaker B answers: //*r* WHEN I've prepared my LECture // *r* if there's any TIME left // *p* I shall GO into TOWN// *r* and After THAT // *p* it will dePEND ON WEATHer //…

Relationship of intonational segmentation to grammatical constituents:

According to Brazil, "the formal opposition that constitutes the intonation system should be kept quite separate in the description from formal oppositions of other kinds" (Brazil 1997, 151).

More recent research, particularly from the French prosodic school, holds that the dichotomy between conclusive vs. continuative contours is the first categorization one should apply when studying prosodic-discourse interface. Whether rejecting this dichotomy as irrelevant to the meaning of prosody (Delais-Roussarie 2005) or adopting it, it should not be ignored: "for several, only the conclusive contours can play a role, by indicating at the same time the reset into zero of the discursive memory. For them, the continuative contour does not play a role but as an indicator of internal structures, relate to the micro-syntactic structures" (Lacheret-Dujour 2007, 19-20). Others (e.g.,

[5] The loop representation is not presented here.

Portes and Bertrand 2006; Portes, Bertrand, and Espesser 2007) retain the final/continuative dichotomy and reintroduce a sub-dichotomy of the minor/major continuation, showing that major continuation has a clear dialogical/interactional role which renders it a full-fledged contour, with a true "discourse value", while minor continuation does not show the same function. Although the dichotomy between terminal and continuous boundary tones seems linear at first sight, it is adopted by several scholars as enabling a multi-faceted interpretation. Lacheret-Dujour (2007) introduces the *période* unit and distinguishes between *micro-périodes* (continuative punctuations) and *macro-périodes* (conclusive punctuation) on the basis of observation of thematic transitions (Lacheret-Dujour 2007, 19-20).

The tension between larger syntactic units versus minor ones is also reflected in short discourse patterns that encompass a single coherent proposition, such as weather forecast broadcasting. Silber-Varod and Kessous (2008) demonstrated that in speech units that extend over an average of one minute in IH, there is only a single terminal boundary at the end of the weather broadcast (2008, 266). These findings strengthen the importance of continuous boundary tones in the speech segmentation process.

Martin (2010) suggests that a terminal boundary tone implies termination of a prosodic unit that encompasses one or more intonation units with continuous boundary tones, as shown in Figure 1 (from Martin, 2010).

"Prosodic contours at the same levels must be phonologically identical; they should not contrast with each other in order to be classified in the same category in the storage-concatenation process. This implies that contours belonging to [different][6] levels in the prosodic structure must not be identical, as each of them has to contrast with only one contour at a time" (Martin 2010).

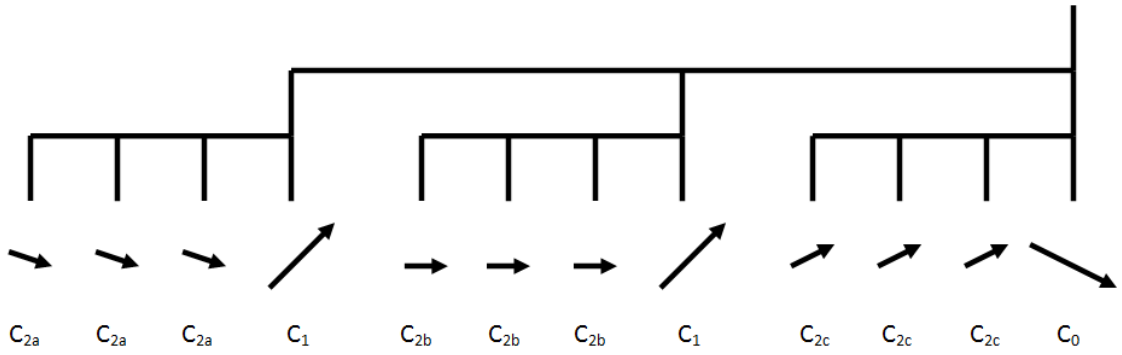


Figure 1: Different prosodic contours encode correspond to levels in the prosodic structure

Avanzi and Lacheret-Dujour (2010) refer to two cases of possible *relations* between Martin's (2010) prosodic contour levels: *liage* (bonding) and *rupture* (break off). Liage (prosodic) is when there are intonative dependency relations between two intonation groups in the same période, as in: *on est arrivé là-bas / c'était de nuit //*, while rupture is when there are boundary tones of the same force, and the two intonation groups are independent of one another, like in a list. For example, *je rentre à l'intérieur / je prends mes appelants //* (Avanzi and Lacheret-Dujour 2010, 339-360). Thus, this hierarchical ranking of prosodic units enables a framework where some units are *prosodically* subordinate to others (Fox 2000, 317-318).

In this research, I have adopted a binary division between perceptually terminal and non-terminal (i.e. continuous) IU boundaries as a platform with which to work. I do utilize the hierarchical characteristic of intonation structure, which recognizes that larger units include smaller ones. Still, I assume (and will not show contradictions to) the fact that between two terminal (T) boundary tones, a sequence of IUs with continuous (C) boundary tones can occur, and that the unit "from T to T" can be considered a higher

[6] In the original paper, this said "similar". I concluded that this was a typo and corrected it.

unit in the *prosodic hierarchy*. I do make use of another structural aspect of prosody, the relational concept, and relate to single-level syntagmatic relationships that occur at prosodic boundaries.

Of the two types of boundary tones, the focus will be on *continuous* boundaries (C-boundaries). The importance of the communicative value of the C-boundary tone is in its linkage function (Portes, Bertrand, and Espesser 2007): "Continuation … can be considered as a 'discourse value' as it links together different chunks of text that could otherwise function as separated utterances (clause chaining). The continuation then functions as a unit-linking as previously highlighted by Matsumoto (2003). In some cases, only the intonation via the continuation can be used in talk-in-interaction as a turn-holding cue" (Portes, Bertrand and Espesser 2007, 160).[7]

2.4 Summary

Before turning to a discussion of the theoretical aspects of the prosody-syntax interface, I will sum up the theoretical premises that are basic to the research, based on Izre'el (2010, 56, 74):

- The primary, and by far the most frequent use of language, is communication.
- Proper linguistic attention must be given to spoken language, as it is a common communication medium.
- Prosody is the suprasegmental aspect of spoken language, and is a no less formal feature of spoken language than segmental features.
- Prosody is the main cue for segmentation of speech units; the IU is a basic structural unit of spoken language.

[7] All continuing contours are labeled "mc" (minor continuation) in Portes and Bertrand (2006).

3 Theoretical approaches to the prosody-syntax interface

Having defined our main concern with the intonation unit boundary tones, the question to be asked is "exactly which part of the sentence or utterance this unit corresponds to..." (Fox 2000, 288). In this respect, Jusczyk (2002) claims that:

> Language involves a duality of patterning … on the one hand, there are patterns that pertain to the way sounds are organized; on the other, there are patterns that relate to how meanings are organized …. It often seems as though the two are studied in relative isolation of one another. (Jusczyk 2002, 1)

According to Ladd (1996), investigating the relationships between syntactic/semantic and prosodic structures has been a major area of research in prosody since the end of the 1960s (e.g., Halliday 1967). Ladd describes the problem of prosodic syntactic 'mismatches' by saying that "If we hear an audible break in a syntactically or semantically 'impossible' location, we may be tempted to say that it is a hesitation rather than an IP [Intonational Phrase, VSV] boundary" (Ladd 1996, 236). Elsewhere, Ladd (2008) says that "Under the usual assumptions about prosodic phrasing, there is no good way to indicate this percept of a 'weaker' boundary; either it is there (and I perceive it as weaker because I am aware of syntactic differences between it and the other boundaries) or it is not there (but I perceive it anyway because I know it is there syntactically)." (Ladd 2008, 294).

Indeed, assuming for the moment that IU is established on the basis of grammatical structure, whether it is a *clause* (Cresti and Moneglia 2005; Moneglia 2004; Izre'el 2005, 2010), an *information unit* (Halliday 2004) or any other grammatical unit, e.g. période (Lacheret-Dujour and Victorri 2002), and assuming that it is not independent of syntactic structure, four possibilities of prosody-syntax interface can be drawn. To illustrate them, four authentic utterances from CoSIH are presented, using the following symbols for indicating final tones: Two vertical lines - ‖ - for a tone indicating finality or "a major (intonation) group" according to IPA (2005); and a single

vertical line - | - for a continuative tone. The syntactic boundaries will be indicated by square brackets: [and].

1. Prosodic Unit (PU) = Syntactic Unit (SU)

Full alignment between intonation units and clausal structures (parallel boundaries)

Rule: syntactic structure X in a single prosodic unit

Example: [aXSav hitkaSaRti eleXa me ha bajit Sel-i]‖ [P1241]
now call.PST-1SG to.2SGM from the house of-mine‖
'just now I called you from my house‖'

This possibility also includes a case where a syntactic structure X is across two or more intonation units, with an intermediate prosodic boundary at the phrase level boundary.

Example:

[[ve ha XaveRa Sel-i ha tova ha Snija] | hi meSaRetet be tel haSomeR]‖ [P1241]
and the friend.F of-mine the good the second | she serves in Tel Hashomer‖
'and my other good friend | she serves in Tel Ha-Shomer‖'

2. PU ≠ SU

Rule: no interface between prosody and syntax

Example:

Prosodic units that contain interjections such as [e] 'eh', [em] 'ehm', [lo] 'no', [ken] 'yes'. These are regulatory intonation units in Chafe's (1994) terminology, and thus call for another coherent form of linguistic structure that interfaces with prosody, e.g., information structure, semantic derived units, etc.

3. PU > SU

Two or more X structures in a single intonation unit.

Example:

[[hi haj-ta jalda kazoti noRa Xamuda]] aval keilu [[jalda ma ze maksima]] ‖ [P1241]
[[she be.PST-2SG.F girl like.that very sweet]] but like [[girl what this adorable]]‖
'[[she was this kind of a very sweet girl]] but like [[such an adorable girl]]'

4. PU < SU

Prosodic boundaries are possible after each syntactic increment.

Example:

[ani medamjenet et kahiR Se| haji-ti ba-h lifnej| ... [C412]
I imgine.F Acc. Cairo that| be.PST-1SG at-her before| ...
'I imagine Cairo that| I visited before| ...'

Taking these authentic examples into account, I will now present some representative studies that deal with prosodic-syntactic interface. In §3.1, I will highlight prosodic phonology approaches (Selkirk 1984, 1995; Ladd 1996, 2008; Gussenhoven 2004). §3.2 presents studies that share independent accounts of prosody and syntax.

3.1 Prosodic phonology

For phonologists, the main motivation behind theories of prosodic structure is to account for the operation of phonological rules. In accordance with this, it has been observed that rules of sentence phonology may operate in a number of prosodic domains of different sizes. This observation led to the positing of a series of prosodic levels organized in hierarchical fashion, called the *prosodic hierarchy* (Selkirk 1984; Nespor and Vogel 1986, inter alia). Thus, larger (higher) units are combinations of smaller (lower) ones. This approach holds that prosody only contributes meaning to utterances, and therefore the initial parsing of the (oral) text is into its segmental components, i.e., the clause or the sentence.

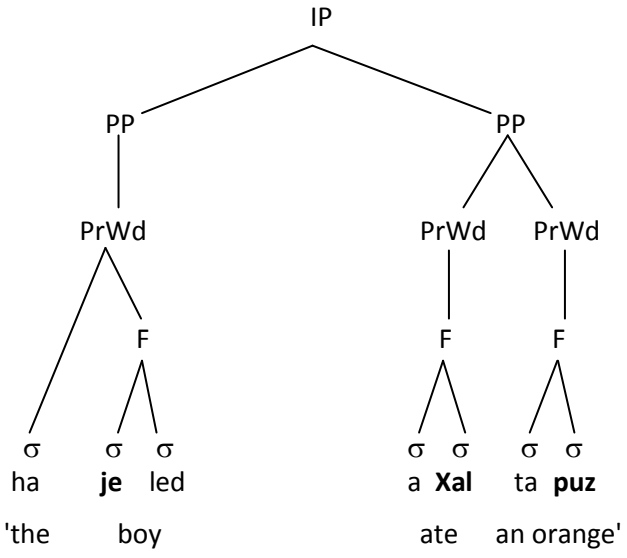
Sentence-prosody parallelism is evident in Selkirk's (1995) work:

> Prosodic structure theory holds that a sentence is endowed with a hierarchically organized prosodic structure that is distinct from the morpho-syntactic structure of the sentence and that phenomena of sentence phonology and phonetics are defined in terms of units of prosodic structure, not morpho-syntactic structure. According to prosodic structure theory, in any language sentences are organized into a structure whose categories are drawn from the set defined in the Prosodic Hierarchy. (Selkirk 1995, 5)

The *prosodic hierarchy* (PH) is a coherent structure where each level dominates one or more units of the next, lower level. The PH represents units that are relevant to the word level as well as the syntactic phrase level and the utterance level. The word level is called *Prosodic Word* (PrWd or Phonological Word), and is the center of the prosodic organization: the PrWd consists of smaller units, foot (Ft), syllable (σ) and mora (μ), but the PrWd is also part of larger structures – the phrase and the utterance. The intonation unit in the present research is parallel to units higher than the PrWd (i.e. the intonational phrase level or phonological phrase level) and lower than the utterance.

For example, (2) demonstrates the prosodic-syntactic interface according to the PH with the sentence [ha=jeled aXal tapuz] (lit. the=boy eat.PST-3SG.M orange) 'the boy ate an orange'. The Intonational Phrase (IP) dominates the Phonological Phrase (PP), and can consist of more than a single PP; the PP that is parallel to the syntactic phrase (e.g. NP, VP, PP) dominates the PrWd and can consist of more than a single PrWd; the PrWd dominates the Foot and can dominate more than one foot, etc.

(2) Mapping of the sentence increment according to PH principles



The IP in (2) consists of two phonological phrases – the first is a NP [ha=jeled] 'the boy' and the second is a VP [aXal tapuz] '(he) ate an orange'. The NP consists of one PrWd [ha=jeled] 'the boy', and the VP consists of two PrWds – the verb [aXal] '(he) ate'

and a NP [tapuz] 'orange'. In the first PrWd there are three syllables, and in the second and third, there are two syllables.

This hierarchy of prosodic categories forms the core of the theory of phonological constraints on prosodic structure. The Constraints on Prosodic Domination: *Layeredness*, *Headedness, Exhaustivity* and *Nonrecursivity*, are the essence of Selkirk's (1995) *strict layer hypothesis* (SLH), which she claims holds universally, in all phonological representations. Another significant contribution of the SLH is constituted by constraints on the alignment of edges of constituents. Selkirk argues that "the relation between syntactic structure and prosodic structure is to be captured by constraints on the alignment of the two structures, ones which require that, for any constituent of category α in syntactic structure, its R (or L) edge coincides with the edge of a constituent of category β in prosodic structure" (Selkirk 1995, 8). Nevertheless, she proposes that "*the set of constraints governing the interface between morphosyntactic and prosodic structure* <u>*makes no reference to functional categories at all*</u> [my emphasis, VSV]. Rather, it is only lexical categories and their phrasal projections which would figure in the statement of morphosyntactic constraints on prosodic structure" (ibid., 10).

Be it a sentence or a clause, the phonological approach considers intonation as a secondary structure to morpho-syntactic structures:

> After the syntactic structures that are needed to express a linguistic message have been assembled, words are selected to 'fill' them.… Prosodic constituents will be constructed *on the basis* [my emphasis, VSV] of the morpho-syntactic structure, including information structure, in simultaneous agreement with phonological conditions on size. ... after the addition of any postlexical tones, adjustments may be made, and the resulting surface representation is delivered to the phonetic implementation. (Gussenhoven 2004, 143)

Thus, the approach led by Selkirk (1984) and Gussenhoven (2004) among others maintains that morpho-syntactic structure is prior to word selection and both are preliminary to prosodic structure.

Fletcher (2010) argues that the crucial role of prosodic phonology lies in the fact that it provided an alternative to syntactic models in that it allowed prosodic boundary cues (for example, pre boundary lengthening) to be interpreted as perceptual cues to levels of linguistic structures in many languages. She sums up by saying that "the general question of the prosody-syntax relationship is not straightforward, but it is more or less agreed that prosodic grouping can be influenced by syntax, although these influences vary depending on the language" (Fletcher 2010, 542).

On the other hand, Ladd takes another phonological approach in suggesting that "... there is some essential difference between syntactic and prosodic structure" (Ladd 2008, 297). He demonstrates this with the famous children's nursery rhyme, "The house that Jack built".[8] The syntactic structures of each verse, shown in (3a), are indefinitely right-branching. The prosodic structure in (3b), however, involves a succession of phrases that do not reflect the syntactic phrasing, and actually come "in the wrong place" from a syntactic point of view, i.e. not at the beginning of each noun phrase (ibid., 237).

(3) Nonisomorphism between syntactic and prosodic structures:

a. [This is [the dog that chased [the cat that killed [the rat that ate [the malt that lay in [the house that Jack built]]]]]]
b. |This is the dog | that chased the cat | that killed the rat | that ate the malt | that lay in the house that Jack built |

Although Ladd's prosodic segmentation is different from the syntactic one, Ladd argues that "prosodic structure must allow nesting of phrases" and "in phonology, boundaries are abstracts entities which are the logical consequence of assuming that intonation has a structure, and are not necessarily phonetic events. Phonetic breaks occur where the underlying structure allows it" (Ladd 1996, 10). I assume these claims are not far from what prosodic phonology, and its representation with the *prosodic hierarchy*, has argued.

[8] Ladd (1996, 237) notes that this was first discussed in this connection by Chomsky and Halle (1968).

3.1.1 Prosodic phonology and Hebrew research

Several studies have examined the prosodic-syntactic interface in IH. From these studies, one can learn that there is a correlation between a prosodic boundary and a syntactic boundary. These studies strengthen Fodor's (2002) "implicit-prosodic hypothesis". She claims that prosody affects the preferred syntactic interpretation (in silent reading). This was tested on spoken Hebrew with relative clauses after construct state NPs (Shaked, Bradley, and Fernández 2004; Shaked 2009), and with PPs in ambiguous sentences (Webman, Fodor, and Fernández 2009).

In this context, Laufer (1996) found that IH speakers pronounce sentences with restrictive modifiers and sentences with non-restrictive modifiers differently. According to Laufer, IH speakers demarcate meaning groups (phrases) after a restrictive modifier, while after a non-restrictive modifier, there is no such boundary. The example brought by Laufer (1996, 284) is in (4). The restrictive grouping is represented in (4a) while the non-restrictive grouping is in (4b).

(4) Meaning groups in spoken Hebrew: restrictive modifier and non-restrictive modifier

a. ha=japan-im ha=XaRuts-im| ja-tsliXu‖
the=Japanese-PL the diligent-PL| 3PL-FUT.succeed‖
'the diligent Japanese will suceed'

versus:

b. ha=japan-im ha=XaRuts-im ja-tsliXu‖
the=Japanese-PL the=diligent-PL 3PL-FUT.succeed ‖
'the diligent Japanese will suceed'

To conclude, the literature review above shows that concerning the aspect of alignment between prosodic structures and syntactic units, the phonological-based approach assumes full alignment of syntax and prosody: "if we hear an audible break in a syntactically or semantically 'impossible' location, we may be tempted to say that it is a hesitation rather than an IP boundary; conversely, if we fail to observe a clear boundary where our rules leads us to expect one, we may be tempted to conclude that

one is present anyway, but that it is hard to hear" (Ladd 1996, 236; and also paraphrased in Ladd 2008, 294). Such an approach argues for speech analysis based solely on linguistic definitions of syntactic phrase boundaries. It proposes primary labeling of syntactic boundaries: "we want to favor a labeling system that basically is syntactic but takes expectations about prosodic and dialogues structure into consideration" (Batliner et al. 1998, 198). The assumption behind this is, of course, that a correspondence between syntactic and prosodic boundaries indeed exists. "Otherwise, prosodic classification of such boundaries would be rather useless for parsing" (ibid., 197).

3.2 Studying prosody independently of syntax

Many of the earlier studies of prosody also assumed a hierarchical structure in terms of speech timing patterns governed by syntax or rhythmic factors, "although the view of *formal* prosodic structure as independent from syntax did not really emerge until the late seventies and eighties" (Hardcastle, Laver, and Gibbon 2010, 528).

The growing interest in corpus linguistics and significant developments in speech technology have enhanced endeavors to better understand the interrelationship between segmental and suprasegmental structures, or between syntax or discourse structure and prosody. This goes hand in hand with a growing interest in the study of spontaneous, non-elicited speech.

In his search for a unit for analysis of spoken language, Izre'el (2005) surveyed works that dealt with the definition of speech units (Izre'el 2005, 2-5). Among others, he mentions the work of GARS (Groupe Aixois de Recherche en Syntaxe) at the University of Provence as an example of the tendency to analyze speech units that can either be equivalent to or larger than the traditional sentence or clause. This school also pinpointed the differences between spoken and written language:

> La syntaxe de la phrase et des propositions, fondée sur les catégories grammaticales et leurs fonctions, ne suffit pas à rendre compte de certaines organisations de la langue parlée [The syntax of the phrase and of propositions,

> based on grammatical categories and their functions, is not enough to give an account of certain structures of the spoken language]. (Blanche-Benveniste 1997, 111)

Thus, this framework distinguishes between micro-syntax and macro-syntax; the latter is designed to deal with structures that can either be equivalent to or larger than the traditional sentence or clause (Avanzi and Lacheret-Dujour 2010). The relations between macro-syntactic elements are different from traditional grammatical relations. In many ways, macro-syntax of this French school is treated within the framework of what would be considered pragmatics or discourse analysis in other schools (Izre'el 2005, 3-4). Another novel approach of the French school is that speech segmentation relies on relevant prosodic parameters that can be defined based on acoustic or perceptual cues only (i.e. without syntactic information); the syntactic structures are described secondarily to the prosodic segmentation (Avanzi 2011). In order to annotate French prosodic structure, automatic language processing software was developed, called ANALOR (Lacheret-Dujour and Victorri 2002; Avanzi, Lacheret-Dujour, and Victorri 2008). This algorithm enables detecting major prosodic breaks and prominent syllables on the basis of acoustic cues only.

> The location and the appreciation of different prominent degrees are important for syntactic description of spoken French. It allows discussing some well-known or instinctive intono-syntactic regularities (as: "left dislocations are always followed by a strong prosodic break", "WH-deletion is prosodically marked in spoken French", etc.), but also to bring new arguments where syntactic tests do not work (in the case of temporal parataxis), or explaining when and why specific parataxis engender an inferential interpretation or not. (Avanzi 2011)

Several studies have taken a similar path of exploration, based on the premise that the IU is the basic unit of conversational language, by checking the constituency of IUs in terms of clauses and Noun Phrases (NP) and mapping clauses into IUs. It seems that most authors agree that a clause is a valid category for the study of spontaneous,

conversational language (cf. also Hirst and Di Cristo 1998). On the other hand, Tao (1996) found that Mandarin consists of a relatively large number of IUs consisting of NPs. To conform to these findings, Tao suggested the concept of a *speech unit*, which is "the correspondence of grammatical elements and intonation units, which is real for language production and analytically advantageous for the study of language" (Tao 1996, 175). Suggesting a dynamic grammar that operates at the level of spontaneous natural speech, Tao further questions the usefulness of the *clause* for the analysis of spoken language, in the same way that other schools reject the sentence as a valid structural unit for the description and analysis of spoken language, notably its spontaneous, conversational varieties. Brazil (1995), leaning on prosody, takes a different route in analyzing the language of spoken narrative. He rejects the validity of what he calls "sentence grammar" and suggests a unit that he calls *increment*, the basic unit of the syntax of targeted, purposeful, linear oral communication.

Chafe's analyses of spoken language (culminating in Chafe 1994) are based on his cognitive theory of information flow. He regards the IU as the basic unit of discourse. He describes the relationship between the IU and clause as follows: "Each clause verbalizes the idea of an event or state, and usually each intonation unit verbalizes a different event or state from the preceding" (Chafe 1994, 69). As mentioned above (§2.2), he distinguishes between fragmentary, substantive, and regulatory IUs: Fragmentary IUs are those that have not come to a successful end; substantive IUs are those that convey ideas and events, states or referents; regulatory IUs are those whose function is the regulation of information flow or interaction between speakers. With Chafe's findings, i.e., that clauses and substantive IUs coincide by 60% (1994, 65-66), a question concerning the centrality of the clause in the study of spoken language was raised. Several studies took a similar path, based on the premise that the IU is the basic unit of conversational language, and examining the constituency of IUs in terms of clauses and NPs as well as mapping clauses into IUs. These studies covered languages as diverse as English and Sasak (where a range of 32%-75% IUs coincide with clauses), including Hebrew (Izre'el 2005, with references to results in other languages). Katzenberger and

Cahana-Amitay (1999) propose the term *processing unit*, "which yields units but need not overlap with a clause" (1999, 200).

The use of prosodic segmentation in the C-ORAL-ROM corpus of Romance languages (inter alia, Cresti et al. 2002; Cresti 2005) resulted in significant implications for the understanding of the structure of the Romance languages comprising that corpus. The basic structural unit of spoken language is suggested to be the *utterance*, which is defined operatively and theoretically: "The operative definition of the utterance is such that every expression marked by a prosodic terminal break is an utterance. ... From our theoretical point of view, an utterance corresponds to the accomplishment of a speech act, as defined by Austin (1962)" (Cresti 2005, 210). On this, Izre'el (2005) notes that "an *utterance* in the Romance corpus equals a set of any number (including one) of sequential intonation units as defined by Chafe and his followers, i.e., all IUs between two final boundaries (=terminal breaks). Therefore, any statistics presented for the C-ORAL-ROM are utterance-based rather than based on a IU count" (2005, 4-5).

For spoken IH, Izre'el (2010) lays the following foundations for the prosody-syntax interface:

- The prosodic group[9] is the basic structural unit of the spoken language. The next unit in hierarchy is the prosodic complex, or the utterance. An utterance can include a single prosodic group or more.
- An utterance includes at least one clause.
- A clause is defined as a unit consisting minimally of a predicate. (Izre'el 2010, 84)

Following the three premises above, Izre'el defines other syntactical units in IH, such as "predicate", and other syntactic relations. These definitions are relevant to the present research and will be discussed further on §7.2.1, where I elaborate on the syntactic structure of IH.

[9] Equivalent to the term “Intonation Unit” used in the present research.

3.2.1 Summary

To sum up, the research is based upon the following premises:

- Prosody and syntax are two independent components of spoken language (Chafe 1994; Gussenhoven 2004; Anderson 2005; Wartenburger, Steinbrink, Telkemeyer, Friedrich, Friederici, and Obrig 2007).
- The intonative structure is prior in perception to the syntactic one (Lacheret-Dujour and Beaugendre 2002). This was concluded in language acquisition research that showed that prosodic cues play a pivotal role for infants in their rapid acquisition of language. Infants as young as six months old are sensitive to prosodic markers of syntactic units smaller than the clause and they use this sensitivity to recognize phrasal units, both noun and verb phrases, in fluent speech (Soderstrom, Seidel, Kemler-Nelson, and Jusczyk 2003; Anderson 2005; Wartenburger et al. 2007).
- The basic structural unit of spoken language analysis is the Intonation Unit (IU). In other words, prosodic segmentation of speech is the independent variable in the present research.
- The prosodic perspective adopted in this research strives to study the realization of prosodic boundaries of IUs thoroughly and independently of segmental (i.e., syntactic) bias. A reflection of the nature of spoken language as consisting of IUs means that the initial parsing of the corpus is into its IUs (Izre'el 2005, 2010; Shriberg et al. 2000; Silber-Varod 2005; Amir, Silber-Varod, and Izre'el 2004). This method has been used before for transcribing spoken Israeli Hebrew (e.g., Katzenberger and Cahana-Amitay 1999; Maschler 2007). IU perceptual segmentation has already been implemented on the present research corpus – CoSIH, by Izre'el (2005), Cohen (2004), Silber-Varod (2005), Gonen (2009), Dekel (2010), and Ozerov (2010). Samples of CoSIH segmentation into IUs are presented in the NMELRC – National Middle East Resource Center.[10]

[10] http://hebrewcorpus.nmelrc.org/

3.3 Spontaneous speech as fundamental for the study of language

The syntactic priority adopted in most of the theoretical approaches mentioned above is increasingly disclaimed as evidence for the grammaticalization of spontaneous speech phenomena, like hesitations, self-repair or false-starts that emerge in Hebrew (Badihi-Kalfus 2005; Maschler 2007) and in other languages (Shriberg 2001; Roll, Frid, and Horne 2007; Fox, Maschler, and Uhmann 2006). Blanche-Benveniste (2007) states that recent studies

> have ... given more grammatical and semantic importance to dysfluencies…. Determiners and subjects signal the nature of the phrase-to-come, without any lexical inside. I suggest an explanation: speakers would give first the syntactic frame, with no lexical fillers, and they would only give the whole phrase, syntax and lexicon together, in a second time…. That is why getting rid of such phenomena is a linguistic mutilation. (Blanche-Benveniste 2007, 61-62)

Wichmann (2000) describes how the prosodic mechanism interacts with the syntactic structure in spontaneous speech:

> In spontaneous, unplanned speech we do not always find clear prosodic boundary signals at syntactic and topical breaks which we expect in read speech. We find, for example, that pauses at clause boundaries occur *after* rather than before a conjunction, and [instead of] the long pauses we expect at clear breaks, the speaker may drift gradually from one focal unit to the next, giving us a topic transition phase rather than a topical break. Indeed, we can often only infer from a prosodic 'beginning' that there must have been an ending. (Wichmann 2000, 21)

However, Wichmann restricts this phenomenon to spontaneous speech thus diminishing its linguistic value.

This inclusive approach has also been realized in *La mise en grille* (Yatziv-Malibert 2002), a comprehensive methodology (following Blanche-Benveniste, e.g. 1997) for syntactic observations. *La mise en grille* takes into account all the linguistic output in the spoken text, and actually confronts philosophical "passing throughs" about the relations

between speech and language as to whether speech, as a major instrument of communication, can tolerate repetitions, hesitations, interjections, filled pauses, etc.; and how language users, listeners and speakers, deal with this list of faults.

Another prosody-syntax interface research has been performed by Horne, Bruce, Frid, Johansson, and Roll (2001-2004), also described in Roll, Frid, and Horne (2007). They led a comparative study on the syntactic complexity between fluent and disfluent *att* 'that', the subordinate particle in Swedish, and between fluent and disfluent *och* 'and', the Swedish conjunction. The goal of their project was to investigate the role that function words play in distinguishing between propositional information (completely planned constituents) and information units which are not completely planned. The study focused on investigating environments containing function words followed by hesitation disfluencies. The segmental and prosodic form of the two Swedish function words *att* and *och* was investigated in spontaneous data from the SweDia project (RJ) and studied in relation to the following hesitation pause duration as well as the intonational structure of the following speech string. They expected there to be a correlation between the form of function words (in particular, the duration of any final aspiration phase), the length of the following hesitation pause and the information status of the following speech unit (complete/non-complete constituent). They claim that the results are relevant to the development of models for parsing, identifying disfluencies, and processing information in spontaneous speech.

It is common knowledge that analyzing spontaneous speech allows us to identify unique patterns of prosody that cannot be established in read speech (Stolcke and Shriberg 1996). Sentences read by informants in a lab, or a lecture read from a manuscript, establish a different spectrum of prosodic patterns than those found in spontaneous speech. Nonetheless, I will now present non-spontaneous examples from IH and other languages that provide evidence for the phenomenon of excessive lengthening that is commonly perceived as hesitation disfluency. Such evidence emphasizes the linguistic regularity of this phenomenon, and hence its predictability.

3.3.1 Planned speech evidence

The first example is from a planned lecture by a scholar at the opening of a university seminar. The speaker is a native Hebrew speaker in his fifties.

The speech is annotated using the same prosodic boundary symbols used at the beginning of chapter 3: | for a continuous boundary and ‖ for a terminal boundary. Elongations are marked with the IPA symbol (ː) and pauses are marked with the number sign (#). The pause duration (seconds) is also shown in brackets.[11]

(5) Evidence of violation of syntactic segmentation from planned Hebrew speech

a. ani Rak Rotse lomaR|Seː #(2.43s) lo mamaS haja konsept baRuR la jom haze mileXatXila| [M-2006]
'I just want to say| thatː #(2.43s) there was no clear concept regarding this day from the beginning|'

b. ani meod mekave| Seː naamod be Xavod ba mesima| Selː letaXzek et ma Se kvaR naasa kan|[M-2006]
'I do hope|thatː we will honorably fulfill the task ofː maintaining what has already been done|'

In both (5a) and (5b), the [Se] 'that' is elongated; in (5b), [Sel] 'of' is also elongated. This strengthens the tendency documented in other languages that hesitation occurs on similar word types, namely function words.

3.3.2 Written language evidence

The hesitation phenomenon is also represented in the literature. When authors wish to imitate this natural speech characteristic, they do so with the ellipsis […]. This is the case, for example, in (6a). It should be pointed out that this does not always reflect hesitation, but may be another kind of a speech "break".

(6) Evidence of the violation of syntactic segmentation from written Hebrew texts
a.

[11] All examples from the spontanuous corpus and other non-spontaneous examples as well are accompanied by an audio file with aligned prosodic annotation (see Appendix IV for details). More about transcription standards and high level transcription standards can be found in Appendix I.

איך מישהו מסוגל להגן על החלאה הזאת ש... שפגעה בי
eX miSehu mesugal lehagen al ha Xela hazot Se … Se paga bi
'how can anyone defend this scum that… that hurt me' (Ram Oren, *Ashram*, p. 66)

Another example of the phenomenon of a "break" after function words occurs in television subtitles (6b-c). These samples were taken from the Children's Channel. In (6b), for example, one shot showed a cartoon character saying [el] 'to' or 'towards' and the next shot showed the anticipated destination [galaksjat ha=SemeS] 'the sun galaxy'. Here, like in the example from the literature in (6a), the dubbing, as well as the parallel subtitles, were trying to imitate pragmatic ends in natural speech by suspension on the prepositions:

	screen	**text**	**gloss**	**translation**
6b	subtitle on screen	el	to	'to'
	subtitle on the following screen	galaksjat ha=SemeS	galaxy_of the=sun	'the sun galaxy'
6c	subtitle on screen	nimtsa be	situate.PST.3SG in	'situated in'
	subtitle on the following screen	galaksjat ha=SemeS	galaxy_of the=sun	'the sun galaxy'

[Ruby Glum's TV program, episode 19 (the Children's Channel) on May 3rd, 2008]

While (6b) is only an example of a prepositional phrase segmentation into its two syntactic components: the preposition and the noun phrase, (6c) is an example of independent orthography of the function word [be] 'in', which according to Hebrew orthographic standards is written as a single letter ב <b> attached to the following word. This orthographic standard is also used with the definite article [ha] in the same NP שמש=ה <h=SmS> 'the sun'. Thus, in written Hebrew, the two subtitles in (6c) would be written in two orthographic words: בְּגלקסיית השמש <b=glksjt h=SmS>. (6a-c) are presented only to show that Hebrew orthographic standards are "violated" in formal written genre: literature, commercials and TV programs, in an attempt to mimic natural speech. In Hebrew, this is not only a matter of mimicking speech but also a matter of violating writing standards.

3.3.3 Evidence from other languages

In addition to the examples from Hebrew spoken and written language, evidence from Swedish for the same phenomenon were studied in Horne et al. (2001-2004) and Roll,

Frid and Horne (2007) (and see §3.3 above). Evidence of such a phenomenon from additional languages can support a re-examination of the prosody-syntax interface. For example, in (7), the French preposition *de* is lengthened.

(7) e 2: la Sa~bR d2: d@ kOmERs
'et euh la Chambre de: de Comerce'

3.3.4 Spontaneous data

The following discussion presents core examples with which my research will deal.

(8) eldad heXlit S=u: lo mvateR [OCh][12]
Eldad decided.PST.3SG.M that=he: not gives-up
'Eldad decided that he wouldn't give up'

(9) bikaS-t Se: ni-kne adaSim ve ke-[13] ve: Xalav [D741]
ask.PST-2SG.F that: 1PL-FUT.buy lentils and @- and: milk
'you asked us to buy lentils and @- and milk'

Example (8) is syntactically analyzed as a main clause [eldad heXlit] 'Eldad decided', with a subordinate complement clause [S=u lo mvater] (lit. that=he not gives-up) 'that he wouldn't give up'. Nonetheless, a perceptual segmentation into its prosodic structure, according to prosodic boundary cues (excessive lengthening of syllables), reveals another segmentation (10):[14]

(10)	eldad heXlit Se hu|	First IU	'Eldad has decided that he'
	lo mvateR||	Following IU	'does not give-up'

This perceptual segmentation into two IUs was also repeated by 7 informants (58%) who listened to it in a filtered recording, within an experiment that was documented in Mettouchi, Lacheret-Dujour, Silber-Varod, and Izre'el (2007).

Example (9) is syntactically analyzed as a main clause [bikaSt] 'you asked', with a following subordinate complement clause [Se=nikne adaSim] 'that we will buy lentils'

---

[12] This example is from a sub-corpus that was discussed in detail in Amir, Silber-Varod, and Izre'el (2004).

[13] The segments with hyphens are false starts

[14] The prosodic annotation follows Du Bois et al. (1993) and Edwards (1993). Nevertheless, the present research implements another annotation system that will be described below.

and a third IU with the second constituent in a coordination structure of NP [ve ke- ve Xalav] 'and @- and milk'. Nonetheless, a careful investigation of the prosodic segmentation of this utterance reveals another structure (11):

(11)	bikaSt Se|	First IU	'you asked that'
	nikne adaSim ve ke-	Second following IU	'we will buy lentils and @'
	ve|	Third following IU	'and'
	Xalav‖	Fourth IU	'and milk'

Referring to (3) in §3.1, where I showed two possible segmentations for the children's nursery rhyme "the house that Jack built", examples (5a-b) and (10)-(11) demonstrate yet a third means of segmentation that allegedly consists of prosodic features only. This segmentation demonstrates the possibility that a boundary exists in the middle of a complement clause (between the first and second IUs). This, of course, does not fit the *prosodic hierarchy* and challenges Ladd's (1996; 2008) prosodic phonology approach. To sum up conclusions from the sporadic examples above, it seems that:

(a) The binary classification for terminal and continuous prosodic boundaries presented in chapter 2 is a good starting point but yet not sufficient for describing continuous patterns found in spontaneous Hebrew, and

(b) If one accepts excessive elongation as an equal member of the continuous prosodic boundary set, then canonical syntactic segmentation is challenged.

4 Research questions

From the theoretical survey above and the evidence brought in §3.3, I extract two theoretical questions of interest to the present research on the prosody-syntax interface. First, how, in fluent speech, do speakers utter two layers, prosodic and syntactic, which are joined into a meaningful utterance at the same time and by the same mechanism, i.e. by speech? Another theoretical question is what is the contribution of prosodic organization (integration and delimitation) to speech? In order to contribute to a better understanding of the relationships between IUs and syntax in IH, a more specific question is added: Does an IU in spontaneous Hebrew encompass a syntactic unit and if so, which unit? With these three theoretical questions in mind, the present research strives to examine concrete prosodic and syntactic aspects at IU boundaries by asking the following questions:

1. As shown in §2.3, in this research a binary division between terminal and non-terminal IUs is taken as a platform. Of these two types, the focus will be on continuous boundaries (annotated above with the boundary symbol, |). I will investigate the question of whether all continuous boundary tones share the same acoustic pattern and hence,
2. Are continuous prosodic boundaries parallel to syntactic boundaries? For example, in Batliner et al. (1998), the correspondence between syntactic (S) labels and prosodic (B) labels showed high agreement (95%).

To answer these questions, a prosodic annotation was performed on a ~30,000-word corpus, and the specific domain of continuous boundaries (described in chapter 6) was annotated according to Part-of-Speech (POS) tags.

5 Corpus

The corpus used in this research contains 19 spontaneous Israeli Hebrew dialogues from The Corpus of Spoken Israeli Hebrew – CoSIH database (Izre'el, Hary, and Rahav 2001; Izre'el and Rahav 2004; available from http://www.tau.ac.il/humanities/semitic/cosih.html). These recordings were made in 2001-2002. The total duration of analyzed speech is over six hours. Each dialogue consists of conversations between one core speaker and various interlocutors with whom the speaker interacted on the day the recording was made.

The corpus under discussion consists of private spoken dialogues of two kinds: direct conversations (face-to-face) and distance (telephone) conversations (Figure 2).

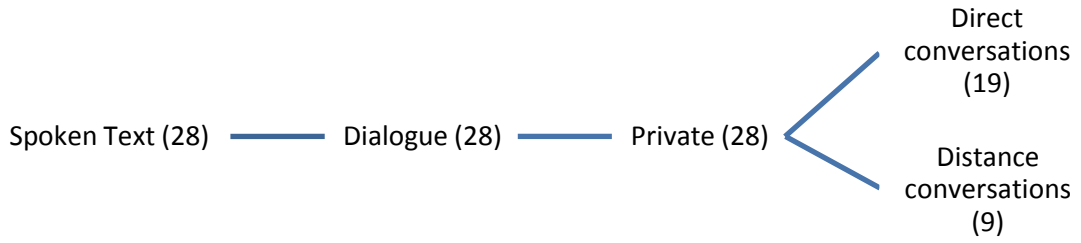


Figure 2: An outline of the corpus structure
(adopted from Figure 2.1 in Bauer and Aarts 2006, 27)

In the present research, I will refer to the direct conversations as F2F (face-to-face dialogues) and the distance conversations as TEL (telephone conversations). The F2F sub-corpus contains spontaneous dialogues. Each dialogue consists of conversations between one core speaker (the "informant", who had the recording equipment on his body for 24 hours) and various interlocutors with whom the speaker interacted on that day. The TEL sub-corpus contains spontaneous phone conversations recorded by the same informants, and were part of the 24 hour routine during which the participants recorded themselves. Nonetheless, the TEL corpus consists only of the informants' speech, and not their interlocutors'. Table 1 summarizes which recordings contain both F2F and TEL channels, and which contain only one of each.

Choosing the database for the present research was not an easy task, since many recordings included background noises such as street noises, radio or TV, etc. These noises made most of the material almost impossible to measure acoustically. Since in the early stages of the research it was decided not to focus on quantitative signal measurements, recordings were selected according to the volume of extractable data. Each recording selected was over 9 minutes long and contained at least 1,000 words.

The dialogues are tagged in the text by their original name in CoSIH (see Table 1). During one session, the informants often spoke both face-to-face and over the phone. Transcriptions of phone conversations consist of the text of the informant only. Phone conversations tended to be of higher acoustic quality than face-to-face sessions, thus their ratio in the corpus was increased by selecting two long phone conversations of over 17 minutes each. Non-native IH speakers and children were not included in the transcriptions.

Table 1: The corpus

	F2F corpus	**F2F duration (minutes)**	**# of speakers per dialogue**	**TEL corpus**	**TEL duration (minutes)**
1				C412; C413	22
2	C512;C514	11.21	2		
3	C1111	9.28	4		
4	C1621	13.93	2		
5	C612; C614	11.41	2		
6	C714	19.90	4		
7	D311	1	2	D341	12.11
8	D631	10.92	2		
9	D122	22.28	3	D122	3.65
10	D23	1.86	2	D23	8.25
11	D731;D741;D742	31.75	2	D731; D742	3.59
12	G311;G313	9.85	3		
13	G1022;G1031	11.94	3		
14	G1241	4.01	2	G1241	17.35
15	G424	8.66	2	G424	1.86
16	G711;G731	8.02	2	G711; G731	4.81
17	G831	6.70	2	G831	8.51
18	G911; D912	11.03	2		
19	OCh	11.72	2		
Total	18	205.47	43	9	164.26

Table 1 is divided into two channels: F2F and TEL. Data include the duration of each session and the number of participants in each F2F conversation. The two corpora, F2F and TEL, contain 31,760 tokens (after clean-up) of which 4,288 are word-types.

