PROSODY IN ISRAELI SIGN LANGUAGE[1]

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Abstract. This is a study of the interaction of phonology with syntax, and, to some extent, with meaning, in a natural sign language. It adopts the theory of prosodic phonology (Nespor and Vogel 1986), testing both its assumptions, which had been based on data from spoken language, and its predictions, on the language of the deaf community in Israel. Evidence is provided to show that Israeli Sign Language (ISL) divides its sentences into the prosodic constituents, phonological phrase and intonational phrase.

Identifiable phonetic cues occur at the end of phonological phrases, and it is argued that these cues mark prominence. As the theory predicts for languages like ISL, whose basic word order is head first, then complement, these data suggest that prominence in ISL falls at the end of phonological phrases. An assimilation rule whose domain is the phonological phrase provides further evidence for this constituent. The rule involves a phonetic element that has no equivalent in spoken language: the nondominant hand. In this way, it is shown how a phonetic system that bears no physical resemblance to that of spoken language is recruited to serve phonological-syntactic organization that is in many ways the same.

The study also provides evidence for the next higher constituent in the prosodic hierarchy, the intonational phrase. Elements such as topicalized constituents form their own intonational phrases in ISL as in spoken languages. Intonational phrases have clear phonetic correlates, one of which is facial expressions which characterize entire intonational phrases. These and other findings reported here support the claim that facial expressions are analogous to intonational melodies in spoken languages. But unlike the tones of spoken language, which follow one another in a sequence, facial articulations can occur simultaneously with one another and with the rest of the communicative message conveyed by the hands. This difference, it is suggested, results from the fact that the many facial articulators are independent, both of each other and of the primary articulators, the hands.

The investigation illuminates similarities as well as differences of prosodic systems in the two natural human language modalities, and points out directions for future research.

key words: prosody, sign language, prosodic phonology, intonation

0. Introduction

Human speech is not transmitted in a monotonous series of evenly articulated units, nor does it come in a constant stream, interrupted only by the need to breathe. Rather, spoken language is broken up into constituents, and these constituents are characterized by patterns of rhythmic and intonational structure. Through these patterns, phonology systematically interprets morphosyntactic and semantic structure. As is the case with other aspects of grammatical structure, the interaction between phonology and other components of the grammar is systematic, and it is characterized by properties that are either universal or definable in terms of parametrical choices across spoken languages. Our goal here is to address the question of whether these prosodic patterns are unique to spoken languages, or whether they are a requirement of the natural human language system, regardless

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of the physical modality of its transmission. We approach this question by investigating Israeli Sign Language (ISL), a natural language used by most deaf people in Israel.

The framework for the investigation is a theory about prosodic structure that is well attested for spoken languages, the theory of Prosodic Phonology (among others, Selkirk 1984, 1986; Nespor and Vogel 1986; Hayes 1989; Truckenbrodt, to appear). To the extent that ISL conforms to the same patterns found in spoken language, this will be taken as confirmation that prosodic structure of the same sort characterizes all human language, regardless of modality, and as support for the particular theory adopted here as well.

Prosodic Phonology is a theory about the organization of a string into phonological constituents. In particular, it is a model of the way in which phonology interprets morphosyntactic structure by signalling relative prominence relations established among its constituents. A hierarchy of prosodic constituents plays a central role in this theory, and its importance has been extensively established for spoken languages. Prosodic constituents have been shown to constitute the domains of sandhi rules, to define the relative prominence among the daughters of a node - i.e., to represent the basic structure of rhythm (Nespor and Vogel 1986) - and to provide the points where a melody is anchored to the linguistic text in the phonology of intonation (Hayes and Lahiri 1991). The prosodic hierarchy also reflects different levels of depth at a juncture, showing that the perception of different cues is explained by the degree of closeness of constituents within the hierarchy (De Pijper and Sanderman 1994).