5.1 Transcription conventions

5.1.1 Single transcription file per speaker

In terms of transcriptions, there is one major difference between F2F and TEL dialogues. In TEL recordings, only the informant can be heard, thus only half of the dialogue is transcribed. In the F2F recordings, on the other hand, all interlocutors are heard and thus all were transcribed. One major decision made during the analysis was to designate each transcription file per speaker, not per conversation. This is an obvious choice with regard to the TEL corpus, since in any case, only one of the speakers is audible. The decision is not trivial in reference to F2F dialogues. However, since the present study is not concerned with the semantic content of the conversations or the discursive reasons for the use of a certain prosodic contour, it was decided to analyze the F2F data as separate one-sided conversations, similar to the TEL recordings. As a result, neither interchanges between speakers nor overlaps were considered parameters (or variables) in the analysis.

The decision to transcribe each speaker separately as an "artificial monologue" was a decision made for syntactic analysis purposes. Doing so provided a basis for the speech chain analysis where only prosodic boundary tones and pauses mark a break in the speech.

5.1.2 Phonemic inventory

The phonemic inventory of Israeli Hebrew includes the consonant inventory presented in (12) and the vowel inventory presented in (13). The transcriptions follow SAMPA (Speech Assessment Methods Phonetic Alphabet) standards,[15] but the feature columns in (12) follow the International Phonetic Alphabet (2005 chart), as well as other special

[15] http://www.phon.ucl.ac.uk/home/sampa/hebrew.htm

characters.[16] In the following paragraph, I describe other decisions that were made concerning the textual database.

There are two main dialects in Modern native Israeli Hebrew:[17] The Oriental dialect and the non-Oriental dialect.[18] The main difference between them is in the consonants: the Oriental dialect has two pharyngeal phonemes, /ħ, ʕ/, which the non-Oriental dialect lacks. Thus, /ħ/ and /x/ were combined into a single SAMPA symbol [X], since their articulation in the research recordings is a non-oriental one. In addition, in the non-Oriental dialect, /ʕ/ merges with /ʔ/. Especially in unstressed syllables, the glottal stop [ʔ] and the pharyngeal fricative [ʕ] may be omitted (though their frequencies seem to depend on personality, style and rapidity of speech). Therefore, these consonants were not included in the consonant set of the present research transcriptions, and are thus marked in gray in (12).

(12) Consonants in Israeli Hebrew[19]

	Bilabial	Labial-dental	Alveolar	Post-alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b		t d			k g			?
Nasal	m		n						
Fricative		f v	s z	S Z		X	R	X\ ?\	h
Approximant	w				j				
Lateral approximant			l						

Affricates can be regarded as phonological units, like in /t͡sar/ 'narrow', but they will be transcribed as sequences of stops followed by a homorganic fricative: /ts/ [ts], thus [tsar]. In addition, there are several sounds which appear as phonemes only in loan words: the palate-alveolar fricative /ʒ/ (e.g., [masaZ]); the affricates /t͡ʃ/ (e.g., [tSips]),

[16] http://web.uvic.ca/ling/resources/ipa/charts/IPAlab/IPAlab.htm

[17] The section on phonemic inventory is based on Laufer (1990).

[18] Demos of the Oriental dialect pronunciation of glottal consonants can be found in: http://hctv.humnet.ucla.edu/departments/linguistics/VowelsandConsonants/appendix/languages/hebrew/hebrew.html.

[19] The audio files that demonstrate all the consonants in Hebrew can be found in: http://web.uvic.ca/ling/resources/ipa/handbook_downloads.htm

and /d͡ʒ/ (e.g., [dZins]); the voiced labial-velar approximant /w/ also exists in common IH loan words; for example, [walla] 'you don't say', which was found 17 times in the research corpus.

The vocalic system of IH includes five phonemic vowels (13).

(13) Vowels in Israeli Hebrew [20]

Phoneme	**Example**
i	[iR] 'city'
e	[tsel] 'shadow'
a	[gav] 'back'
o	[oR] 'light'
u	[guR] 'puppy'

Diphthongs can be treated as sequences of two vowels, or as a vowel and a semi-vowel. For example, [dei] or [dej] 'fairly'. Also, the sonorant consonant /j/ may be deleted in casual speech, especially before /i/, and especially in unstressed syllables, due to the Obligatory Contour Principle (OCP), i.e., when the sonority gap between the consonant and the vowel is minimal (Bolozky 2002, 250-251). Nonetheless, cases of semi-vowels [j] at word-final coda position, as in [lifnej] 'before', will be transcribed with the semi-vowel symbol [j], a decision which also reflects the orthographic form of the word לפני 'before'.[21]

Stress in IH can be distinctive in nouns, e.g. ˈboker 'morning' vs. boˈker 'cowboy' and across categories, e.g.ˈberex 'knee' vs. beˈrex 'Pro.3rd person + blessed'. Although the vowels and consonants are longer in stressed syllables, and vowels are centralized and shorter if unstressed, in the present research, the stress mark was not transcribed.

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[20] The audio files that demonstrate all the vowels in Hebrew can be found in: http://web.uvic.ca/ling/resources/ipa/handbook_downloads.htm

[21] There are only 28 word-final diphthongs in the corpus that occur in the relevant prosodic domain – before C-boundaries (see §2.3 and chapter 6). These were treated in the same way in Silber-Varod (2010).

Appendix I covers all phoneme transcriptions according to SAMPA for Hebrew, with additional reference to phonemes that were transcribed or ignored in this document.

5.1.3 Clitic – the minimal syntactic unit transcribed

In linguistics, a clitic is "a term used in grammar to refer to a form which resembles a word, but which cannot stand on its own as a normal utterance, being phonologically dependent upon a neighbouring word (its *host*) in a construction" (Chrystal 2008, 80). Clitic words ('clitics') can be classified into *proclitics* (i.e. they depend upon a following word, as in the case of articles) and *enclitics* (i.e. they depend upon a preceding word, as in the attachment (cliticization) of some pronouns to the end of a verb form in Italian or Spanish). In IH, for example, [ha] 'the' is considered a proclitic since it precedes the host word (see example in Table 2).

In the present research, monosyllabic proclitics, mainly function words, are the minimal syntactic units and thus transcribed as separate words (i.e. between spaces). This convention differs from Hebrew orthography, where mono-grapheme function words (e.g. ה [ha] 'the', ו [ve] 'and', ש [Se] 'that') are attached to the following word (Table 2). Affixes, on the other hand, were transcribed as a single unit with the host word. The question if a word is a clitic or an affix is another relevant issue in the transcription standards of the present research. It was decided to treat clitics in complex structures as prefixes (see §5.1.3.1 for details).

Table 2: Transcribing Hebrew clitics as separate orthographic words

SAMPA transcription in the present research	Translation	Hebrew orthographic convention
ha bajit	'the house'	הבית
2 orthographic words		1 orthographic word

As Table 2 demonstrates, there is a difference between Hebrew orthographic standards and the way the present research treats the transcription of clitics. In addition to /h/, 'the' (pronounced [ha]), there are six more proclitics in Hebrew: /m/ 'from' (pronounced [mi] or [me]), /sh/ 'that' (mostly pronounced [Se]), /v/ 'and' (mostly

pronounced [ve], but which in idioms can be pronounced [va]), /k/ 'as' (pronounced [ke]), /l/ 'to' (pronounced [le] or [li]), and /b/ 'in/at' (pronounced [be] or [bi]). Indeed, Rosén (1977, 69) claims that one-consonant morphemes "have now to be phonemicized /be/ 'in', /me/ 'from', /le/ 'to'," and this is the representation of prepositions that will be adopted in the present research. The vowel that follows the consonant thus attached depends in general on two environments: the beginning of the next word and the presence of a definite article /ha/ 'the'. In the latter case, /ha/ contracts with the preposition through elision, so that [ba] 'in the' is a preposition /be/ followed by the definite article /ha/ 'the' (ibid, 163). In the former case, for example, the colloquial [be=kfar] 'in a village' becomes [bi=khfar]. To sum up, proclitics in IH have a CV structure. This treatment as a separate word was applied to seven proclitics with a CV structure.

The same proclitics may become enclitics in colloquial IH or Hebrew slang. This is evident in coined expressions like [paam=be] 'once in a while' (Netzer 2007, 338), or [o=Se o=Se] 'either this or that' (Rosenthal 2005, 4) and [ha=ISa=Sel] 'the wife of', which is used when pointing to someone who is married to a famous person. This expression can also be used for other relations, such as [aX=Sel] 'brother of'; [ben=Sel] 'son of', etc.

Syllabification in the clitic environment is discussed in Bolozky and Schwarzwald (1990, 23) and Bolozky (1999). The authors note that *e*-deletion in Hebrew clitics is considered part of the general phenomenon of V-deletion of unstressed syllables. It should be noted that the most salient constraint in IH syllabification is that every syllable must have a vowel. Hence, reduction of a vowel must affect the syllabic structure.

> The most likely vowels to be affected by casual reduction/deletion are 'minimal' (unmarked) derived vowels (typically *e* and to a lesser extent *i* and *a*), and of those, the first ones to undergo laxing and reduction are the frequent ones. 'Derived' status refers either to derivation by a previous phonological process (i.e. [meir] 'light.PTCP.SG.masc.'), or to affixation. Frequently occurring collocations facilitate reduction…. (Bolozky and Schwarzwald 1990, 24)

Bolozky and Schwarzwald claim that phonetic reduction and assimilation are casual speech phenomena that are essentially a function of decreased attention, which result in unstressed syllabic nuclei not fully achieving their target (1990, 23). Ariel (1990) argues that the ease with which a piece of given information is processed reflects its degree of mental accessibility. The high degree of mental accessibility for the addressee and their frequent occurrence in speech make them easy to reconstruct, even from limited phonetic traces (Bolozky 2003, 122).

The phenomenon of V-deletion of unstressed syllables was also applied to Tiberian Hebrew in Dresher (1994), whose concern was with the accent system in Tiberian Hebrew: "We observe first that prepositions, complementizers, and other minor-class lexical items typically pattern with the following word, e.g. with cliticization of the preposition to the following noun" (Dresher 1994, 19). No other treatment or evidence such as that presented in §3.3.1-§3.3.4, are as yet available concerning IH clitics.

5.1.3.1 Complex structures

Clitics syntactically function above the word level (i.e. on the phrase or clause level), and thus may be considered *phrasal affixes* (Luraghi and Parodi 2008, 78).

Despite the convention regarding the minimal syntactic unit in the present research, complex adverbial structures with structures as in (14), were transcribed and annotated as single word. Complex adverbial structures have the structure of CC+OC (closed class + open class), i.e. a clitic and an NP. After preliminary analysis and following studies on the fusion rate of such structures (Nir and Berman 2010; Nir-Sagiv and Berman 2010), it was decided to transcribe them as a single orthographic unit, in order not to bias the prosodic-syntactic interface results. The importance of this decision is that in spoken IH, certain proclitics that have an independent form, such as [be] 'in', also have a morphemic form, as *continuous bound prefixes*. In these cases, the affixes do not have an independent form due to the fact that IH speakers consider them a single unit, a word with a definite part of speech annotation. For example, the first word in (14), [ba=hatXala] 'in the beginning', is an adverb. The full list of complex structures can be

found in Appendix I, which details the transcription conventions in the present research. A handful of samples are presented in (14).

(14) Complex structures transcribed as a single unit

a.	ba=hatXala	'initially' (lit. in.the- beginning)
b.	ba=Xajim	'alive' or 'living' (lit. in.the-life)
c.	ha=ba	'the next' (lit. the-next.M.SG)
d.	ha=bRit	(lit. the-alliance), the second noun in the construct-state NP [aRtsot ha=bRit] 'the United States'
e.	ha=emet	'to be frank' (lit. the=truth)
f.	la=XodeS	'in the month' (lit. to-the=month)

5.1.4 Tokens versus types

One of the aspects of the decision to transcribe clitics as separate "words" (i.e., between spaces) is the affect of such a decision on frequencies, and therefore on probabilities. As mentioned above, the two corpora, F2F and TEL, contain 31,760 tokens, of which 4,289 are word-types (types per tokens ratio: 13%). Assuming that in the present research, decisions on what is considered an orthographic word (see §5.1.3) are similar to those for standard English, the types per token ratio in spontaneous IH is much higher than in spontaneous English, where it was calculated as 3%-5% (Gishri, Silber-Varod, and Moyal 2010). This may be due to the synthetic morphology system of Hebrew, which generates multiple forms for each stem.

Transcribing proclitics as separate words affected the word lists of both the F2F and the TEL sub-corpora. Table 3 shows that most of the 10 most frequent words in both corpora are monosyllabic. Additional transcribing conventions are listed in Appendix I ("Word level transcription standards" table), where homophone cases are treated. Homophones, such as [lo] 'no' and [lo] (lit. to-1SG.M) 'to him', were differently transcribed in order not to bias the tokenization calculations as well as the POS tagging procedure.

Table 3: The 10 most frequent words in the F2F and TEL corpora

	F2F corpus	**Occurrences**	**% of 24,630 tokens**	**TEL corpus**	**Occurrences**	**% of 7,129 tokens**
1	[ze] 'this'	991	4.02	[ani] 'I'	236	3.31
2	[lo] 'no'	980	3.98	[ha] 'the'	236	3.31
3	[ha] 'the'	958	3.89	[ve] 'and'	236	3.31
4	[Se] 'that'	569	2.31	[ze] 'this'	230	3.23
5	[ma] 'what'	559	2.27	[lo] 'no'	212	2.97
6	[ani] 'I'	555	2.25	[ken] 'yes'	191	2.68
7	[ve] 'and'	488	1.98	[Se] 'that'	171	2.40
8	[et] 'Acc.'	386	1.57	[ma] 'what'	153	2.15
9	[hi] 'she'	306	1.24	[e] [22]	149	2.09
10	[hu] 'he'	290	1.18	[be] 'in'	107	1.50
11				[az] 'so'	94	1.32

All the words on the list are considered function words, and as such, all belong to the category of closed class words. And all, except *ken* 'yes' and *lo* 'no', are grammatical increments, as opposed to lexical increments (Nir-Sagiv and Berman 2010).

5.1.4.1 The F2F database

The F2F corpus contains 18 spontaneous face-to-face dialogues from CoSIH. The total number of speakers in the F2F corpus is 43. The speech of interlocutors contained anywhere between 1 IU and hundreds. The F2F corpus contains 24,630 tokens of which 3,655 are word-types (types per tokens ratio: 14%).

5.1.4.2 The TEL database

The TEL corpus contains 9 spontaneous one-sided conversations from CoSIH. As demonstrated in Table 1, all but one speaker (C412-413 recording) participated in the F2F sub-corpus as well. The TEL corpus contains 7,130 tokens of which 1,466 are word-types (types per tokens ratio: 20%).

[22] This [e] (elongation marker) is not a lexical word, but was transcribed as such. Maschler (2009, 23) regards it as a discourse marker.

6 Prosodic boundary patterns

"If one wants to know the color distribution in a field of flowers, one first needs to establish the set of colors that are in the field; then one can start counting the flowers of a particular color" (Bauer, Gaskell, and Allum 2006, 8). This metaphore can be applied to prosodic events. In other words, in order to count any aspect of prosody, it is first necessary to categorize the prosodic "world". Prosodic features and characteristics need to be distinguished before any occurrence rate or percentage can be attributed to the feature. The notion of qualitative distinctions between prosodic categories needs to be clear before one can measure how many prosodic events belong to one category or another.

6.1 Boundary tones in spontaneous Israeli Hebrew

The label inventory of prosodic boundary tones or *morphèmes intonatifs* (Lacheret-Dujour and Beaugendre 2002, 23-29), that were defined and labeled in the present research, are summarized in Table 4. The lefthand column shows the dichotomy between the two boundary types: C-boundaries and T-boundaries. Fragmented (F) boundaries are also listed since they were used in the annotation process. Within these types, two T-boundary tones, T and TQ, and five C-boundary tones, CN, CE, CR, CRF and CF, were annotated. These boundary tones are defined in §6.1.1 and §6.1.2.

6.1.1 T-boundary tones

A. Terminal (T) tones, mostly falling, were annotated in the case of statement IUs, including backchannel IUs, e.g. [ken] 'yes', [naXon] 'true'.
B. Terminal Question (TQ) tones were annotated in the case of questions, either WH-questions with falling tones or yes-no questions with rising tones (Cohen 2009).

6.1.2 C-boundary tones

The study of what I call *continuous boundary tones* has an interface with what is today referred to as *comma prediction* in language technologies (Favre, Hakkani-Tür, and

Shriberg 2009) or *speech segmentation* in speech recognition research (inter alia, Ostendorf et al. 2008).

> Speakers naturally group words into semantically coherent phrases indicated by timing and pitch cues; these prosodic phrase boundaries often coincide with major syntactic constituent boundaries but have a much flatter structure than syntax. *Prosodic phrase boundaries tend to coincide with commas and semi-colons* [my emphasis, VSV], but they also occur in other syntactically important places and thus they provide smaller (and potentially more useful) units for processing. (Ostendorf et al. 2008, 61)

In this respect, the continuous boundaries function as "comma markers" in speech. However, it should be stressed again that in the present research, the prosodic boundaries were annotated *independently* of the syntactic structure. These are the annotated C-boundary patterns:

A. Continuous neutral (CN) was annotated in the case of a level tone at the end of an IU that has a continuous communication value.
B. Continuous elongation (CE) was annotated in the case of an elongated level tone at the end of an IU that has a continuous communication value.
C. Continuous rise (CR) was annotated in the case of a rising tone at the end of an IU that has a continuous communication value.
D. Continuous rise-fall (CRF) was annotated in the case of a rising-falling tone at the end of an IU that has a continuous communication value.
E. Continuous fall (CF) was annotated in the case of a falling tone at the end of an IU that has a continuous communication value.

These five tones reflect the fact that the communicative value of C-boundaries is realized in different ways – through falling tones, rising tones (for example, CR boundary tones were found most often in Hebrew weather broadcasts (Silber-Varod and Kessous 2008), level tones and rising-falling tones. These C-boundary patterns reflect the

necessity to enhance the single annotation symbol, i.e. |, as well as the linguistic discussion dedicated to the continuous boundary tone.

Table 4: Prosodic boundary labeling in Israeli Hebrew

Boundary type	Boundary tone	Description	Characteristic acoustic cues
Terminal boundaries	**T**	Terminal	On perceptual basis
	TQ	Terminal Question	On perceptual basis
Continuous boundaries	**CN**	Continuous Neutral	level f_0 lengthened less than230ms
	CE	Continuous Elongation	Level f_0 ("flat or slowly falling pitch contour" Shriberg 2001, 161) Lengthening (Shriberg 2001) Creaky voice (Shriberg 2001)
	CR	Continuous Rise	f_0 Rise
	CRF	Continuous Rise-Fall	f_0 Rise-fall at the last syllable (or two syllables in case of penultimate stress) of the IU
	CF	Continuous Fall	f_0 Fall
Fragmentary (truncated)			Glottal stop or other indication that the speaker breaks off (truncates) the IU before completing its projected contour

6.1.3 Perceptual segmentation of IUs

The annotation of boundary tones in the present research is primarily based on perception. Mettouchi et al. (2007) show that experts' parsing of IUs is efficient but that experts are over-sensitive when parsing, in comparison to native speakers. Perceptual segmentation may create a problem of **reliability** in IU parsing. As Batliner and his colleagues (1998) note,

> a common problem for all these [evaluation] measures [for labeling schemes] is the fact that there is no 'objective' reference everybody agrees on as is the case for phoneme or word recognition: all these annotations are based on partly different and competing theoretical assumptions. The ultimate proof for such scheme is, in our opinion, therefore only a sort of *external validity*, namely its usefulness for the intended purpose…. (Batliner et al. 1998, 212)

IU perceptual segmentation has already been implemented on the present research corpus – CoSIH – by Izre'el (2005), Cohen (2004), Silber-Varod (2005), and Dekel (2010). Samples of CoSIH segmentation into IUs can be found on the NMELRC – National Middle East Resource Center – website. A similar annotation method was also applied in the C-ORAL-ROM project (Danieli et al. 2004; Cresti and Moneglia 2005).

Moreover, alignment between the transcription and the sound wave was achieved using the PRAAT textgrid tool (Boersma and Weenink, 1992-2007), with considerable reliance on acoustic features and measurements. This was used to code every speech sound produced and to re-examine the initial labeling.

To sum up, the annotation of boundary tones in the present research is primarily based on perception. Secondary validity was achieved using acoustic measurements (see §6.2). This results in a back and forth annotation method between perceptual annotation and acoustic measurements, with priority given to major perceptual differences discussed in §6.2. The prosodic boundary data in both corpora is presented in the §6.1.5.1-§6.1.5.2.

6.1.4 Pauses

The first prosodic parameter, according to which speech is segmented, is the pause. Dankovičová and her colleagues (2004) explain the difficulty in measuring a pause as a boundary marker because "there has been considerable variation in the literature in deciding what the minimal duration is for a gap in speech to be considered as an encoding (cognitive) phenomenon, as opposed to an articulatory phenomenon (such as stop closure)" (Dankovičová et al. 2004, 18). Phonemes with low amplitude, like fricatives, also make it difficult to decide, since it is hard to know where the fricative energy ends and the pause begins. At the beginning of a pause, for example, the speaker may keep the articulators in the position of the last segment. Therefore, it can be difficult to decide where the last segment of the IU ends and the pause begins. This is even more problematic when background noise is present, such as in recordings of daily life used in the present research. Nevertheless, a pause is the feature most commonly

referred to as a boundary marker (Edwards 1993, 23; Cruttenden 1997, 30; Dankovičová et al. 2004), and the question that remains open concerns the minimum duration of a break in speech flow that is to be called a pause, and what should only be considered an "articulatory pause".

In her survey on the pause as an important component of the temporal structure of speech, Fletcher (2010, 573-575) mentions an upper threshold of around 100 milliseconds [hereinafter: ms] corresponding to the closure phase of a voiceless stop (an "articulatory pause"). Knowles (1991, 152) set a minimum of 250ms for a (silent) pause; Roelof de Pijper and Sandeman (1994, 2041) set a minimum of 100ms; Dankovičová et al. (2004, 18-19) note that adult English speakers produce a minimum of 130ms as a pause (filled or unfilled). Avanzi, Lacheret-Dujour and Victorri (2008) define 300ms for pauses in French, while Batliner et al. (1998) annotate only pauses longer than half a second (500ms). It seems that the pause threshold is a matter of the research target. Avanzi, Lacheret-Dujour and Victorri (2008) are concerned with acoustical parameters for the detection of *périodes* and therefore define a rather long duration (300ms), while Roelof de Pijper and Sandeman (1994, 2041) are concerned with perceptual segmentation and therefore shorter durations were documented.

In the present research, a threshold of 100ms was set. This threshold is based on a combination of perception and previous research on the acoustics of IU boundaries in both spontaneous Hebrew (Silber-Varod 2005, 48-51) and planned Hebrew speech (Silber-Varod and Kessous 2008).

Tables 5 and 6 (below) show that a pause may follow each of the prosodic boundaries, but is more likely to occur after T-boundaries and less likely to occur after C-boundaries. This can be explained, not by the minor-major acoustic dichotomy between boundaries, but rather by the dichotomy between the communication value of each type: T-boundaries reflect a closure (of a proposition or of a response), while C-boundaries reflect a continuum within the flow of speech. Still, as the first parameter of IU boundary, a threshold had to be set.

6.1.5 An example of prosodic labeling and initial results

An inconclusive example of the annotation system is demonstrated in (15), and the f_0 contour of the first five IUs in (15) is presented in Figure 3. Each IU in (15) is written on a separate line which ends with the C-boundary label. Pauses (marked with #) are also on a separate line (e.g. lines 4, 6). The cells in the figure are numbered 1-5, according to the parallel IUs in (15).

(15) An example of the annotation system of prosodic boundaries:

1	tRemp ze Sta **CE**	'hitchhiking is when you CE'
2	medabeR im anaSim ba eRev **CR**	'talk to people in the evening CR'
3	im miSehu nosea la moRon **CR**	'if someone is driving to Moron (Mongolia) CR'
4	#	
5	az hu omeR leXa Se hahu Sama Se hahu Se hu Se hu Se hu Se hu **CR** 'so he tells you that this guy heard that that this guy that he that he that he that he CR'	
6	#	
7	ve ze **CE**	'and this CE'
8	ata **CE**	'you CE'
9	#	
10	bRen- medabRim im ha ben adam **CN**	'@- you talk with this guy CN'
11	sogRim ito al meXiR **CN**	'you close the deal CN'
12	#	[OCh]

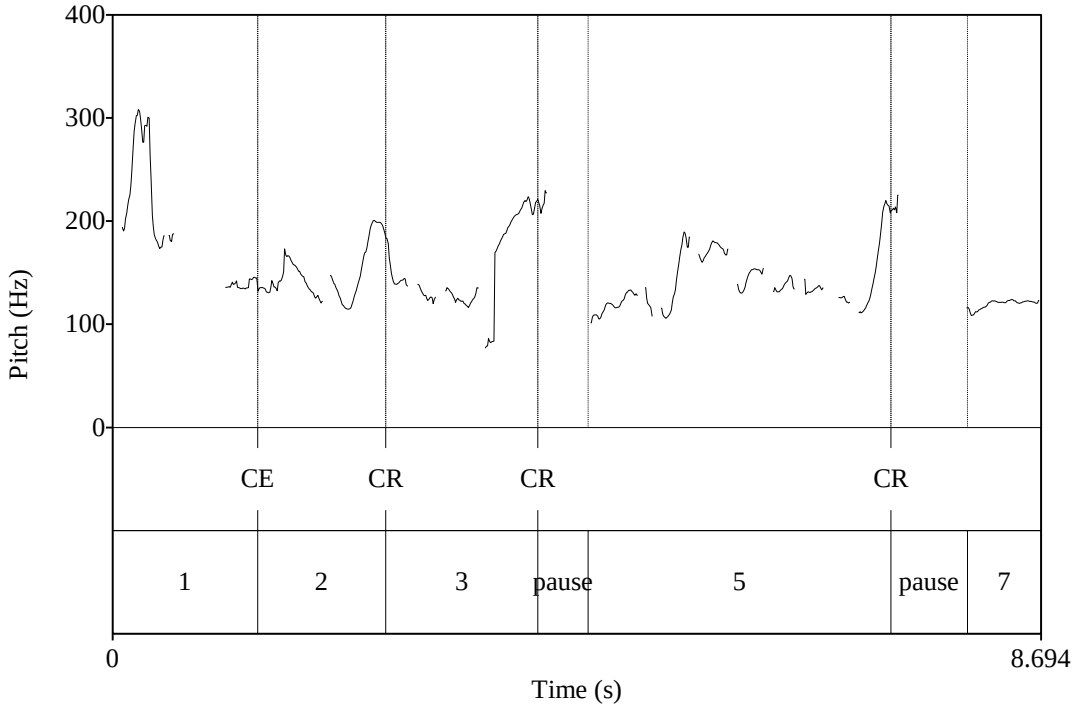


Figure 3: Five sequential C-boundaries of lines 1-7 in (15)

6.1.5.1 F2F annotation data

The total duration of the F2F corpus is 189 minutes, with 24,630 word tokens and 3,655 word types (after clean-up of truncations and unintelligible words). Among the 7,128 IUs found, 4,893 (69%) contain terminal tones. This huge proportion of terminal IUs is reasonable considering the dialogue genre of the corpus, which includes backchannel expressions ([ken] 'yes', [okej] 'okay', etc.) and short utterances due to frequent turn-taking, as well as questions. 301 IUs (4%) are truncated; and 1,934 (27%) have various C-boundaries.

The distribution of the prosodic boundary types is illustrated in Figure 4.

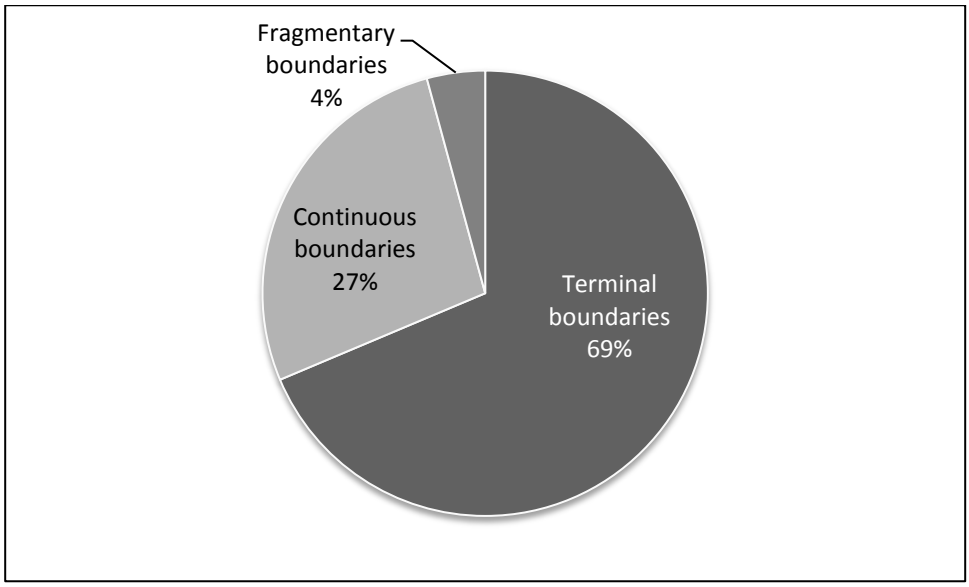


Figure 4: Distribution of prosodic boundary types in the F2F corpus

Pauses over 100ms were annotated with the number sign (#). In the F2F corpus, 4,819 pauses were annotated. Most pauses occur following T-boundaries. The number of pauses declines after C-boundaries, as shown in Table 5, and 2% of the pauses follow Fragmentary IUs. The remaining 30 (not included in Table 5) are pauses following unintelligible words or other non-speech events.

Table 5: Prosodic boundaries in the F2F corpus – Occurrences and following pause indication

Boundary tones in F2F	**Occurrences**	**% of all IUs**	**Boundaries followed by a pause**	**% of boundaries followed by a pause**
T	3,591	50.38	2,939	81.73
TQ	1,302	18.27	1,093	83.87
CE	764	10.72	208	27.23
CN	694	9.74	267	38.47
CR	272	3.82	119	43.75
CRF	129	1.80	42	32.81
CF	75	1.05	22	29.33
F	301	4.22	99	32.89
Total	7,128	100.00	4,789	

6.1.5.2 TEL annotation data

The total duration of the TEL corpus is 82.13 minutes, with 7,129 word tokens and 1,466 word types (after clean-up). Among the 2,272 IUs, 1,276 (56%) contain terminal tones. 155 IUs (7%) are truncated; and 841 (37%) have various C-boundaries, according to the distribution in Table 6. 1,390 pauses were annotated in the TEL corpus, 76% of which followed T-boundaries. The number of pauses declines after C-boundaries, as shown in Table 6. In addition, 42 pauses occur following Fs and the remaining 3 (not included in the table) follow unintelligible words or other non-speech events.

Table 6: Prosodic boundaries in the TEL corpus – Occurrences and following pause indications

Boundary tones in TEL	Occurrences	% of all IUs	Boundaries followed by a pause	% of boundaries followed by a pause
T	973	42.83	807	82.94
TQ	303	13.33	244	80.53
CE	408	17.96	152	37.25
CN	227	9.99	70	30.84
CR	116	5.11	45	38.79
CRF	28	1.23	4	14.29
CF	62	2.73	23	27.10
F	155	6.82	42	32.89
Total	2,272	100.00	1,387	

Tables 5 and 6 show similar tendencies concerning the distribution of prosodic boundaries. The distribution of pauses following the boundaries is similar in both corpora, excluding the percentage of pauses following CRF boundaries. Nonetheless, at more advanced stages of the present research, the pause is no longer a significant parameter in the analysis.

After comparing the T-boundaries and C-boundaries in terms of their communicative value (§2.3), as well as the above data in terms of distribution and pauses presence, from this section on, only C-boundaries are discussed, since, unlike T-boundaries, it is assumed that C-boundaries are not parallel to syntactic sentence

boundaries. This assumption makes C-boundaries a distinct domain for prosody-syntax research, as was demonstrated in §3.3.

The next section presents an acoustical definition for each of the five C-boundaries that the present research focuses on. The distribution of C-boundaries in F2F is illustrated in Figure 5. It is evident that CEs and CNs are the most salient C-boundaries. In the TEL corpus, CEs comprise an even larger proportion. Therefore, the discussion will begin with the definition of the *CE boundary tone*.

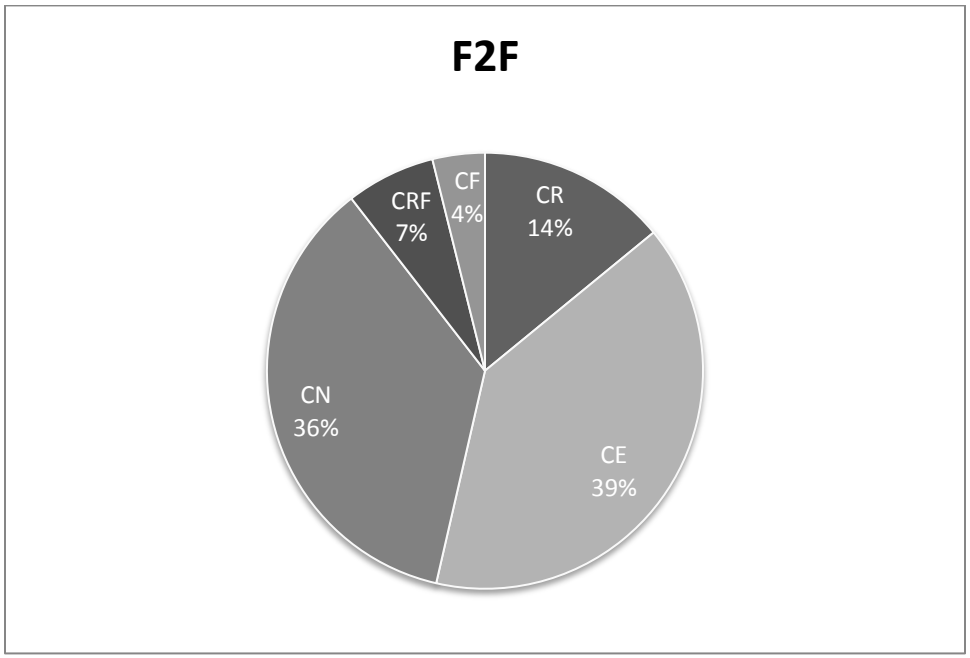


Figure 5: Distribution of C-boundaries in the F2F corpus

6.2 Phonetic realizations of continuous boundary tones

The following sections provide examples of acoustic analyses of the five C-boundaries illustrated by PRAAT tools (Boersma and Weenink 1992-2007).

6.2.1 Continuous Elongation (CE) boundary tones

In the present research, the familiar terms *filled pauses* and *hesitation disfluencies* (Cruttenden 1997, 30; Shriberg 2001; Carter and McCarthy 2006, 172-173; Fletcher 2010, 573-575) are replaced with c*ontinuous elongation* (CE), a term defined as a prosodic boundary pattern of speech, i.e. a boundary tone pattern. The CE boundary

tone is realized as distinctive elongation on the final syllable of the IU, up to a contour that is taken to represent a *hesitation*. 1,172 CE boundary tones were annotated in the corpus. This represents only 12% of all boundaries detected, but a substantial proportion **(**42%) of the C-boundary tones (39% in the F2F corpus and 49% in the TEL corpus), illustrated in Figure 5 above, for the F2F corpus.

As the *CE boundary tone* is a new term within a new perspective that the present research suggests, in the discussion below, the following issues will be explained:

1. Term conversion from *filled pause* or *hesitation disfluency* to *continuous elongation*.
2. A shift from a disfluency phenomenon to a prosodic pattern.

6.2.1.1 Term conversion

The use of the term *filled pause* categorizes the phenomenon as a type of a pause. Indeed, Fletcher (2010) relates to two types of pauses: "pauses are often defined as either filled or unfilled/silent. ... filled pauses are disfluencies that consist generally of voiced material that can correspond to elongated single vowels like 'uh' in English, or portions of syllables" (Fletcher 2010, 573). In the present research, I define only perceptually silent pauses (over 100ms) as pauses, and words or prosodic events (e.g. [e] 'eh' or [em] 'ehm') as speech sounds. From the data in §6.1.5.1-§6.1.5.2 above, it is evident that (silent) pauses follow all types of prosodic boundaries, including CEs.

The term *CE boundary tone* also replaces another well-known term that refers to the same phenomenon, and is usually regarded as one of the *disfluency* types (Shriberg 1994; Stolcke and Shriberg 1996; Shriberg 2001). Shriberg (1994, 2001), for example, deals with 'hesitation disfluencies' (which she termed 'filled pauses') among other disfluencies: repetitions (*'all **the the** tools'*), 'deletions' or false starts (*'**it's**- I could get it where I work'*), substitutions (*'any health cover any health **insurance'***), insertions (*'and I felt I **also** felt'*), articulation errors (*'and [**pin**] pistachio nuts'*),[23] all of which consist of segmental increments, i.e. phenomena that represent a word or part of a word. This fine distinction between types of disfluencies – segmental (repetition, false starts, etc.)

[23] All disfluency types and examples are from Shriberg (2001, 155).

versus suprasegmental (hesitation disfluency) precluded the use of the term hesitation disfluency in this research.

Another perspective for treating these [e]s and [em]s is viewing them as discourse markers, as in Maschler (2009, 23) who investigated discourse markers in the Hebrew database. The "filled pause terminology" is different from the "discourse marker terminology" in that the latter considers the [e] a lexical event, almost a lexical *entry*, with its defined gramaticization characteristics.

6.2.1.2 A shift from disfluency to a prosodic pattern

Regarding the shift from a disfluency phenomenon to a prosodic pattern, I argue that the same perceived disfluency phenomenon has several realizations, as shown also in Shriberg (2001), and for that reason, it seems reasonable to gather all kinds of realizations into one category – a prosodic pattern. Silber-Varod (2010) showed that CE boundaries have three realizations, i.e. three distinct phonetic manifestations with regard to word-level phonology:

1. elongated word-final syllables
2. appended e vowels that are inserted after a word, but within the same intonation unit
3. isolated [e]s or [em]s

A similar identification between the first and the third realization is mentioned in Shriberg (2001):

> One of the most commonly observed effects of disfluency is a lengthening of rhymes or syllables preceding the interruption point. ... For example, in the utterance shown ..., there is a repetition disfluency of *'the the'*. ... The first instance of *'the'* (which constitutes the reparandum) is much longer than the second instance. ... This suggests that in the reparandum, speakers are signaling delay, hesitating much like they might display with a filled pause. (Shriberg 2001, 161 [my emphasis, VSV])

The three realizations are demonstrated in Figures 6-8. The first is the excessive lengthening of a word-final syllable. The syllable [Sta] (Se=ata) 'when you' is excessively elongated.

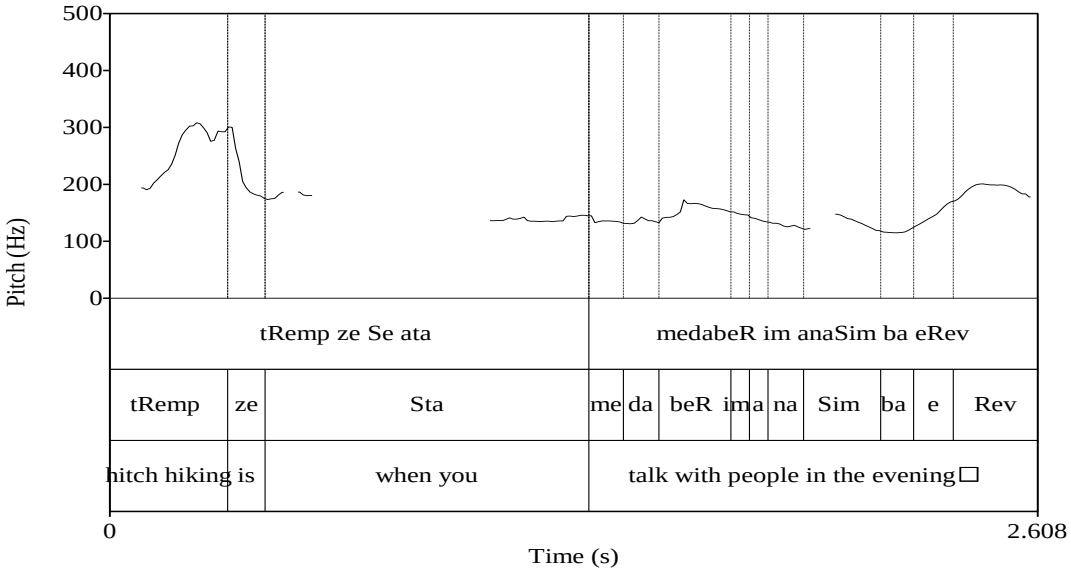


Figure 6: An example of an elongated syllable carrying the CE boundary tone

The second realization is when an appended [e] is inserted after a word, but within the same intonation unit. The suggestion that an (appended) [e], the default vowel in IH, is (part of) an elongated prosodic pattern is a new notion this research proposes. This notion is based on two arguments: First, although lengthened CV syllables, where the vowel is [e] (e.g. [Se] 'that'), cannot be divided into two [e]-components (i.e., Ce+e), other vowels with successive [e]s are evidence of this appended increment; for example, [hi e] 'she eh'.

Furthermore, this (typically long) [e] is prosodically attached to the preceding word, which most likely would not be elongated were it not for this appended [e]. Figure 7 demonstrates this attachment that I consider a C-boundary marker. The last lexical word in the IU is [biSvil] 'in order to' with an appended [e] attached to it.

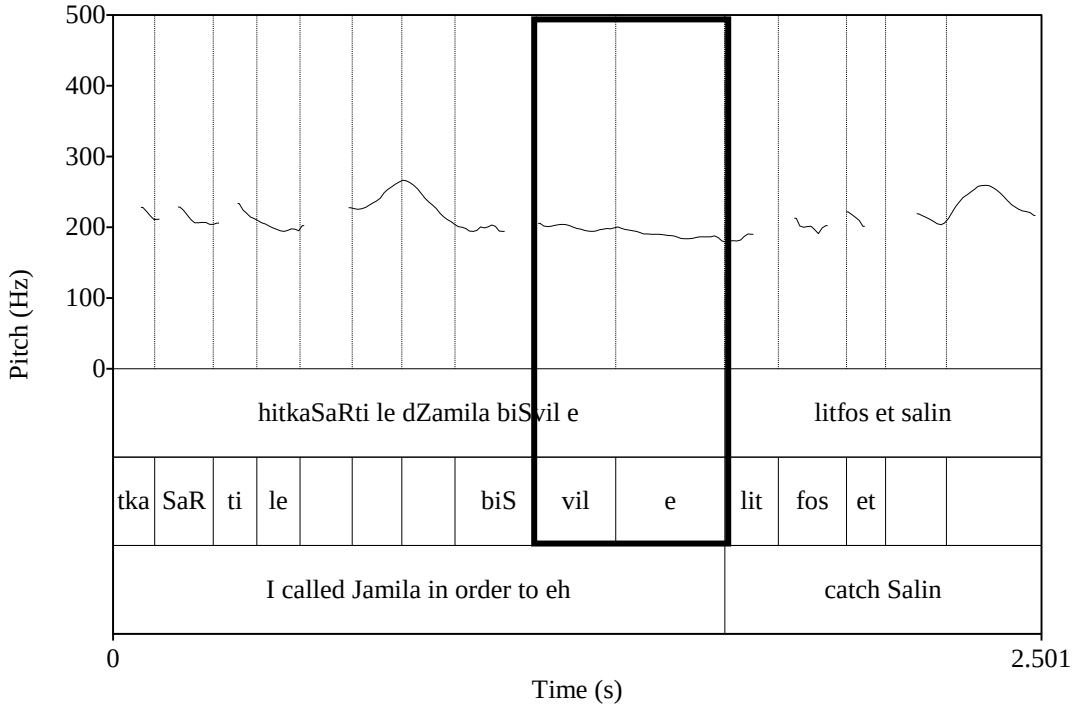


Figure 7: An example of an appended [e] carrying the CE boundary tone

The third realization of a CE boundary tone occurs when the speaker utters an isolated [e] 'eh' or [em] 'ehm', commonly termed a 'filled pause'. This means that the IU consists of only a single syllable, e.g. [e], which carries the boundary tone alone, as in (16).

(16) An IU that consists of an isolated [e]

ze biRat **CN**	'it's the capital of'
#	
e CE	'eh'
#	
ha **CE**	'the'
ha **CE**	'the'
saUT gobi[24] **T**	'South Gobi' [OCh]

The realization of an isolated CE tone also occurs when the speaker utters elongated monosyllabic words such as [ve] 'and', as in Figure 8.

[24] Articulated as in American-English.

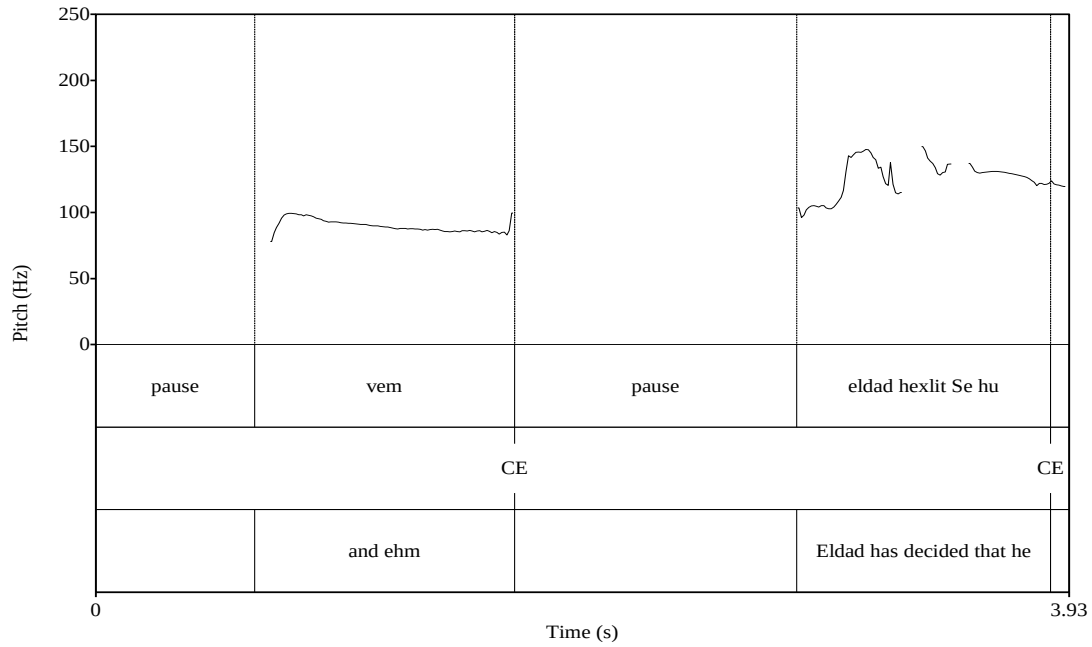


Figure 8: An example of an isolated [vem] (ve em) 'and ehm' carrying the CE boundary tone

Table 7 presents a scheme of the possible syllabic structures that can be found in word-final syllables and the corresponding expected elongation type. The first column specifies open vs. closed syllable structures. The next column shows the possible *final segments* in the syllable.

The *elongated segment* column details which segments are expected to undergo elongation: the *vowel* in the case of an open syllable, such as in [oː] 'or', [keiluː] 'as if', [beː] 'in'; or an *appended e* in the case of open syllables that do not end with an *e*, such as in [ha e] 'the eh'. In the case of closed syllables in the last lexical word of an IU, either the vowel nucleus vowel or the final consonant, in the case of sonorant or continuant codas, may be lengthened. It is also possible for stops to be lengthened, as in the case of the Swedish disfluencies *att* 'that' and *och* 'and', which were documented and analyzed in (Roll, Frid and Horne 2007). Nevertheless, an appended [e] is generally expected following closed syllables, as in [aval eː] 'but eh'.

The *Measure of duration* column indicates which segments were measured with respect to their duration in each syllabic structure and the *Threshold* column details the cases where a threshold of 230ms was set. It should be noted that in many cases,

perception of elongation was ruled out because of this 230ms threshold (see section §6.2.1.3 for a discussion of the phonetic realization of the CE boundary tone). In cases of appended [e]s, no duration measurements were carried out and such cases were automatically marked as CE boundaries. Silber-Varod (2010) shows that there is correlation between two realizations of the CE boundary tone (an isolated [e] was not calculated) and the final syllable types (open vs. closed) in the F2F corpus.

Table 7: Phonological scheme of CE boundaries in IH

Final syllable type	**Final segment**	**Elongated segment**	**Measure of duration**	**Threshold**
Open	Any vowel	Vowel	Onset+nucleus	**>230ms**
	Only *a*, *i*, *o*, or *u*	Appended [e]	N/A	Any length of appended [e]
Closed	Consonant	Vowel+consonant	Nucleus+coda[25]	**>230ms**
	Consonant	Appended [e]	N/A	Any length of appended [e]

Tables 8a-b present the results in both the F2F and the TEL sub-corpora. The contingency tables summarize the syllable types in three prosodic variables: two realizations of CE tone (*Elongated Word-final syllables* and *Word-final syllables with an appended e*) and one group of fluent speech (*NON-elongated Word-final syllables*). Data were retrieved using AntConc 3.2.1 (Anthony 2007). The results are statistically significant (F2F: χ^2= 430; TEL: χ^2= 179; p<0.001). Another final syllable type, diphthong, is mentioned, but constitutes only 2% of the corpus.

Table 8a: Occurrences of word-final syllable types per prosodic variable in the F2F corpus

Final syllable type	NON-elongated Word-final syllables (%)	Elongated Word-final syllables (%)	Word-final syllables with appended [e] (%)	**Total (%)**
Open	12,813 (55%)	**452 (90%)**	14 (7%)	13,279 (55%)
Diphthong	384 (2%)	3 (1%)	6 (3%)	393 (2%)
Closed	10,037 (43%)	47 (9%)	**176 (90%)**	10,260 (43%)
Total	23,234 (100%)	502 (100%)	196 (100%)	23,932 (100%)

[25] In the case of closed syllables in the last lexical word of an IU, either the nucleus vowel or the final consonant (in the case of sonorant or continuant codas) may be lengthened. See discussion in Silber-Varod (2010).

Table 8b: Occurrences of word-final syllable types per prosodic variable in the TEL corpus

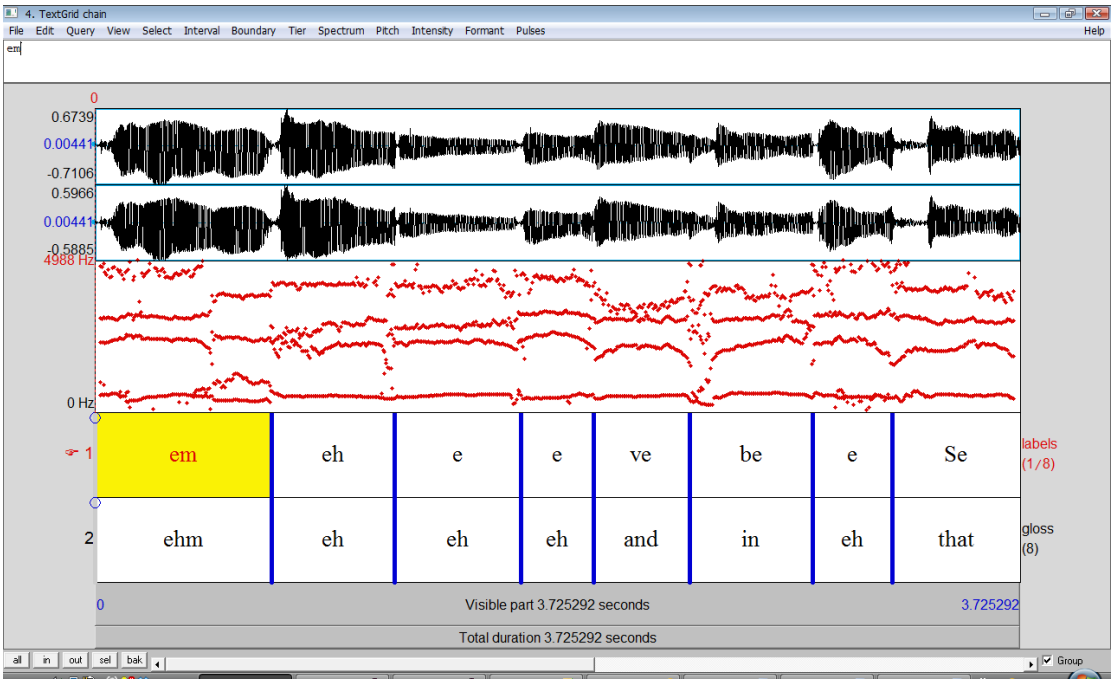
Final syllable type	NON-elongated Word-final syllables (%)	Elongated Word-final syllables (%)	Word-final syllables with appended [e] (%)	**Total (%)**
Open	3,684 (54%)	**225 (80%)**	5 (5%)	3,909 (55%)
Diphthong	146 (25%)	1 (0.36%)	0 (0%)	147 (2%)
Closed	3,020 (44%)	54 (19%)	**98 (95%)**	3,074 (43%)
Total	6,850 (100%)	280 (100%)	103 (100%)	7,130 (100%)

The gray cells in Tables 8a-8b demonstrate the distribution between the two realizations in the corpus. Syllable elongation occurs when the final syllable is open, while an appended [e] is common when the final syllable is closed. These findings can be interpreted as showing how Hebrew speakers manipulate the elongation effect. Still, the two CE realizations also occur in other syllable types, i.e., closed syllables are also lengthened and an appended [e] is also attached to open syllables. This was also found by Roll, Frid, and Horne (2007, 229), who measured the durations of the monosyllabic word *att* 'that' in Swedish, in fluent and disfluent environments. To conclude, in the present research, the three realizations are assembled into a single prosodic pattern termed the CE boundary tone. Such an approach allows for comparative cross-linguistic studies that examine this perceptual interpretation (e.g. that the speaker wants to continue), universal features (e.g. elongation), as well as language-dependent features (e.g. the elongated vowel quality).

6.2.1.3 The phonetic realization of the CE boundary tone

The phonetic characteristics of the CE boundary tone in IH will be described according to measurements of three acoustic parameters (cf. Silber-Varod 2010):

Formants (or **vowel quality**): CE boundaries in spoken Hebrew are mostly produced by the mid-front vowel [e]. Spectrogram 1 demonstrates this by a combined sound sample of artificially concatenated elongated syllables in the C412+413 recording. Formant measurements correlate to the [e] vowel formants found in Most, Amir and Tobin (2000, 297-298).



Spectrogram 1: The mid-front vowel [e] as realized carrying the CE boundary tone in spoken Israeli Hebrew

This vowel, which is "the 'neutral or rest position' is not always the same for different languages" (Fox 2000, 30). Fox (2000) suggests that the 'hesitation vowel' used by speakers is different even in speakers of different varieties of English. This is also suggested by Shriberg (1994), who says that "Filled pauses have variants in many (perhaps all) languages, but their vowel quality varies predictably with the vowel inventory of the language" (1994, 24-25). Shriberg demonstrates how disfluency is also associated with alternations in vowel quality – an elongated *the* is pronounced as the variant [Di] (2001, 163). Cruttenden (1997) provides additional examples of the differences in the sound of filled pauses between dialects and languages: "In R.P. and in many other dialects of English the latter [the filled pause] typically involves the use of a central vowel [ə] ... in Scottish English a sound in the region of the vowel in gate and play is typical while in Russian an alveolar nasal is more common that a bilabial nasal" (Cruttenden 1997, 30). Two examples of how the "hesitation" vowel varies between languages are in (17)-(18). In French, it is the closed-mid front vowel ø, like *euh* in (17),

while in American English, it is the open-mid back vowel ʌ, like *uh* in (18) or a vowel close to schwa, as mentioned in Shriberg (2001, 164).

(17) *et **euh** la Chamber de de Comerce* [26]

(18) and we don't always know **uh** all the facts that were involved ...[27]

***f*$_0$:** A CE boundary is produced on a level-tone.[28] A level-tone is defined as the average key for the speaker. In Figure 9, the tone of the elongated vowel is measured at 192Hz for the female speaker in the C412+413 recording.

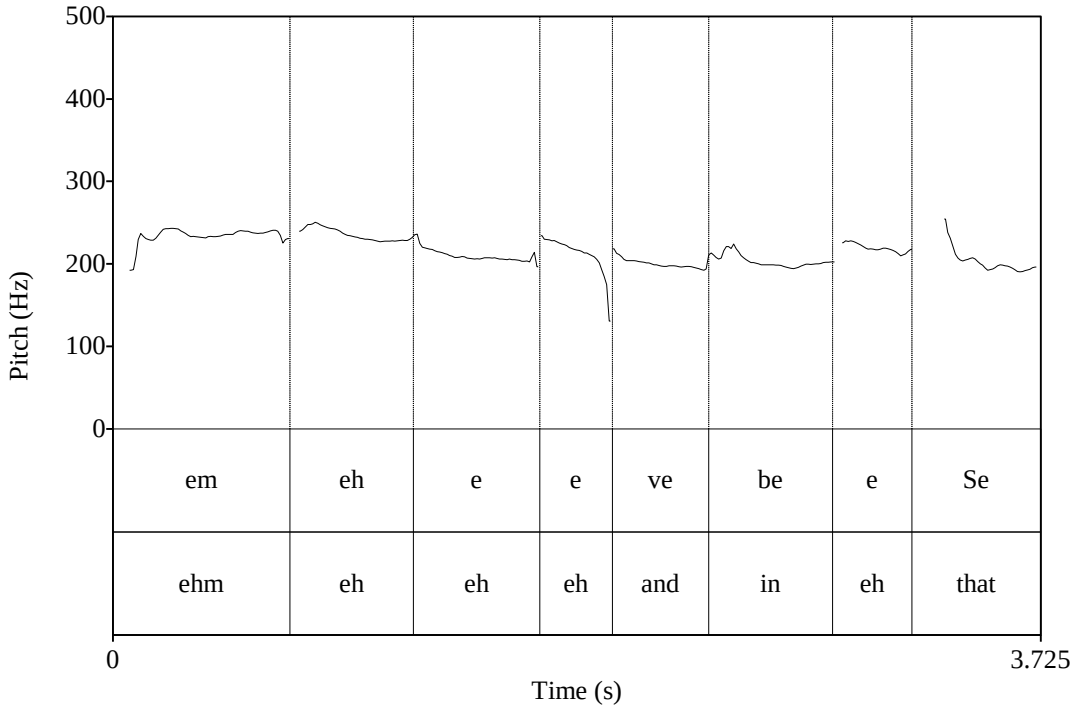


Figure 9: A level tone of female speaker, as realized at CE boundaries of spoken Israeli Hebrew

Shriberg (1994) notes that filled pauses tend to be low in f_0 and to show a level or slightly falling f_0 pattern. More specifically, she found that clause-internal filled pauses were uttered at an f_0 that could be predicted from the f_0 of the closest *preceding* peak

[26] Example courtesy of Mathieu Avanzi.

[27] Obama's interview on Al-Arabiya TV, http://www.youtube.com/watch?v=HO_lLttxxrs, minute 1.00-1.06.

[28] *Flat intonation* in Portes and Bertrand's labeling system (2006, 7).

f_0. Shriberg suggests that "filled pauses (at least those occurring within a clause) are intonationally well-formed" (Shriberg 1994, 25).

Duration: Syllables carrying the CE boundary tone differ dramatically from other syllables in duration. In the present research, all syllables carrying CE tones were annotated as such only after a threshold of 230ms was set (see §6.2.6). The reason for setting a threshold is to avoid bias in perception.

Moreover, all possible realizations of CE tones were mapped in Table 7, and as a result, only two types of syllables (the gray cells in Table 7) were to be measured. The decision to set the threshold at 230ms was made after a pilot study carried out on two representative recordings, one from the F2F and the other from the TEL corpus. The durational measurements of syllables carrying CE tones and other boundary tones in the pilot study are presented in §6.2.6.

The phenomenon defined here as CE boundary tones has been treated differently in other studies. Of these, I will mention two studies that explicitly refer to the issue of prosodic boundaries when discussing the hesitation phenomenon.

Within the framework of *période intonative* (Lacheret-Dujour and Victorri 2002), which consists of prosodic parameters only, the presence of hesitation disfluency blocks the possibility of a *période* boundary and a minimal prosodic unit is marked by it – *le groupe intonatif* (intonation group): "malgré la pause suffisante après le premier groupe intonatif (*tu prends le boulevard euh*; see in (19)), le découpage en période est bloqué à cause de la présence d'un « euh » d'hésitation, d'un saut mélodique (réinitialisation) insuffisant, ainsi qu'une faible amplitude de f_0 sur la dernière syllable" (Avanzi and Lacheret-Dujour 2010, 340). Within the *période intonative* framework, the boundary after hesitation disfluencies is a minor one (annotated with a single slash [/] in (19)).

(19) *tu prends le boulevard euh / là qui part de nef Chavant / là le boulevard qui passe à côté d'Habitat*

Shriberg (2001) refers to the lengthening of disfluencies as different from the type of pre-boundary lengthening observed in fluent speech.

> Durationally, the degree of lengthening can be far greater for disfluencies than for fluent boundaries, and the shapes of the distributions are different. The disfluency cases suggest a uniform probability of additional time in a hesitation, while fluent boundaries have a more symmetrical distribution. Second, they are different intonationally, since fluent pre-boundary lengthening is usually associated with a pitch movement conveying a boundary tone (e.g. continuation rise, final fall, etc.), whereas the lengthening accompanying disfluency tends to have a flat or slowly falling pitch contour much like those described ... for filled pauses. This is not surprising: lengthening, like uttering a filled pause, allows speakers to pause in the production of message content without ceasing phonation. (Shriberg 2001, 161)

Both approaches view what is called a *CE boundary tone* here as a boundary, since both consider the phenomenon a "pause without a pause" mechanism. Yet, the present research does treat it as a *boundary tone*, due to its defined acoustic pattern, which among other C-patterns has a communicative value signaling that the speakers wish to continue speaking. The CE boundary tone and the other C-boundaries in the set of continuous boundary tones are defined in the following sections.

6.2.2 Continuous Neutral (CN) boundary tones

Continuous Neutral (CN) boundary tones are boundaries with a level (neutral) tone, similar to CEs, but without the lengthening. Since CEs were annotated only when the final syllable was longer than 230ms, it can be said that the CN is a complementary boundary tone to CEs.

Figure 10 demonstrates an occurrence of a CN boundary tone for the utterance in (20).

(20) gam biglal Se jeS et ha Xalon ha anak haze **CN** ve gam ha Xalon Sel ha koma ha eljona **CR** [C714]
'also because there is this huge window **CN** and also the upper floor window **CR**'

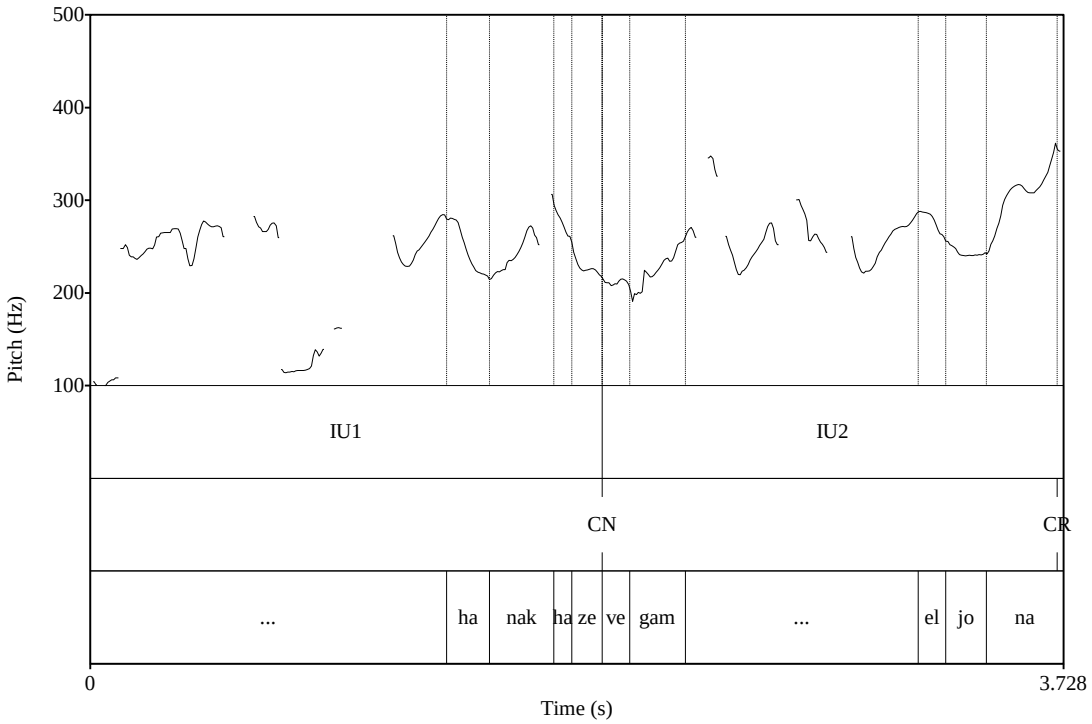


Figure 10: An example of a CN boundary tone

The first IU (IU1) ends with f_0 around 220Hz at its final syllable [ze] 'this' (as the segmentation on the bottom tier demonstrates), while the first syllable in the second IU (IU2), [ve] 'and', begins with f_0 values around 210Hz. These f_0 values represent the level tone of the speaker, a woman in her twenties. For illustration reasons only, a segmentation of the surrounding syllables around [ze] 'this' was carried out (bottom tier of the figure) to show that its duration is not anomalous, as compared to other unstressed syllables with a CV structure.

6.2.3 Continuous Rise (CR) boundary tones

The CR boundary tone, like the CE boundary tone, has a dominant acoustic characteristic – the rising f_0 – that makes its perceptual identification more valid. Taking Figure 10 as an example, IU2 ends with a CR boundary tone carried by the final syllable of [eljo**na**] 'upper.F'. The last syllable [na] begins at 240Hz and ends at 356Hz, a 100Hz rising slope within 294ms of the last syllable [na]. In IH, a rising T-boundary tone occurs in yes-no

questions and in appeal IUs. According to Silber-Varod and Kessous (2008), the CR contours function as default continuous contours. This seemingly makes three types of rising tones. A fourth type is the rising boundary tone of lists, studied by Portes, Bertrand, and Espesser (2007) for French, and Wichmann (2000, 85-86) for English. These types were not acoustically compared in the present study, and it is still an open question if there are three rising tones or if they are indeed acoustically the same. The multi-fold functions of the rising tone should be studied in future research.

6.2.4 Continuous Rise-Fall (CRF) boundary tones

The rise-fall boundary tone has prominent acoustic parameters: a complex pitch contour of a rise and a fall in the same syllable. For example, the utterance in (21) represents a series of CRF boundary tones, which creates an isotony (equality of pitch accent or pitch movements).

(21) po **CRF** jeS **CRF** SaRSeRet haRim **CRF** Se nikRet Gurvan tsajXan [OCh]
'here **CRF** there is **CRF** a mountain chain **CRF** which is called Gurvan Saikhan'

The syllable carrying the boundary tone in Figure 11 is [Rim] (the second syllable in the disyllabic word /haRim/ 'mountains'), with a duration of 340ms. The f_0 contour has two peaks. The first one is the perceived rise-fall.

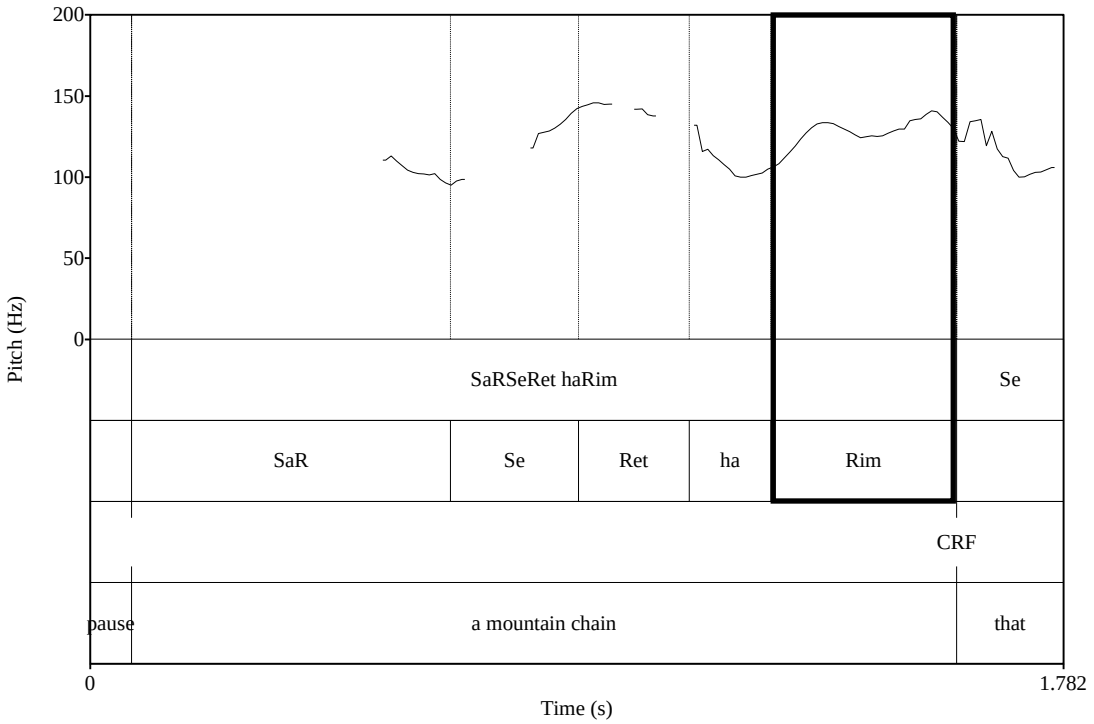


Figure 11: f_0 contour of a CRF boundary tone in the final syllable in [haRim] 'mountains'

6.2.5 Continuous Fall (CF) boundary tones

The fall boundary tone was annotated whenever the continuous boundary tone had a fall in the f_0 contour. For example, the utterance in (22) represents a sequence of IUs, in which the first one ends with CF boundary tones, the second with a CN boundary tone, the third with a CE and the fourth with a T.

(22) jeS otobosim ktsat **CF** jeS tipa **CN** lo kmo **CE** ze **T** [OCh]
'there are buses a little **CF** there are a bit **CN** not like **CE** this **T**'

Figure 12 demonstrates the difference between CF and CN in terms of the f_0 values. In order to illustrate this difference, I segmented the phones of [ktsat] 'a little' which is the final word carrying the CF tone in the first IU. The f_0 values in the vowel [a] of [ktsat] are around 60Hz. The f_0 values are doubled in the [a] of [tipa] 'a bit', which is the final word carrying the CN tone in the second IU. It also illustrates the values in the CF boundary tone in the OCh recording. The f_0 contour is at the same level in the second

and the third IUs, since both are level tones, only the second ends with a CN and the third with a CE, as illustrated in the long duration of the monosyllabic word [kmo] 'like'.

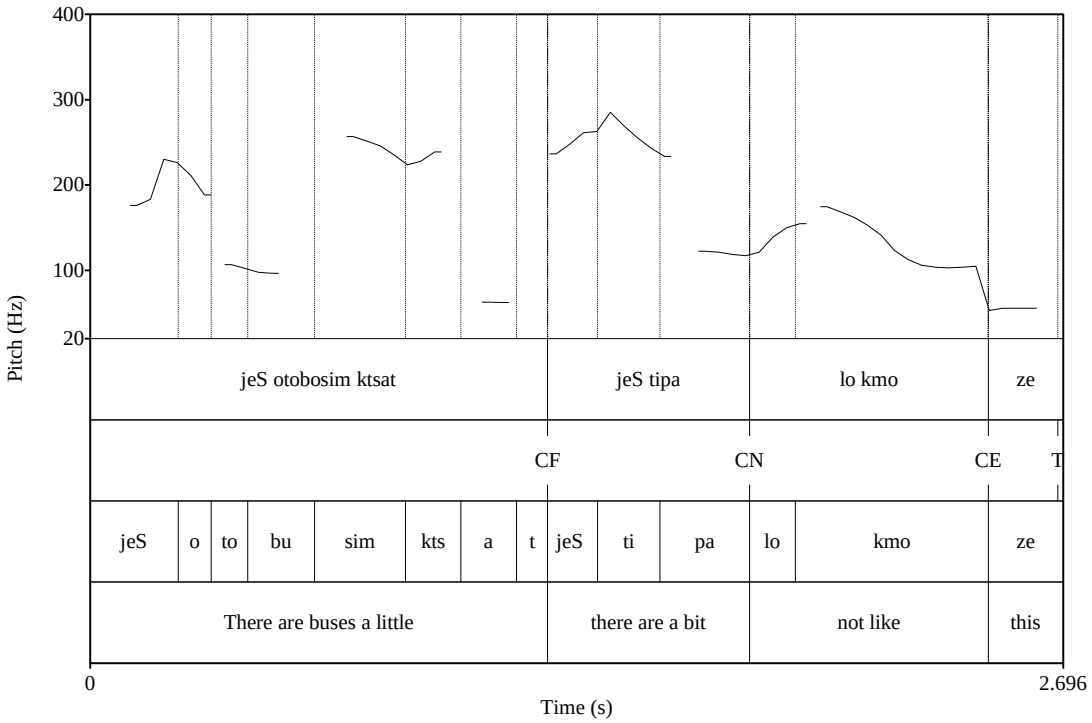


Figure 12: An example of an f_0 contour at a CF boundary tone

6.2.6 Syllable duration in various prosodic environments

The decision to set a 230ms threshold for syllables that were perceptually annotated as CE boundaries (see Table 7 above) was made as a result of the pilot study discussed below. The initial idea to set a threshold for CE boundaries, and not to annotate CE boundaries according to subjective perception, like the annotation of the other boundary tones, was to avoid bias claims. Reinforcement for the 230ms threshold was found in Shriberg (2001), who measured duration of vowels in filled pauses and elsewhere (i.e. in fluent speech). Shriberg's results demonstrated that vowels of over 200ms (0.2 sec)[29] are rare in fluent speech compared to their normalized frequency in filled pauses (2001, 165, Fig. 9). Taking into account the differences between two languages, American-English and Hebrew, and considering the fact that Shriberg (2001)

[29] The figure in Shriberg (2010, 165) does not point directly to 200ms, but the durations in the x-axis can be assumed by drawing imaginary points on it.

measured the vowel durations and not the whole syllable, a 230ms threshold seems to be a reasonable starting point to work with, as demonstrated in the results of the pilot study.

In order to compare the durational parameter of the syllables in the five continuous boundaries, a pilot study of 22 minutes from the TEL corpus (the female speaker in the C412+413 recording) and 12 minutes from the F2F corpus (the male speaker in the OCh recording) were segmented manually into syllables. These two recordings were chosen for the pilot study since their acoustic quality meets basic acoustic measurement standards, such as a clear voice and an absence of background noises or speech overlaps – all of which are common to all other CoSIH recordings that were chosen for the present research.

In the TEL study, the number of IUs is 610; in the F2F study, 177. 67 Truncated IUs were annotated in TEL and eight in F2F. The number of syllables measured in each corpus is given in Tables 9a-b, which also summarizes the durational measurements taken.

In this pilot study, the duration of the entire syllable was measured, i.e. the measurements were not carried out according to the scheme in Table 7. The threshold of the CE boundary tone was set. Nonetheless, the two realizations of CE boundaries were separated in the analysis and appended [e] durations were calculated separately from elongated syllables. According to the measurement results, the appended [e]s were found to have the highest standard deviation (SD) values in OCh and were even higher in C412+413. This demonstrates the varied durations of appended [e] as well as isolated [e]s and [em]s that constitute an IU. The syllables that carry the CE tone were found in both recordings to have the highest mean values, while the fluent syllables were found in both cases with the lowest mean values. Tables 9a and 9b summarize the durational measurements in the F2F and the TEL sample corpora.

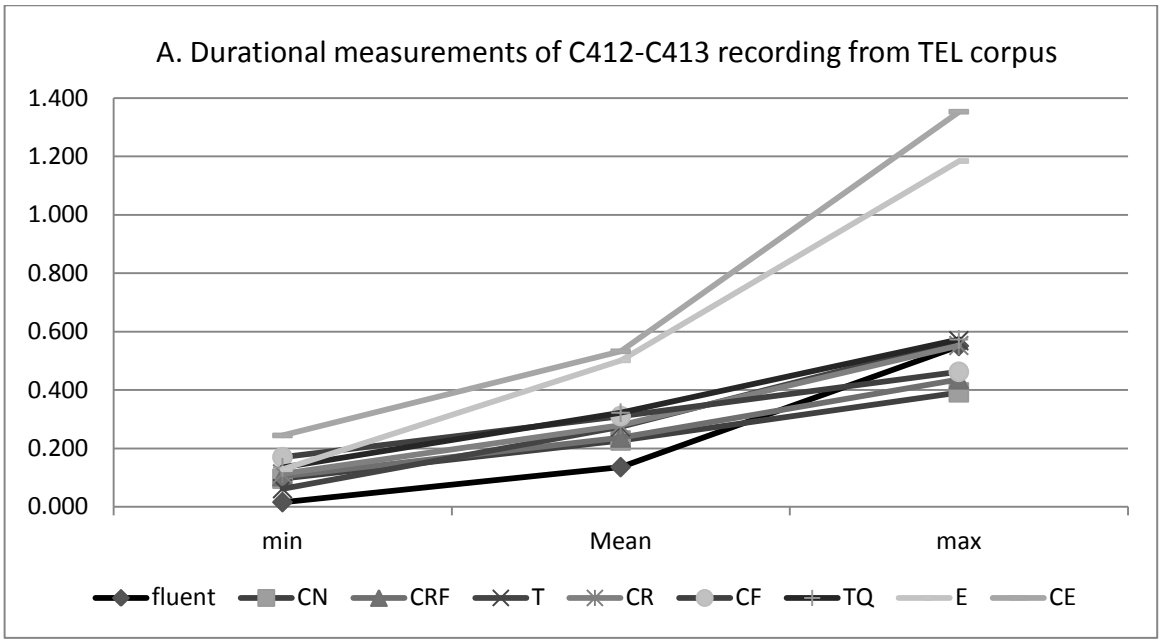
Table 9a: Syllable durations according to prosodic environments in TEL speech (C412+413 recording)

Prosodic environment	Mean	SD	Min	Max	Median	N
Fluent	0.136	0.066	0.016	0.551	0.125	2,820
CN	0.227	0.062	0.096	0.392	0.225	56
CRF	0.238	0.122	0.105	0.437	0.224	5
T	0.274	0.089	0.062	0.569	0.276	243
CR	0.280	0.114	0.113	0.552	0.256	39
CF	0.311	0.100	0.170	0.462	0.268	14
TQ	0.322	0.112	0.135	0.573	0.316	29
Appended [e] or isolated [e]	0.502	0.230	0.129	1.184	0.489	86
CE	0.533	0.238	0.245	1.353	0.468	138
F						67
Total syllables						**3,497**

Table 9b: Syllable durations according to prosodic environments in F2F speech (OCh)

Prosodic environment	Mean	SD	Min	Max	Median	N
Fluent	0.139	0.065	0.024	0.576	0.130	845
TQ	0.186	0.045	0.126	0.246	0.195	9
T	0.227	0.099	0.072	0.489	0.209	50
CR	0.273	0.111	0.122	0.555	0.229	32
CN	0.284	0.161	0.104	0.672	0.254	28
CF	0.298	0.115	0.121	0.602	0.273	16
CRF	0.400	0.131	0.235	0.638	0.366	7
Appended [e] or isolated [e]	0.419	0.293	0.071	1.097	0.279	16
CE	0.447	0.217	0.241	1.049	0.379	19
F						8
Total syllables						**1,030**

Figure 13 demonstrates the syllable durations according to prosodic environments in terms of minimum, mean and maximum values. In both parts of the figure, the darkest lines are the fluent syllables while the lightest lines are the elongated syllables (CE) and appended [e]. It is thus demonstrated that the 230ms threshold is valid in both the TEL and the F2F speech sample.



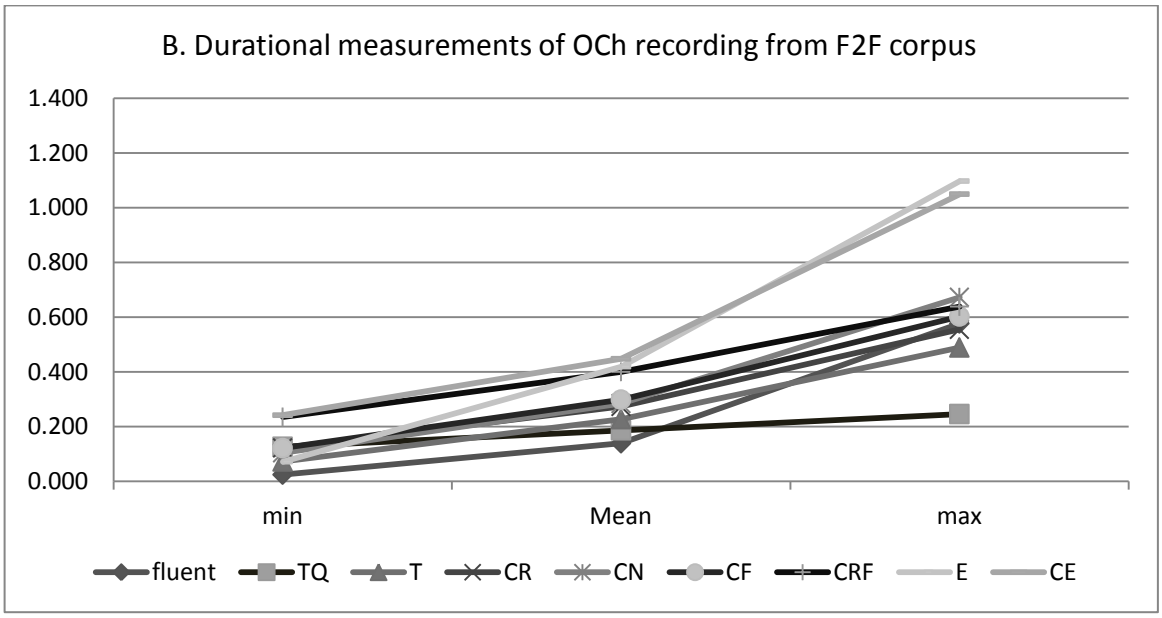


Figure 13: Min, max and mean values of syllable durations according to prosodic environments: fluent syllable vs. boundary tones syllables, including the appended [e]

Clearly, the results suggest that in IH, like in AE, "filled pauses differ dramatically from … other instances in duration" (Shriberg 2001, 164). Nevertheless, the duration measurements were carried out on a relatively small portion of the corpus and elongated syllables at CE boundaries in spoken Israeli Hebrew are still to be investigated in future research.

7 Methodology

7.1 Linear (n-gram) analysis

The present research uses linear analysis called *n*-gram. An *n*-gram model considers the probability of *n* items occurring in sequence, i.e., it is a type of probabilistic model for predicting the next item in a sequence (Oakes 1998, 243-247). The items can be phonemes, syllables, letters, words or base pairs. In the present research, the probability calculation was performed on *n*-grams of two types: bigrams (a sequence of 2 items) and trigrams (a sequence of 3 items). The items analyzed were Parts of Speech (POS) and C-boundaries (prosody). *n*-gram processing used AntConc software (Anthony 2007).

The calculation was performed as follows: For a bigram of AB, where A is a Part-of-Speech and B is a C-boundary, the number of repetitions of AB in the corpus was divided by the number of repetitions of A in the corpus. For example, if the sequence of a conjunction (CONJ) followed by a CE boundary tone (represented as "CONJ CE") occurred 148 times in the corpus, and CONJ occurred 179 times, then p=148/179 = 0.826. Probability values may be between 0 and 1. A 100% probability (p=1) is found in cases of unique POSs (a single occurrence of AB divided by a single occurrence of a specific A).

Annotations and calculations were performed on the words that precede and/or follow the C-boundaries.

7.2 The C-boundary domain of analysis

This research focuses on the prosodic level; therefore, all the *n*-grams analyzed contain the boundary tone markers and their adjacent words. *n*-gram probabilities were performed on both the segmental level (lexical or POS level) and the suprasegmental level (C-boundaries). The lexical word preceding the C-boundary and the lexical word following it were tagged according to the POS tag set, and the C-boundary itself was tagged (e.g. CR).

The analysis focused on dependency relations between POSs that have a continuous boundary tone between them. For example, in the string in (23), which includes two C-boundaries, only the underlined sequences were annotated and calculated.[30]

(23) az amaRti lla Se **CE** etmol halaXti le Xatuna **CRF** az keilu **T** [D631]
'so I told her that **CE** yesterday I went to a wedding **CRF** so like **T**'

The POS tag set (24) used in this study is a modification of the Leipzig Glossing Rules (Comrie, Haspelmath and Bickel 2008) and Bar-Haim, Sima'an, and Winter's (2008) tagging of IH written texts, and was designed specifically for the needs and findings of the present research (i.e., it might omit parts of speech that were not found in the annotated data, and vice versa). The POS tag set consists of 25 major tags and 7 minor tags. The minor tags represent either a complex structure of two major types (e.g., accusative marker with pronominal suffix) or specific lexemes that were tagged separately because their syntactic position was different (e.g., Negation lexeme [lo] 'no' vs. Negation lexeme [?al] 'do not) or whose function varied from the other words in the main category (e.g., Inflectional forms of the lexeme [haja-ø] 'be.PST-3SG' vs. Modal lexeme (auxiliary)).

[30] In several defined cases, the sequences were wider (see Tables 10 and 14 for the clean-up process).