Forty years of research on sign language indicates that it is both legitimate and feasible to look for prosodic constituents in visual-gestural languages as well. It has, in fact, been shown that there are significant similarities between the grammar of spoken languages and that of sign languages in both phonology (e.g. Liddell 1984; Sandler 1989; Perlmutter 1992; van der Hulst 1993; Brentari 1999) and syntax (e.g. Padden 1986; Lillo-Martin 1991; Aarons, Bahan, Kegl, and Neidle 1992). Continuing the search for language universals, then, it is reasonable to make certain hypotheses about prosody in sign language as well, i.e., about the interface between phonology and other components of the grammar in such languages. As prosodic structure accounts for the phonological interpretation of morphosyntactic and semantic structure in spoken language, it is possible that a similar structure - though implemented in a different modality - characterizes the organization of the sign stream in sign languages. It is this hypothesis that we attempt to explore in the present study. While the constituents of the prosodic hierarchy range, from bottom to top, from the syllable (or the mora) all the way up to the phonological utterance, we will concentrate here exclusively on two phrasal levels: the phonological phrase and the intonational phrase.[2]

Recent proposals regarding prosodic bootstrapping of syntactic parameters in hearing infants (Mazuka 1996; Nespor, Guasti and Christophe 1996; Christophe, Guasti, Nespor, Dupoux and van Ooyen 1997; Guasti, Nespor, Christophe and van Ooyen to appear) give additional motivation for investigating the relationship between syntax and phonology in the language of deaf people. That is, assuming that the human species is endowed with the ability to acquire language, and considering the fact that the development of sign language in infants proceeds in steps and time periods analogous to those of spoken language (Meier and Newport 1985, Meier 1991), it is to be expected that the different modalities in which the structures generated by the grammar are transmitted should share some properties

[2] It is argued in Sandler (1999) that the prosodic word is a constituent in ISL.

of prosodic organization. Specifically, if the phonological interpretation of a speech string in spoken language gives a cue to its syntactic structure, it is possible that the level of structure corresponding to phonology in sign language interprets the syntactic structure of the sign string as well. We investigate this possibility here.

In addition to cueing syntactic structure, prosody performs other important grammatical roles. Phonological prominence cues semantic notions such as focus, and the variation of the pitch of the voice (intonation) can determine illocutionary force as well as both linguistic and paralinguistic nuances of meaning. We believe that the interesting hypothesis to adopt is that sign language offers phonological correlates for these same roles. While the primary goal of this study is to investigate prosodic constituency, we will also discuss our preliminary findings with respect to these other roles of prosody in sign language.

In order to test our hypothesis that prosody is universal to all human language including sign language, however, it is first necessary to acknowledge the fundamental differences between the channels of transmission in the two natural language modalities. In the face of these differences, we must attempt to reach some understanding of the relationship between sign language and the physical system which transmits it -- a challenge that we tackle in this paper. The paper is organized as follows. In section 1, we provide a short description of the basic ideas we assume from prosodic phonology and its role in the interpretation of syntax, with special attention to word order. In section 2, we offer a brief description of sign language phonology as a frame of reference. The heart of this study is in section 3, in which we present our understanding of the prosodic organization of ISL. Some suggestive results about the nature of intonation in sign language are also presented there. In section 4, we draw some conclusions.

1. Prosodic Phonology

The prosodic hierarchy, as an adequate representation of the phonological component, was originally motivated on the basis of phonological phenomena of various types, among them, those traditionally known as external sandhi rules (Selkirk 1984, Nespor and Vogel 1986). The establishment of prosodic constituents as a level of representation in the theory of grammar is motivated by the same considerations that motivate the establishment of constituents in other components. In particular, it is demonstrated that only by making reference to those constituents can we give an adequate and economical account of grammatical - in this case phonological - competence.

Under the hypothesis we adopt, it is predicted that any natural language will have prosodic structure that plays the roles described in the introduction: providing domains for phenomena applying at word junctures that may have different degrees of depth, and representing the relative prominence assigned to the elements of this structure. In other words, languages in any modality, spoken or signed, must have two properties, among others: a phonological architecture that is related to morphosyntactic structure, and a rhythmic structure that signals an alternation of more and less prominent elements in different grammatically relevant ways. In sections 1.1. and 1.2., these issues will be considered regarding two of the prosodic constituents above the word level: the phonological phrase and the intonational phrase.

Prosodic phonology draws on the observation that phonological constituents are often isomorphic to syntactic constituents, thus making communication possible. In fact, there are many cases in which identical sequences of words with different syntactic structures also have different phonologies, as in the case of the

Italian examples in (1), where the parentheses indicate the different analyses into phonological phrases. 'P' stands for the prosodic constiuent, phonological phrase, whose characteristics will be described in Section 1.1.