(24) The POS tag set

1.	ACC	Accusative marker (Acc.)
a.	ACC-PRON	Acc. with pronominal suffix
2.	ADJ	Adjective
3.	ADV	Adverb
4.	AUX	Modal lexeme (auxiliary)
b.	BE	Inflectional forms of the lexeme /hjj/ 'be'
5.	CONJ	Conjunction
6.	DEF	Definite article [ha] 'the'
7.	DM	Discourse marker
8.	EXT	Existentials /jeS/ 'there is' and /en/ 'there is not'
9.	IMP	Imperative verbal forms
10.	INF	Infinitive
11.	MOD	Modifier and quantifier
12.	N	Noun
c.	N-POSS	Possessive suffixes attached to a nominal
13.	LO	Negation lexeme /lo/ 'no'
d.	AL	Negation lexeme /?al/ 'don't'
14.	NUM	Numeral expression
15.	PN	Proper noun
16.	POLITE	Polite interjections, e.g., [bevakaSa] 'please'
17.	POSS	Possessive particle /Sel/ 'of'
e.	POSS-PRON	Possessive item [Sel] 'of' with pronominal suffix
18.	PREP	Preposition
f.	PREP-DEF	Preposition with definite article
g.	PREP-PRON	Preposition with pronominal complement suffixes
19.	PRON	Pronoun
20.	PRP	Personal-pronoun
21.	PTCP	Active participle
22.	Q	Wh-word, question word
23.	SUB	Subordinate particle [Se] 'that'. Both complementizer and relative pronoun
24.	V	Verb (either prefix or suffix conjugation)
25.	ZE	Demonstrative pronoun [ze] 'this'

In the linear representation, the C-*boundary* is analyzed relative to the POS tags before and after it. This does not contradict the fact that the C-boundary *tone* is actually carried by the last syllable/s of the IU, which can be a monosyllabic word or the final syllable/s of a word or, theoretically, any other speech element (e.g. appended [e]).

7.2.1 Word order in spontaneous spoken Hebrew

Word order and linearization are major areas of linguistic inquiry within all linguistic traditions (Siewierska 1996, 372). Among the 'basic orders' found in languages of the world, Hebrew is said to prefer a SVO word order (Glinert 1989, 413). Nevertheless, Israeli Hebrew word order is relatively free and all possible alternatives can appear in specific contexts, as shown in (25).

(25) OV order in Israeli Hebrew

et anat bikaS-ti
ACC Anat ask.PST-1SG
'I asked for Anat'

Borochovsky Bar-Aba (2010) claims that one of the basic concerns in the study of spoken Hebrew syntax is the issue of syntactic construction, which also reflects issues of word order (2010, 54, 77-81). Her survey of current studies reflects the validity of this issue. Following these studies that concern issues such as morph-syntax, pragmatics and discourse markers (Borochovsky Bar-Aba 2010, 54-69), I will try to show that methodology combining POS and C-boundaries sequences illuminates phrase final and clause final positions, as well as phrase internal positions, i.e., *n*-gram methodology is also applicable to "non-strict word-order" languages such as Hebrew, which in its spoken spontaneous form is said to be characterized as a "mixture" (Borochovsky Bar-Aba 2010, 77-81), but that some production errors go through a gramaticization process (ibid., 95-97). In order to understand the research, it is important to explain the general linguistic characteristics regarding Israeli Hebrew syntagmatic constraints.

The syntactic structure of Israeli Hebrew has been treated in detail in works such as Rosén (1977), Berman (1978) and Glinet (1989). Several standard issues are mentioned with respect to IH word order:

Adjectives always follow nouns while numerals precede them, with the exception of the numeral 'one' that always follows the noun it modifies. Definite nouns are preceded by the definite article [ha] 'the‘, which also appears in the modifying adjective [ha=banana ha=tsehuba] lit. the=banana the=yellow, 'the yellow banana'. Prepositions

also appear at the head of the phrase. The subordination marker [Se] 'that' appears before the subordinate clause. Question words such as [mi] 'who', [ma] 'what', [mataj] 'when', [efo] 'where', appear at the beginning of the phrase, in standard Hebrew (cf. Borochovsky Bar-Aba 2010, 95-96).

Like other Semitic languages, the isomorphic connection between phonology, morphology, syntax and semantics is much more overt when compared with the Indo-European languages. The vast majority of the words of the language can be analyzed into consonantal roots signaling broad semantic fields. These roots are combined with fixed morphophonemic patterns for what is traditionally called nominal, verbal, and adjectival forms. Nouns in IH exhibit prosodic and vocalic restrictions called *mishkal* ('weight').

In the verb system, Israeli Hebrew morphology is characterized by the non-concatenative Semitic type structure. A verb must belong to one of the five to eight morphological classes called *binyanim* ('constructions'). Verbs are also accompanied by affixes indicating tense, person, number, and gender.

For spoken IH, Izre'el (2010, 84) lays the following foundations:

- A predicate is defined as the "new" element in the discourse.
- The clause has two basic structures: unipartite, consisting of only a predicate, and bipartite, consisting – in its minimal structure – of a subject and a predicate.
- Accordingly, a subject is defined vis-à-vis the predicate.
- A binary classification of predicate types in Hebrew as verbal vs. nominal should be avoided. Any POS can become a predicate, as well as multi-word constructions. The verb, inherently consisting of both the subject and the predicate (in a synthetic structure), can become the predicate of a higher-rank clause (in an analytical construction).
- Subjects can be nominal or pronominal as well as consisting of nominalized structures.

- The subject of the verb is pronominal (e.g. [gadl-a] 'grow.PST-3SG.F), and is structurally required, being part of the morphological complex that constitutes a verb.
- Pronominal subjects may or may not have referents.
- The subject of reference in the extra-linguistic domain is not part of the linguistic system; this subject of reference may or may not be represented in the discourse.

Hebrew, as a "non-strict word-order" language, does not allow clitics and affixes at the phrase final position. Thus, the preposition-stranding phenomenon does not occur in Hebrew, as demonstrated in (26).

(26) No P-stranding in IH:
a. *ani tohe mi natat et ha=sefeR le=
'I wonder whom you gave the=book to='

b. ani tohe le=mi natat et ha=sefeR
'I wonder to=whom you gave the=book'

This characteristic of Hebrew means that we will not find prepositions in clause final position or in phrase final position. Indeed, this syntactic constraint is overruled in case of coined idioms, such as (27).

(27) haji-ti Sam paam=be
be.PST-1SG there once=in
'I was there once in [a while]'

As far as coined idioms are concerned, in IH we also find conjunctions in phrase final position, such as [aval] 'but' (28).

(28) bli aval bli Xaval
without but, without pity
'no excuses'

The coined idioms in (27)-(28) should thus be tagged differently from simple conjunctions or prepositions, since the host word and the clitic together are considered a single unit. Such idioms were not found in the corpus.

To sum up, although *n*-gram methodology seems more applicable to strict word order languages, spontaneous IH has word order constraints that can be analyzed through *n*-gram methodology.

8 Results

8.1 Elements preceding C-boundaries

The following description refers to bigrams of POS *preceding* the C-boundary, i.e. the element that carries the boundary tone, and the C-boundary type. The database consists of 2,775 bigrams (1,934 in F2F and 841 in TEL), parallel to the 2,775 C-boundaries in Tables 5-6.

8.1.1 Clean-up

A clean-up process was carried out on the data before summarizing the results. The most frequent POS-C boundary sequence was found to be "[e] CE", which occurs 287 times (line 8 in Table 10). Since "[e] CE" does not reflect the POS before the boundary, but rather the prosodic event (cf. Silber-Varod 2010), a modified list was created, of the POSs preceding the appended [e]. Hence, CE and "[e] CE" boundaries are both counted as one type – CE boundaries. Table 10 describes the clean-up process on the preceding POS list.

Table 10: Clean-up process of elements preceding C-boundaries

	Preceding elements		**F2F (1,934)**	**TEL (841)**	**Total in Spontaneous IH corpus (2,775)**
1	Unintelligible words (@)	sequence	45	5	50
2	Isolated [em]	# [em]	10	23	33
3	Isolated [e]	# [e]	28	25	53
4		C* [e]	7	2	9
5		T* [e]	2	4	6
6	Unintelligible words before [e]		2	1	3
7	an [e] at the beginning of the recording		1		1
8	Preceding POS to [e] after clean-up		190	97	287
9	Total "preceding" bigrams		1,839	781	2,620

Before arriving at the clean-up numbers in line 8, several sequences were removed:

- Of the 2,775 bigrams in the IH corpus, 50 preceding elements were unintelligible or truncated words (line 1).

- 101 cases were interpreted as isolated [e] or [em] (lines 2-5): 33 [em]s and 53 [e]s were preceded by a pause (lines 2-3) and 15 [e]s were preceded by prosodic boundaries (lines 4-5).

  The meaning of isolated [e] or [em]s is that pauses, C- boundaries and T-boundaries were found before an [e], and not lexical words to which an appended [e] is attached (see §6.2.1.2 and Silber-Varod 2010).
- 3 unintelligible words/syllables [@] were found before an appended [e] and were removed from the data (line 6).
- A single case was found of an [e] at the beginning of the recording (line 7).

All the above cases were removed from the "POS-C boundary" sequence list. To conclude, the "preceding elements" list consists of **2,620** bigrams of POS and C-boundaries (1839 in F2F and 781 in TEL, line 9).

8.1.2 Elements preceding C-boundaries: Findings

The first calculation performed was the occurrence scale of the POS-C-boundary bigram. Of the 1,839 bigrams in F2F, 118 different bigrams (types) were discerned; and of the 781 bigrams in TEL, 100 different bigrams (types) were discerned. The most frequent bigram in F2F is nouns preceding CN boundaries (Table 11a, line 1); this bigram is the second most frequent bigram in TEL (Table 11b, line 2). The most frequent bigram in TEL is conjunctions preceding CE boundaries (Table 11b, line 1), which is in third position in the F2F corpus (Table 11a, line 3).

16 singleton bigrams (unique cases) occur in F2F and 24 in TEL. Of these singletons, several represent a POS that occurs only once in the bigram list. For example, "AL **CE**" and "POLITE **CE**" are unique cases in TEL, and thus receive probability score of 1 (in comparison to the probability of 0.821 for the most frequent bigram in TEL). Such cases will be considered in this respect.

Tables 11a-b show three parameters: occurrences, probability and lexical category, for the 10 most frequent bigrams. The ideal is to find a set or sets of bigrams that are the most frequent, the most probable and with the same lexical category of

POS and the same C-boundary. Such findings would demonstrate a high measure of regularity of the C-boundary annotation, which can also be interpreted as regularity in spontaneous speech processing.

Table 11a: Occurrences of "POS C-boundary" bigrams in the F2F corpus

	Bigram (POS + C-boundary)	**Occurrences**	**Probability**[31]	**Lexical category**
1	N **CN**	152	0.476	Open
2	N **CR**	90	0.282	Open
3	CONJ **CE**	85	0.817	***Closed***
4	DEF **CE**	83	0.933	***Closed***
5	PRP **CE**	74	0.733	***Closed***
6	PREP **CE**	68	0.861	***Closed***
7	ADV **CN**	60	0.484	Open
8	PREP-PRON **CN**	52	0.605	***Closed***
9	PN **CN**	50	0.472	Open
10	DM **CE**	49	0.438	***Closed***

Table 11b: Occurrences of "POS C-boundary" bigrams in the TEL corpus

	Bigram (POS + C-boundary)	**Occurrences**	**Probability**	**Lexical category**
1	CONJ **CE**	64	0.821	***Closed***
2	N **CN**	57	0.416	Open
3	DM **CE**	47	0.560	***Closed***
4	N **CR**	41	0.299	Open
5	PRP **CE**	37	0.822	***Closed***
6	PREP **CE**	32	0.821	***Closed***
7	DM **CN**	27	0.321	***Closed***
8	DEF **CE**	22	0.957	***Closed***
9	ADV **CE**	18	0.391	Open
10	MOD **CE**	a. 17	0.739	Open
	N **CE**	b. 17	0.124	Open
	N **CF**	c. 17	0.124	Open

In terms of number of repetitions, each table includes over 40% of the bigrams: the 763 bigrams in Table 11a represent 41% of F2F bigrams and the 396 bigrams in Table 11b represent 51% of TEL bigrams. In both cases, this is a salient proportion of bigrams representing only the Top 10. A closer look at Tables 11a-b reveals that in terms of probability, these are not top-10 lists. Second, there is no specific dominance of one

[31] All calculations were performed using Antconc 3.2.1 version (Anthony 2007).

of the C-boundaries. Finally, the lexical categories of the POS are either closed or open, with no preference for either. Table 12 shows the 11 most probable bigrams with more than 10 occurrences.

Table 12: Probabilities of the 11 most probable "preceding" bigrams in the spontaneous IH corpora

	Bigram (POS + C-boundary)	**Occurrences**	**Probability**	**Lexical category**
1	POSS **CE**	22	0.957	***Closed***
2	DEF **CE**	105	0.938	***Closed***
3	PREP-DEF **CE**	44	0.880	***Closed***
4	SUB **CE**	42	0.875	***Closed***
5	PREP **CE**	100	0.847	***Closed***
6	CONJ **CE**	149	0.819	***Closed***
7	PRP **CE**	111	0.760	***Closed***
8	MOD **CE**	36	0.692	Open
9	BE **CE**	17	0.630	***Closed***
10	AUX **CE**	10	0.625	***Closed***
11	EXT **CE**	11	0.611	***Closed***

Table 12 contains fewer bigrams (24% of all 2,620 bigrams in both corpora) than Tables 11a-b but shows more regularity: the CE boundary is dominant. As to the preceding POS – ten of the eleven preceding POSs belong to the closed lexical category, which therefore seems a significant parameter in predicting the grammatical element preceding C-boundaries in general and the CE boundary in particular.

As to the separate treatment of the two sub-corpora, this will no longer be applied. The TEL and the F2F recordings were taken from the same informants except in two cases: C412-+413 which is a telephone conversation only and OCh which is a F2F dialogue only. As all recordings were taken from the daily life of the informants, whether they were speaking with people in the same room or on the telephone, there seems to be no reason for separate analysis, and the results from both sub-corpora will be treated as the results of spontaneous IH speech. An examination of differences between the two channels remains for future research.

Table 13 shows the results of all the "preceding" bigrams. The bigrams are ordered with respect to their probabilities in CE boundaries into three groups: A, B and C. The fourth group consists of POSs with fewer than 10 occurrences before CE. The reason for

grouping the POS categories according to the CE boundary is first because the CE boundary is the most frequent among the C-boundaries and second, as shown in Tables 11a-b and 12, CE bigrams show the most regularity: most frequent, most probable.

Group A includes POSs with a high probability ($p>0.6$) of occurring before CE (black cells). This group is mainly characterized by the fact that its POSs do not occur before all five boundaries (the "#N/A" symbol reflects non-occur cases).

Group B includes POSs with an intermediate probability ($0.3<p<0.6$) of occurring before CE (grey cells). This group is mainly characterized by the fact that its POSs also occur with the same probabilities before CN.

Group C includes POSs with a low probability ($p<0.3$) of occurring before CE. This group is mainly characterized by the fact that all its members occur before all POSs (hence the lower probability rates in general). Moreover, in common with group B, this group has intermediate probability values before CN.

The last group includes POSs with a small number of repetitions (less than 10 occurrences) before CE boundaries. As demonstrated by the colored cells, these POS occur with high to intermediate probability before CN and CR.

Table 13: Probabilities of "preceding" bigrams (POS + C-boundaries)

Group	Occurrences before CE	POS	CE	CN	CR	CRF	CF
A	22	POSS	0.957	0.043	#N/A	#N/A	#N/A
	105	DEF	0.938	0.063	#N/A	#N/A	#N/A
	44	PREP-DEF	0.880	0.100	#N/A	#N/A	0.020
	42	SUB	0.875	0.104	#N/A	#N/A	0.021
	100	PREP	0.847	0.119	0.017	0.017	#N/A
	149	CONJ	0.819	0.154	#N/A	0.005	0.022
	111	PRP	0.760	0.164	0.021	0.034	0.021
	36	MOD	0.692	0.231	0.058	#N/A	0.019
	17	BE	0.630	0.185	0.037	0.111	0.037
	10	AUX	0.625	0.375	#N/A	#N/A	#N/A
	11	EXT	0.611	0.333	#N/A	0.056	#N/A
B	96	DM	0.490	0.342	0.026	0.066	0.077
	13	Q	0.464	0.357	#N/A	0.071	0.107
	47	ZE	0.405	0.319	0.138	0.103	0.034
	18	INF	0.391	0.304	0.130	0.065	0.109
	28	LO	0.373	0.293	0.053	0.280	#N/A
C	22	V	0.268	0.378	0.256	0.061	0.037
	43	ADV	0.253	0.447	0.147	0.088	0.065
	27	PREP-PRON	0.239	0.558	0.080	0.044	0.080
	19	PRON	0.204	0.473	0.194	0.054	0.075
	13	PTCP	0.124	0.476	0.219	0.067	0.114
	50	N	0.110	0.458	0.287	0.075	0.070
	13	PN	0.101	0.426	0.364	0.070	0.039
	3	ADJ	0.028	0.468	0.312	0.083	0.110
	2	IMP	0.154	0.692	#N/A	0.154	#N/A
	2	ACC-PRON	0.095	0.571	0.238	#N/A	0.095
	2	NUM	0.071	0.393	0.464	0.036	0.036
	2	POSS-PRON	0.067	0.367	0.400	0.067	0.100
	2	ACC	1.000	#N/A	#N/A	#N/A	#N/A
	1	POLITE	0.143	0.571	0.286	#N/A	#N/A
	1	AL	0.500	0.500	#N/A	#N/A	#N/A
	0	N-POSS	#N/A	0.500	0.167	#N/A	0.333

To sum up the results of "preceding" bigrams, two findings should be stressed:

1. There is a difference in the distribution of C-boundaries after each of the POSs. Several POSs carry similar distributions, while others carry a different, and even opposite, distribution of C-boundaries. These similarities and differences may be

relevant to understanding the role of prosody in general and of C-boundaries in particular.

2. At first glance, it is evident that POSs in Group A, which share a high probability to be elongated, also share a syntactic characteristic: they require a syntactic complement. The complementation varies from "within the same phrase" complements, e.g. POSS [Sel], DEF [ha], PREP (prepositions), and even MOD (modifiers), to "within the same clause" complements, e.g. personal pronouns (subjects/agents) which require a predicate, and SUB [Se], which open a subordinate clausal complement. Discourse markers (in Group B), for example, do not show such a requirement; and most of the nouns and adjectives in Group C do not directly imply such a requirement either, although I will show below that several do require a syntactic complement.

8.2 Elements following C-boundaries

In this section, I will briefly describe POSs that follow C-boundaries. Information on following elements is important to determine whether such patterns of bigrams also occur after C-boundaries. The findings below show the distribution of bigrams with a C-boundary and the first element *after* it, i.e. the first element of the next IU. The database consists of 2,775 bigrams (1,934 in F2F and 841 in TEL), which is parallel to 2,775 C-boundaries mentioned in Tables 5-6.

8.2.1 Clean-up

A clean-up process was carried out on the data before summarizing the results, as for the "preceding" bigrams (§8.1.1). Table 14 shows the clean-up process for elements following C-boundaries.

Table 14: Clean-up process of elements following C-boundaries

	Following elements		**F2F (1,934)**	**TEL (841)**	**Total bigrams in Spontaneous IH corpus (2,775)**
1	Unintelligible words (@)		38	13	51
2	Pauses (#)	# @	15	9	24
3		# [e]	11	12	23
4		# [em]	3	8	11
5	Secondary-immediate following POS after pauses		625	241	866
6	Clean up of isolated [e] and [em]		13	28	41
7	End of the recording		1		1
8	Total "following" bigrams		1,853	771	2,624

Before arriving at the clean-up numbers in line 8, several sequences were removed:

- 51 following elements were unintelligible or truncated words (line 1).
- In case of a pause after a C-boundary, the POS following the pause was taken into account (line 5). 58 cases of pauses following a C-boundary were removed (lines 2-4):
    - 24 cases of unintelligible words after pauses (line 2).
    - 34 cases of [e] and [em] following a pause (lines 3-4), since these were themselves isolated instances
- An additional 41 cases were pauses after "preceding" isolated [e] and [em] (line 6).
- A single case of a C-boundary followed by a pause at the end of the recording (line 7).

The modified list therefore contains 2,624 "following" bigrams (1,853 in F2F and 771 in TEL, line 8).

8.2.2 Elements following C-boundaries: Findings

As with the "preceding" calculations, the first calculation performed was of occurrences of the "following" bigrams (Table 15). Of the 2,624 bigrams, 126 different bigrams (types) were discerned; and among the 771 bigrams in TEL, 131 different types were discerned. The most frequent bigram consists of nouns following CE boundaries (Table

15, line 1). 15 singleton bigrams (unique cases) were found and will not be mentioned further.

Table 15 shows three parameters: occurrences, probability and lexical category, for the 10 bigrams that occurred most *frequently*. The ideal is to find a set or sets of bigrams that are the most frequent, the most probable and with the same lexical category of POS and the same C-boundary. Such findings would demonstrate a high measure of regularity of the C-boundary annotation, which can also be interpreted as regularity in spontaneous speech processing.

Table 15: Occurrences of "C-boundary POS" bigrams

	Bigram (C-boundary + POS)	**Occurrences**	**Probability**	**Lexical category**
1	**CE** N	186	0.173	Open
2	**CN** CONJ	147	0.166	**Closed**
3	**CR** CONJ	118	0.315	**Closed**
4	**CN** PRP	112	0.127	**Closed**
5	**CE** DM	96	0.089	**Closed**
6	**CE** PRP	91	0.084	**Closed**
7	**CN** DM	67	0.076	**Closed**
8	**CN** PREP	62	0.070	**Closed**
9	**CE** V	60	0.056	Open
10	**CN** V	59	0.067	Open

In terms of number of repetitions, Table 15 includes 38% of the bigrams, a salient proportion of bigrams representing only the top 10. In terms of probability, the probability values do not decrease, indicating that this is not a top-10 list in terms of probabilities (which are far lower than those found for preceding POSs). Nonetheless, although Table 15 does not indicate the dominance of any specific C-boundary, certain POSs seem to follow groups of C-boundaries: CN and CR seem to "attract" CONJ (lines 2-3), while CN and CE seem to "attract" PRP (lines 4 and 6), DM (lines 5 and 7) and V (lines 9-10). These findings will be discussed below. Moreover, a larger proportion of lexical categories is closed (7 cases) rather than open (3 cases). As with the "preceding" bigrams (Table 12), Table 16 shows the top 10 bigrams in terms of *probability*.

Table 16: Probabilities of the 10 most probable "following" bigrams

	Bigram (C-boundary + POS)	Occurrences	Probability	Lexical category
1	**CR** CONJ	118	0.315	**Closed**
2	**CF** CONJ	31	0.228	**Closed**
3	**CF** PRP	24	0.176	**Closed**
4	**CE** N	186	0.173	Open
5	**CN** CONJ	147	0.166	**Closed**
6	**CN** PRP	112	0.127	**Closed**
7	**CR** PRP	47	0.125	**Closed**
8	**CRF** DM	16	0.106	**Closed**
9	**CF** DM	14	0.103	**Closed**
10	**CRF** CONJ	15	0.099	**Closed**

One of the most prominent findings is that the top 10 probabilities for "following" bigrams are far lower than the probabilities for "preceding" bigrams (Table 12). Table 16 also shows less coherence in terms of C-boundaries. The list contains all five boundaries. The table may suggest that a new clause begins in the following IU: three bigrams with PRP (personal-pronouns) follow CF (line 3), CN (line 6), and CR (line 7); four cases of CONJ (conjunctions) follow CR (line 1), CF (line 2), CN (line 5), and CRF (line 10); and two cases of DM (discourse marker) follow CRF (line 8) and CF (line 9). Nonetheless, the single case of a noun following a CE boundary (line 4), may also imply a new clause, but one can also hypothesize that this actually reflects the high probability of function words *preceding* CE and that the nouns may be part of the phrases that began before a CE boundary. This issue, as well as other seemingly clause-initial or clause-final "markers", will be dealt with in §8.3-§8.5.[32]

Table 17 shows the results of all the "following" bigrams. Like in Table 13 above, the bigrams are ordered with respect to their probabilities in CE boundaries into three groups: A ($p>0.1$), B ($0.01<p<0.1$) and C ($p<0.01$). The fourth group consists of POSs with fewer than 10 occurrences after CE. The reason for grouping the POS categories according to the CE boundary is because CE boundary is the most frequent among the C-boundaries.

[32] For example, a discussion of the suggestion that CONJ may imply that a new clause begins is found in §8.5.1.6 – Coordination structure dependency B.

Table 17: Probabilities of "following" bigrams (C-boundaries + POS)

Group	CE	CN	CR	CRF	CF	POS	Occurrences after CE
A	0.173	0.058	0.048	0.026	0.074	N	186
B	0.089	0.076	0.088	0.106	0.103	DM	96
	0.084	0.127	0.125	0.093	0.176	PRP	91
	0.056	0.067	0.053	0.066	0.051	V	60
	0.054	0.070	0.080	0.066	0.044	PREP	58
	0.054	0.037	0.040	0.086	0.022	ZE	58
	0.048	0.043	0.037	0.046	0.037	ADV	52
	0.046	0.166	0.315	0.099	0.228	CONJ	50
	0.041	0.032	0.016	0.020	0.007	MOD	44
	0.041	0.01	0.003	0.033	0.029	ADJ	44
	0.040	0.025	0.013	0.007	0.015	PN	43
	0.038	0.025	0.011	0.020	0.029	PTCP	41
	0.034	0.047	0.013	0.066	0.029	Q	37
	0.033	0.045	0.013	0.086	0.029	LO	36
	0.025	0.025	0.008	0.020	0.022	DEF	27
	0.025	0.014	0.003	#N/A	#N/A	INF	27
	0.019	0.014	0.008	0.013	0.007	PRON	21
	0.018	0.026	0.027	0.040	0.029	EXT	19
	0.015	0.010	0.005	0.007	0.015	PREP-DEF	16
	0.012	0.017	0.013	0.013	#N/A	IMP	13
	0.012	0.006	0.013	0.007	0.015	NUM	13
C	0.009	0.024	0.048	0.046	0.015	SUB	10
	0.009	0.016	0.005	0.020	#N/A	BE	10
	0.009	0.008	0.003	0.007	0.007	AUX	10
	0.006	0.002	#N/A	0.007	0.007	ACC	6
	0.005	0.002	0.005	#N/A	#N/A	POSS	5
	0.002	0.003	0.005	#N/A	#N/A	PREP-PRON	2
	0.001	0.005	#N/A	#N/A	0.007	POLITE	1
	0.001	0.002	#N/A	#N/A	#N/A	AL	1
	#N/A	#N/A	#N/A	#N/A	#N/A	ACC-PRON	0
	#N/A	#N/A	#N/A	#N/A	#N/A	POSS-PRON	0
	#N/A	#N/A	#N/A	#N/A	#N/A	N-POSS	0

From a comparison of the two tables, 13 and 17, it is evident that the "following" bigrams are different in distribution, a fact that suggests the existence of some kind of relationship between preceding and following syntactic elements. For example, if the most probable "following" bigram is "CR CONJ", and one of the most probable "preceding" bigrams is "CONJ CE", then an oppositional relation between these two C-boundaries should be considered.

As to the gaps between the rather high probabilities of "preceding" bigrams compared to the low probabilities of "following" bigrams, it can be said that, in terms of POS categories, there is more regularity at IU final position than at IU initial position. In Table 17, the only POS in the A group is N – which belongs to Group C in Table 13; while in the third group in Table 17, there are three POSs found in Group A in Table 13. Table 17 also shows very clearly that CONJ (conjunctions) and to a lesser extent – PRP (personal pronouns) are most likely to occur after three C-boundaries (CR, CN and CF), but not after CE (and CRF which shows very low probabilities in general). In the following section, these results will be highlighted when describing the C-boundary "environment", i.e., trigrams which include both preceding and following POSs.

8.3 Dependencies over C-boundaries

In this section, the results of both the preceding *and* the following POS attachments to C-boundaries will be described, in order to examine whether any relations exist between the POSs on the two sides of the C-boundary. These a-priori relations are called *dependencies* in this research, since it is assumed that C-boundaries connect dependent syntactic structures (e.g., a head and its dependent).

The method will be similar to the previous two sections (§8.1-§8.2) – according to probabilities of mixed sequences of POSs and C-boundaries, only this time examining trigram sequences.

8.3.1 Why examine both sides of the boundary?

The conclusion from the results in §8.1-§8.2 is that looking only at the preceding POS or at the following POS indeed may lead to hypotheses concerning the role of each of the five C-boundaries, but it is not enough to look only at one side. It is especially important to find out if C-boundaries, or specifically the CE boundary, are, for example, domains of repetition, which can only be determined if we look at both sides of the boundary (finding the same POS before and after the C-boundary might serve as a clue).

For example, the strings in (29)-(31) contain three cases of CE boundaries followed by POSS [Sel] 'of' and a PN (proper name). A sequence of "POSS PN" is actually the

second part of a NP with two nouns that share attributive relations. Thus, (29)-(31) may reflect the same dependency (attributive relations between two nouns), but looking only at the preceding POS in these examples might be misleading, since the POS is different each time: [tsilumim] 'photos', which is a noun in (29), [Sel] 'of' in (30), and [lo] 'no' in (31).

(29) tsilumim **CE** Sel afganistan [OCh]
'photos **CE** of Afganistan'

(30) miklaXat Sel e **CE** Sel ofiR CN [P1022]
shower of eh **CE** of Ofir
'Ofir's shower'

(31) ze lo **CE** Sel loakeR [P911]
this no **CE** of Loaker
'it is not Loaker's'

It should be mentioned that [Sel] 'of' also follows T boundaries among others, which means that [Sel] can open a clause (e.g., a question).

Another set of examples is shown in (32)-(35), where construct state nouns (the *Nismach, nomen rectum*, the first noun in a compound) were found before C-boundaries. These construct state nouns create with another noun(s) a morphosyntactic compound called *Smikhut*. The latter increment (the *Somech*, *nomen regens*, the compositional morpheme) reflects attributive relations (e.g. genitive, tool, material). The first noun is morphologically in its construct state[33] while the second one is in its "absolute" state. For example: [BiRat jisRael] 'capital_of Israel'. In the following four specific cases, the expected compositional lexeme (the second noun in the compound) is not found immediately after the C-boundary due to various disfluencies (e.g. repetitions, as in (33)-(34), repairs, as in (35)):

[33] When a masculine singular noun is in the construct state, it may or may not undergo vowel change.

(32) ze biRat **CN** # e **CE** # ha **CE** ha **CE** saUT gobi **T** [OCh]
'this is capital_of **CN** # eh **CE** # the **CE** the **CE** South Gobi **T**'

(33) Svilej **CR** Svilej afaR **T** [OCh]
paths_of **CR** paths_of dust **T**
'paths, dirt paths (trails)'

(34) kav e **CE** si- **F** kav tmiXa v- **F** # ve **CE** mejda **CR** [C413]
'line_of eh **CE** @- **F** line_of support an- **CE** # and **CE** information **CR**'
'support and information telephone number'

(35) Kol minej divRej e **CE** ha dvaRim haele [D122]
'many kinds of things_of eh **CE** these things'

The research strives to take such different cases into consideration, to determine what the most probable phenomenon at the C-boundaries environment is, and to see if there is a difference in the dependency distribution among C-boundaries. For example: Is a C-boundary, notably CE, a repetition domain or a repair domain (both leading us to expect the same POS before and after the CE), or is it only a prosodic "bridge", in which case we would expect to find dependent increments, and C-boundaries occurring within a clause? Alternately, do we find clues to the ends of clauses before C-boundaries, so that we can assume that C-boundaries are only minor prosodic breaks between clauses? And, of course, is there an inherent difference between the different C-boundaries, as Tables 13 and 17 imply?

8.3.2 Results of dependencies over C-boundaries

The first stage in describing dependency over C-boundaries will be to examine the number of repetitions and probability of the "POS C-boundary POS" trigram. Following the clean-up procedure discussed above, pauses were ignored and the POS after or before the pause was considered; isolated [e]s and [em]s, on the other hand, break the sequence and therefore when they were in the immediate environment of a C-boundary, the entire sequence was removed from the results. The modified list consists of 2,517 cases (tokens), 1,777 in F2F and 742 in TEL. Of the 962 trigram types, 502 (52%) are singleton (unique) trigrams.

Table 18 shows three parameters: occurrences, probability and (assumed) syntactic dependency, for the 10 most *frequent* trigrams. As with the bigrams, the ideal is to find a set or sets of trigrams that are the most frequent, the most probable and that have a definable relation[34] between the POSs. Such findings would demonstrate a high measure of regularity of the C-boundary annotation, which can also be interpreted as regularity in spontaneous speech processing.

The most frequent trigram is "N CN CONJ", which occurs 52 times. This trigram correlates with the data in Table 11a (line 1) and Table 11b (line 2), which deal with preceding POSs, in this case N, and in Table 15 (line 2) and Table 16 (line 5), which deal with following POSs, in this case, CONJ.

Table 18: Occurrences of the 12 most frequent trigrams (POSs on both sides of the C-boundary)

	Preceding	**C**	**Following**	**Occurrences**	**Probability**[35]	**Assumed dependency**
1	N	**CN**	CONJ	52	0.118	Within coordination structure
2	N	**CR**	CONJ	45	0.105	Within coordination structure
3	DEF	**CE**	N	43	0.413	Within N
4	PREP	**CE**	N	26	0.224	Within PP
5	CONJ	**CE**	CONJ	21	0.124	Repetition
6	DM	**CE**	PRP	21	0.114	None
7	CONJ	**CE**	PRP	19	0.112	Within coordination structure
8	N	**CN**	PRP	19	0.043	None
9	PRP	**CE**	V	18	0.129	Between subject and predicate
10	ADJ	**CN**	CONJ	17	0.157	Within coordination structure
11	PREP	**CE**	PREP	17	0.147	Repetition
12	PRP	**CE**	PTCP	17	0.122	Between subject and predicate

Table 18 shows that eight of the dependencies are over CE boundaries (lines 3-7, 9, 11-12), three are over CN boundaries (lines 1, 8, 10) and a single case is over a CR boundary (line 2). All the dependencies include words of the closed set (e.g. prepositions, conjunctions, pronouns), either *before* the C-boundary – as in all eight cases with CE, or *after* the C-boundary (three cases after CN and one case after CR). In

[34] Absence of relations will also be considered definable relations.

[35] Probabilities of trigrams were calculated by AntConc version 3.2.1w.

five cases (lines 1-2, 5, 7, 10), a conjunction is involved, which reflects a dependency within coordination structure: in four cases the conjunction follows either CN or CR boundaries and in two cases (lines 5, 7) the conjunction precedes a CE boundary. The dependency in line 3 is between the definite article [ha] 'the' and its dependent noun, i.e. within the noun phrase. The dependency in line 4 is within the prepositional phrase. Lines 6 and 8 reflect no dependencies, in line 6 because a DM is involved, and in line 8 because in IH a sequence of N and PRP does not imply any immediate dependency. In lines 9 and 12, the dependency is between a subject (PRP) and a predicate (V). Two cases seem to be repetitions since they show the same POS before and after CE boundary (lines 5 and 11).

Since trigrams show very low probability values,[36] combining occurrence rate and probability parameters resulted in a new list of trigrams. Table 19a includes only trigrams with 10 occurrences and above.

Table 19a: Probabilities of the 10 most probable trigrams with 10+ occurrences

	Preceding	**C**	**Following**	**Occurrences**	**Probability**	**Assumed dependency**
1	DEF	**CE**	N	43	0.413	Within NP
2	PREP-DEF	**CE**	N	16	0.333	Within PP and NP
3	PREP	**CE**	N	26	0.224	Within PP
4	ADJ	**CN**	CONJ	17	0.157	Within coordination structure
5	PREP	**CE**	PREP	17	0.147	Repetition
6	PRON	**CN**	CONJ	12	0.138	Within coordination structure
7	PRP	**CE**	V	18	0.129	Between subject and predicate
8	CONJ	**CE**	CONJ	21	0.124	Repetition
9	PRP	**CE**	PTCP	17	0.122	Between subject and predicate
10	N	**CN**	CONJ	52	0.118	Within coordination structure

Table 19a shows tendencies similar to Table 18. The dependencies over CE boundaries are dominant – 7 cases. In terms of number of repetitions and probability, the results show even more regularity of CE boundaries (the top-3 trigrams are with CE) than with other C-boundaries. By stretching the list in Table 19a further, we find the same dominance and tendencies:

[36] By definition, the larger the *n*-gram, the lower the probability.

Table 19b: Next 10 most probable trigrams with 5+ occurrences

	Preceding	C	Following	Occurrences	Probability	Assumed Dependency
11	POSS	**CE**	N	7	0.333	Within PP
12	EXT	**CE**	N	6	0.333	Between predicate and obligatory argument
13	POSS	**CE**	PN	5	0.238	Within PP
14	NUM	**CR**	NUM	5	0.192	Within numeral expression
15	PREP-DEF	**CE**	PREP-DEF	9	0.188	Repetition
16	MOD	**CE**	N	6	0.176	Within NP
17	MOD	**CE**	ADJ	7	0.137	Within AP
18	DM	**CE**	PRP	21	0.114	None
19	CONJ	**CE**	PRP	19	0.112	Within coordination structure
20	ADJ	**CR**	CONJ	12	0.111	Within coordination structure

CE is still dominant in terms of occurrence rate and probability. Five cases over CE are of dependencies within phrases (lines 11, 13, 16-17), while one dependency over CR (line 14) is within a numeral expression. In line 12, the dependency is between existential predicates (closed set words) and an obligatory argument. Dependency within coordination structure is expected in line 19. One case seems to be of repetition, since it shows the same POS before and after the CE boundary (line 15). Last, elongated discourse markers (line 18) do not show any dependency; still, like in most of the dependencies above, the elongated element is of closed set words. To conclude from the 20 trigrams in Tables 19a-b, a generalization of 10 dependencies was examined:

Four are dependencies within phrases (NP or PP): the dependencies within NPs are of a definite article and a noun; a modifier and a noun/adjective; nouns attributive relation with [Sel].

Two are dependencies between a subject and a predicate: the predicate is either verbal or nominal, as in the case of the existential predicate.

Two are within the coordination structure; either the conjunction precedes the C-boundary or follows it.

A **single** case is within a telephone number;

Another shows no dependencies but elongated DM.

8.4 Dependencies per C-boundary

The sections below discuss the dominant dependencies over each of the C-boundaries.

8.4.1 Dependencies over the CE-boundary tone

There are 329 types of CE dependencies among the 997 trigrams (tokens) with CE boundaries. Table 20 shows the top 10 dependencies over CE boundaries in terms of probability (10+ occurrences), which constitute of 21% of the CE trigrams. Examples of the trigrams follow the Table.

Table 20: The top-10 dependencies over CE boundaries, ordered by probability

	Preceding	CE	Following	Occurrences	Prob.	Dependencies
1	DEF	**CE**	N	43	0.413	Within noun
2	PREP-DEF	**CE**	N	16	0.333	Within noun
3	PREP	**CE**	N	26	0.224	Within preposition phrase
4	PREP	**CE**	PREP	17	0.147	Repetition
5	PRP	**CE**	V	18	0.129	Between subject and predicate
6	CONJ	**CE**	CONJ	20	0.124	Repetition
7	PRP	**CE**	PTCP	17	0.122	Between subject and predicate
8	DM	**CE**	PRP	21	0.114	None
9	CONJ	**CE**	PRP	19	0.112	Within a coordination structure
10	CONJ	**CE**	DM	16	0.094	None

The first three trigrams have a following Noun and preceding function words (DEF, PREP-DEF and PREP). The trigram in line 4 indicates a repetition. Lines 5-6 are dependencies between a subject and a predicate; the repetition of POS in line 7 does not necessarily indicate a repetition, as shown in the example below. Lines 8-9 demonstrate a dependency between a conjunction and a personal pronoun that is the subject of a clause.

3gram	**Examples**
1	ha **CE** maRtsa Sel-i [C413] the **CE** lecturer of-1SG 'my lecturer'
2	b-a **CE** tijul [P1241] on-the **CE** trip 'on the trip'
3	bXina be **CE** # histoRja Sel naSim [C412] exam in **CE** # history of women 'an exam on the history of women'
4	meaSeR li-Xjot be **CE** be hitnagSut kol ha zman [C1111] than to-live in **CE** in conflict all the time 'than living in conflict all the time'
5	ve hi **CE** amR-a li Se hi holeXet li-Son [C514] and she **CE** tell.PST-3SG.F me that she go.PTCP.SG.F to-sleep 'and she told me that she was going to sleep'
6	aval e **CE** # imm miSehu ja-XziR [D741] but eh **CE** # if someone 3SG.M-FUT.return 'but eh if someone will return [something]'
7	az hem **CE** mizdakn-im tl- neXlaSim ve noflim T [OCh] so they **CE** old.PTCP-PL.M @- weak.PTCP.PL.M and fall.PTCP.PL.M 'so they are getting old @- getting weak and falling down'
8	zot_omeRet e **CE** at pogeSet kaXa anaSim [C413] I_mean eh **CE** you.2SG.F meet.PTCP.SG.F this_way people 'I mean eh you meet people this way'
9	aval e **CE** hem amRu [P313] but eh **CE** they tell.PST.3PL.M 'but eh they told (me to write down the details)'
10	ve **CE** zehu **T** [P1241] and **CE** that_is_that **T** 'and that is that'

8.4.2 Dependencies over the CN-boundary tone

There are 312 types of CN dependencies among the 862 trigrams over CN boundaries. It should be noted that the sequence where N precedes a C-boundary and a conjunction follows it, is common to all C-boundaries except CE, and that a preceding N and a following conjunction is a sequence which also occurs over T and TQ boundaries, as in (36)-(39).

(36) ve amRu ha jeled mitbalbel **T** hu **CE** mi ben e **CE** Stej safot **T** ve az hi amRa lahem [C6]
'and they said the child gets confused **T** he **CE** between eh **CE** two languages **T** and then she told them...'

(37) im bezek **T** aval aXRej Se Silamt **CN** [D631]
'with Bezeq **T** but after you paid **CN**'

(38) en laXem bajit **TQ** ve Roim Se anaXnu jeladim ktanim [C1621]
'don't you have a home **TQ** and it was obvious that we were little kids'

(39) ma ha keSeR le olamot atsilut ve ha bRia **TQ** aval e **CE** [D631]
'what does it have to do with nobility and creation of the world **TQ** but e **CE**'

These results make the distinction between CE and CN quite vivid.

Table 21 The top-10 dependencies over CN boundaries, ordered by probability

	Preceding	CN	Following	Occurrences	Prob.	Dependencies
1	ADJ	**CN**	CONJ	17	0.157	A new clause after the CN boundary
2	PRON	**CN**	CONJ	12	0.138	A new clause after the CN boundary
3	N	**CN**	CONJ	52	0.118	A new clause after the CN boundary
4	PTCP	**CN**	PRP	10	0.099	A new clause after the CN boundary
5	PN	**CN**	CONJ	12	0.095	Within coordination structure
6	PREP-PRON	**CN**	PRP	10	0.093	A new clause after the CN boundary
7	ADV	**CN**	PRP	15	0.091	A new clause after the CN boundary
8	ADV	**CN**	CONJ	10	0.061	A new clause after the CN boundary
9	N	**CN**	PRP	19	0.043	A new clause after the CN boundary
10	N	**CN**	DM	16	0.036	None

Table 21 shows the top-10 dependencies over CN boundaries in terms of probability, which occur more than 10 times. The first nine trigrams represent a new clause (in a new IU) after the CN boundary, while the trigrams in line 10 show no dependency.