(1) a. [La vecchia]$_P$ [sbarra]$_P$ [la porta]$_P$
the-old ***(fem.)*** blocks the ***(def. art.)*** -door
'The old lady blocks the door'

b. [La vecchia sbarra]$_P$ [la porta]$_P$
the - old - bar it ***(object pron.)*** - carries
'The old bar carries it'

However, if syntactic and prosodic structure were always fully isomorphic as in (1), there would be no need for an independent prosodic component in the grammar. In fact, there are several ways in which prosodic constituents derived from syntactic structure are not isomorphic to them (Selkirk 1980, 1981; Nespor and Vogel 1986, Hayes 1989; Ghini 1993). It follows that the syntactic tree cannot provide an adequate level of representation for phonological phenomena. Thus, just as the morpheme and the syntactic word are not isomorphic to the prosodic categories syllable or foot, there is also nonisomorhpism between prosodic and syntactic constituents at higher levels of structure, such as the phonological phrase. This nonisomorphism is an important motivation for the existence of prosodic constituents.

A typical case of nonisomorphism consists in the fact that specifiers and heads are systematically joined together into phonological phrases, while they do not form a constituent in syntax, as seen in (2a) and (2b), respectively.

(2) a. prosodic constituency
[$_P$ the coast] [$_P$ of Greece]

b. syntactic constituency
[$_{NP}$ the [$_N$ coast] [$_{PP}$ of Greece]]

The literature also reports many cases of another type of nonisomorphism between prosodic and syntactic structures -- the nonsystematic alignment of prosodic constituents to syntactic constituents. For example, in some languages, such as Italian, a nonbranching complement may be restructured in the same phonological phrase that includes the head, while a branching complement may not be so restructured (Nespor and Vogel 1986). The concepts of branching and of restructuring will be further explained and exemplified in section 1.1.

One question that should be answered is whether or not nonisomorphism of this kind is a necessary characteristic of grammar in any language, regardless of modality. At least two possibilities may be envisaged. One possibility is that the nonisomorphism of prosodic and syntactic structures in spoken languages is due to physical properties of the speech modality in which these languages transmit the structures generated by the grammar. For example, it may be partly determined by the amount of air the lungs may contain. If this is the case, transmission in sign language may very well not exhibit any nonisomorphism with syntactic structure. A second possibility is that at the basis of the cases of nonisomorphism found in spoken language is a rhythmic tendency to have certain elements recur at regular intervals, in other words, to have phonological constituents at the same level

resemble each other in length, so as to establish a rhythmic pattern.[3] On the assumption that rhythmic patterning is a deep and pervasive characteristic of any biological system, we would expect to find some cases of nonisomorphism between prosodic structure and syntax in sign language as well. Whether or not signs are organized into a phonological structure which is identical to syntactic structure is an empirical question, one that will be addressed in sections 3 and 4 below. In 1.1. and 1.2., a description will be given of the two prosodic constituents on which we will concentrate in analyzing the prosodic system of Israeli Sign Language: the phonological phrase and the intonational phrase.

1.1. The phonological phrase

The definition of the domain of the phonological phrase that we assume in the rest of this paper is given in (3)

(3) Phonological Phrase Domain (modified from Nespor and Vogel 1986)

The domain of a P consists of a lexical head (X) and all elements on its nonrecursive side up to another head outside of the maximal projection of X.

The syntactic head of a phrase is the word that determines the syntactic category of the whole phrase and the only necessary element of that phrase: the head of a noun phrase is a noun; the head of a verb phrase is a verb, etc. Recursivity is that property of language that allows for structures to be embedded in other structures of the same type, thus creating strings of unlimited length. For example, a sentence can be embedded into another sentence. Languages differ in terms of the direction of recursivity. English is right-recursive ([*The boy thinks*] main clause [*that his father is Superman*)]subordinate clause.) This means that its nonrecursive side is the left side of the head. Turkish instead is left recursive ([Marina'nIn bu mesagI almasInI] subordinate clause [istiyorum]main clause (marina - this message - receives - (I) want) 'I want that Marina receives this message'). The nonrecursive side in Turkish is thus to the right of the head.