3gram **Example**

1 ze lo holeX lihjot maSehu mesubaX **CN** ki hem lo holXim lehaSkia joteR midaj be maSkaot [D341]
'it is not going to be too complicated **CN** since they will not invest too much in alcohol'

2 halaX hisgiR-ø et atsmo **CN** ve jaSav-ø mamaS ktsat zman [C1621]
go.PST.3SG. turn_in.PST-3SG ACC himself **CN** and sit.PST-3SG really little time
'(he) turned himself in and was imprisoned for a short time'

3 kol jom medabRot ba telefon **CN** ve nifgaSot ve hakol [P1241]
'every day (they) talk on the phone **CN** and meet and everything'

4 ki be ikaRon hu mevi **CN** at jodaat haRej Se ani lo oXelet [P831]
'since in principle he brings **CN** you do know that I don't eat'

5 ken ani adabeR im madZed **CN** ve ani adabeR it- im e [C521]
'yes I will speak with Majed **CN** and I will speak wi- with eh'

6 az nikba ito **CN** ani gam lo ekanes le tveRja [P831]
'so let's settle with him **CN** I will not go into Tiberia either'

7 hi mamaS fisfesa po **CN** ani kol kaX hitaXzavti CN [P711]
'she really missed the point here **CN** I was so disappointed'

8 ulaj lo kedaj leeXol et ze aXaR kaX **CN** aval e CE # [D122]
'maybe it is not such a good idea to eat it later **CN** but eh CE'

9 at mevia et ha kafe **CN** ani mevia **CE** jeRakot **CN** [P831]
'you are bringing the coffee **CN** I am bringing **CE** vegetables **CN**'

10 lehavin et ha geogRafja Sel ha dvaRim **CN** zot_omeRet **T** [C412]
to understand the geography of things **CN** I_mean **T**'

8.4.3 Dependencies over the CR boundary tone

There are 128 types of CR dependencies among the 371 trigrams with CR boundaries. Table 22 shows the top-10 dependencies over CR boundaries in terms of probability, which occur more than 5 times.

Table 22: The top-10 dependencies over CR boundaries in terms of probability

	Preceding	CR	Following	Occurrences	Prob.	Dependency
1	NUM	**CR**	NUM	5	0.192	Within a numeral expression
2	ADJ	**CR**	CONJ	13	0.111	Within coordination structure
3	N	**CR**	CONJ	45	0.102	Within coordination structure
4	V	**CR**	CONJ	8	0.101	Within coordination structure
5	PN	**CR**	CONJ	11	0.087	Within coordination structure
6	PRON	**CR**	CONJ	7	0.080	Within coordination structure
7	PTCP	**CR**	CONJ	7	0.069	Within coordination structure
8	ADJ	**CR**	PRP	6	0.056	A new clause after the CR boundary
9	PN	**CR**	PREP	6	0.048	A new clause after the CR boundary?
10	PN	**CR**	V	6	0.048	A new clause after the CR boundary

3gram **Examples**

1 Stajim efes aRba **CR** # Smonim ve Seva Smonim ve aRba [C412]
'two zero four **CR** # eighty seven eighty four'

2 ze haja ha Salav ha RiSon **CR** # ve ha Salav ha Seni **CR** # hu hifsik im ivRit [C-612]
that was the stage the first **CR** # and the stage the second **CR** # he stopped with Hebrew
'that was the first stage **CR** # and in the second stage **CR** # he stopped with Hebrew'

3 jom eXad niXnasti la miRpaa **CR** ve Xajal jaSav lejadi [P1241]
'one day I entered the clinic **CR** and a solider sat next-to me'

4 ezeSehu makom Xanaja CR Se ja-Xanu **CR** ve je-tsu el ha kviS [P831]
kind place-of parking CR that 3PL-FUT.park **CR** and 3PL-FUT.go_out to the road
'a kind of parking place they will park and go out on the road'

5 hitkaSRa le boRenSten **CR** ve boRenSten amaR Se hu lo jaXol [C512]
'(she) called Borenstein **CR** and Borenstein said that he cannot'

6 asi-nu min lup kaze **CR** ve be=ikaRon tijal-nu al sfat ha agam CR [OCh]
do.PST-1PL kind loop like.that **CR** and in=principle walk.PST-1PL along bank_of the river
'we drove in a kind of circle and we actually walked along the river bank'

7 im ha SemeS ze mitjabeS **CR** ve ze …[OCh]
with the-sun it dry.PTCP.SG.M **CR** and it…
'in the sun it dries and it …'

8 nagid ha tiRa meRubaat **CR** # hi Ribua [OCh]
say the castle quadrangular.SG.F **CR** # she square
'let's say the castle is quadrangular it's a square'

9 a. ani tsRiXa linsoa le makabi **CR** # be neot RaXel Rega [P831]
'I have to go to the Maccabi (clinic) **CR** # in Neot Rachel for a moment'

b. ani hiStaXRaRti be septembeR **CR** be oktobeR hitXilu kvaR ha limudim [C1621]
'I was discharged in September **CR** in October the university already began'

10 aXRej ze XazaR-nu le Xatgal **CR** # lakaX-nu tRempim le moRon [OCh]
after this return.PST-1PL to Hatgal **CR** # took.PST-1PL free-rides to Moron
'after this we returned to Hatgal we hitchhiked to Moron'

The dependency in line 1 represents a prosodic boundary, i.e., a CR boundary, within enumeration. Portes, Bertrand and Espesser (2007) observed a clear formal difference between the 'continuation rise' and rising contours appearing in enumerations: "Concerning the rising contour appearing in enumeration context, it can be considered as a subclass of continuation rise... We propose that the list rise corresponds to the stylized version of the continuation rise" (Portes, Bertrand, and Espesser 2007, 161). This difference was not tested in the present research due to a small number of enumeration cases in the corpus. Therefore, the issue remains for future study.

The dependencies in lines 2-3, 5-6 also occur with high probability over CN boundaries (Table 21 lines 1-3, 5). The dependency in lines 4 and 7 represents a similar structure of a predicate at the end of an IU and a following IU that begins with a conjunction.

The dependency in line 8 represents a new clause after the CR boundary, since, as mentioned above, adjectives in IH follow the subject and do not precede it. The dependency in line 9 shows possible relations within a clause. From the two examples brought to this trigram, it is evident that there are two dependency types in this case: in

9a it is an appendix within a noun phrase "makabi be neot RaXel" 'Maccabi (branch) in Neot Rachel', while in 9b it is a new clause that begins with a prepositional phrase after the CR.

The trigram "**PN** CR **V**" in line 10 may seem to be a dependency between a subject (proper name) and a predicate (verb), but all six cases of this trigram demonstrate a new clause that begins after the CR boundary. The proper name before the CR boundary is within a prepositional phrase, as shown in the example.

8.4.4 Dependencies over the CRF boundary tone

There are 104 types of CRF dependencies among the 151 trigrams with CRF boundaries. 73 trigrams with CRF are singletons, and 15 more occur only twice. Table 23 shows only the three cases of the most probable trigrams with three occurrences each; and two trigrams that occurred four times each.

Table 23: Dependencies over CRF boundaries

	Preceding	CRF	Following	Occurrences	Prob.	Dependency
1	NEG [lo]	**CRF**	NEG [lo]	3	0.041	Repetition
2	NEG [lo]	**CRF**	PRP	3	0.041	A new clause after the CR boundary
3	NEG [lo]	**CRF**	PREP	3	0.041	A new clause after the CR boundary
4	N	**CRF**	CONJ	4	0.009	A new clause after the CR boundary
5	N	**CRF**	SUB	4	0.009	Between main and subordinate clauses

The three trigrams in lines 1-3 represent a CRF tone over the negation lexeme [lo] 'no', and a new clause after the CRF boundary. These cases, and 17 additional cases of [lo] before the CRF tone in the corpus, are evidence of a characteristic tone that is attached to [lo] in IH. Nevertheless, [lo] is more frequently uttered with a CE tone (28 cases in the corpus) and with the neutral CN tone (22 cases). The dependency in line 4 is also one of the most probable with CN and CR boundary tones. The dependency in line 5 represents relations between main and subordinate clauses. This dependency is not unique to CRF, although it is the first time it is mentioned. It actually occurs 35 times over C-boundaries, but until this, it was not one of the most probable cases. To sum up the CRF

boundary, the dependencies over CRF are scarce and therefore should be dealt with in a larger database, where more occurrences of this boundary tone will be found.

3gram	**Example**
1	keilu lo **CRF** lo biglal ha minusim [D341] 'like not **CRF** not because of the overdraft'
2	lo **CRF** ani hiStaXRaRti be septembeR [C1621] 'no **CRF** I was discharged in September'
3	lo **CRF** be Stajim ze ha aXaRon [C514] 'no **CRF** at two it is the last one'
4	likRo le teXnai mekaReRim **CRF** gam jiftoR et ze [D122] 'to call a refrigerator technician **CRF** also will solve it'
5	po **CRF** jeS **CRF** # SaRSeRet haRim **CRF** Se nikRet guRvan tsajXan 'here **CRF** there is **CRF** # a mountain range **CRF** which is called Gurvan Saikhan'

8.4.5 Dependencies over the CF boundary tone

There are 90 types of CF dependencies (types) among the 136 trigrams with CF boundaries. The most frequent one occurs 12 times and is a sequence of "N CF CONJ" (p=0.027). This dependency was also found to be most frequent in CN, CR and CRF, discussed above. The next dependencies occur five times or less. All of them occur in other C-boundaries as well and therefore will not be detailed here.

8.5 From POS to lexeme analysis – The preceding elements

Further to the descriptions of POS probabilities (§8.1-8.3) and with each of the C-boundaries (§8.4), the present section will also relate to preceding POSs and to dependencies, but from a closer perspective.

Although Table 13 shows the probability ratios of POS before C-boundaries, the description above was concerned mainly with whether the POS does or does not occur before any of the C-boundaries.

Following the results in §8.1 about grouping the preceding POSs into three categories, I will highlight both typical characteristics of each of the C-boundary environments and unique cases. Authentic examples from the corpus will be brought to illustrate the generalizations. This attention to concrete cases will be of help in basing the analysis on more solid and clearer data. The description will be presented according

to the three groups in Table 13, which is based on CE bigrams. CE was chosen as the anchor point since it is the only C-boundary that has bigram probabilities higher than 0.70.

8.5.1 Group A POS

The probability results in Figure 14 show all POSs that are most likely to be elongated, i.e. before CE, in comparison to probabilities of other C-boundary bigrams. Examples of each of the bigrams with CE are presented below the figure, where an account of the lexemes "behind" these POS reveals that the POSs in group A consist each of very few, if not of single, lexemes. Although the nuances of the grey scales are a bit difficult to perceive, it is the *grouping* of C-boundaries on the x-axis which is of importance, rather than the difference between POSs.

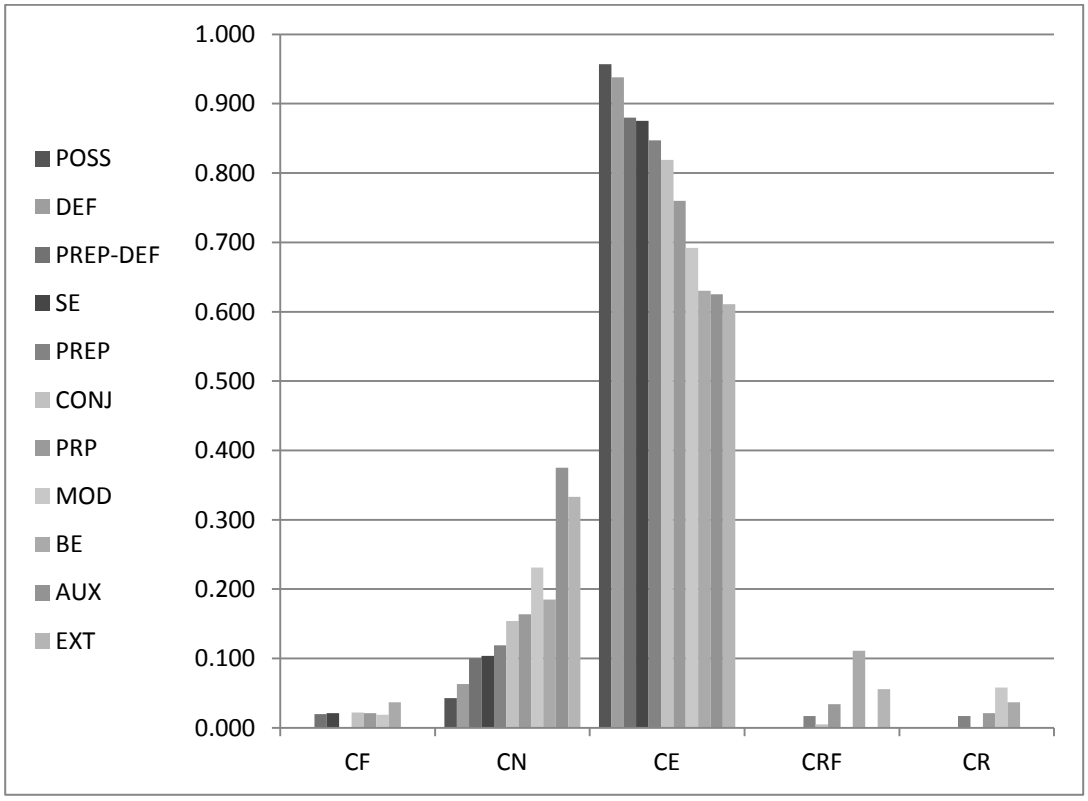


Figure 14: Most probable (p>0.6) bigrams with CE compared with probabilities of other C-boundary bigrams

8.5.1.1 POSS [Sel] 'of'

The POSS tag consists of a single word, [Sel] 'of', which in IH does not necessarily reflect possessive relations. A representative example is shown in (40).

(40) Semot Sel sRatim **CR** ve Semot Sel e **CE** zamaRim **CR** [C412]
'names of movies **CR** and names of eh **CE** singers **CR**'

In general, [Sel] 'of' conjuncts between two nouns with attributive relations, and thus is an analytic form of construct state NPs (see §8.3.1). The same attributive relations between two nouns, also exist in eight POSS-DEF [Sel ha] 'of the' sequences that precede the CE boundary, as in (41). Nevertheless, these [Sel ha] 'of the' sequences are grouped and counted with the DEF [ha] 'the' POS before the C-boundary.

(41) hu me ha sug Sel ha **CE** # natslanim [P424]
'he is of the kind of the **CE** # exploiters'

[Sel] dependency

[Sel] dependencies occur when an expected nominal in a [Sel] construction occurs right after the elongated [Sel] 'of'. Such cases were found in the research and are shown in §8.3.2 (Table 19b, lines 11 and 13). In (40) above, the difference between CR and CE is reflected in the different syntactical environment. While CR occurs after the full NP [Semot Sel sRatim] 'names of movies' and [Semot Sel zamaRim] 'names of singers', the CE occurs after the conjunction [Sel]. In (42) there is also a 405ms breath pause between the two words.

(42) siim Sel e **CE** # psagot [OCh]
'peaks of eh **CE** # heights'

The same dependency occurs with the hesitation marker [em] 'ehm' in (43):

(43) ve jeS haRbe Xanujot **CR** Sel e **CE** # em **CE** halbaSa taXtona [D741]
'and there are many shops **CR** of eh **CE** # ehm **CE** lingerie'

There are also three cases with a following NUM, as in (44):

(44) sedeR godel Sel e **CE** # aRbaim ve Stajim Saot [OCh]
'an estimate of eh **CE** # forty two hours'

8.5.1.2 DEF [ha] 'the'

The DEF tag consists of a single word [ha] 'the', the definite article in IH. A representative example is shown in (45).

(45) ani jeXola lehavin et ha **CE** # et ha **CE** # tiskul **T** # [C412]
I can to understand ACC the **CE** # ACC the **CE** # frustration **T**
'I can understand the the frustration'

Thus, the high probability of DEF in the "preceding POS" Table (Table 12, line 2) reflects a "strong" dependency within a noun phrase that is shown in the dependency Table (Table 19a, line 1), where we see that cases of elongated [ha] 'the' before a noun are most expected to be split by a CE boundary. It can also be concluded that an elongated [ha] reflects dependency on an expected following noun that will or will not be uttered.

Moreover, the grammatical element preceding the [ha] reflects the syntactic slot that this split NP fills. In 53% of these cases (25 cases, including two cases of [et kol ha] 'Acc. all the') the accusative [et] precedes [ha], a string which reflects two possibilities: the first, that the split NP with the elongated [ha] is the direct object of a transitive verb, as in (46); the second, that the NP is an argument in an EXT structure (Kuzar 2002), as in (47). This issue will be discussed further below.

(46) hu ose b-a blendeR et ha **CE** Rotev **TQ** [C1111]
he makes in-the blender ACC the **CE** sauce **TQ**
'does he make the sauce in the blender'

(47) az jeS l-i et ha **CE** ze **T** [P911]
so EXT to-1SG ACC the **CE** this **T**'
'so I have this'

8.5.1.3 PREP-DEF

The PREP-DEF tag has two forms [ba] 'in-the' and [la] 'to-the'. Representative examples are shown in (48)-(49).

(48) ze lo bba lijdej bituj **T** Se ze ba **CE** sefeR **T** [P711]
it was not expressed **T** that it is in-the **CE** book **T**
'it didn’t seem to be in the book'

(49) al ha Xultsot Se hu hizmin la **CE** pluga Selo **CR** [P831]
on the T-shirts that he order.PST.3SG to-the **CE** company of.3sg.f **CR**
'(to pay for) the T-shirts he ordered for his (military) company'

The same dependency as of the definite article (§8.5.1.2) is found in each of the 16 elongated PREP-DEFs (Table 19a, line 2). On the other hand, Table 19b, line 15, reflects repetition of this construction. In five of these cases, the repeated PREP-DEF is precedent to a Noun, a single case is precedent to [ze] 'this', and another one (50) is precedent to an adjective, which is an ellipsis of [sandalim sguRot joteR].

(50) aRbaim ve aRba ba **CE** ba **CE** # ba sguRot joteR **T** [D741]
fourty four in-the **CE** in-the **CE** # closed more **T**
'fourty-four of the of the more closed ones'

8.5.1.4 SUB [Se]

The SUB tag consists of a single word [Se] 'that' (or 'who' or 'which'), which reflects two types of subordinate particles: 29 relative pronouns, as in (51) and 16 complementizers of verbal structures, as in (52).

(51) Rov ha anaSim Se **CE** hiSpiu al ma Se ani maamina hajom [C413]
'most of the people who **CE** influenced what I believe today'

(52) bikaS-t Se **CE** ni-kne adaSim [D741]
ask.PST-2SG.F that **CE** 1PL-FUT.buy lentils
'you asked us to buy lentils'

Three [Se] 'that' are within complex particles, as in (53)-(55).

(53) biglal Se **CE** haji-nu koma RiSona **CRF** [C1621]
'since that **CE** be.PST-1PL floor first **CRF**
'since we lived on the first floor'

(54) be emtsa detsembeR ani mitlabetet **T** # lamRot Se **CE** jeS li avoda [C1621]
'in mid December I have second thoughts **T** # even though **CE** I have a job'

(55) tsaRiX laleXet liRot et ha tSipsim **TQ** # o Se **CE** Rak sam-tem **TQ** [C714]
... **TQ** # or that **CE** just put.PST-2PL **TQ**
'should we check on the chips or maybe you just put (them in the oil)'

8.5.1.5 Prepositions

When a preposition is elongated with a CE boundary tone, it is assumed that the dependency is within a phrase, between the preposition and the NP.

To the "PREP CE N" sequence, an additional sequence might be added: "PREP CE NUM", which occurs three times (56)-(58), although in (57) the POS tag NUM represents an hour, not a numeral. (58) is exceptional since it reflects a repetition with correction after the elongated preposition; therefore, the projected dependency is indeed between a PREP and a NP [tiSim aXuz me CE… ha kahal SelaX] (lit. ninty percent from CE... the audience of.2SG) '90% of your readers'.

(56) ze mea kilometeR ze eXad le **CE** elef **T** [OCh]
this one-hundred kilometer this one to **CE** one-thousand **T**
'this is one hundred kilometers it is one to a thousand'

(57) Se je-Xaku be **CE** # XameS va Xetsi **TQ** [P831]
that 3PL-FUT.wait at **CE** # five and half **TQ**
'should they wait at five thirty'

(58) buRim laXalutin kmo tiSim aXuz me **CE** # tiSim ve XamiSa aXuz me ha kahal SelaX [C412]
'completely ignorant like ninety percent of **CE** # ninety five percent of your audience'

Regarding the apparent repetition of "PREP CE PREP" in Table 19a, line 5, such seeming repetitions include mere repetitions (9 cases); corrections, as in (59); an allophonic correction (60), and no repetition at all, as in (61).

(59) ze hakol gam.ken al e **CE** be Ramat ha kombina biXlal **T** [OCh]
this everything also about eh **CE** in level.of the shady.business anyway **T**
'this is also all about eh a shady business plan'

(60) me ha majim kaze mi **CE** # me ezeSehu omek T [P711]
'from water like that from **CE** # from some kind of depth T'

(61) jeS tslil kaze kmo **CE** be tanuR kaze **T** [C1111]
'there is such a sound like **CE** in an oven like that **T**'

Repetitions of prepositions, although regarded as disfluency, reflect the potential break after prepositions. In fact, these repetitions might be evidence that the CE boundary occurs due to its *preceding* element, and not due to the *following* element (as implied in "complexity hypothesis" theory (Clark and Wasow 1998; Roll, Frid, and Horne 2007) (see discussion in §9.4.1.1).

8.5.1.6 Conjunctions

The CONJ tag consists mainly of two words [ve] 'and' (over 720 times) and [aval] 'but' (over 240 times). A representative example is in (62).

(62) ba jom ha RiSon haja eze efes **T** aval e **CE** # jomajim aXaRehem haja joteR Xam **T** [OCh]
'on the first day it was around zero **T** but eh **CE** # two days later it was warmer **T**'

Of the 178 conjunctions that precede C-boundaries, 58% are of [ve] (86 cases) and [aval] (18 cases). [ve] 'and' occurs mostly before CE-boundaries and 7 times before CN-boundaries. [aval] occurs 10 times before CN, six times before CE and the rest with other C-boundaries. But unlike [ve], [aval] is also found in IH before terminal (T and TQ) boundary tones, a phenomenon which reflects the relatively free increment order in IH. Indeed, there are also 6 cases in the corpus where [ve] is found before T and TQ boundaries, as (63)-(65) demonstrate. In the case of [aval], the free increment order is reflected, as in (63), while in [ve] cases, the increment order remains and a continuity effect increases (64)-(65).

(63) ma ha laXats aval **TQ** [C1621]
what the pressure but **TQ**
'what is all the fuss about'

(64) # ve **TQ** [P831]
'# and **TQ**'

(65) ReSima mesudeRet Sel Seelot ve **T** # ve az e **CE** [C412]
'an ordered list of questions and **T** # and then eh **CE**'

[ve] and [aval] are mentioned in Maschler's (2009) comprehensive work on Hebrew discourse markers. Since the massive amount of [ve] and [aval] affects the

dependency relations of conjunctions over C-boundaries, it is not surprising that they demonstrate the behavior of DMs (Table 19b, lines 18-19).

Coordination structure dependency A

Two dependencies where the conjunction precedes the CE are in lines 8 and 19 in Tables 19a-b. Line 8 seems to be a repetition: "CONJ CE CONJ". Examining the word level of these 20 cases shows 14 mere repetitions, 11 of which are repeated [ve]; 1 case of repeated [aval]; 1 case of repeated [ulaj] and 1 case of repeated [kSe]. Six cases are not repetitions but a kind of new start, with two different conjunctions: an elongated one before the C-boundary and another following it, as in (66)-(67).

(66) aval e **CE** # imm miSehu jaXziR **CRF** # [D741]
but eh **CE** # if someone will return it **CRF** #
'but eh if someone returns it'

(67) ze gam e **CE** afilu imm … [D122]
'it is also eh **CE** even if…'

It seems that repetition of conjunctions before and after the CE boundary does not reflect dependency within phrases, or at least not dependency that can be studied from the immediate environment of the C-boundary. The repetition in (68) is the only case where, after examining the wider context, the conjunction can be analyzed as a conjunction within a VP.

(68) ve anaSim aXRej ze **CE** panu elaj ve **CE** # e **CE** ve **CE** ve Saalu Seelot CN [C413]
'and later people **CE** addressed me and # **CE** eh **CE** and **CE** and asked questions CN'

The other repetitions seem to be cases of discourse markers. Indeed, in IH, several conjunctions are analyzed as discourse markers; for example, Maschler (2009, 23) analyzes [ve] 'and' as a discourse marker.

The 19 cases in Table 19b (line 19) include the following string: "CONJ CE PRP". This seems to be a conjunction before a personal pronoun that is the subject of a sentence, as in (69)-(70):

(69) ki **CE** ani lo magia le Sam ani magia le oRot **T** [C612]
'because **CE** I do not get there I get to Orot **T**'

(70) ani mitlabeSet **CN** # ve **CE** # ani holeXet lesadeR et ha bituaX SelaX **T** [P831]
'I am getting dressed **CN** # and **CE** # I am going to take care of your insurance **T**'

From (69)-(70), it is evident that the elongated conjunction indeed connects two continuous units, and therefore reflects a syntactic dependency, and does not fulfill only a discursive function.

Coordination structure dependency B

Coordination structure dependency is reflected not only when the conjunction precedes the C-boundary, as shown in Table 19b (lines 8 and 19), but also when the conjunction follows the C-boundary, as in Tables 19a-b (lines 4, 6, 8, 10, and 20). From these, it is evident that conjunctions can follow CNs and even CRs. Unlike the uncertainty in the discursive role of elongated conjunctions before CEs, i.e. whether they function as DMs or as conjunctions, the four trigrams in lines 4, 6 and 10 and 20 do function as conjunctions, a role that is evident due to the complex adjective in (71): [meod anija ve meod aluva] 'very poor and very shabby', but also due to the elaborate story in the following sentence in (72) and in (73). Examples (74)-(75) demonstrate the opposition characteristic of conjunctions:

ADJ **CN** CONJ (line 4):

(71) Se hajta neXmada kazot aval meod anija **CN** ve meod aluva **CN** [C612]
'who was kind of nice but very poor **CN** and very shabby **CN**'

(72) ani mamaS gea **CR** # aval ha **CE** XaveRim ba avoda ... [P1022]
'I am really proud **CR** # but the **CE** friends at work …'

PRON **CN** CONJ (line 6):

(73) hisgiR-ø et atsmo **CN** ve jaSav mamaS ktsat zman **T** [C1621]
turn-in.PST-3SG.M ACC himself **CN** and sit.PST.3SG.M really little time **T**
'he turned himself in and was imprisoned for a short time'

N **CN** CONJ (line 10):

(74) kol jom medabRot ba telefon **CN** ve nifgaSot ve hakol **T** # [P1241]
'every day (they) talk on the phone **CN** and meet and everything **T**'

ADJ **CR** CONJ (line 20):

(75) ve hakol haja **CRF** kaze **CN** # e **CE** neXmad ve tov **CR** ve pitom @ **T** [D631]
'and everything was **CRF** like **CN** # eh **CE** nice and good **CR** and suddenly @ **T**'

The difference between the use of CR and CN in the above coordination structures seems to stem from the dichotomic characteristic of CR. (75), for example, demonstrates an opposition function, while the CN examples, (71)-(74), have a continuative function, since the coordination structures are located between items of the same semantic value or when there are more than two items on the list. Nonetheless, a CONJ after a C-boundary is common to CR and CN boundary tones, which are different from the preceding CONJ, which is common to the CE boundary tone.

8.5.1.7 Personal pronouns

The PRP tag consists of the eight personal pronouns in spontaneous IH: [ani] 'I', [ata] 'you.SG.M', [at] 'you.SG.F', [atem] 'you.PL.M/F', [hu] 'he', [hi] 'she', [hem] 'they.PL.M/F. These are usually found in the subject position of a clause, as in (76), but also in other syntactic slots: extraposition (left dislocation/detachment) as in (77), or as a substantive non-clausal IU, which consists of the subject only, as in (78). (78) is unique in the sense that the pragmatic end is reflected vividly both in the repetition and in the minimal syntactic increment that it consists of. (79) is another use of a CR boundary after a PRP. This is the pragmatic use of a rising boundary tone, which is beyond the scope of the present research.

(76) eldad hexlit Se hu **CE** lo mvateR **T** [OCh]
'Eldad decided that he **CE** would not give-up **T**'

(77) hem **CE** be ezeSehu Salav i.efSaR le-hadlik otam **T** [C714]
they **CE** in some stage impossible to-light these **T**
'these at some stage it is impossible to light them'

(78) Se hahu Sama Se hahu Se hu Se hu Se hu Se hu **CR** [OCh]
'that that one heard that that one that he that he that he that he **CR**'

(79) amaRti lla ani **CR** # ani elaXem al ze Se at taXSevi levad [P424]
'I told her I **CR** # I would fight for you to think for yourself'

Subject-Predicate (S-P) dependency

Spoken IH uses SVO word order in sentences with subject pronouns (see §7.2.1). No VSO structures were found in the environment of C-boundaries in the present research. All cases of the Verb-C-boundary-PRP sequence are due to new starts (i.e. new clauses) after the C-boundary.

The assumed dependencies in Table 19a, lines 7 and 9, are between a subject and a verbal or participial predicate. Participles are indeed different in structure and capacities from Hebrew verbs, but are usually seen as enabling paradigmatic change with verbs in a sentence, as in (81a-c). Additional examples of the S-P dependency over C-boundaries are given in (80)-(86).

(80) Trigram: PRP **CE** V (Table 19a, line 7):
a. Verbs with a pronominal suffix
i. # ata **CE** # Samata Se hitkaSaRti le **CE** kupat Xolim **TQ** [P711]
2SG **CE** # hear.PST-2SG that call.PST-1SG to CE medical clinic **TQ**
'did you hear that I called the medical clinic'

This dependency occurs over the CN-boundary as well:

ii. ani **CN** asi-ti kRuv [C1111]
I **CN** make.PST-1SG cabbage
'I made cabbage'

b. Verbs with a pronominal prefix
i. ani **CE** e-leX aXSav le tsaXi [P831]
I **CE** 1SG-FUT.go now to Tsahi
'I will go to Tsahi now'

This dependency occurs over the CN boundary:

ii. lo anaXnu **CN** ni-fgoS oto [P311]
no we **CN** 1PL-FUT.meet him
'no we will meet him'

(81) Trigram: PRP **CE** PTCP (Table 19a, line 9):
a. tRemp ze S=ta **CE** medabeR im anSim be eRev [OCh]
'hitchhiking is when you **CE** talk to people in the evening'

This dependency also occurs over CN-boundaries, as in (81b), and in one case with CF (81c).

b. ani **CN** nosaat le makabi [P831]
'I **CN** am-going to Maccabi'

c. ata **CF** jodea efo mabas **TQ** [P424]
'you **CF** know where Mabas is **TQ**'

Subject-predicate dependency is also apparent in three cases of proper names (PN) in the subject position, as in (82), or a noun in the subject position, as in (83).

(82) Trigram: PN **CE** V:
aval gali **CE** jada Se... [C1621]
'but Gali **CE** knew that...'

(83) Trigram: N **CRF** PTCP:
ha etsim **CRF** mizdaknim CR ve noflim **T** [OCh]
'the trees **CRF** are getting old, and falling down **T**'

On the other hand, there is no SV dependency over CF or CR boundaries, although there are cases of proper names before and a verb after these C-boundaries. In such sequences, the proper name is usually within a PP that is an adjunct, while the predicate opens a main clause, as in (84)-(85).

(84) be ejs **CR** # ole mea Sivim Sekel **T** [D23]
'at Ace (a store) **CR** # (it) costs one-hundred seventy shekels **T**'

(85) kSe haji-ti XaveRa Sel uRi **CR** # jaSan-ti b-a moSav ha aXoRi [C1621]
when be.PST-1SG.F girlfriend of Uri **CR** # sleep.PST-1SG.F in-the seat the back
'when I was Uri's girlfriend I slept in the back seat'

A single case of subject-predicate dependency over the CR-boundary is when the proper name is in the attribute position within a subject NP with the conjunction [Sel]

(86). This single case may reflect the prosody of appositions, since [bat doda Sel josi] 'cousin of Yossi' is an apposition of [gali] 'Gali':

(86) gali bat doda Seli **CR** # gali bat doda Sel josi **CR** kina Se halaX-nu biladeha [C1621]
'Gali cousin of.mine **CR** # Gali cousin of Yossi **CR** envy.PST-3SG that go.PST-1PL without.2SG'
'my cousin Gali Yossi's cousin Gali was jealous because we went without her'

To sum up, the S-P dependency over C-boundaries occurs mostly with CEs and to a lesser extent with CNs. A single case was found over CRF (83) and over CF (81c). CRs do not show such dependency, unless in a complex NP with an apposition, as in (86).

8.5.1.8 Modifiers

A modifier is the POS tag given quantifiers and other modifiers that precede the noun they modify. Examples (87)-(88) are representative examples of modifiers that precede a C-boundary within a phrase: NP in (87) and AP in (88). (89), on the other hand, also has a modifier before a C-boundary, but with no dependency on the following POS.

(87) lehagiS llo kol Savua **CN** # eze **CE** # peiper katan **T** [C412]
to submit to.3SG every week **CN** # a certain **CE** # paper small **T**
'to submit a short paper to him every week'

(88) jeS la-hem et ha lakoXot haXi **CE** besedeR [D341]
EXT to-3PL ACC the clients most **CE** okay
'they have the most reliable clients'

(89) lo XaveRot haXi haXi haXi **CR** # aval **CE** [P1241]
no friends the-most the-most the-most **CR** # but **CE**
'not the very best friends but'

Example (89) is different from the two preceding cases in that in IH a triple repetition of [haXi] 'most' means 'the very best' – a full pronounced adjective that does not require a syntactic continuation.

Quantifiers were also tagged as MOD since they also precede the noun that they attribute (except the number 'one'. "'1', alone among numerals, follows its noun…" (Glinert 1989, 82)). (90) is a representative example.

(90) Smona esRe **CR** ve tSa esRe **CR** ve esRim Sana **T** [D741]
'eighteen **CR** and nineteen **CR** and twenty years **T**'

Example (90) is a characteristic list contour with CR-boundary tone.

Modifier dependencies

Cases of modifier-adjective dependency over CE were counted. For example, (88) above and (91):

(91) haRbe joteR e **CE** ofnati **CRF**[37] [D741]
'much more eh **CE** fashionable **CRF**'

Cases of modifier-noun dependency over CE were counted. For example, (88) above and (92).

(92) mea XamiSim e **CE** iS **T #** [C413]
'one hundred fifty eh **CE** people **T**'

Cases as in (87)-(88) and (91)-(92) show "strong" dependency within a phrase. The two trigrams in Table 19b lines 16-17 show the high probability of this modifiers' dependency.

8.5.1.9 BE

The BE tag consists of a single root /HJJ/ 'be' with suffix or prefix conjugations, which reflects two syntactic roles: modality and copula functions. Representative examples of the modal function are shown in (93). The examples in (94) demonstrate the copula role of the root /HJJ/ in IH. This function is limited to adding a tense to non-verbal clauses or to expressing a habitual aspect in the past, such as 'I used to run twice a week'.

(93) Modal [BE]:
a. imm haji-ti **CF** b-a tiRon **F** # b-a bsis tiRonim [C1621]
if be.PST-1SG **CF** in-the training **F** # in-the base recruits
'if I were in basic training on the recruits' base'

[37] In the current example, each of the sequential modifiers: [harbe] 'much' and [joter] 'more' was tagged as a separate modifier.

b. lo ze ani lo haji-ti **CE** ze gam lo [D122]
lo this 1SG not be.PST-1SG **CE** this also no
'not this I would not (throw) this (out) either'

Two cases of BE with prefix conjugation are interpreted as modal lexemes also due to the preceding [Se] 'that':

c. Se ji-hje **CE** # aRuk-im [C714]
that 3SG.M-FUT.be **CE** # long-PL
'so let it be long'

d. Se ji-hje **CE** RaXav **T** [C714]
that 3SG.M-FUT.be **CE** wide.SG **T**
'so let it be wide'

(94) Copula
a. Copula with CE-boundary tone:
i. ze kvaR haja **CE** # emtsa septembeR [OCh]
this already was **CE** # middle September
'it was already mid-September'

b. Copula with other C-boundary tones:
i. juval haja **CN** b-a gan [C612]
'Yuval was **CN** in-the kindergarden'

ii. suRja ve ele ji-hju **CR** ve mi jisRael lo **T** [C714]
Syria and these 3PL-FUT.be **CR** and from Israel no **T**
'Syria and others will attend but not Israel'

The underlined prepositions in examples (94b-i)-(94b-ii) imply that the BE lexeme functions as a locative existence proposition (Borochovsy Bar-Aba 2001). The question is whether the relatively high probability (p=0.586) of the bigram "BE CE" implies one of the two roles – modal or copula – of BE. The results show that the semantic values cannot be concluded from the C-boundary distribution. One thing is common to all BEs that precede C-boundaries – they require a complement, i.e. none of these examples are at the end of a clause, like, for example, a grammatically correct sentence such as [davaR kaze lo haja] 'something like that has never been'.

8.5.1.10 AUX – Modal lexemes

The AUX tag consists of modal lexemes such as [jaXol] 'can' and [tsaRiX] 'have to'. These lexemes are similar to the POSs discussed above, in the sense that they are often uttered within a phrase (i.e. VP). Representative examples are shown in (95)-(97).

(95) efo ha davaR haze Se tsaRiX-ø e **CE** lenakot oto **TQ** [D731]
where the thing the-this that need.3SG eh **CE** to clean ACC.3SG **TQ**
'where is that thing that has eh to be cleaned'

(96) jaXl-a **CE** gam le-hitgaReS aval **T** [C1111]
can.PST-3SG.F **CE** also to-get.divorced but **T**
'but (she) could have gotten a divorce too'

(97) anaXnu amuRim e **CE** le-atsev i-ta [D341]
we suppose.PASS.PL eh **CE** to-design with-3SG.F
'we are supposed eh to design with it'

8.5.1.11 Existentials [jeS] 'there is' and [en] 'there is not'

The EXT tag consists mainly of two words [jeS] 'there is' and [en] 'there is not'. In addition to [jeS] and [en], another existential predicate, [kajam] 'exists', was found once before a CE-boundary, in (100). Representative examples of the two major lexemes are shown in (98)-(99).

(98) ha injan Sel en fejot Sedonim en e **CE** miflatsot en e **CE** ze **T** [C1621]
'the issue (that there are) no fairies imps (there are) no eh **CE** monsters no eh **CE** this **T**'

(99) jeS e **CE** aX kaze [OCh]
EXT eh **CE** fireplace like.this
'there is eh that kind of fireplace'

Example (100) has the same rhematic structure, like the unmarked structure of the existentials [jeS] and [en] in IH (Kuzar 2002, 340).

(100) hajom kajam-ø **CE** # kav e **CE** si- **F** kav tmiXa … [C413]
today exist-3SG.M **CE** # line.of eh **CE** @- **F** line.of support …'
'today there is a telephone number of eh a support number …'

Two EXT with suffix conjugation, [haja-ø] (lit. EXT.PST-3SG.M) 'there was', and one with prefix conjugation, [ji-hju] (lit. 3PL-FUT.EXT) 'there will be', are also counted as existentials before C-boundaries. (101) is an example of EXT with suffix conjugation before a CN-boundary tone.

(101) safaR-ti Savua Se lo haja-ø **CN** od Savua Se lo haja-ø **CN** aXSav jeS **T** [D631]
count.PST-1SG week that no EXT.PST-3SG.M **CN** another week that no EXT.PST-3SG.M **CN** now EXT **T**
'I counted a week without (a lesson) another week without (a lesson) now there is (a lesson)'

Existential dependency

Six EXT–N dependencies occur over C-boundaries, with relatively high probability (Table 19b, line 12). Three of them are mentioned in (98)-(100).

The example in (102), although it has the same trigram annotation "EXT CE N" as in (98)-(100) above, does not reflect a dependency, but rather an abandoned [en], and a new clause after the CE. After the speaker completes this new clause [Sum heveti] 'I brought garlic', he continues what he wanted to say with the abandoned [en] 'there is not' in the following IU. This time the EXT is produced with a CN boundary tone followed by a pause.

(102) heve-ti batsal **CN** en e **CE** Sum heveti **T** en **CN** # sXoRa keilu **T** [P1022]
bring.PST-1SG onion **CN** NEG.EXT eh **CE** garlic bring.PST-1SG **T** NEG.EXT **CN** # merchandise like **T**
'I brought onion there is no eh I brought garlic there is no merchandise like'

The same dependency is reflected over other C-boundaries, though less frequently, as in (103)-(104):

(103) po **CRF** jeS **CRF** # SaRSeRet haRim **CRF** Se nikR-et guRvan tsajXan **T** [OCh]
here **CRF** EXT **CRF** # chain mountains **CRF** that call.PASS-3SG.F Gurvan Saikhan **T**
'here there is a mountain range which is called Gurvan Saikhan'

(104) po jeS **CN** # ktsitsot Sel savta nomi [D122]
here EXT **CN** # burgers of grandma Naomi
'here you have grandma Naomi's burgers'

8.5.1.12 Other POSs

In addition to the POSs discussed above, several sub-categories of POSs were also found with high probability before CE: construct-state nouns, NEG-[?al][38] 'do not' and the accusative marker [et] 'Acc.'. Their high probability is due to the fact that the rare (one or two) cases when they occur are before CE and not before other C-boundaries.

NEG-[?al] 'do not'

With respect to the two occurrences of the negation [?al] 'do not', no conclusion can be reached, except that [?al] is always the first increment in a syntactic structure and thus needs a continuation, like the other POSs in group A. Nonetheless, [?al] 'do not' can be uttered as an interjection, for pragmatic reasons, such as the warning in (105).

Accusative marker [et] 'Acc.'

The accusative marker was discussed above with respect to its attachment to the definite article [ha] 'the'. In addition, the elongated accusative marker will be discussed below (§9.4.1.1), with regard to encliticization. One of the elongated ACC occurrences is in (106).

(105) NEG-[?al] 'do not'

a. ?al **CN** jeS lemata ktsat saRuf ?al te-gaRdi joteR [C714]
do.not **CN** EXT bottom bit burn do.not 2SG.F-FUT.scrape anymore
'don't the bottom is a bit burned don’t scrape anymore'

b. ?al **CE** ta-lXits oto T # [P1241]
do.not **CE** 2SG.M-FUT.pressure ACC.3SG.M
'don't pressure him'

(106) [et] ACC

a. az asaf-nu et e **CE** tsijona mi geha **T** [P831]
so pick_up.PST-1PL ACC eh **CE** Tsiyona from Geha **T**
'so we picked eh Tsiyona up from Geha'

[38] The negation word *don't* is pronounced in IH [?al] or [al], but is transcribed in the present research [?al] in order to differentiate it from [al] 'on'. All "irregular" transcriptions used in the present research are summarized in Appendix I – Word level transcription standards.

Construct-state nouns

Construct state nouns (the first noun in a compound) were found 11 times before C-boundaries. It is assumed that the compositional lexeme (the second word in a construct state) is therefore expected after the C-boundary. These 11 spilt nouns are shown in (107a)-(107k).

(107) Construct-state nouns

a. ze jihje be m **CE** # sof e **CE** ogust **T** [D631]
'it will be at the ehm **CE** end_of eh **CE** August **T**'

b. ki ze bet sefeR e **CE** omanut ve itsuv [D341]
'since it is a school_of eh **CE** art and design'

c. asiti Snej **CE** kos-ot_ø e **CE** oRez [D731]
make.PST-1SG **CE** cup-PL_of **CE** rice
'I made two cups of rice'

d. milXemet e **CE** XamiSim ve SeS **T** [C412]
war_of **CE** fifty and six **T**
'the 1956 war'

e. ani be emtsa **CF** peilut miStaRtit kan [P311]
'I am in the middle_of **CF** police activity here'

f. ze biRat **CN** # e **CE** # ha **CE** ha **CE** saUT gobi **T** [OCh]
'this is the capital.of **CN** # eh **CE** # the CE the **CE** south Gobi'

g. ve asit iskat **CN** Xajim SelaX **T** [P1022]
'and you made the deal_of **CN** your life **T**'

h. hasbaRa be nose **CE** hatRada min-it b-a kampus **T** [C413]
publicity in subject.of **CE** harassment sex-SG.F in-the campus **T**
'publicity about sexual harassment on campus'

i. Svilej **CR** Svilej afaR **T** [OCh]
paths_of **CR** paths_of dust **T**
'paths dirt paths (trails)'

j. kav ø e **CE** si- **F** kav tmiXa v- **F** # ve **CE** mejda **CR** [C413]
'line of eh **CE** @- **F** line.of support an- and **CE** information **CR**'
'support and information telephone number'

k. kol minej divRej e **CE** ha dvaRim ... [D122]
many kind_of things_of **CE** the things …
'many kinds of things of the things ...'

In (108), there is a different case, similar to construct-state nouns, where a CRF boundary occurs within a NP [kita CRF jud] {class CRF ten} '10th grade'. Nevertheless, this is not a construct state noun, but an absolute form of the noun [kita] 'grade' (literally 'class'). Such relations are considered a kind of apposition, but one that consists of proximity relations, even dependency, as in [koma Smone] '8th floor'.[39]

(108) be kita **CRF** jud **CR** kSe haji-ti XaveR-a **F** aXRej kita jud **CN** kSe haji-ti XaveR-a Sel uRi **CR** [C1621]
at class **CRF** ten **CR** when be.PST-1SG friend-SG.F **F** after class ten **CN** when be.PST-1SG friend-SG.F of Uri **CR**
'in the 10th grade when I was a girlfriend of after the 10th grade when I was Uri's girlfriend'

To summarize, Group A POSs all require complements. Of these, eight grammatical elements (POSS, DEF, PREP-DEF, SUB, PREP, CONJ, MOD, AUX) require complements on the syntactic phrase level. The existential elements require a second argument (Kuzar 2002).

8.5.2 Group B items

Figure 15 shows the group that has medium likelihood to be elongated ($0.3<p<0.6$). The distribution pattern is different in this group. It is not dominated by CE, and the POSs also occur before other C-boundaries. Most of the POSs before CN also have probabilities above 0.3. Examples of each of the bigrams with these POSs are presented below, explaining the lexemes "behind" these POSs. The POSs in Group B differ in the number of lexemes they consist of, i.e. two POSs are open category lexemes (DM and

[39] I would like to thank Prof. Esther Borochovsy Bar-Aba for clarifying this point.

INF) while three others are closed. ZE and LO each consist of a single lexeme; Q consists of seven lexemes.

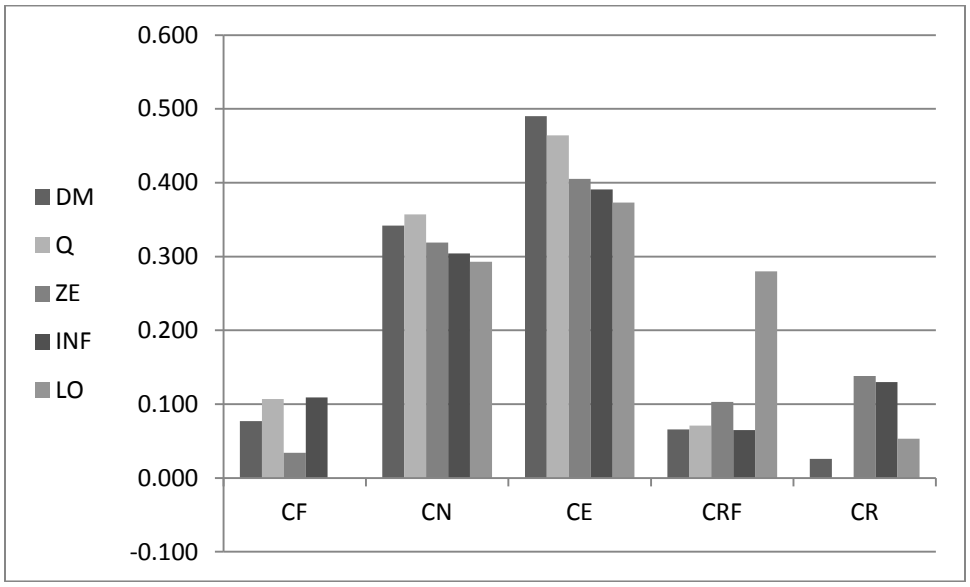


Figure 15: Intermediate probabilities (0.3<p<0.6) of bigrams with CE-boundaries compared with probabilities of other C-boundary bigrams

8.5.2.1 DM – Discourse markers

A discourse marker is an utterance (usually consisting of one word) that, according to Maschler (2009) "must have a metalingual interpretation in the context in which it occurs" (2009, 17-18). In addition, a prototypical discourse marker must fulfill a structural requirement – the utterance must occur at IU initial position, i.e. a speaker's new turn or "in the same-speaker talk, immediately following any intonation contour other than continuing intonation" (Maschler 2009, 17).

196 discourse markers (DM) preceding C-boundaries were tagged.[40] The most frequent DMs before C-boundaries are [keilu] 'like', which occurs 57 times, [az] 'so', which occurs 46 times, [a] 'ah', which occurs 14 times and [ken] 'yeah', which occurs 10 times. These four DMs have two distinct distributions before C-boundaries: [keilu] and

[40] This does not exclude the possibility that they might be utterance-initial as well, as suggested by Maschler (2009).

[az] are more frequent before CE, i.e. they tend to be elongated. All other DMs have fewer than 10 occurrences before C-boundaries.

It should be noted that the same DMs occur in several C-boundaries, and, as shown in (109), the most frequent DM, [keilu] 'like', can also be uttered without any boundary at all. Such results demonstrate the diversity, in terms of semantics and prosodic structure, of DMs in IH (see Maschler 2009, for a comprehensive analysis of Hebrew DMs). Examples (109)-(111) demonstrate three prosodic environments of [keilu] 'like': in fluent speech (109); before CR (110); and before CE (111). The three prosodic environments reflect different positions of the DM in the utterance. (112) and (113) demonstrate two different prosodic boundaries after the DM [az] 'so', CN and CE.

(109) af paam lo taRaXnu keilu linsoa le bet Sean [C614]
'we never bothered like to travel to Bet-Shean'

(110) kivtSutSim Sel nejaR keilu **CR** # ve al ze osa **T** [C714]
'Papier-mâché like **CR** # and on this I do **T**'

(111) ve me az keilu **CE** naasenu XaveRot **T** [P1241]
'and since then like **CE** we have become friends **T**'

(112) Rega az **CN** az kRa **F** # kRa li ani avo itXa **T** [D23]
'wait so **CN** so call **F** # call me and I will come with you **T**'

(113) okej jala **T** # az **CE** at be XameS po **TQ** [P831]
'okay let's do it **T** # so **CE** you will be here at five **TQ**'

Discourse marker and subject sequences

According to Tables 19a-b, personal pronouns are most likely to follow elongated DMs, which may imply a new start after DMs. Indeed, all 21 cases in Table 19b line 18, are of a new clause with personal pronouns as the subject after an elongated DM, like in (114). It can also be said that the DM itself indicates a new turn, but the syntactic clause begins only after it, with the personal pronoun.

(114) az e **CE** hi hajta jalda kazoti noRa Xamuda [P1241]
'so eh **CE** she was this very sweet kind of girl'

The trigram "DM CE PRP" in line 18 can teach us about the trigram in line 19 – "CONJ CE PRP". Since conjunctions function as DMs in IH (Maschler 2009, 23-24), if the conjunction precedes a CE-boundary that is followed by personal pronoun, the function of that conjunction may actually be a discourse marker, and not a conjunct. As shown above, this is not a straightforward conclusion, and may apply only to elongated [ve] 'and' cases.

8.5.2.2 Q – Question words

The Q tag consists of seven words: 20 [ma] 'what', two [efo] 'where', two [eX] 'how', two [kama] 'how much', and single occurrences of [lama] 'why', and [mataj] 'when'. (115) and (116) show representative examples of two frequent question words.

(115) ata jodea efo **CE** makabi **TQ** [P831]
'do you know where **CE** Maccabi is **TQ**'

(116) bekitsuR ma **CE** jeS le elal latus le kahiR biXlal **TQ** [D742]
'in short, what **CE** is Elal doing flying to Cairo **TQ**'

A single occurrence of [haim], the yes/no question word in IH, also occurred before a CE boundary (117).

(117) ve haim **CE** jeS davaR kaze o en davaR kaze [C412]
'and is **CE** there such a thing or is there no such thing'

Qs were not found before CR, probably because if the Q word is pronounced in a rising tone, it is interpreted as a question (TQ boundary) that consists of the Q word alone. In a complex question, where the Q word opens the sentence, we would not expect a rising tone on the Q. The fact that all C-boundaries except CR occur after Q is evidence of the systematic use of C-boundaries by the speaker's and/or the listener's interpretation of the rising tone in the environment of Q word, i.e. listeners cannot accept Q words with a rising tone, unless they are questions.

8.5.2.3 [ze] 'this' – Demonstrative pronoun dependencies

The ZE tag consists of a single word [ze] 'this', which is an indefinite pronoun. [ze] 'this', is mostly used as a demonstrative pronoun, as in [ani Rotse et ze] 'I want Acc. this'. [ze] was not tagged as a type of a pronoun since, as demonstrated by Izre'el (2010, 71-72) and by Borochovsky Bar-Aba (2010, 183-207), it can fulfill various word types in nominal and verbal clauses. Nevertheless, three dominant syntactic position of [ze] can be described:

- An expletive subject, as in (118), where it is expected to share a C-boundary distribution, similar to personal pronouns. In this respect, Borochovsky Bar-Aba (2010, 190) concludes that many roles of [ze] 'this' at sentence initial position are vague and ambiguate.
- A copula (as in (119)-(120)), where it can also be realized in feminine form [zot], as demonstrated in (119). Borochovsky Bar-Aba (2010, 186-189) discusses many authentic examples of the copula role that [ze] fulfils.
- A demonstrative pronoun, as in (121)-(128).

(118) im ha SemeS ze mitjabeS **CR** ve ze **CE** nehefaX le **CE** ha Xalav nehefaX le gvina **T** [OCh]
'in the sun it dries **CR** and it **CE** turns into **CE** the milk turns into cheese **T**'

(119) pRojekt SliSi ze **CE** # leatsev ataR la bet sefeR **T** [D341]
'(the) third project is **CE** # to design a website for the school **T**'

(120) idan zot **CN** ha mak-it **T** [P1241]
'Idan is.F **CN** the squadron.leader-SG.F **T**'

By differentiating between the functions of [ze], more consistency can be found with respect to C-boundary distribution. The most frequent trigram of [ze] in the C-boundary environment is "CE [ze] T", i.e. in 23 cases, where [ze] occurs after a CE boundary, it is followed by a T-boundary. This trigram reflects dependency relations between an elongated POS and a demonstrative pronoun [ze] 'this', which is used whenever the speaker cannot find or does not see much point in articulating an exact word. From examples (121)-(128), it is evident that the POS that precedes [ze] 'this', i.e.

the POS that is elongated, requires a complement. It is also evident that it can be any elongated POS: Existentials [jeS] 'there is' or [en] 'there is not', as in (121)-(122); POSS [Sel] 'of' (123); or nominals such as [zug] 'couple' (124).

As to the syntactic slot that [ze] fulfills, in (121)-(124), [ze] 'this' may take the role of a noun or an adjective, but in (125)-(128), [ze] 'this' is a lexical filler for any syntactic structure that can be revealed later in the discourse (as in (128)):

(121) jeS Sam Rak e **CE** ze **T** # Rak e **CE** izim [OCh]
'there are only eh **CE** this **T** # only eh **CE** goats'

(122) en e **CE** ze **T** [C1621]
'there is no **CE** this **T**'

(123) Sel e **CE** ze **T** [C1111]
'of eh **CE** this **T**'

(124) mamaS zug e **CE** ze **T** [C1111]
'really a couple eh **CE** this **T**'

(125) ulaj e **CE** ulaj e **CE** ze **T** [C514]
'maybe eh **CE** maybe eh **CE** this **T**'

(126) tov ze beetsem e **CE** ze **T** [P1022]
'okay, this is actually eh **CE** this **T**'

(127) ani lo jadati Se at e **CE** ze **T** [P831]
'I didn't know that you are eh **CE** this **T**'

(128) ani lo uXal e **CE** ze **T** # laleXet le Xatsi Xinam [P831]
'I won't be able eh **CE** this **T** # to go to 'Half-Price' [supermarket]'

8.5.2.4 INF – Infinitives

The INF tag consists of an open category word class. A representative example is shown in (129).

(129) ve likfots la SagRiRut e **CE** lehotsi e **CE** viza **T** [P831]
'and to visit the embassy eh **CE** to-get eh **CE** Visa **T**'

Infinitives before C-boundaries do not directly reflect a break in a syntactic structure, e.g., a phrase or a clause, as has been shown with other POSs. The eight different infinitives found in the corpus before CE are all transitive (e.g., [lehotsi] 'to take out' in (129) above), except for one intransitive complex verb,[41] [jaXol lihjot Se] 'could be that ...' (lit. can.PTCP.3SG be.INF that), which in its specific meaning requires a complement clause. This indicates that these elongated infinitives require a complement within the verb phrase.

Another type of element annotated as INF is a group of infinitive prefixes that were found elongated with their gerund after the CE boundary, as in (130). These cases will be discussed below.

(130) holeX li- **CE** kRot **TQ** [C714]
'going to- **CE** happen **TQ**'

8.5.2.5 NEG-[lo] 'no'

The NEG-[lo] tag consists of a single word. A representative example is shown in (131).

(131) dag-im hem lo **CE** mejabS-im **TQ** [OCh]
fish-PL.M they do.not **CE** dry-PL.M **TQ**
'don't they dry fish'

Of the 74 [lo] 'no' preceding C-boundaries, 33 (44%) are isolated, i.e., constitute a single IU, as demonstrated in (132). This is parallel to the occurrence of [ken] 'yes' as a single IU, which functions as a backchannel utterance.

(132) lo **CN** mamaS Ro-im **T** [C521]
no **CN** so see.PTCP-PL.M **T**
'it isn't really visible'

[lo] within a syntactic structure is well demonstrated in the 14 cases where personal pronouns preceded [lo], thus negating the action represented by the verb, as in (133), and in 9 cases of [ze lo] 'this is not' sequence before C-boundaries, as in (134),

[41] The verb [jaXol] 'could' is defined as a verb that requires an infinitive only (Stern 1994: 44, 208).

where [lo] negates attributive relations between the deictic [ze] 'this', which refers to a product on the supermarket shelf, and a nominalized predicate.

(133) mitos ka-ze Se <u>ani lo **CE**</u> Sama-ti al **F** [C714]
myth like-that <u>I not **CE**</u> hear.PST-1SG about **F**
'I didn't hear about a myth like that'

(134) <u>ze lo **CE**</u> Sel loakeR ha amiti **T** [P911]
<u>this not **CE**</u> of Loaker the real **T**
'This is not real Loaker's'

8.5.3 Group C items

Group C POSs are less likely to appear before CE, and more likely before CN and CR. This is well demonstrated in Figure 16. Examples of each of the bigrams with CE are presented below the figure, where an account of the lexemes "behind" these POS reveals that the POS in group C is usually in clause final.

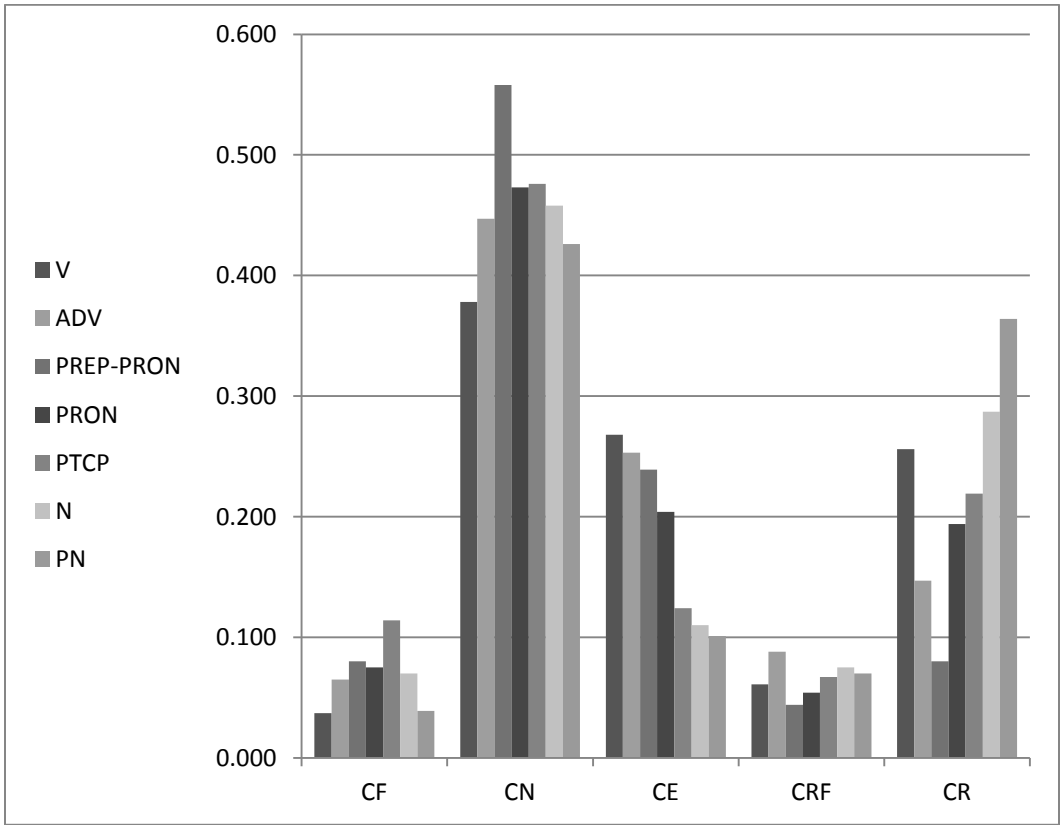


Figure 16: Least probable bigrams with CE boundaries ($p<0.3$) compared with probabilities of other C-boundary bigrams

8.5.3.1 V – Verbs

Most of the verbs before CE are of the suffix conjugation, like [asi-nu] do.PST-1PL 'we did', [amaR-ti] say.PST-1SG 'I said' or [sam-ta] put.PST-2SG.M 'you put' in (135). This inflectional suffix conjugation includes the person marker.

Only two cases of verbs before a CE boundary are of a verb with prefix conjugations: the verb [ja-gidu] 3PL-FUT.tell 'they will tell' and the verb [ni-sa] 1PL-FUT.travel 'we will travel' in (136).

Verbs before the other C-boundaries do not show such a tendency with respect to inflectional suffix, as in (137)-(138). Moreover, the verbs at CE boundaries are also transitive, as in (135)-(136), which reflects the required argument after the CE boundary, while those before the other C-boundaries do not show such consistency, as in (137)-(138).

(135) dani sam-ta **CE** Semen zajit **TQ** [P1022]
Dani put.PST-2SG.M **CE** oil_of olive **TQ**
'Dani did you put olive oil (in it)'

(136) anaXnu CE ni-sa **CE** # anaXnu nosim le nju joRk [C412]
we CE 1PL-FUT.travel **CE** # we go.PTCP.PL.M to New York
'we are going we are going to New York'

(137) hu ja-gia **CN** ve aXaR-kaX ni-mSoX lean Se ze **…** [P831]
he 3SG.M-FUT.arrive **CN** and after-that 1PL-FUT.pull where that this …
'he will arrive and then we will carry on to wherever it ... '

(138) hi omeRet Se hem Rav-u **CN** # lo Rav-u **CN** lo jodaat **CN** [D631]
she says that they fight.PST-3PL **CN** # no fight.PST-3PL **CN** not know.PTCP.SG.F **CN**
'she says that they fought (they) didn't fight I don't know'

The verb and its complement (obligatory or adjunct) dependencies

Dependencies between a verb and its obligatory complements, i.e. direct (139) or indirect objects (140), or adjuncts, occur over C-boundaries.

(139) Dependency between a verb and its direct object:
a. asi-nu e **CE** # e **CE** tSeRkesim **T** [C614]
do.PST-1PL eh **CE** # eh **CE** Circassians **T**
'we toured eh eh the Circassians'

b. asi-nu e **CE** et ha tavoR **TQ** [C614]
do.PST-1PL eh **CE** ACC the Tabor **TQ**
'did we tour eh Mount Tabor'

c. imm ani haji-ti kotevet e **CE** otobijogRafja **CN** [P711]
if I be.PST-1SG write.PTCP.SG.F eh **CE** autobiography **CN**
'if I were writing eh an autobiography'

This dependency occurs with CF boundary as well:

d. paam hizmanu **CF** et alon @ **CN** [C1621]
'once we invited **CF** Alon @ **CN**'

(140) Dependency between a verb and its indirect object:
hu Rotse linsoa **CF** le kaduRegel **TQ** [C1111]
'does he want to go to a football game'

8.5.3.2 ADV – Adverbs

Adverbs in the environment of C-boundaries reflect a main clause and adverbial phrase dependency, where adverbs modify the clause. Adverbs were found at clause-initial (141), clause-final (142) and clause-internal (145-150) positions.

(141) hajom **CE** ha jeladim haRbe joteR noRaim **T** [C714]
'today **CE** the children are much worse **T**'

(142) ve lo haji-ti mesajem-et oto af.paam **CN** # az e [C1621]
and no be.PST-1SG finish.PTCP-SG.F ACC.3M never **CN** # so eh
'and I would never have finished it so eh'

Yet, this dependency cannot be described through the *n*-gram methodology of the present research, which consists of syntagmatic relations. A few examples will, however, be presented here to fill the gap in the description, and to demonstrate the limitations of the present research methodology.

In (143), the complex adverb [be ofen muskal] 'in (an) educated way' follows the main clause, while in (144), the adverb is in the middle of the clause, between the subject [hu] 'he' and the predicate. This is also the case in (145) and (146). Examples

(147)-(148) are existential clauses where the locative adverbs (synonyms [po] 'here' and [kan] 'here') follow the existential predicates.

(143) ata lo jodea sfat em SelXa **CN** e **CE** # be ofen muskal **T** [C6]
'you do not know your mother tongue **CN** eh **CE** # in (an) educated way **T**'

(144) hu kvaR e **CE** meXonat kvisa tiken @ **T** [D122]
'he was already eh **CE** (the) washing machine he fixed @ **T**'

(145) ani mamaS **CE** meuXzav mimena [C1111]
'I am really **CE** disappointed with her'

(146) hu Rak e **CE** # jada [OCh]
'he only **CE** # knew'

(147) jeS po **CE** kol minej hoRaot **T** [C1111]
EXT here **CE** all kind_of instructions **T**
'there are all kinds of instructions here'

(148) en kan e **CE** joteR midaj T [D122]
NEG.EXT here eh **CE** too much **T**
'there are not too many here'

Dependencies between temporal adverbial phrases and the main clause are also split by CF boundaries (149).

(149) bidijuk Svuajim lifnej ze **CF** # ha Rav kohen Sataf li et ha moaX [D631]
'exactly two weeks before that **CF** # Rabbi Cohen brain-washed me'

8.5.3.3 PREP-PRON

In the present corpus, 11 word-types were tagged as prepositions with suffixes (PREP-PRON): [al] 'on', [be] 'in/at', [bimkom] 'instead', [biSvil] 'for', [el] 'to', [etsel] 'with/*chez*', [im] 'with', [le] 'to', [lejad] 'near', [lifnej] 'before', [me] 'from'.

- 62 PREP-PRONs occur before CN boundaries, 46 (74%) of them are [le] with suffix, e.g. [llo] 'to him' in (150).

(150) ani osa llo **CN** en zonot ba aRets [C1621]
I do.PTCP.1SG.F to-3SG.M **CN** NEG.EXT prostitutes in-the country
'I tell him there are no prostitutes in Israel'

- Nine PREP-PRONs occur before CF boundaries, 7 (77%) of which are [l-] 'to' with suffix, e.g. [llo] 'to him'.
- Nine PREP-PRONs occur before CRs. There is no dominance of a specific preposition, for example (151):

(151) ata paga-ta bah **CR** # az ani niXnas la esek **T** [P424]
you.SG.M hurt.PST-2SG.M in-3SG.F **CR** # so I get_in.PTCP.SG.M to business **T**
'you hurt her so I intervened'

- Five PREP-PRONs occur before CRF. There is no dominance of a specific preposition.
- 26 PREP-PRONs tokens occur before CE boundaries. Only two types of inflectional prepositions occur before CE: [le] 'to', as in (152)-(153), and [im], as in (154). Both prepositions fill the indirect object slot, i.e. an obligatory argument of a predicate slot. Moreover, the distribution between the two prepositions is 24 (92%!) inflectional [le] 'to', and only two are inflectional [im] 'with'.

It is evident that a limited set of PREP-PRONs attracts the CE boundary tone and that at least in the case of [le]-PRON, the predicate has two arguments, the indirect object before the CE and the direct object after the CE, as demonstrated in (152)-(153).

(152) Se lo ji-hje le-Xa **CE** le Rega e **CE** # safek **T** [D741]
That no 3SG.M-FUT.be to-2SG.M **CE** to moment eh **CE** # doubt **T**
'you should not have a moment's eh doubt'

(153) amaR-ti lla **CE** ani be helem **T** [P1022]
told.PST-1SG to-3SG.F **CE** I in shock **T**
'I told her I'm in shock'

8.5.3.4 PRON – Pronouns

In addition to the PREP-PRON forms discussed in the previous section, other forms of pronouns were also found before C-boundaries. The words tagged as pronouns are of two categories: titular pronouns, which have a syntactic role similar to that of adjectives, i.e. classifying a noun, as in (154)-(155), and pronouns which substitute for

nouns, as in (156). The most frequent titular pronouns are [kaze] 'like-this' and [haze] 'this' and their plural forms: [kaele] 'like-these', [haele] 'these'.

The common noun substitutes are [kulam] 'everybody' and its singular negative form [af-eXad] 'nobody-M.' as well as [miSehu] 'somebody' (156).

(154) mekamben be gimelim ve be kaele **CN** ve maale et ha Xom **TQ** [P1241]
'manipulates with sick leaves and with such **CN** and raises the temperature **TQ**'

(155) efo jeS od e **CE** kaze **CE** # asabim kaele **TQ** [D631]
'where are there more eh **CE** like-this **CE** # weeds like-these **TQ**'

(156) o Se ata holeX leXajeg le miSehu **CN** [C1111]
'or that you intend to dial to (telephone) someone **CN**'

Since adjectives and nouns have similar distributions before C-boundaries, it is not surprising that PRONs also show such distribution.

8.5.3.5 PTCP – Participles

Representative examples of PTCPs before C-boundaries are in (157)-(159).

(157) ani sama be keaRa meaRbevet **CN** [C714]
I put.PTCP.1SG.F in bowl stir.PTCP.1SG.F **CN**
'I put it in a bowl and stir'

(158) ani lo zoXeRet lean joRed ve efo olot **CR** [P1241]
I no remember.PTCP.1SG.F where-to descend.PTCP.3SG.M and where ascend.PTCP.3PL.F **CR**
'I don't remember where it descends and where they ascend'

(159) be gil SloS esRe ata lo jodea **CE** sfat em SelXa **CN** [C612]
'at age 13 you don't know **CE** your mother tongue **CN**'

The difference between PTCPs that occur before CE and those that occur before other C-boundaries is similar to the case of verbs discussed above. Transitive PTCPs tend to occur before CE (159) and non-transitive PTCPs before other C-boundaries, in clause-final position (158).

8.5.3.6 N, PN and NUM

Nouns and proper nouns share similar distribution before C-boundaries (except proper nouns that are more likely to occur before CRs, as shown in Figure 16). Representative examples are shown in (160) and in the underlined CN boundary in (161), both in clause-final or phrase-final position.

(160) kol jom medabRot ba telefon **CN** ve nifgaSot ve hakol **T** [P1241]
'everyday (they) talk on the phone **CN** and meet and everything **T**'

(161) aXRej kita jud **CN** kSe hajiti XaveRa Sel uRi **CR** [C1621]
after grade 10 **CN** when be.PST-1SG girlfriend of Uri **CR**
'after 10th grade **CN** when I was Uri's girlfriend **CR**'

8.5.4 Other elongated POSs

Examples of POSs found with fewer than 10 occurrences before CE are shown below. For each POS, there is an example of a POS before CE and of the same POS before other C-boundaries. The examples illustrate the similarities as well as the differences between CE and other C-boundaries regarding the syntactic structure within which they occur. For example, the ACC-PRON before CN is in ditransitive VP final position, while before CE, it is in intermediate position within a trivalent VP (the locative PP is not yet uttered). On the other hand, an identical IMP occurs both before CRF and CE boundaries.

8.5.4.1 ADJ – Adjectives

Adjectives are modifiers that, in Hebrew, follow the nouns they modify. Thus, the noun and the adjective together constitute a NP. These dependency relations between nouns and adjectives were observed over C-boundaries (162)-(164).

(162) ve ani avi jeka- **F** jeRakot e **CE** # Stufim **CN** # [P831]
and I will bring vet- **F** vegetables eh **CE** # washed **CN**
'and I will bring vet- washed vegetables'

(163) pilpel **CN** # memule **TQ** [D122]
pepper **CN** # stuffed **TQ**
'stuffed pepper'

(164) at lo koRet sifRut **CN** # tova **CN** # adajin **T** [C612]
you.SG.F not read literature **CN** # good.SG.F **CN** # yet **T**
'you don't read good literature yet'

A single case of a CE boundary within a construct state adjective was found (165):

(165) ha tRans e **CE** sibiRit **CN**[42] [OCh]
'the trans- eh **CE** Siberian (train) **CN**'

ADJs were also found before C-boundaries (166)-(167). In (166), there is a CN boundary between the subject and the predicate.

(166) ima Sela ha meatsbenet **CN** # hajta gaRa be koma RiSona **T** [C1621]
her mother annoy.3SG.F **CN** # be.PST.3SG.F live. PST.3SG.F on floor first **T**
'her annoying mother lived on the first floor'

(167) dugma aXeRet e **CE** gam e **CE**[D742]
example another.SG.F **CE** also eh **CE**
'another example too'

8.5.4.2 IMP – Imperative

The IMP annotation was given not only to grammatical imperatives, but also to 2nd person prefix conjugation form, since they express the mood of imperatives (Dekel 2010, 144). Three imperatives, (168)-(170), are from the semantic field of listening: [ta-kSiv] '2SG.M-FUT.listen' and [ti-Smei] '2SG.F-FUT.listen'. These occur before CRF and CE, but not before CN (171). The use of excessive lengthening (both in the case of CE and also with CRF, when the last syllable is lengthened with a rising-falling tone) with regard to such listening verbs, may not be mere coincidence. Non-neutral prosody gets more attention from the listener. In other words, the "listening imperative lexemes", together with the elongated prosodic boundary, function as regulators of information flow between the interlocutors, similar to discourse markers, which is what, according to Chafe (1994), differentiates such regulatory IUs from substantive and truncated IUs.

(168) aval ti-Smei **CE** toX SeS Saot hi jald-a **T** [C521]
but 2SG.F-FUT.listen **CE** within six hours she deliver.PST-3SG.F **T**
'but listen within six hours she had the baby'

---

[42] Although [tRans] itself is not an adjective, it is a prefix for geographical adjectives, e.g. [trans-atlanti] 'trans-atlantic'.

(169) lo nu ta-kSiv **CRF** az … [P1241]
no come.on 2SG.M-FUT.listen **CRF** so ...
'no come on listen so …'

(170) ti-Smei **CRF** ze XazaR-ø biglal Se ze ofna **T** [D741]
2SG.F-FUT.listen **CRF** this come.back.PST-3SG.M since that this fashion **T**
'listen it came back since it is fashionable'

(171) nu az ta-vi **CN** ta-vi meXiR [D741]
well so 2SG.M-FUT.bring CN 2SG.M-FUT.bring price
'come on so reduce reduce the price'

8.5.4.3 ACC-PRON

The distribution of ACC-PRONs before C-boundaries shows no dominance either for CR or CE. Here are two representative examples, where the ACC-PRON is in clause-final position before CN (172) and before a CE and an obligatory locative argument in (173).

(172) aba Sela Raa oti **CN** [P424]
father of-her see.PST.3SG.M ACC.1SG **CN**
'her father saw me'

(173) ha Seela imm efSaR lasim ota **CE** # nagid et ha sakin ha=zot **CR** al ha=ze **T** [P911]
the question if possible put.INF ACC.3SG **CE** # say ACC the knife the=this.F **CR** on the=this.M **T**
'the question is whether it is possible to put it let's say this knife on that'

8.5.4.4 POSS-PRON

While both independent personal pronouns and their affixed forms with prepositions (PREP-PRON, see §8.5.3.3) show a gradual occurrence rate where CE and CN boundaries are the most frequent and CR is one of the least frequent, the distribution of C-boundaries is reversed when it comes to POSS-PRONs, as in (174)-(175), and N-POSSs (§8.5.4.6 below). In (174), the POSS-PRON before CE is indeed phrase-final but clause internal. In (175), the POSS-PRON is clause-final.

(174) ha Sef Sel-i **CE** # mevaSel **T** [P1022]
the chef of-1SG **CE** # cook.PTCP.3SG.M **T**
'my chef cooks'

(175) ve ata omeR llo ma ha Xom Sel-i **CR** # ani jeXola lekabel gimel **T** [P1241]
and you.SG.M tell.PTCP.SG.M to-3SG.M what the temperature of-1SG **CR** # I can.PTCP.SG.F get.INF sick_leave **T**
'and you tell him what my temperature is I can get sick leave'

8.5.4.5 POLITE

Six word-types were annotated as POLITE before C-boundaries: [toda] 'thanks', [toda raba] 'thank you very much' [sliXa] 'sorry', [lehitRaot] 'see you', [halo] 'hello', [baRuX haSem] 'thank God'. (176)-(177) are two examples of POLITE before C-boundaries.

(176) e **CE** # sliXa **CN** # vaRda tisa im ha oto Sela le adi **CR** [C612]
eh **CE** # excuse me **CN** # Varda will go with her car to Adi **CR**
'eh excuse me Varda will drive to Adi'

(177) az lehitRaot e **CE** taRgiS tov jom tov **T** [P711]
'so see you eh **CE** feel well have a good day **T**'

8.5.4.6 N-POSS

Although it is common to think that in IH the distribution of N-POSS is limited to certain fixed lexical items, such as family members, as in (178)-(179), they were also found in the corpus with other NPs, as in (180).

(178) naniaX baal-i **CR** [D631]
suppose husband-POSS.1SG **CR**
'let's say my husband'

(179) ma ani a-gid le-Xa aX-i **CN** [D23]
what I 1SG-FUT.say to-2SG.M brother-POSS.1SG **CN**
'what can I say to you my brother'

(180) kol eXad jodea et mekom-o aba **T** # et tafkid-o **CN** et mekom-o **T** [P711]
every body know.PTCP.SG.M ACC place-POSS.3SG daddy **T** # ACC job-POSS.3SG **CN** ACC place-POSS.3SG **T**
'everybody knows his place daddy his job his place'

8.5.4.7 Apposition dependencies

Example (180) also demonstrates, beyond the issue of N-POSS, a sequence of appositions. Appositions are a type of syntactic dependencies that occur in the

environment of C-boundaries. Nonetheless, apposition dependency cannot be described through syntagmatic relations and is presented here to fill a gap in the description. (181)-(184) are representative examples.

(181) ata jodea gam tambal **CF** saRut kaze **CN** [P424]
'you know also an idiot **CF** a defect like **CN**'

(182) baXuRa meod XaXama **CF** maskila **CF** baXuRa besedeR **CN** [P424]
'a young lady very smart **CF** educated **CF** an OK young lady **CN**'

(183) peilut miStaRtit kan **CF** ba miSmaR ha ezRaXi [P311]
'police activity here **CF** in the civil guard'

(184) maSehu Se hu **CE** # Se meik alav **CF** meRim oto **CF** e mitRomem im **F** [P711]
'something that he **CE** # that troubles him **CF** raises him **CF** e rises with **F**'

8.6 Interim summary

In §8.1-§8.5, I showed the results of *n*-gram analysis of the five C-boundaries defined in chapter 6. The research began with a **36** POS tag set, according to which the elements preceding and following C-boundaries were annotated. After a clean-up process, the most frequent and most likely "preceding" bigrams and "following" bigrams were listed, and open or closed lexical categories were assigned to each.

The results demonstrated the dominance of the CE boundary in the "preceding" bigrams, which reflects the fact that a rather restricted group of closed set POSs appears with this CE boundary tone, compared to a rather varied group of POSs with each of the other C-boundary tones – CR, CN, CRF, CF.

In the "following" bigrams, the results demonstrate, again, the similarity, in terms of POS attachment, between four C-boundaries – CR, CN, CRF, CF – and the unique case of the CE boundary. Only three POSs were found after the four C-boundaries: PRP, CONJ and DM. On the other hand, N was the POS most likely to appear after CE.

Since the primary target of the research was to uncover relations between the preceding and following POSs, trigram calculations were performed. After a clean-up process, the most frequent and most likely trigrams were listed and assumed

dependencies were assigned to each. At this point, **four** different types of dependencies were observed:[43]

a. Dependencies <u>within phrases</u>
   i. DEF **CE** N
   ii. PREP-DEF **CE** N
   iii. PREP **CE** N
   iv. POSS **CE** N
   v. POSS **CE** PN
   vi. MOD **CE** N
   vii. MOD **CE** ADJ

b. Dependency <u>between a subject and a predicate</u>
   i. PRP **CE** V
   ii. PRP **CE** PTCP
   iii. EXT **CE** N

c. Dependencies <u>within coordination construction</u>
   i. ADJ **CN** CONJ
   ii. PRON **CN** CONJ
   iii. N **CN** CONJ
   iv. ADJ **CN** CONJ
   v. CONJ **CE** PRP
   vi. NUM **CR** NUM

   These dependencies are of two types, syndetic coordination or simply juxtaposed (a-syndetic coordination). In the present study, the syndetic coordination is either when the CONJ follows the C-boundary (examples i-iv), or when the CONJ precedes the C-boundary, mainly CE (example v). A-syndetic construction appeared <u>within enumeration</u> dependency (example vi).

d. <u>No dependency</u>
   i. PREP **CE** PREP
   ii. CONJ **CE** CONJ
   iii. PREP-DEF **CE** PREP-DEF
   iv. DM **CE** PRP

These four types of dependencies can be scaled according to their *strengths*:

1. "No dependency": The weakest is when a C-boundary does not split a syntactic dependency. This occurs when a new start begins after the C-boundary and is

[43] All cases are listed in Tables 19a-b.

common to all 4 boundaries: CN, CR, CRF, and CF. The other type is when a C-boundary follows DMs – this is typical of CE boundaries.

2. "Within coordination construction": A stronger dependency occurs when a coordination structure is observed. This dependency is divided into two types which affect the C-boundary distribution. When the conjunction follows the C-boundary, it is more likely that CN CR CRF and CF will occur. When the conjunction precedes the C-boundary, it is most probable that the CE boundary will occur.
3. "Between a subject and a predicate": CE boundaries are more likely to occur within this dependency.
4. "Within phrases": This is the strongest dependency that C-boundaries break, and it is most likely that CE boundaries will occur here.

Although only ~30% of the prosodic boundaries in the corpus are C-boundaries, (see Figure 4),[44] they seem to play a significant role in spoken IH.

[44] This is also mentioned in Silber-Varod (2010) with regard to the F2F corpus only.

9 Analysis

The aim of the present study was to investigate two aspects of speech: suprasegmental characteristics and syntagmatic relations. More specifically, it focused on the demarcation and segmentation roles of prosody and its interface with the lexical or the grammatical sequence. In this context, the research concentrated on prosodic C-boundary patterns and the dependencies between POSs in the C-boundary environment.

The hypothesis underlying the study was that prosody and syntax are different levels of speech and therefore prosodic units do not necessarily correspond to syntactic structures. Moreover, while *prosodic unit* refers in the present research to the *intonation unit*, the term *syntactic structures* refers to "units or building blocks of different sizes, not just individual words and their [morphological] endings" (Carter and McCarthy 2006, 2). The aim was therefore to find a mechanism that regulates these two levels of human language. The research premise defines prosody as the primary linguistic tool of speech segmentation. Thus, in order to find the regularities underlying the prosodic-syntactic interface, IU segmentation was carried according to two communication values of boundary tones: terminal vs. continuous. The results chapter concentrated on the C-boundary inventory in a corpus of spontaneous Israeli Hebrew and the POS preceding and following each of the C-boundaries. In §8.6, I suggested a mapping between dependency relations and prosodic boundaries. This mapping demonstrated that two main syntactic structures were challenged by CE boundaries – *phrases* and *clauses* – while the four other boundary tones (CN, CR, CRF, and CF) connect not only micro-syntactic but also macro-syntactic relations (in Avanzi and Lacheret-Dujour's (2010) terminology).

The term *phrase* refers to syntactic constituents, which "have individual functions in the sentence" (Carter and McCarthy 2006, 2). *Clauses* are defined as consisting of subject and predicate. Predicates in IH can be occupied by all word types: the verbal predicate, but also "nominal (substantives, adjectives), participles, pronominal (personal pronouns, demonstratives, interrogatives and other pronouns), adverbs and adverbial

phrases. Also, clauses and other complex phrases can be found as predicates as well" (Izre'el 2010, 72). Thus, it is its prosodic-syntactic *interface* that makes the CE boundary tone a unique domain for interpretations and speech understanding.

The analysis below attempts to answer the following question: How can the phenomenon of continuous boundary tones, mostly CEs, which are actually prosodic breaks within syntactic units, be explained linguistically? The answer will use the notion of heads in grammatical theory: "the idea that one word may dominate another – that a subordinate word depends on a head word – is the central insight of traditional dependency grammar and its more recent offspring" (Fraser, Corbett, and McGlashan 1993, 3).

Further to the theoretical frameworks mentioned in chapter 2 dealing with the prosodic-syntactic interface, it is argued here that no theory that deals with this interface has suggested any approach to deal with the excessive elongation phenomenon within its framework. In the following, I will try to adapt Dependency Grammar (DG), which is a syntactic theory, to a prosodic-syntactic framework. I will begin by presenting the DG principles relevant to the present research.

9.1 Dependency, Heads and Dependents

Dependency Grammar (DG) is a grammar in which syntactic structure is expressed primarily in terms of dependency relations. A dependency relation is a grammatical relation that holds between a pair of elements on the same level in a sentence. One of the elements *depends* morphologically, syntactically, or semantically on the other. Dependency relations contrast with constituency relations which hold between elements on different levels of a sentence (Fraser 1996, 71). In DG, the syntactic structures "are represented by dependency trees or sets of nodes whose inter connections specify structural relations, i.e., a governor controls its dependents by dependency rules which specify the correct structural relations for each class of unit" (Brown and Miller 1996, 397; illustrated in Fraser 1996, 72). According to Brown and Miller (1996), "in contrast with constituent structures, functional structures focuses on,

not arrangements of constituents, but the relationships between constituents" (1996, xiii). Schneider (1998) notes that of the models that take the functional relations as primary, "the most syntactic" is DG, in which relations such as 'head' and 'modifier' are primary. One of the principles that he mentions concerns the syntactic duality that exists in a single word:

> What is important in DG is the ability to analyze words at both levels, structural and linear: dependency is a grammar in which individual words both act as terminal nodes and as non-terminal nodes. They are terminal because they directly access the lexicon, because in its purest form, dependency only knows words; and they are non-terminal because they "require", they "subcategorize for" other words, so-called dependents. (Schneider 1998, 7)

In the traditional verb-dependency theory as first developed by Tesnière (1959), in a clause, the head is the verb (nuclei) and all the nouns, including the subject, are complements of the verb (Brown and Miller 1996, xiv; Luraghi and Parodi 2008, 15-16). Although modern DG emerged from Tesnière's (1959) structural syntax, dependency is an old concept:

> Early notions of dependency grammar are discernable in the Sanskrit grammar... (Between 600 and 300 BC), in the Greek grammar ... (second century AD) and Latin grammar ... (*c*. AD 450).... the medieval Arabic grammarians contrasted the governor or head of a phrase with the governed or dependent elements of the phrase. They stipulate amongst other things that the governor could have many dependents but a dependent could have only one governor; dependency relations were necessarily unidirectional; and dependents were required to be adjacent to their governors. (Fraser, Corbett, and McGlashan 1993, 3; and historical survey on the notion of the 'head', 1-6)

In contrast with the enormous amount of formal, theoretical, and descriptive work on constituent structure, there has been very little theoretical development of dependency analysis. A significant development is Hudson's 'Word Grammar' (WG)

(Hudson 1993, 1996, 2006). Hudson describes the structure of the sentence in terms of a variety of dependency relations alone, virtually discarding constituent structure altogether (Brown and Miller 1996, xxii).[45] Hudson's theory of language structure is called 'Word Grammar' because of the central role of the word as the only unit of syntax. Hudson explains that according to WG, it is not possible to do syntax without mentioning heads since "'head' is the name for one end of the dependency relations which are taken as fundamental. In dependency theory, a word is a head of other words that depend on it, and not, as in GB, that a word is a head to its mother phrase" (Hudson 1993, 275). Hudson notes that "heads should be among the categories used in the mental representations that ordinary people construct when they hear or utter sentences" (ibid.). Schneider (1998) points out that WG is "admittedly extremely lexical. Although Tesnière defines not the word but the nucleus to be the most basic element, nuclei on the lexical or 'terminal node' level usually consists of only one word" (Schneider 1998, 76). As mentioned before, according to Tesnière (1959), except in verbless clauses, the root dependence is from the verb. Nonetheless, the notion of head in DG (and in other theories which use it) is not unambiguous. Indeed, it is assumed that the head and the dependent are to a certain extent arbitrary. According to Schneider (1998), "the debate if the subject or the verb should be the 'core' of a sentence is still undecided, perhaps undecidable ... It is equally debatable for many structures which word form should be regarded as its head" (1998, 5).

Hudson (1993) concludes that 'head' is a category which unifies a range of different properties (e.g. percolation purpose, government). According to Hudson (1993), the *head* category is associated to the concept *dependent* and both are psychologically real: "they are real not only in grammars but also in sentence structure" (Hudson 1993, 266).

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[45] Hudson refers to constituency theory as "any version which derives grammatical relations from surface constituency relations; it is most obviously manifested in Government and Binding (GB)" (Hudson 1993, 276).

The present research adopted the DG principle which handles syntax "in terms of grammatical relations between pairs of individual words, such as the relation of the subject to the predicate or of a modifier to a common noun" (Ninio 1996, 90). It can be said that dependency relations evolved from Tesnière's (1959) notion of verb valency, which has both semantic and syntactic implications. Today, valence is even attributed to lexicalized prepositions, e.g., the locative [be] 'in/at'.

In the specific case of elongated prepositions, the C-boundaries that split such dependencies (CN, CRF and CR, in addition to CE) reveal the valence structure of the main verb. Rosén (1977) suggests considering the preposition as forming one constituent together with the verb: "The preposition constitutes the government properties of the verb" (Rosén 1977, 169-170). Rosén presents an example of the prepositions /le/ 'to', /be/ 'in' and /al/ 'on', and notes that, with the occurrence of certain verbs, these prepositions have no substitution, and function as cases (such as the accusative case marker [et] 'Acc.').

Crystal (2008) defines dependency rules in the following way:

> In a prepositional phrase, such as *on the box*, the preposition governs the noun, and the noun governs the article. Dependencies are usually displayed as arcs, which relate words (rather than constituents). The statements which specify the governing and dependent relations which each class of unit may enter into are known as **dependency rules**. (Crystal 2008, 137)

Hence, the relevance of DG to the present research is the possibility of linking the evidence presented in chapter 8, specifically the evidence concerning elongated POSs, and dependency rules. To be more specific, should a link between form (CE boundary tone) and function (either *head* or *dependent*) be established, as in the following hypothetical rules:

- Elongated personal pronouns will be considered dependents of V heads or any other predicates.

At least in IH analysis, it is helpful to remember that there may be confusion when using morphological dependency as a criterion for defining syntactical dependency. As Schneider (1998) notes, "Many linguists … point out that the direction of the dependency is often unclear….[but] this is only one more confusion between syntactic and morphological dependency. E.g. the main verb and the grammatical subject can be said to mutually depend on each other" (ibid., 26). Or, in other words, "the subject determines the verb morphologically, while the subject depends on the verb syntactically" (ibid., 41).

- Elongated articles, e.g. [ha] 'the', will be considered dependents of N heads.

  According to Schneider, "For this construction it seems to be hardest to determine a head and no clear answer seems to emerge yet" (1998, 48). On the other hand, Hudson (1990, 268-276) suggests the determiner as head.

- Elongated prepositions, e.g., [be] 'in' will be dependents of N heads.
- Elongated subordinate conjunctions [Se] 'that' will be considered dependent of a more complex unit, the subordinate clause.

  These last two points are not straightforward. In verbal clauses, both *P+NP* (prepositional phrase) and *COMP+S* (subordinate clause) are verb complements, i.e. selected by the verb valence. While P assigns Case to NP or COMP assigns [+/-finite] to S, NP and S depend on the verb. Therefore, P and COMP can be parts of the nucleus, exactly the same way Tesnière treats functional words (Schneider 1998, 52). For example, in the sequence [halaX le tel aviv] 'went to Tel Aviv', the transitive verb [halaX-ø] 'go.PST-3SG.M' and the PP [le tel-aviv] 'to Tel Aviv' are analyzed as head [halaX le] 'went to' and dependent [tel aviv] 'Tel Aviv'.

- Other elongated conjunctions (e.g. [ve] 'and') will be considered dependents of the first conjunct they are coordinating, as suggested by Mel'čuk (1988).

  Mel'čuk (1988: 41) continues his coordination dependency analysis by saying that the conjunction is then the Head of its following conjunct, thus arguing for a linear

analysis of coordination structure dependencies. Another point of view is that of Rosta (2006), who says that "coordinate structures employ nonterminal, nonlexical, nodes, which are linked to others not by dependencies but by part-whole relations" (Rosta 2006, 189-190), and that of Schneider (1998): "In pure dependency, coordination cannot be expressed. A dependency system will have to employ a constituency element like Tesnière's *junctions*" (Schneider 1998, 90). Schneider concludes that "For current dependency theories, coordination remains a very serious problem" (1998, 12). In his chapter in Sugayama and Hudson (2006), Rosta states, "I propose that coordinations are hypocentric phrases whose SH [structural head] is the conjunction. Each conjunct is DH [distributional head]. The conjuncts are dependents of the conjunction, and the conjunction is proxy of its dependents" (Rosta 2006, 190).

On the other hand, for constructions like *subject+verb*, *AUX+V* and *DEF+N*, perhaps even *COMP+S*[46] and *P+NP*, "it is questionable … if a clear dependent should be established, as both elements usually require each other. It is justifiable to think of them in terms of what Engel [1994: 25] calls *Concomitance* or to think of the first element in these constructions (except for *subject*, of course) as a functional marker or head" (Schneider 1998, 53). Indeed, as will be shown in §9.6, what is head and what is dependent remains an open question.

9.2 Function words as heads in Dependency Grammar

While fully aware of the arbitrariness in regarding one element as a head and another as the dependent, Schneider (1998) suggests that functional words are heads in DG:

> Both NP and VP can be seen as having very similar and symmetrical functional heads on two levels: On the first level, quantification for nouns and inflection for verbs. This expresses a simple ontological truth. Real-world objects (nouns) are instantiated by quantification; events (verbs) are instantiated by setting them into

[46] In the present research, this construction is annotated as SUB+V.

> a time frame. On the second level, P [preposition, V.S.V.] for DPs [definite phrase, V.S.V] and C [complementizer, V.S.V] for VPs.
>
> As is typical for functional heads, all of them can remain empty. This suggestion implies that every NP is a PP, in case there is no overt preposition, the P slot is simply empty – such is the state of functional heads. But functional heads ideally mark some grammatical relation, contain grammatical features. (Schneider 1998, 67-68)

Another argument for determining the head is the *morphosyntactic locus*. "The (actual) inflectional locus within a construction is a candidate for the head of the construct…. E.g. for a VP, the auxiliary verb carries the inflection and is a head candidate" (Schneider 1998, 38). Thus, an INFL head (I(NFL)-AUX) is now generally accepted in dependency theory, and there is consensus regarding a few other functional heads:

COMP: It is generally accepted that COMP is a functional head; i.e., [Se] 'that' is a head

DEF: In keeping with the X-bar DP hypothesis, dependency theory will probably follow X-bar. Currently, most scholars still view the noun as head.

As mentioned above, one possible generalization regarding the elongated POS is the term *function words*. Results show that these elongated elements serve as function words in the process the speaker performs when pronouncing a content word (Kimball 1973, 29). This is not surprising, considering the role of function words – the "cement" of the language.

9.3 Function words and elongation

Since DG begins with the notion of the verb as the head, I will take a closer look at verbs in IH. Verbs are heads of items that saturate their valence, i.e. their arguments. Since elongated verbs were also found in the present research (see §8.5.3.1), a question emerges about the functional element within the verb that goes through elongation. Indeed, the morphology of Hebrew verb structures (*binyanim*) has prefix and suffix conjugations that mark the person, and indicate gender and number (singular or plural)

that are found in nouns. For example, the verb [asi-nu] 'do.PST-1PL' occurs in the corpus three times before a CE boundary (for example, (139a)-(139b) above). The suffix [-nu] '1PL' has the semantic meaning of the person and number (i.e., 'we'), which means that the elongated part is the subject. It was found to be elongated in separate structures, and can definitely be interpreted as a dependent of V. Thus, the elongated part, when a morpheme, can be considered the functional element of the word as opposed to the substantive core element.

Another example is the gerund form in Hebrew. As applied to Hebrew, the term "gerund" refers either to the verb's action noun (*Shem Pe'ula*), or to the part of the infinitive following the infinitival prefix /le/ 'to'. Cases of elongated infinitival prefixes (185a)-(185i) also demonstrate the tendency of elongated elements to be part of functional (prefixes) vs. substantive elements (gerund):

(185) Infinitive prefixes,/le/ 'to', preceding CE:

a. at jodaat le- **CE** le-Sapets oto ktsat ve ze **T** [D341]
'you know (how) to- **CE** to-renovate it a little and this'

b. holeX li- **CE** kRot **TQ** [C714]
going to- **CE** happen.INF **TQ**
'is it going to happen'

c. ze mamaS **F** # jaXol la- **CE** le-halhiv otXa meod **T** [P711]
it really **F** # can to- **CE** to-excite ACC.2SG.M very **T**
'it really can excite you very much'

d. hu tsaRiX le- **CE** le-hotsi Xultsot **CN** [P831]
he need to- **CE** to-get out shirts **CN**
'he needs to to get the shirts out'

e. ani holeXet aXSav le- **CE** sadeR **T** [P831]
'I am going now to- **CE** tide.INF **T**'

f. ve holeXet l- **F** # la- **CE** haSlim et kol Sot ha Sena **CN** [D341]
'and going l- **F** # to- **CE** refill.INF all the missing sleeping hours **CN**'

g. ve laS- la- **CE** asot RoSem kaze **T** [OCh]
'and @- to- **CE** make.INF such an impression **T**'

h. az hu nivXaR me ha **CE** SliXim be kanada le **CE** le-jatseg et ha **CE** [C612]
'so he was chosen from the **CE** diplomats in Canada to **CE** to-represent the **CE**'

i. meod mosif le **CN** le-havin et ha geogRafja [C412]
very contribute to **CN** to-understand ACC the geography
'it contributes a lot to to understanding the geography'

Although these cases can be considered coincidental, I view them as evidence of function words that sometimes cling to the preceding words, and thus together create phonological words. This may be due to the speaker's (unconscious?) wish to utter his ideas unambiguously. Since the relations between the verb and its arguments determine the precise lexical meaning of the verb, or the several meanings of a specific verb (Stern 1994, 16-17), the meaning of that verb will be unambiguous only when an increment that neutralizes a possible ambiguity is uttered. For example, [holeXet le] 'going to' is an unambiguous verb as opposed to [holeXet] 'goes', which has an intransitive meaning as well. Such an explanation should also be relevant to the prosodic separation between the two parts of the infinitive, the infinitival prefix [le] 'to' and the gerund [sadeR] 'arrange', in the case of (185e).

The examples in (185) are an opposite phenomenon to the [e] *elision* findings in Bolozky (2003). According to Bolozky, in affixes "a short vowel is a common option (again, owing to the high frequency, easy recoverability and accessibility of affixes)" (ibid., 124). The findings of elongated infinitive prefixes /le/ 'to' in the present research are a phenomenon also found in other Semitic languages. The following example was found in Moroccan Arabic (documented and analyzed in Izre'el and Mettouchi forthcoming):

(186) ... mʕa əl=ħbaːb u n **CE** bəddl-u əl=wəqt
... with DEF=relative.PL.M and 1.SBJ- **CE** change\1PFV-PL DEF=time
'... with the relatives and we change atmosphere' [ary_AV_narr_01_20]

The prefix [n] 'FUT.1PL' is elongated and [beddlu] 'change' follows the CE-boundary. The examples above suggest that the elongated category is a function element, which can be a word, a clitic, and even an affix, and that it can be interpreted

as a dependent. However, viewing the elongated function elements as dependents is only one option for analysis, which suggests that the head element is uttered in a separate IU but within the same syntactic unit. Thus, CE boundaries are breaks within syntactic dependencies.

9.4 Function words and encliticization

Another way to look at these elongated elements is to view them as phrase-final elements. This will require the interpretation of all IUs preceding CE boundaries as encompassing a (kind of) syntactic unit; and the analysis of the POSs in the following IU as an element that begins a separate syntactic unit (for example, a new phrase). This means that the elongated [ha] 'the', for example, will be at phrase final position, and the definite noun following the CE, at phrase initial position.

The possibility that elongated function words can be analyzed as having final position in a syntactic unit (such as a phrase-final position) is disregarded here, since there is no such possibility in IH, unless it is idiomatic, as in (187).

(187) Idioms with prepositions in final position

a.	aX Sel…	'brother of'
b.	rak Se…	'only that''
c.	tsXok tsXok aval…	'laugh laugh but'
d.	si ha…	'pick of the'
e.	paam be	'once in a while' (lit. once=in)
f.	halaX im hirgiS bli	'goes with feels without'
g.	ze haja al-jad	'that was close'

The examples above are entries taken from a Hebrew slang dictionary (Rosenthal 2005). Among the idioms in (187), only (187e)-(187g) are actually prepositions in phrase-final position. Examples (187a)-(187d), which are marked with an ellipsis […], are not idioms in themselves but parts of a noun phrase, yet the preposition is in final position. This makes the interpretation of function words as enclitics debatable and further research is required.

Preposition stranding also does not exist in Hebrew, as demonstrated in (188):

(188)

a. *ma$_i$ ata XoSev al t$_i$?
what you.M.SG think about?
'What do you think about?'

b. *efo$_i$ ata gaR be t$_i$?
where you.M.SG live in?
'Where do you live in?'

Back to the present research data, it can be argued that encliticization in IH *is* an option when not in phrase-final position. Thus, it can be argued that the prosodic encliticization of monosyllabic function words, for which the present research has brought evidence, are not phrase-final, but still enclitics. Selkirk (1995) comments that "a small subset of English monosyllabic function words, the ones written as orthographic 'contractions' ... behave as if they are enclitic to the preceding word ... rather than proclitic to the lexeme in the following [phrase]. It is an interesting fact that these contracted forms are only possible if they are not phrase-final ..., atypical prosodic encliticization that they display must somehow reflect this fact. For now, this remains a puzzle" (Selkirk 1995, note 9). While it is not trivial to deduce from contracted forms to elongated forms, two syntactic features help in this deduction: the fact that in both languages, English and Hebrew, we are dealing with monosyllabic function words, and the fact that in both languages, these function words cannot be in phrase-final position.

Additional evidence for the encliticization possibility emerges from the elongated [Se] 'that' cases. In IH, the subordinate conjunction [Se] 'that' may be in an enclitic position when it is within complex subordinators, i.e. structures which are the combination of a function words and a following /Se/ 'that'. Such cases are, for example, [ma Se] 'what', [mi Se] 'who', [efo Se] 'where', and so on. One possibility might be to consider each of these as a coined phrase, i.e. a prosodic word (PrWd), and since they carry a single stress, they should be transcribed as enclitics [má=Se], [mí=Se], [éfo=Se] etc. e.g. (189) and not as in (191)-(190).[47]

[47] I would like to thank Illan Gonen for providing me with these examples and for his fruitful e-mail correspondence on the subject.

(189) mí=Se bá bá
'who=that comes comes'

(190) mí Se=bá bá
'who that=comes comes'

(191) *mí=Se=bá bá
'who=that=comes comes'

(189) can also be transcribed as (191), but if a primary stress is realized on [mí], then [mí=Se=bá] must be divided into two phonological words. The question is, is it a proclitic [Se=] or an enclitic [=Se]?

The findings in the present research show that function words that were dealt with as proclitics (Bolozky 1999, 2003) are actually the most likely to be split from their host.[48] Bolozky (2003, 121-122) discusses the influence of the function word [ha] 'the' on [e] deletion in the adjacent following word due to re-syllabification, as in (192). The minimal vowel [e] is the vowel most susceptible to casual/fast speech elision, reduction and assimilation. In particular, reduction tends to apply under various conditions. It occurs:

(i) when [e] belongs to an affix (e.g., [ti-] '2SG.FUT' in (193)), or a cliticized function word, as in (194)-(195).

(ii) In the context of an appended vowel (usually an [e]) which removes the sonority sequence violation by allowing consonant redistribution through re-syllabification, as in (192) (Bolozky 2003, 121-124).

(192) *msi.ba 'party', But [ha=me.si.ba][49] 'the=party' > [ham.si.ba]

(193) ti-Skevi be=Seket > [tSkevi beSeket] ~ [SkevibeSeket]
2SG.F-FUT.lie.down in=silence
'lie down quietly'

[48] Which written Hebrew standards consider part of the following word (i.e., as the same grapheme).

[49] The dots reflect syllable boundaries.

The [e] deletion in (192) is in the lexical word /msiba/ 'party', but as demonstrated in (193), Bolozky (ibid., 124) brings evidence of short vowel deletions in prefixes, such as [e] deletion in /le/ 'to' that comes before a weak consonant in the absolute infinitive form (194)-(195):

(194) le-hasbiR > l-asbiR [e] deletion of a prefix vowel
'to-explain'

(195) Se=jikanes > S=ikanes [e] deletion of a clitic vowel
that=3SG.M-FUT.come.in
'let him in'

In addition to Bolozky's (inter alia 2003) authentic data, the present research includes examples of *opposite* tendencies of [Se] 'that' attachment, which show that [Se] and other function words attach to the precedent word, and thus might be regarded as enclitics. Nevertheless, if we decide that [Se] is morphosyntactically an enclitic [=Se], as in (189), how will we explain it when it occurs at the beginning of a phrase of a clause? i.e. when there is no preceding word to cling to, as in modal utterances such as [Se ti-hiji bRia] (lit. that 2SG.F-FUT.be healthy) 'may you be in good health'. In the present research, for example, [Se] occurs after a T boundary 45 times in the corpus, as in (196).

(196) ehm **T** # Se ja-vou **T** # Se ja-vou **T** [P831]
ehm **T** # that 3PL-FUT.come **T** # that 3PL-FUT.come **T**
'ehm let them come let them come'

Additional evidence is presented and discussed in the following section.

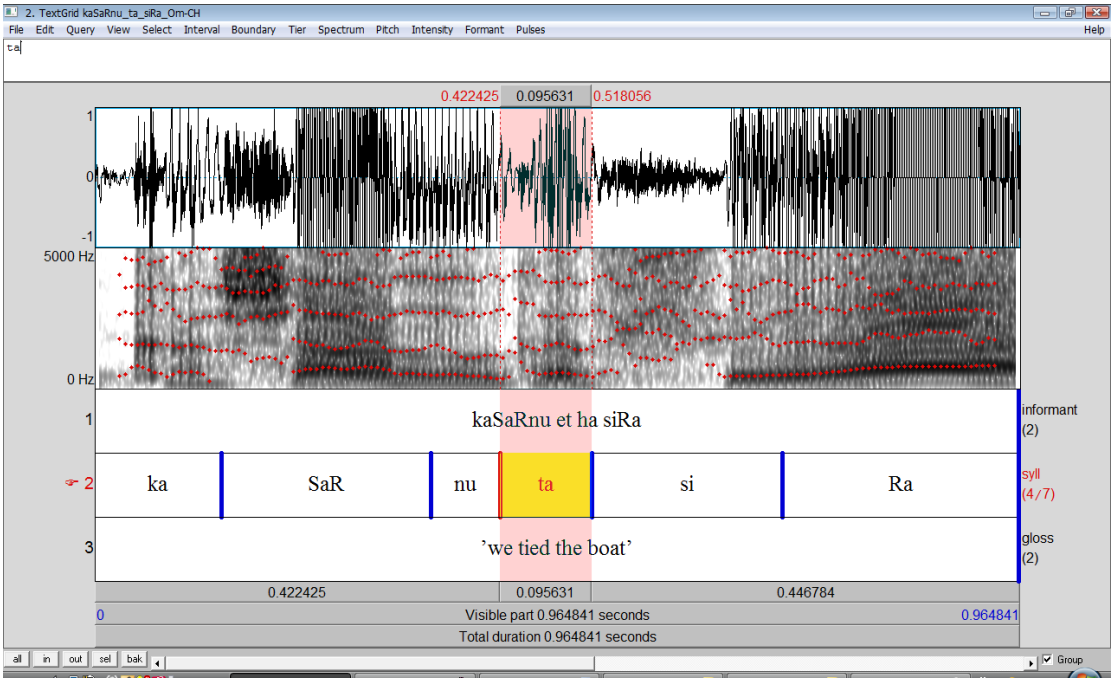
9.4.1 Encliticization of the definite article

In IH, there are two synthetic forms of prepositions with the definite article [ha] 'the': [ba] /b-ha/ 'in the' and [la] /l-ha/ 'to the'. These cases were annotated as PREP-DEF in the present research. The PREP-DEF construction was mentioned in Tables 12 (line 3), 19a (line 2) and 19b (line 15). The PREP-DEF construction implies that the definite article [ha] is an enclitic of /be/ and /le/. In order to determine whether these are unique

idiomatic forms, I looked for all sequences of function words preceding DEF in the corpus. The results of this investigation are presented below.

9.4.1.1 ACC-DEF

In 252 cases, [ha] 'the' is preceded by [et] 'Acc.', the Accusative marker in IH. The /et ha/ 'Acc. the' bigram has one of the ten highest probabilities (p=0.52) in the corpus. Indeed, the phonetic realization of this sequence in spontaneous IH is usually [ta] 'Acc. the',[50] as shown in Spectrogram 2 (the highlighted chunk demonstrates this phenomenon). The sequence was not split by a C-boundary. An ACC with an appended [e] was followed by a CE boundary only twice, and usually followed by an N or a DM.



Spectrogram 2: The phonetic realization of /et ha/ 'Acc. the' as [ta] (from OCh)

9.4.1.2 PREP-DEF

There were 80 cases of the PREP-DEF sequence [me ha] 'from the' (no allophonic [mi ha] sequences were found) in the corpus (p=0.661). This sequence occurs five times before CE boundaries, but it is never split by a C-boundary (e.g. *[me C^{i} ha]).

[50] This phonetic representation was not included in the transcriptions of the current research. Rather, the [et ha] transcription was performed.

The same is true for the 56 cases of [al ha] 'about the', among them five "[al ha] CE" sequences, but no splits between [al] and [ha].

9.4.1.3 POSS-DEF

40 cases of [Sel ha] 'of the' were found in the corpus, among them eight followed by a C-boundary (7 before CE and one before CN). No splits "[Sel C^i ha]" were found.

9.4.1.4 SUB-DEF

16 cases of [Se ha] 'that the' sequences, among them two "[Se ha] CE" sequences and 1 "[Se ha] CN". No "[Se C^i ha]" sequences, splits between the subordinate conjunction and the definite article, were found.

9.4.1.5 DM-DEF

The same findings were found for six occurrences of [az ha] 'so the' as well. These cases are summed up in (197):[51]

(197) Prosody of Function phrase (Func.P) with definite NP

a.	Func.-DEF N	in fluent speech. e.g., [b-a bajit] 'in the house'
b.	Func.-DEF **CE**/**CN** N	in disfluent speech. e.g., [b-a **CE** bajit] 'in the house'
* c.	Func. **C^i** DEF N	e.g., [be **CE** ha=bajit] 'in the house'

The finding that an elongated [ha] 'the' is prosodically attached to a preceding word, mainly another function word, and that the definite article is not expected to be separated from its preceding function word can be expressed as a rule (198):

(198) The definite article [ha] with a function word preceding it, is always enclitic

To sum up, function words in IH are sometimes proclitics (the fluent case) and sometimes enclitics (when preceding CE boundaries). Hence, the generalization that I offer with respect to the above findings is that function words in IH are clitics, especially when they have CV structure. We can conclude from the results that function words "lean" backwards to the preceding word, when they have a word to lean on. This assumption is based on findings for prepositions followed by the definite articles [ha]:

[51] Copulas and personal pronouns are not included in this proposed rule.

/ba/ 'in the' and /la/ 'to the', and, to a certain extent, also the common [ta] 'Acc. the'. Since clitics have no primary stress of their own, when there is no preceding word to lean on, clitics are forced to lean forward, on the immediate coincidental following element.[52] Anderson (2005) states that "the choice of proclitics or enclitics attachment can be made to follow from a more general principle of a language's prosodic organization" (2005, 63). I believe the results of this research strengthen this statement.

9.5 The element following the CE boundary

I have attempted to explain the phenomenon of CE boundaries from the point of view of the "preceding" POS, the elongated POS, and to show that regularity exists in terms of word class (function words) and that the prosodic pattern of elongation can be explained in terms of form and function, i.e. head-dependent relations and/or encliticization. Yet another aspect of C-boundaries is the following POS, or more generally – the following syntactic structure.

In the study of disfluencies such as 'filled pauses', a major approach views them as indicators of increased cognitive processing (inter alia, Shriberg 2001; Clark and Wasow 1998). For example, Shriberg (2001) claims that disfluency rates depend on the length and complexity of the sentence (2001, 157).

Clark and Wasow (1998) showed that in American English, complex syntactic structures predict repetitions of function words. Their findings led them to formulate the *commit-and-restore model* of repeated words (Clark and Wasow 1998, 203) and to propose the Complexity Hypothesis: "Our proposal is that constituents are harder to plan at the conceptual or syntactic level the greater their *grammatical weight*" (1998, 205). For example, they showed that speakers repeat the definite article *the* when it precedes a complex noun phrase. A complex NP is one that is followed by modifiers, as in "*the dog [down the street]*", as opposed to a modifier that comes before the noun, as in "*the [mangy] dog*". Thus, they divide NPs into "simple" NPs, which don't have anything after the head noun, and "complex" NPs, which do. Horne, Bruce, Frid,

[52] I would like to thank Ilan Gonen for the fruitful discussion, which helped me put my ideas into words.

Johansson, and Roll (2001-2004) and Roll, Frid, and Horne (2007) concluded that a disfluent *att* 'that' is evidence of cognitive processing of more complex syntactic structures.

A kind of complexity approach was also implemented on the Tiberian Hebrew accent system (*te'amim*). Dresher (1994) brings examples of subjects preceding verbs, where the combination of the subject and the verb varies in terms of complexity. He demonstrates two cases of long subjects and relatively short verb phrases, where the main break (*pause* in Dresher's terminology) falls between the subject and the verb; and two other cases with short subjects, where the main break falls after the verb. "These pause values correspond to a structure in which the verb and the subject form a constituent, contrary to the syntax. The difference between the two types of cases has to do with the length and prosodic complexity (i.e. number of phrases) of the subject relative to the verb phrase" (Dresher 1994, 25).

According to the results of the present research, the elongated words vary in terms of complexity. For example, two of the elongated words with the highest probability are [ha] and [Sel], which call for a simple structure to follow them – a noun or a proper name or any other pronoun. The results show that there is wide variation in the following CE boundary structures compared to narrower variation in the elongated elements, i.e. which show more regularity. Another example are cases of elongated construct state nouns and infinitive prefixes, with the prediction of only simple following structures, a noun and a gerund, respectively. Second, taking the most elongated POSs – POSS, DEF, SUB, PREP and CONJ – it is argued here that syntactic complexity cannot be the key to the elongation phenomenon. This is because the three POSs – POSS, DEF and PREP – predict a noun after them, while after SUB and CONJ more complex structures are expected. This simple argument rejects complexity as the explanation for the elongation phenomenon since there is no hierarchical order with regard to complexity, neither in elongated POSs nor in the expected following structures.

Through the following examples, I will try to illustrate this argument. The examples are of two fluent and disfluent function words: the subordinate particle [Se]

'that' (199)-(203) and the definite article [ha] (204)-(204i). This is a qualitative comparison only.

(199) Subordinate particle [Se] 'that' within an NP that is a clausal direct object

a. pagaSti gam haRbe gvaRim **Se** heeminu Se ken [C413] *fluent*
'I also met many men **that** believed that it is so'

b. ani medamjenet et kahiR **Se CE** # hajiti ba lifnej [C412] *disfluent*
'I imagine Cairo **that CE** # I visited before'

(200) Saying verb with a clausal direct object

a. ve boRenStein amaR **Se** hu lo jaXol [C514] *fluent*
'and Borenstein said **that** he could not'

b. hu dej amaR **Se CE** ledaato en F en beaja [C412] *disfluent*
'he kind of said **that CE** in his opinion there is no F there is no problem'

c. bikaS-t **Se CE** ni-kne adaSim ve ke- **F** ve **CE** Xalav **TQ** [D741] *disfluent*
ask.PST-2SG.F **that CE** 1PL-FUT.buy lentils and @- **F** and **CE** milk **TQ**
'you asked us to buy lentils and and milk'

(201) [Se] within an NP that is a relative clause

a. et haemet **Se** jeS li Stej XaveRot noRa noRa tovot **T** [P1241] *fluent*
'the truth is **that** I have two very very good friends **T**'

b. Rov ha anaSim **Se CE** hiSpiu al ma Se ani maamina hajom [C412] *disfluent*
'most of the people **who CE** influenced what I believe today'

c. ve od davaR **Se CE** tahiti legabav [C412] *disfluent*
'and one more thing **that CE** I was wondering about'

(202) [Se] within a complex subordinate conjunction

a. **ma Se** ani maRgiSa ve ulaj ze... [C413] *fluent*
what that I feel and maybe this ...
'what I feel and maybe it is ...'

b. ve anaSim me ha kahal natnu tSuvot haRbe joteR **CE** # tovot mi=ma Se **CE** ani **CE** hajiti jeXola latet [C413] *disfluent*
and the audience gave answers much more **CE** # good.PL.F from=what that **CE** I **CE** was able to give
'and the audience gave much better answers than what I could have given'

c. ze ma Se **CE** keilu **CE** # ze ma Se ose l-i et ze **T** [C413] *disfluent + fluent*
this what that **CE** like **CE** # this what that do.PTCP.SG.M to-1SG ACC this **T**
'this is what like this is what gives me the drive'

(203) complex article within a temporal adverb

a. me=az Se ani zoXeR et atsmi ... [P424] *fluent*
from=then that I remember.PTCP.SG.M ACC myself ...
'since I can remember myself ...'

b. hi kvaR lo kajemet me=az Se **CE** # kama me ha mejasdim azv-u [C413] *disfluent*
she already no exists from=then that **CE** # several from the founders leave.PST-3PL
'it no longer exists since several of the founders left'

(204) Different prosody with the definite article [ha] 'the'

a. **ha** kvutsa kama ktsat aXRej Se avaR ha Xok [C413] *fluent subject NP*
'**the** group was established a little after the law was passed'

b. ha **CE** seRet ha=ze haja tov **T** [C1111] *disfluent subject NP*
the **CE** movie the=this was good **T**
'this was a good movie'

---

c. hi paam sipR-a **al ha** Xajim Sel-a be jafo [C612] *fluent NP within PP*
she once tell.PST-3SG **about the** life of-3SG.F in Jaffa
'she once told about her life in Jaffa'

d. at paSut moRaXat al ha **CE** iton **CE** devek **TQ** [C714] *disfluent NP within PP*
you just smear on the **CE** newspaper **CE** the glue **TQ**
'you just smear glue on the newspaper'

---

e. aval ha balon nafal **T** [C521] *fluent "simple" NP*
'but the balloon fell **T**'

f. aval ha **CE** XaveRim ba avoda [P1022] *disfluent "complex" NP*
'but the **CE** friends at work'

---

g. ani amaRti llo timkoR li Rak et ha gdola [D741] *fluent AP (categorical shift/ellipsis)*
'I told him sell me only ACC the big (one)'

h. taRim et ha Retsua **CN** ha **CE** RiSona **T** [D741] *disfluent AP within NP*
pick up ACC the strap **CN** the **CE** first **T**
'pick up the first strap'

i. ve gam ha Xalon Sel ha koma ha eljona [C714] *fluent modified NP*
'and also the upper floor window'

j. gam ha **CE** mitsRit Se meSubetset be ze [C412] *disfluent NP with relative clause*
'also the **CE** Egyptian who is placed in it'

Still, there are cases in which even demonstrative pronouns are split (205)-(207):

(205) Se gvaRim hem ha= **CE** ele **T** ([ele] 'these' refers to sales persons) [D741]
'that men are the= **CE** these **T**'

(206) … et ha= **CE** ele **T** [P711]
... ACC the= **CE** these **T**
'… these'

(207) mmi ze ha= **CE** ze **TQ** [D741]
'who is the= **CE** this **TQ**'

Examples (205)-(207) also reject the complexity hypothesis since the elongated function word [ha] 'the' does not precede a complex syntactic structure. However, it can be claimed, according to the complexity hypothesis, that the elongated [ha] is an *indication* of a complex structure, which is ignored during the "hesitation disfluency" and is replaced with demonstrative pronouns [ele] and [ze].

In order to try to compete with the complexity hypothesis, 61 definite NPs from a single recording of the TEL corpus were examined and defined according to two categories, following Clark and Wasow (1998): A "simple" NP, which does not have a following relative clause, as in (204)-(204); and a "complex" NP, which does, as in (204) above.

43 definite "simple" NPs and 18 definite "complex" NPs were found. Of the eight elongated [ha] 'the', four (22%) were found before "complex" NPs, demonstrated in (208a)-(208c), and three (6%) were found before "simple" NPs, demonstrated in (208d)-(208e). One case is an abandoned [ha] 'the'.

(208) The complexity hypothesis re-examined with the definite article [ha] 'the'

a. gam ha **CE** mitsRit [Se meSubetset be ze] **CE** ve gam ha **CE** # ehm **CE** # gam kahiR [Se meSubetset be ze] **T** [C412]

'also the **CE** Egyptian (language) [which is placed in it] **CE** and also the **CE** # ehm **CE** # also Cairo [which is placed in it] **T**'

b. ha **CE** kvutsa ha feministit Selanu **CRF** [Se hikamnu ba univeRsita] [C413]
'the **CE** our feminist group **CRF** [that we established at the university]'

c. ha **CE** maRtsa Sel-i **CF** [Se haji-ti ozeRet meXkaR Sel-a] [C413]
the **CE** lecturer of-1SG **CF** [that be.PST-1SG assistant.F_of research of-3SG.F]
'my lecturer whose assistant I was'

d. ani jeXola lehavin et ha **CE** # et ha **CE** # tiskul **T** [C412]
'I can understand ACC the **CE** # ACC the **CE** # frustration **T**'

e. ki lo XaSav-ti Se ha **CE** # haRtsaa Sel-i mevi- **F** movia- **F** movila le kivunim ka-ele **T** [C413]
since not think.PST-1SG that the **CE** # lecture of-1SG la- **F** le- **F** leads to directions like-these **T**
'since I did not think that my lecture could lead in such directions'

Nonetheless, this attempt to define complexity according to the presence of relative clauses may be inadequate for IH, since, unlike English, adjectives in IH follow nouns, so an NP with an adjective and a relative clause, as in (208b) and (208c) is much more complex than an NP with only a relative clause, as in (208a). Another reservation relates to the position of the NP in the clause. In (208a)-(208c), it is the subject, while in (208d)-(208e) (and the abandoned case), it is the direct object. Clearly, this comparison is limited and cannot provide evidence for the complexity hypothesis. Its importance is in the linguistic issues raised that should be dealt with in a future research.

A more adequate theory which can explain why speakers mainly elongate before nouns and verbs is accessibility theory (AT). Ariel (2001) argues that the ease with which a piece of given information is processed reflects its degree of mental accessibility, and that representations of linguistic material and physically salient objects are assumed to be in the short-term working memory, as opposed to representations of encyclopedic knowledge, which are assumed to be in long-term memory. Two principal criteria of AT associated with specific degrees of accessibility may be relevant to explaining the following elements: The first is informativity. Accessibility markers representing a low

degree of accessibility incorporate more lexical information than those representing a high degree of accessibility (e.g. open lexical categories vs. closed categories). Second, the attenuation criterion (phonological size) states that all things being equal, the less accessible an entity referred to by an expression is, the larger the expression is phonologically. This criterion also refers to the difference between stressed and unstressed forms. Shorter and unstressed forms have a higher degree of accessibility (e.g., CV function words) than longer and stressed forms (e.g., verbs, proper names, etc.).

For example, after a transitive verb that compels a direct object or indirect complements, adjuncts etc., the (obligatory or non-obligatory) preposition, which is more accessible than the following syntactic structure (e.g. NP), is attached to the preceding verb and thus implies the verb's valence and meaning. If this is the reason for encliticization of elongated forms, then the procliticization phenomenon, mentioned in Bolozky (1999, 2003) and Bolozky and Schwarzwald (1990) should be explained. Indeed, there is no question regarding Bolozky's phonological analysis of proclitics: function words don't have stress and deletion occurs in the unstressed vowel of CV function words. If so, encliticization (elongated forms) and procliticization (contracted forms) do not occur due to the same linguistic phenomenon. Procliticization is a phonological phenomenon while encliticization is due to cognitive processes and working memory constraints. The speaker has to draw on less accessible lexeme(s).

Moreover, to return to WG, when Hudson (1993) compares constituency theory and dependency theory with respect to the load on working memory, he argues that dependency theory allows us to count the number of active dependencies, defining a dependency as active if either the head or the dependent are still awaited. An active dependency is satisfied as soon as the word concerned is encountered (1993, 275-279). At that point, the burden on the working memory decreases and more space remains for continuous processing of information. Thus, as opposed to the complexity hypothesis, the CE boundary tone phenomenon can be explained by AT and Hudson's "active dependency" as a working memory load that is about to be satisfied.

To conclude, both the complexity hypothesis and AT theory deal with cognitive processes which are beyond the scope of the present research and their adaptation to the prosody of IH remains for future research.

9.6 Dependency between the lead and a target word

According to the dependency approach adopted here, what is common to all elongated words is the fact that they imply *continuity*, regardless of whether they are dependents of heads or heads of dependents. What should be stressed here is that they share a [+dependency] syntactic feature. It can be said that what is actually elongated is not the word itself (or a syllable of the word), but this syntactic feature.

For example, the results of the present research show a noun to be defined with a [-dependency] feature; a construct state noun with [+dependency]; a preposition with [+dependency]; an intransitive verb with [-dependency], e.g. /halaX-ø/ 'walk.PST-3SG.M', but a transitive verb with [+dependency], e.g. /halaX/ 'go.PST-3SG.M', as in [halaX le tel aviv] 'went to Tel Aviv'. Thus, the [+dependency] feature shows that "there is more to come", i.e. what are the communicative intentions of the speaker. It allows the speaker to think, if either the head or the dependent are still awaited, by elongating structures. In my view, what is common to elongated grammatical elements is the [+dependency] feature. I will refer to these elongated increments as *leads*, a term used in acoustic phonetics as part of the study of voice onset time variations in initial plosive consonants: **voicing lead** refers to the occurrence of voicing before the plosive release (burst); it contrasts with 'voicing lag' (Crystal 2008, 271).

Lead will be used here as a generic term for a variety of syntactical increments that have the [+dependency] feature and that are to be followed by another syntactical increment. In the context of the present research, *leads* are sometimes marked prosodically by the CE boundary tone. I present the term *lead* since, as was demonstrated in §9.1, the term *head* cannot always be attributed to the elongated POSs in the present study.

In the previous sections (§9.1-§9.5), I have tried to explain the CE boundary tone phenomenon through several theories. Of these, one characteristic can also be said to apply to the findings of the present research on spontaneous spoken Hebrew, that of "syntactic planning coming before lexical planning" (Blanche-Benveniste 2007, 61). This simple statement does not depend on the complexity hypothesis, does not involve head-dependent terminology and most important – it refers to speech and not to theoretical syntactic structures or written-oriented approaches. To this statement, I would like to add another term – placeholder (Podlesskaya 2010). In spontaneous speech, placeholders "mainly have a pronominal origin and serve as a preparatory substitute for a delayed constituent" (Podlesskaya 2010, 11) and placeholders are "among other lexical and grammatical resources that allow the speaker to refer to object and events for which the speaker fails to retrieve the exact name, or simply finds the exact name to be unnecessary or inappropriate" (ibid.). Both Blanche-Benveniste (2007) and Podlesskaya (2010) assume the pronominal nature of disfluencies or placeholders. In this respect, I adopt this approach by saying that excessive elongations are prosodic morphemes which also have a pronominal nature. This is to say that speakers first utter the syntactic frame – the lead with its [+dependency] feature, which is carried by the CE boundary tone with its pronominal nature. The lead is expected to be followed by a *syntactic increment* or a *target word*.

9.7 Summary

The present research attempts to describe and explain the phenomenon of excessive elongated forms by promoting prosody and prosodic patterns before the syntactic structures.

The main concern of the above analysis was to find a syntactic approach that can deal with the elongation phenomenon and that will be able to classify the elongated POS. The analysis was performed on results that showed dependencies between POSs, or words, across C-boundaries; mainly the phenomenon of the CE boundary tone. I first tried to explain the dependencies through Dependency Grammar (DG) – a syntactic

theory that does not refer to prosody, and used the terms *head* and *dependent* to find a common feature of POSs that carry the CE boundary tone (i.e., the (pre-)elongated word). Then I tried to show that the elongated elements also share the fact that they are function words. I also tried to explain that an elongated POS is actually an enclitic in the intonation unit final position. This encliticization was demonstrated through the Hebrew definite article [ha] 'the'. The following POS, or structure, was also discussed and it was suggested that the Complexity Hypothesis failed to explain the results. Finally, a new syntactic term for elongated POSs that carry the CE boundary tone was presented – *lead*.

Prosody was used here as the only parameter for perceptual segmentation of spontaneous speech. Five continuous boundary tones that Hebrew speakers use in order to process their ideas were defined: CN, CE, CR, CRF, CF. The distinction between CR and CE was found to be meaningful with regard to their syntagmatic surroundings.

The results show that the CR boundary tone has a characteristic syntactic environment – the end of clauses, which reflects its use as an unmarked continuous boundary tone. This is especially apparent in weather forecasts research (Silber-Varod and Kessous 2008). CE, on the other hand, is a marked continuous boundary tone, since it regularly "breaks" grammatical dependencies.

CN, which is the most frequent C-boundary, was found to be ambiguous. On one hand, it shares several syntactic environments with CE. This is expected, since it was defined as a level tone boundary without elongation (less than 230ms). On the other hand, it behaves like CR; i.e., it is also found in clause final position. There are a few limitations on this C-boundary classification: first, its acoustic definition may not be adequate. A level tone is more difficult to perceive than a rising or falling tone, and the fact that no other acoustic cue is added (except a pause), makes CN acoustically a minor boundary cue. Second, following the results (see interim summary in §8.6), CN boundaries sometimes behave as CRs and sometimes as CEs. Therefore, it can be suggested that both CR and CE should be given *wider* acoustic definitions: CE annotation will include syllables of less than 230ms; while CR will be annotated in less prominent

risings. According to this suggestion, the CN boundary tone in IH prosody would still be unnecessary, since it would not have communicative value.

The CRF boundary tone, on the other hand, although acoustically well defined, was not a dominant "participant" in spontaneous Hebrew prosody. Results show no specific syntactic regularities in the dependency structures around CRF. It is suggested here that the CRF boundary has more pragmatic ends, and that it is used when the speaker wants to stretch the word in order to create anticipation in the listener's mind. However, this prosodic-pragmatic interface remains for a future research.

The CF boundary tone, like CRF, was not dominant in the results. This may be due to the fact that a continuous falling tone is difficult to distinguish from the default terminal boundary tone.

Yet the focus of the present research was on the extended elongation phenomenon. I believe the results show that this is a phenomenon of spoken language that should be dealt with in segmental and suprasegmental terminology as an equal player. Moreover, the present research defined and analyzed two dimensions of the CE boundary tone phenomenon: its paradigmatic and syntagmatic pivots.

The paradigmatic axis is its phonological structure, as mentioned in §6.2.1.2 and shown in Table 7: The CE structure is realized either by elongated syllable, mainly with (C)V_{eaoui} structure, as in (209), or by an appended [e] that is added to the final syllable in an IU, as in (210).

(209) ha beaja be **CE** lo be ze aval [D23]
'the problem in **CE** (is) not in this however'

(210) Sel e **CE** tsipoRim [OCh]
'of eh **CE** birds'

The syntagmatic aspect is the dependency between the elongated word and the word following the CE boundary. The syntagmatic aspect connects form and function as *leads* are most commonly found to be elongated since they function as cues to continuity.

9.8 Introducing the speeCHain perspective

From the onset, the present research was prosodically motivated and prosodically driven. Thus, a prosodic point of view will be now presented: a suggestion for a new perspective on the prosody-syntax interface, which is relevant to the whole set of C-boundaries, but emerged from a tentative observation on the CE boundary tone. I call this perspective *the speeCHain perspective*,[53] with a capital CH, since this typography reflects the *tension* between prosody and syntax in speech.

Both Hudson (inter alia 1993), Ariel (1990) and Clark and Wasow (1998) were mentioned above with respect to the part that the mental lexicon plays in the speech process. "The **mental lexicon** is the stored mental representation of what we know about the lexical items in our language" (Crystal 2008, 278-279). I claim that the prosody of C-boundaries helps to carry out the speech process, and that CE boundaries reflect this process ideally. Since the results showed that CE occurs within syntactic units, even within phrases or constituents, and basically that elongated words are function words, I can assume that C-boundaries function to delineate (and thus they are boundaries) as well as to connect (and thus they have a continuous feature, continuative value of communication) syntactic units. The elongated production of function words does not break syntax even if followed by a pause; rather, it implies syntactic continuity.

Referring back to the syntactic and prosodic segmentations presented in chapter 3, and specifically to examples (3a) and (3b) that are repeated here, one can see that a unit does not have to include a *head* with all its *dependents*.

(3a) [This is [the dog that chased [the cat that killed [the rat that ate [the malt that lay in [the house that Jack built]]]]]]

(3b) |This is the dog | that chased the cat | that killed the rat | that ate the malt | that lay in the house that Jack built |

[53] The term *speech chain* was used by Denes and Pinson (1993) in the sense of "the different forms of a spoken message in its progress from the brain of the speaker to the brain of the listener"; see also Figure 1.1 in Denes and Pinson 1993, 5). My use of the term SpeeCHain is different from theirs, in the sense that the model reflects the processing of the intonation unit.

In (3a), a subject NP, *the cat that killed*, opens a new syntactic unit while in (3b), a relative clause, *that chased the cat*, opens a prosodic unit. In both segmentations, the unit alludes to the preceding or the following *dependent* that is in a separate unit. Thus, a noun phrase like *the cat that killed* implies that there is an object that was killed. A prosodic unit like *that chased the cat* implies a subject who *chased the cat*. These indications create tension, or anticipation.

My hypothesis is that through CE boundaries, we are exposed to this type of tension in speech but that this CE boundary tension is produced by prosody, and not by phrasal analysis. This tension exists in speech between the prosodic layer and the textual, segmental, layer, and is modeled in Figure 17 and Figure 18 as rings in a chain, in what I call "the SpeeCHain perspective".

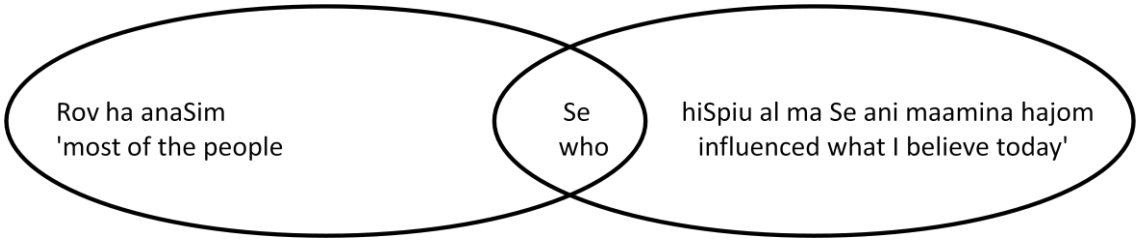


Figure 17: The SpeeCHain perspective: Tension between prosody and syntax

Figure 17 demonstrates a sequence of two IUs from [C413]: [Rov ha anaSim Se CE hiSpiu al ma Se ani maamina hajom CR] 'most of the people who CE influenced what I believe today'. The ellipse on the left in Figure 17 represents the IU [Rov ha anaSim Se] 'most of the people who', which has a continuous CE boundary tone. The ellipse on the right represents the relative clause [hiSpiu al ma Se ani ma'amina hajom] 'influenced what I believe today'. The fact that the two IUs are written in linear sequence indicates that they form a single syntactic unit (albeit complex), a NP with its modifier clause. The subordinate particle [Se] 'that' is located in between. This chain model reflects the *tension* which the combination of prosody, in this case the CE boundary tone, and the syntagmatic axis, produce; a tension which cannot be reflected in a hierarchic model such as the rectangular model:

IU	IU
Syntactic unit	

My suggestion is strongly based on European structuralism which claims that "the prosodic forms are valid only because they enter into a grid of functional relations" (Lacheret-Dujour and Beaugendre 2002, 268). Such an approach gives a better understanding of speech processing in general and of phenomena in CE boundaries in particular. This model also goes hand in hand with a "left-to-right" model of prosody, which "embodies the basically linear nature of the speech-event itself" (Fox 2000, 363).

The speeCHain model does not apply only to elongated CE boundaries, but to all continuous boundaries. It reflects how the continuous boundary tone has a two-fold role of demarcation (defining syntactic boundaries) and grouping (signaling connections between units). A more comprehensive demonstration of the speeCHain model is shown in Figure 18, where two types of C-boundaries reflect this two-fold role of continuous boundaries on a four IU sequence.

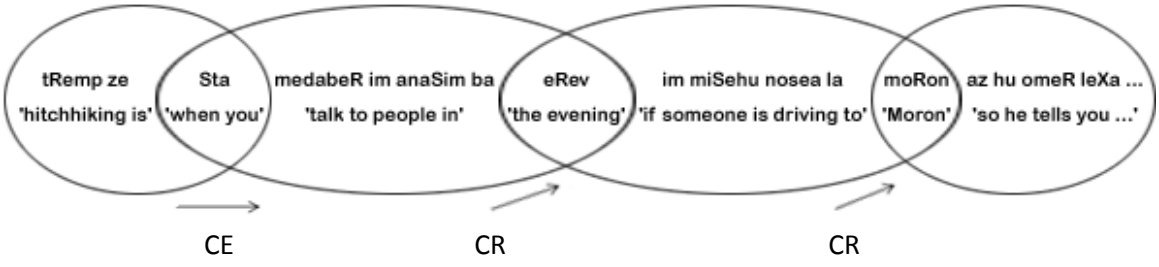


Figure 18: The SpeeCHain model: Prosodic chain of continuous IUs

tRemp ze Sta **CE**	'hitchhiking is when you **CE**
medabeR im anaSim ba eRev **CR**	talk to people in the evening **CR**
im miSehu nosea la moRon **CR** #	if someone is driving to Moron (Mongolia) **CR** #
az hu omeR leXa ... [OCh]	so he tells you ...'

10 Conclusions

10.1 Summary

1. The Continuous Elongation boundary tone is one of the mechanisms that speakers use to connect their ideas through speech.
2. By defining the prosodic characteristics of CE, it has been shown that CE is indeed a boundary which has the communicative value of continuation. This boundary does not always overlap with syntactic units, meaning that CE most often occurs within phrases, and not between phrases.
3. Elongated words are usually function words that are attached to the word that precedes them, and not to the following word. The attachment is not due only to prosody or phonological rules, but can be attributed to the strength of syntactic relations (i.e. dependencies) between the elongated word and the word that precedes it, and between the elongated word and the following words.
4. Due to the immediate accessibility characteristic and the structural role that *leads* play in defining the syntactic structure, an IU that ends with a CE boundary does not break the syntactic structure. On the contrary, the expected syntactic structure is already indicated in the IU that ends with the elongation, i.e. the syntactic structure is thus complete. The lexeme(s) in the next IU does not contribute a fundamental increment to the *structure*, only to the *content*.
5. This mechanism reduces the burden of the working memory, and thus enables processing of new information.
6. In the above analysis, I suggest an encompassing approach to prosodic-syntactic interface. I suggest that through the CE boundaries phenomenon, speakers and listeners are exposed to the tension between the prosodic strata and the syntactic strata of language. The tension is between a prosodic *break* (2 IUs: one that ends with CE and the following IU) and syntactic *continuity*. This tension occurs in ~10-18% of spontaneous speech in Israeli Hebrew and is what enables the speaker to process speech. I claim that this tension clarifies the role of prosody in speech.
7. This interface can be modeled in what I call "speeCHain perspective".

From this research, I learned about a structural aspect of prosody in speech, which is to enable the flow of speech (to chain/connect speech) with miscellaneous interactions (varied interface) between prosody and syntax. I believe the CE technique discussed in the present research is a good example of this.

10.2 Contributions

The goal of this research was to investigate continuous prosodic boundaries of IUs in spontaneous spoken Hebrew. My approach to speech analysis is prosody-based.

Specific contributions of this research include:

- **Prosodic boundary classification:** Developing a systematic classification for prosodic boundaries, with an emphasis on different kinds of continuous boundaries; defining the variety of prosodic boundaries and the acoustic cues for using them to improve accuracy of perceptual parsing.
- **Documentation** of the prosodic boundary classification as a transcription method for future labeling of various corpora.
- **Prosodic-syntactic interface:** Analysis of the relationship between prosodic events (units, boundaries) and syntactic structures; studying how the acoustic and segmental cues contribute to our understanding of the structure of IUs and to the process of spontaneous Hebrew.
- **SpeeCHain perspective:** A new perspective for understanding spoken language, which integrates prosody and the segmental string. I believe that this perspective can contribute to speech recognition applications such as comma – internal sentence punctuation – prediction (Favre, Hakkani-Tür, and Shriberg 2009; Hillard et al. 2006).

10.3 Future research

The contribution of this thesis represents only a preliminary step, however, toward the longer-term goal of unified prosodic patterns in IH. To that end, much work remains to be done. A number of specific areas for future study were noted throughout this work. More generally, the following important broad areas remain to be addressed:

One area is the modeling of other corpora beyond the limited (but rich) spontaneous corpus examined in the present work. This includes exploring regularities in semantic, prosodic, discourse-related, pragmatic, and cultural factors of elongation production and C-boundary distribution. It also includes examining additional styles of spontaneous speech and additional speakers to test the generalizability of the results.

A second goal is to enrich the acoustical characteristics of the prosodic boundaries in spoken IH, in order to come closer to more precise definitions. For example, future work needs to take into account acoustical measurements, such as the duration of silent pauses, f_0 variables, etc.

Third, much insight into elongated (CE boundaries) elements (words) could be gained from cross-linguistic studies. For example, comparison of languages differing in syntax could shed light on the syntactic organization of such elongations. Examination of languages with lesser grammatical agreement than Hebrew (e.g. English) would make visible certain repairs that cannot be seen on the surface in Hebrew. For example:

In Hebrew: be **CE** b-a bajit 'in CE in-the house'

In French: une **CE** un homme

But in English: a **CE** a man

Languages with lexical tone, in which f_0 relationships across syllables are more highly constrained than in Hebrew, could be useful for studying the intonation of all C-boundaries and of elongations in particular.

Fourth, future work could be facilitated by methods that reduce time and effort in annotating data. One approach would be to develop tools to automatically label prosodic boundaries and prominences in large databases, as is already done in other languages (e.g., ANALOR for French). A second approach would be to reduce the overall amount of data needed to discern trends, by reducing variability in the data. This could be achieved by appropriate elicitation methods (e.g. planned lab interviews that consist of questions by the researcher and answers by the informant).

Finally, for speech applications, the long-term goal is integration of prosodic boundaries in general and of CE boundaries in particular in an overall architecture for

the intelligent automatic processing of spontaneous speech. This includes speech recognition architecture that will include prosody in general and elongation in particular in its recognition parameters, or text-to-speech technology that will sound more natural and even spontaneous.

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Appendix I: Transcription standards

1. Phoneme level transcription standards

The transcription of the data follows the system presented in the original SAMPA[54] chart of phonemic distinctions in Hebrew,[55] with adaptations to the current research.

Symbol	Keyword	English gloss	Orthography	Remarks
Consonants				
Plosives				
p	pil	elephant	**פִּיל**	
b	bajit	house	**בַּיִת**	
t	tik	bag	**תִּיק**	
d	delet	door	**דֶּלֶת**	
k	kelev	dog	**כֶּלֶב**	
g	gamal	camel	**גָּמָל**	
?	Sa?al	asked	**שָׁאַל**	Not transcribed in the current corpus. For example, /sa?al/ is transcribed as [Saal]
Fricatives				
f	falafel	felafel	**פָּלָאפֶל**	
v	veRed	rose	**וֶרֶד**	
s	sof	end	**סוֹף**	
z	zamaR	singer	**זַמָּר**	
S	SiR	song	**שִׁיר**	
X	aRoX	long	**אָרוֹךְ**	X is the notation for velar and uvular fricatives
h	haR	mountain	**הַר**	
Affricate				
ts	tsalaXat	plate	**צַלַּחַת**	
Nasals				
m	maRak	soup	**מָרָק**	
n	nafal	fell	**נָפַל**	

[54] http://www.phon.ucl.ac.uk/home/sampa/

[55] http://www.phon.ucl.ac.uk/home/sampa/hebrew.htm

Symbol	Keyword	English gloss	Orthography	Remarks
Liquids				
l	lavan	white	**לָבָן**	
R	RoS	head	**רֹאשׁ**	
Semivowel				
j	jad	hand	**יָד**	
w	walla	really	**וואלה**	
Vowels				
i	tik	bag	**תִּיק**	
e	even	stone	**אֶבֶן**	
a	amaR	said	**אָמַר**	
o	Salom	peace	**שָׁלוֹם**	
u	guR	puppy	**גּוּר**	
Rare, dialectal or marginal phonemes				
Z	masaZ	massage	**מַסָאז**	
X\	X\atul (Xatul)	cat	**חָתוּל**	Pronounced in standard IH as a velar fricative and therefore annotated as X.
tS	tSips	chips	**צ׳יפְּס**	
dZ	dZins	jeans	**ג׳ינְס**	
?\	pa?\al (pa?al)	acted	**פָּעַל**	Not transcribed in the current corpus. For example, the /pa?\al/ is transcribed as [paal].

The stress mark (") was not annotated.

2. Word level transcription standards

Transcription	Morphology	English gloss	Hebrew Orthography
lla	le-hi	'to her'	לָהּ
la	le-ha	'to the'	לַ
llo	le-hu	'to him'	לוֹ
lo	lo	'no', 'not'	לא
al	al	'on', 'about'	עַל
ʔal	al	'do not'	אַל
ba	be ha	'in the'	בַּ
bah	be-hi	'of her', 'in her'	בָּהּ
bba	came.3SG.PST	'arrived', 'came'	בָּא
imm		'if'	אִם
im		'with'	עִם
mi	me	'from'	מִ
mmi		'who'	מִי
li	le-ani	'to me'	לִי
lei	le	'to'	לְ

3. Complex structures transcribed as single units

Adverbials

ba=hatXala	'in the beginning'
ba=sof	'in the end'
ba=taXles	'in practical terms' (slang)
ba=toR	'in the line'
ba=Xajim	'in life'
be=deReX (-klal)	'usually'
be=diavad	'in retrospect'
be=dijuk/ bi=dijuk[56]	'exactly'
bi=svivot	'around'
be=emet	'really'
be=enaj	'in my opinion'
be=eneXa	'in your opinion'
be=ereX	'approximately'
be=etsem	'actually'

[56] [bi-] 'in' is the allophone of [be] 'in'. [li] (transcribed as [lei] as a convention in the present research); 'to' is the allophone of [le]; [me] 'from' is the allophone of [mi].

be=ezRat (ha Sem)	'with God's will'
be=feRuS	'clearly'
be=hizdamnut	'at the appropriate moment'
be=ikaR	'especially'
be=ikaRon	'in principle'
be=kitsuR	'in a nut shell'
be=Xol [bekol]	'in each'
be=koaX	'forcefully'
be=nosaf	'in addition'
be=Sum	'in no'
be=teavon	'bon appetite'
be=toR	'as'
be=toX	'inside'
be=Xajaj	'I swear'
ha=bajt-a	'the home-to'

Construct-state proper name

Ha=bRit, in the construct-state proper name [aRtsot habRit] 'the United States'

ha=din in the construct-state proper name [jom hadin] 'Day of Judgment'

ha=deReX in the construct-state proper name [em hadeReX], a shopping complex that is literally named 'main road'.

Demonstrative pronouns

ha=ze 'this.Msg'

ha=zot 'this.F.sg'

ha=zo 'this.F.sg'

ha=ele 'these.pl'

ha=hu 'that.Msg'

ha=hi 'that.Fsg',

Adjectives

ha=ba 'the next.M'

ha=baa 'the next.F'.

Interrogative

ha=im	'is it?' (at beginning of yes/no question or interrogative phrase)

Discourse marker:

ha=emet	'to be frank'

4. Intonation unit level transcription standards

The system used is as follows:

1. - : A single hyphen at word end indicates where the speaker has truncated a word, leaving the end of the (projected) word unuttered.
2. <…>: The arrows enclose any comment I have chosen to make. The comment is in capital letters.
3. @: The symbol is used to indicate speech which is not audible enough to allow a reasonable guess at what was said. One @ is used for each syllable of indecipherable speech.

5. Prosodic annotations

IU Intonation unit

T Terminal boundary tone

TQ Terminal Question boundary tone

F Fragmented (truncated) intonation unit

CN Continuous Neutral boundary tone

CE Continuous Elongated boundary tone

CR Continuous Rise boundary tone

CRF Continuous Rise-Fall boundary tone

CF Continuous Fall boundary tone

Pause

6. Other abbreviations

F2F Face-to-Face dialogues

TEL Telephone conversations

7. High level transcription standards

Each example in the text consists of two levels of written representation, broad phonetic transcription and translation. An optional third level is a morpho-syntactic gloss, included whenever it was necessary to represent morpho-syntactic aspects. Each of the corpus examples and several out-of corpus examples are also accompanied by a fourth level: the audio string (see appendix IV):

1. A phonetic transcription with SAMPA symbols and prosodic annotation.
2. A morphological gloss according to Leipzig glossing rules.[57]
3. An English translation between apostrophes (').
4. An audio file with aligned prosodic annotation (in textgrid format).

[57] http://www.eva.mpg.de/lingua/resources/glossing-rules.php

Appendix II: Transcription sample from OCh recording

line	tmin	tier	text	tmax
1	4.216528	Omer	po CRF	4.549379
2	4.549379	Omer	jeS CRF	5.187625
3	5.187625	Omer	#	5.857823
4	5.857823	Omer	SaRSeRet haRim CRF	7.36877
5	7.36877	Omer	Se nikRet guRvan tsajXan T	8.856796
6	8.856796	Omer	#	9.445696
7	9.445696	Omer	Se ze SloSet ha jefejfijot be mongolit T	11.24522
8	11.24522	Omer	#	11.52542
9	11.52542	Omer	SaloS CE	12.54143
10	12.54143	Omer	siim Sel e CE	13.55435
11	13.55435	Omer	#	14.01287
12	14.01287	Omer	psagot Sel haRim kaele CR	15.22548
13	15.22548	Omer	#	16.54752
14	16.54752	Omer	ze be CE	17.36871
15	17.36871	Omer	hine ze ata Roe TQ	18.26384
16	18.26384	Omer	eX mongolja TQ	18.96746
17	18.96746	Omer	elef Smona meot SiSim ve XameS T	20.41308
18	20.41308	Omer	gova T	20.844
19	20.844	Omer	#	21.72859
20	21.72859	Omer	ve kol mongolja ze Rama aXat gvoha T	23.58925
21	23.58925	Omer	#	24.17569
22	24.17569	Omer	kaze mejabSim al ha CE	25.4823
23	25.4823	Omer	geRim CRF	25.92115
24	25.92115	Omer	et ha gvinot CR	26.54718
25	26.54718	Omer	#	27.38201
26	27.38201	Omer	zoXeR Se heReti leXa ba tmunot TQ	28.63452
27	28.63452	Omer	et male CE	29.10082
28	29.10082	Omer	kaele gvinot hem samim al ha ohel CR	30.45458
29	30.45458	Omer	#	31.08493
30	31.08493	Omer	im ha SemeS ze mitjabeS CR	32.33641
31	32.33641	Omer	ve ze CE	32.76017
32	32.76017	Omer	nehefaX le CE	33.48897
33	33.48897	Omer	ha Xalav nehefaX le gvina T	34.69358
34	34.69358	Omer	#	36

Appendix III: Part-of-Speech tag set

The Part of Speech annotation is based on the List of Standard Abbreviations in the Leipzig Glossing Rules. [58]

1.	ACC	Accusative marker (Acc.)
2.	ACC-PRON	Acc. with pronominal suffix
3.	ADJ	Adjective
4.	ADV	Adverb
5.	AUX	Modal lexeme (auxiliary)
6.	BE	Inflectional forms of the lexeme [haja] 'be'
7.	CONJ	Conjunction
8.	DEF	Definite article [ha] 'the'
9.	DM	Discourse marker
10.	EXT	Existentials [jeS] 'there is' and [en] 'there is not'
11.	IMP	Imperative verbal form
12.	INF	Infinitive
13.	MOD	Modifier and quantifier
14.	N	Noun
15.	N-POSS	Possessive suffixes attached to a nominal
16.	AL	Negation lexeme ([?al] 'don't)
17.	LO	Negation lexeme ([lo] 'no')
18.	NUM	Numeral expression
19.	PN	Proper noun
20.	POLITE	Polite interjections, e.g., [bevakaSa] 'please'
21.	POSS	Possessive particle [Sel] 'of'
22.	POSS-PRON	Possessive particle [Sel] 'of' with pronominal suffix
23.	PREP	Preposition
24.	PREP-DEF	Preposition with Definiteness marker
25.	PREP-PRON	Preposition with pronominal complement suffix
26.	PRON	Pronoun
27.	PRP	Personal-pronoun
28.	PTCP	Active participle
29.	Q	Wh-word, question word
30.	SUB	Subordinate particle [Se] 'that'. Both for complement and relative pronoun
31.	V	Verb (either prefix or suffix conjugation)
32.	ZE	Demonstrative Pronoun [ze] 'this'

[58] Leipzig Glossing Rules (LGR). List of Standard Abbreviations <http://www.eva.mpg.de/lingua/resources/glossing-rules.php >

Appendix IV: CD with the audio files of the dissertation samples

The present research consists of speech analysis that was performed on spontaneous spoken recordings. One of the didactic issues when performing a study that consists of spoken material is the ability to demonstrate the issues discussed. Before technology allowed researchers to do so, this was achieved by representing the spoken material in the written text through phonetic transcription. Transcription is still an important and required representation of linguistic texts; nevertheless, today technology allows us to accompany the written representation with audio material, aligned to the relevant annotation and transcription.

Thus, in the present research, each of the examples consists of four levels of representation: Three levels of written representation described in Appendix I, and a fourth level – the audio material.

The audio files were executed using PRAAT software (Boersma and Weenink 1992-2007) and can only be opened with PRAAT since the files are in "collection" format, which means that they consist of two files: a sound file (.wav) and a textgrid file. The textgrid file enables seeing the alignment between the speech material and the prosodic annotation.

The collection files are named in such a way that the reader can easily select the relevant file while reading the dissertation. The file name consists of three parts: the number of the example in the text between brackets '()'; two or three words of the transcribed speech; and the name of the recording. For example, the representation in the dissertation of example number (8) is:

(8) eldad hexlit Se hu: lo mvater [OCh]
Eldad decide.PST-3SG.M that he: not gives_up
'Eldad decided that he wouldn’t give up'

And the name of the parallel audio file is: "8-eldad hexlit Se hu lo mvater_OCh".

Hebrew Abstract

מטרת עבודה זו לבחון היבט מבני מסוים בדיבור: החלוקה ליחידות אינטונציה. הגישה הננקטת בעבודת מחקר זו דוגלת ברעיון שחלוקת הדיבור ליחידות נעשית על-ידי הפרוזודיה – היא האינפורמציה המצויה בתזמון ובמלודיה של הדיבור. השפה המדוברת היא אמצעי התקשורת המרכזי בין בני-האדם, ולכן הבנה של מרכיב הפרוזודיה היא בסיס חיוני לפיתוח תיאוריות בלשניות. תכוניות פרוזודיות ודפוסים של הבלטה מסמנים את מבנה הדיבור, זאת על-ידי כך שהם מספקים קישור בין מימושים פונטיים ופרשנות לשונית של מבעים. הפרוזודיה מספקת רמזים לשוניים ובהם: האופן שבו יש לחלק את רצף המילים; המרכיבים שהם במוקד המבע; פירוש מודאלי של המבע (למשל, כשאלה או כחיווי); ואף איתור מפנה בנושא השיחה. על אף שלא ניתן להתוות קו מוחלט בין עיסוק בפן הפונולוגי לבין עיסוק בפן הפרוזודי של הדיבור, מקובל ליחס את האינפורמציה הטמונה בפרוזודיה לרובד הסופראסגמנטלי (suprasegmental) של הדיבור, הוא הרובד המורכב מסמנים אקוסטיים, כגון תדירות יסודית (f_0), עוצמה (intensity), משך (duration), המתפרסים על פני יותר מסגמנט אחד. גם פסקים (pauses) מסמנים גבול בין יחידות ומהווים רכיב אחד במכלול הסמנים הפרוזודיים. סמנים אלה מאפשרים, בין היתר, זיהוי של היחידות הלשוניות בשפה, כגון גבולות בין מילים ובין מבעים. לפיכך, פרוזודיה מהווה מקור מידע ראשוני ועיקרי במחקר זה, מתוך הנחת עבודה שהיא מספקת מידע לשוני שאינו נמצא, דווקא, במישור התחבירי.

חלוקת הדיבור ליחידות אינטונציה חופפת לכאורה לשלושה סוגים של יחידות פרוזודיות מעל לרמת המילה הפרוזודית: הצירוף הפונולוגי (Phonological Phrase), צירוף הנגנה (Intonational Phrase) והמבע (Utterance) (ראו אצל Fletcher 2010, 259). ההיררכיה הפרוזודית הזו מדגימה את ההנחה המקובלת שיחידות פרוזודיות הינן רלוונטיות רק כאשר הן מקושרות לרבדים אחרים בשפה, כלומר לפונמות (segments), להברות, למילים, לצירופים ולמשפטים (או לפסוקיות). במחקר זה אני שואפת להציג גישה מקיפה ליחסים שבין הרובד התחבירי לרובד הפרוזודי בעברית המדוברת הספונטנית, כפי שהם מתממשים בגבולות הפרוזודיים שבין יחידות אינטונציה. השאלה איזה מבנה לשוני מיוצג על-ידי יחידות הדיבור הפרוזודיות היא מרכזית במחקר זה, ואחת מהנחות המחקר היא שהרובד הפרוזודי בדיבור לאו דווקא חופף לרובד התחבירי. כלומר, גבול של יחידה פרוזודית אינו חייב להיות גם גבול של יחידה תחבירית, ולהפך – גבול תחבירי לא חייב להיות ממומש עם גבול פרוזודי. לפיכך קיימות כמה אפשרויות: שיחידת אינטונציה מקבילה למבנה תחבירי X, שיחידת אינטונציה מכילה כמה מבני X, או שיחידת אינטונציה בוקעת מבנה X.

עוד בטרם נבחן ממשק פרוזודיה-תחביר, מוקדש חלק נכבד מן המחקר להגדרת הטונים הפרוזודיים בגבולות של יחידות האינטונציה. טונים אלה מסמנים קיטוע של הדיבור באמצעות סמנים אקוסטיים, ובכך מממשים את אחד מתפקידי הפרוזודיה – לסמן את מבנה הדיבור. המחקר מונע מן העובדה שניתוחים המוקדשים לשפה העברית ברמת יחידות אינטונציה הם מעטים ביותר. על אף שכל שפות אנוש משתמשות בטונים עולים ויורדים ובגיוון באורך הסגמנטים, תפקיד האלמנטים האקוסטיים

האלה והגיוון בהם שונה משפה לשפה, אם כי חוקרי פרוזודיה מסכימים כי קיים שוני בין השפות ביחסים שבין הצורה הפרוזודית ותפקידה. כך, מחקר זה שואף, בין היתר, לקשר בין מימושים אקוסטיים לבין הפרשנות הלשונית המוענקת לטונים בגבולות של יחידות אינטונציה ולהציב תיאור מקיף לדפוסים של טונים פרוזודיים בגבולות של יחידות אינטונציה בעברית ספונטנית, מתוך תקווה כי תיאור כזה יתרום להבנה כוללת של דפוסים פרוזודיים.

תרומה ייחודית של המחקר הנוכחי נעוצה בבחירת הקורפוס. מלכתחילה עמדה בבסיס המחקר הנחת העבודה שחאחת ממטרות המחקר היא ניתוח פרוזודי של קורפוס של עברית ספונטנית. במחקר הנוכחי נותחו 19 מקטעים מ-19 הקלטות שנבחרו מקורפוס מעמ"ד – מאגר העברית המדוברת בישראל. ההקלטות הינן של שיחות אותנטיות וספונטניות מחיי היום-יום שהוקלטו בשנים 2001-2002. כל מקטע שנותח מבוסס על דובר עיקרי אחד, האדם שנשא על עצמו את מכשיר ההקלטה, ובני שיחו באותו היום. רוב השיחות בוצעו בשני ערוצים עיקריים – שיחות פנים-אל-פנים ושיחות טלפון. הקורפוס מבוסס על 31,760 תמניות (tokens) ופרוש על פני כ-6 שעות של הקלטה. כל ההקלטות תועתקו באופן ידני על פי שיטת התעתוק של SAMPA (Speech Assessment Methods Phonetic Alphabet) ותויגו על פי גבולות של יחידות אינטונציה.

המחקר כולל שני שלבים עיקריים: השלב הראשון במחקר היה לזהות דפוסים שבאמצעותם ייקבעו הן המאפיינים האקוסטיים והן המאפיינים התפיסתיים של גבולות פרוזודיים ובשלב השני בוצע ניתוח לינארי של המילים (ברמת חלקי דיבר, Parts of Speech) משני צידי הגבול הפרוזודי, ונבדקה התלות התחבירית בין המילים האלה. תוצאות התהליך הניבו קטגוריזציה של יחסי התלות, שיכולה לתרום להבנת ממשק פרוזודיה-תחביר בעברית ספונטנית בפרט ושל שפה מדוברת בכלל.

בהתייחס לשלב הראשון, הגישה במחקר הנוכחי מכתיבה חלוקה תפיסתית בינארית לשני סוגי טון בסיום יחידת אינטונציה: טונים מסיימים וטונים ממשיכים. בבסיס ההבחנה בין טונים אלה מצוי הערך התקשורתי השונה שלהם. טון גבול תויג כטון מסיים (Terminal boundary tone - T), כאשר הדובר סימן באמצעותו שאין לו יותר מה לומר, לדוגמה, בסיום משפטי חיווי או משפטי שאלה; ואילו טון גבול סומן כטון ממשיך (Continuous boundary tone - C), כאשר הדובר סימן באמצעותו שהוא עדיין לא סיים את דבריו. הטונים הממשיכים תויגו בנוסף לחמישה תת-סוגים: טון ממשיך-עולה (CR – Continuous Rise),טון ממשיך-יורד (CF – Continuous Fall); טון ממשיך-עולה-יורד (CRF – Continuous Rise-Fall); טון ממשיך-נייטרלי (CN – Continuous Neutral); וטון ממשיך-מישורי (level tone) המבוצע תוך הארכה ניכרת, ושסומן כ-CE (Continuous Elongation). על מנת להגדיר את חמשת הטונים הממשיכים היה צורך לזהות את המבנה הפונולוגי של היחידה הנושאת את הטון הסופי. הדבר בוצע באמצעות שני מחקרים מקדימים (Silber-Varod and Kessous 2008; Silber-Varod 2010) שבוצעו על קורפוסים מצומצמים יותר. אחת מתוצאות המחקרים היא הגדרה חדשה, או גישה חדשה לתופעה מוכרת הקרויה היסוס (hesitation disfluency).

תופעה זו של הגיית צליל חסר משמעות לכאורה, "אֶה", זכתה בעבר להתייחסות שונה מאשר זו המוצגת במחקר הנוכחי ואשר אפשר לסכמה בחלוקה לשלוש גישות שמייצגות את התפתחות

ההתייחסות לתופעה זו: הגישה הוותיקה ביותר רואה בהפקות אלה סוג של הפסקות בדיבור, קטיעת שטף הדיבור. המינוח שנקבע לתופעה זו אצל קרוטנדן (1997) הוא filled pause ובעברית תורגם ל"פסק ממולא". גם המינוח של בורוכובסקי-בראבא (2005) "ממלא חלל" משקף את הגישה הזו, הרואה בהגיית הצליל הזה סוג של פסק שטעמו "שמירה על התור", הדובר לא מעוניין שיקטעו אותו ולכן מסמן שיש לו עוד מה לומר. השימוש במונח filled pause התקבע גם כאשר הגישה לתופעה השתנתה. בגישה אחרת, ההתייחסות היא כאל תופעה של חוסר שטף בדיבור, סוג של גמגום, של טעות בהפקה, ובמילה אחת: disfluency. המחקר על עצירות בשטף הדיבור, כְּשָׁלִים בדיבור, התפתח בשנים האחרונות, כתוצאה של התפתחות מחקר הדיבור וההתייחסות לשפה המדוברת כאל חומר גלם הראוי למחקר מקיף, ושאין לבטל בו תופעות שלכאורה נראות "אקראיות", "פחותות ערך", "נחותות". בגישה זו תופעת ההיסוס היא חלק ממכלול של כשלים, כגון חזרות, התחלות נפל, prolongations (השהייה על סגמנט מסוים, גם עיצור, וכתוצאה מזה הארכה שלו). ואכן, המחקר מסוג זה משופע יחסית בהתייחסות להפקת ה"אֶה", ובעברית כאמור, התקבע המונח "היסוס".

הגישה השלישית רואה בהפקות חוזרות אלה, ובכל דפוס פרוזודי קבוע, חלק מן המבנים הפרוזודיים. התייחסות זו גוררת בהכרח התחקות אחר המאפיינים הפרוזודיים של התופעה, שהתכונה הפרוזודית הבולטת בה היא הארכה ניכרת של הברה, ובלועזית elongation. בגישה זו, שבה אני נוקטת, יש לבחון את הדפוס ולבדוק אם אפשר לזהות בו משמעות (כגון שהדובר מעוניין להמשיך את דבריו), תכונות אוניברסליות (כגון הארכת ההברה), כמו גם תכונות תלויות-שפה (כגון איכות התנועה המוארכת כברירת מחדל). למשל, בעברית התנועה שהיא ברירת מחדל לתופעה היא [e], בצרפתית [œ] ובאנגלית [ʌ]. כך, במחקר הנוכחי תופעה זאת נעקרת ממסגרת המחקר הקאנונית שלה כסוג של קטיעת שטף הדיבור (בנוסף לתופעות כגון חזרות, התחלות נפל וכדו'), או בכינויה המוכר יותר "פסק ממולא" (filled pause), ומתקבעת כסוג של דפוס ריתמי של הדיבור, כלומר כדפוס של טון גבול של יחידת אינטונציה. טון זה הוזכר קודם בתיוג "טון ממשיך-מישורי", מכיוון שהוא נתפס אצל המאזין כמסמן "משהו נוסף עומד להיאמר". התכונה הפרוזודית הבולטת ביותר של טון זה היא ההארכה הניכרת, ולפיכך התיוג שלה במחקר הנוכחי הוא CE עבור *Elongation* Continuous.

בשלב השני, ובהמשך לגישה המבנית הננקטת, המחקר הנוכחי מבקש לנבא דגמים של הרצף הסגמנטלי הסובב, המקיף, את הגבולות הממשיכים דווקא ולא את הגבולות המסיימים, שם הסיום התחבירי חופף לכאורה לסיום הפרוזודי. ואכן, בשלב השני של המחקר בוצע תיוג לחלקי דיבר בסביבת הגבולות הפרוזודיים, קרי תיוג של המילה הקודמת לגבול הממשיך ותיוג של המילה העוקבת לו. יש לציין כי המילה הקודמת לגבול מכילה למעשה את ההברה הנושאת, על פי רוב, את הטון הפרוזודי של הגבול (למשל, טון עולה, טון נייטרלי וכו') ואילו המילה העוקבת לגבול הפרוזודי היא זו הפותחת יחידת אינטונציה חדשה. סדירויות אחדות בנוגע לממשק פרוזודיה-תחביר נצפו מניתוח הממצאים: התוצאות מראות כי בעוד שכל הגבולות הממשיכים "מפצלים" יחסי תלות "חלשים" בין מילים, גבול CE ייחודי בכך שהוא צפוי להתרחש בין מילים בעלות תלות תחבירית גבוהה ביניהן. גבול CE נצפה כמפצל ארבעה

סוגים של יחסי תלות, כפי שמתואר להלן על-פי דירוג יחסי התלות, מן ה"חלש" ביותר עד ל"חזק" ביותר. הסטאטוס הייחודי של גבול CE ניכר מן התיאור הבא.

- **ללא תלות:** סוג התלות החלש ביותר הוא כאשר גבול ממשיך מתרחש בין מילים שאין ביניהן תלות תחבירית, כלומר כאשר אין יחסים תחביריים ישירים בין המילה הנושאת את טון הגבול הממשיך והמילה הראשונה ביחידת האינטונציה העוקבת (כלומר שהן אינן באותו צירוף או באותה פסוקית). סוג זה נפוץ לארבעת הגבולות הממשיכים CN, CR, CRF, CF. לעומת זאת, הגבול הממשיך שבא אחרי סמני שיח, שגם הם משויך לקטגוריה "ללא תלות", הוא בעיקר גבול CE.
- **תלות במבנה חיבור:** תלות במבנה חיבור (coordination, conjunction) נצפתה בין מילת החיבור (conjunct) והאיברים המחוברים (צירופים, משפטים). אולם תלות זו נחלקת לשני סוגים עיקריים מבחינת ממשק פרוזודיה-תחביר. גבולות ממשיכים נוטים להופיע לפני מילת החיבור במקרים של הגבולות CN, CR, CRF ו-CF, אך מופיעים לאחר מילת החיבור במקרה של גבול CE.
- **תלות בין נושא ופרדיקט:** יחסי תלות אלה נצפו בעיקר בסביבת גבול CE, כלומר גבול CE נוטה להופיע בין הנושא לנשוא.
- **תלות תוך-צירופית** (intra-phrasal dependency)**:** תלות תוך-צירופית היא תלות המתרחשת בין רכיבים בתוך הצירוף, למשל בין מילת היחס לשם העצם בצירוף-יחס. תלות זו נחשבת לתלות החזקה ביותר שנצפתה בסביבת גבולות ממשיכים. גם כאן, ההסתברות הגבוהה ביותר היא להופעת גבול CE.

בהמשך לממצאים אלה ולקטגוריזציה של יחסי התלות לעיל המחקר מציע פרספקטיבה המסבירה את קיום הגבולות הממשיכים באופן כללי ואת תופעת גבול ה-CE במיוחד. לפי הפרספקטיבה המוצעת תופעת גבול CE מצביעה על קיום מתח בין הרובד הפרוזודי לרובד התחבירי בשפה. המתח נחשף כאשר דוברים מפיקים את הטון הממשיך-מישורי המבוצע תוך הארכה ניכרת (CE). המתח מתרחש בין פיצול פרוזודי (לשתי יחידות אינטונציה: האחת המסתיימת בגבול CE והשנייה העוקבת לגבול) והמשכיות תחבירית. גבולות CE נצפו בכ-40% מן הגבולות הממשיכים בעברית ספונטנית, וגבול זה, יחד עם שאר הגבולות הממשיכים מאפשר לדובר, כמו גם למאזין, לעבד את הדיבור. המתח הזה מבהיר, כך טוען המחקר, את התפקיד המבני של הפרוזודיה בדיבור, שמומחש במודל "פרספקטיבת שרשור הדיבור" (speeCHain perspective). מודל זה מתמקד בשרשור היחידות הפרוזודיות המסתיימות בטון ממשיך ובקשר השיטתי בין הרכיבים התחביריים שמופרדים באמצעות יחידות פרוזודיות.

לסיכום, המחקר מבקש להציג כיצד הרצף הסגמנטלי בשפה המדוברת משיק לגבולות פרוזודיים בדיבור; הוא כולל גם ניתוח של התכוניות האקוסטיות של מבני הגבולות הפרוזודיים; הגדרת קטגוריות לקידוד גבולות פרוזודיים; ולבסוף, חתירה למציאת פרספקטיבה כוללת שתאפשר את השימוש בקטגוריות השונות שהוגדרו למבני הגבולות הפרוזודיים. כך, מחקר זה שואף לשכלל את ההבנה של היחסים הפרוזודיים-תחביריים בעברית הספונטנית בפרט, ובניתוח השפה המדוברת בכלל.

אוניברסיטת תל-אביב
הפקולטה למדעי הרוח ע"ש לסטר וסאלי אנטין
בית הספר למדעי היהדות ע"ש חיים רוזנברג

שִׁרְשׁוּר הדיבור:

ממשק פרוזודיה-תחביר בעברית המדוברת הספונטנית

חיבור לשם קבלת התואר "דוקטור לפילוסופיה"

מאת

ורד זילבר-ורוד

מנחה: פרופ' שלמה יזרעאל

הוגש לסנאט של אוניברסיטת תל-אביב

2011