Languages recursive to the right have heads preceding their complements. Thus a verb preceeds a direct object (*write*head *poems*direct object) and a preposition a noun (*in*preposition *Greek*noun). Languages recursive to the left have complements preceding their head. Thus the direct object precedes the verb (kitabI yazdIm 'the book (I) wrote') and a noun before a postposition (Cumartesinden sonra 'Wednesday after').

The domain of P defined in (3) is such that a P extends from the head of a phrase leftward in right recursive languages and from the head rightward in left recursive languages. Since, as we have said, the parameter that establishes the direction of recursivity of a language also establishes the unmarked relative order of heads and complements, (3) creates Ps that are head final for languages in which the head precedes its complements, such as Italian or English, and head initial for languages in which the head follows its complements, such as Turkish or Bengali.[4] Placing the head of a phrase in a specific position within a phonological constituent clearly marks syntactic boundaries, and may even disambiguate otherwise ambiguous sentences, as was shown in the Italian example (1) above. In (1a), *vecchia* is a noun, meaning 'old lady'. It is the head of its syntactic phrase, and the

[3] See Boyes-Braem (this volume) for evidence of rhythmic patterning of this sort in German Swiss Sign Language.

[4] For an example of the analysis of a string into phonological phrases, cf. (9a) below.

phonological phrase is constructed leftwards from it. In (1b), *sbarra* is a noun, meaning 'bar', and the phonological phrase is constructed leftwards from it.

In addition to phonetic correlates of phonological phrase edges, such as final lengthening, the P is phonologically characterized in two ways : a) by having phonological rules that are bound to it, and b) by having the relative prominence relations among its elements realized in such a way that either the leftmost or the rightmost constituent carries the main prominence, depending on the language.

An example of a phononological rule whose domain is the phonological phrase is Raddopiamento Sintattico in Italian. This rule lengthens a consonant at the beginning of a word after a stressed syllable. In (4a), for example, the [p] in *piú* is lengthened after the stressed [e]. If the consonant is separated from the stressed syllable by a phonological phrase boundary, however, as in (4b), then the rule of RS does not apply and the consonant is not lengthened (examples from Nespor and Vogel 1986).

(4) a. [Il tuo pappagallo] $_P$ [é **p**iú **l**oquace] $_P$ [del mio] $_P$
'[Your parrot] *[is more talkative] [than mine].'

b. [Guardó] P [piú attentamente] P [e vide] P [che era un pitone] P
'[He looked] [more carefully] [and saw] [it was a python].'

The definition of the relative prominence of the constituents that form a P is given in (5).

(5) Phonological Phrase Relative Prominence (adapted from Nespor and Vogel 1986)

In Head-Complement languages the rightmost node of a P is labelled strong; in Complement-Head languages the leftmost node of a P is labelled strong. All sister nodes of strong are labelled weak.

Relative prominence is exemplified on the basis of Hebrew, a head - complement language in (6a), and Turkish, a complement - head language, in (6b).[5]

(6a) Hebrew
yeled **gadol**
'boy big'

(b) Turkish
büyük çocuk
big boy'

The most prominent node of the phonological phrase is more stressed than its sister constituents across languages. The specific phonetic correlates of stress vary somewhat from one language to another: while duration may be the main cue to stress in one language, pitch may be more important in another.

[5] The noun phrases in (6) are comprised of adjective phrases and nouns. Since the adjective phrases are not branching, they do not form their own phonological phrases, but are restructured into the same phonological phrase as the nouns they modify, and receive prominence as a result of their position in the phonological phrase according to (5). Restructuring is stated formally in (8).

It follows from the definition in (5) that the relative prominence relations within the phonological phrase give a cue to the value a language has chosen for the Head - Complement parameter. In a language such as Italian, where heads systematically precede their complements, the strong node of a phonological phrase is at its right edge. In a language such as Turkish, where heads systematically follow their complements, the same prominence is at the left edge of its phonological phrases.

This relation between word order and prominence is actually more complex than these simple examples imply. For example, although English is a head-complement language, like Hebrew, in which the order of head and modifier is expected to follow the same head-first pattern, the order of noun and adjective in English is modifier – head (*big boy,* rather than *boy big)*. Nevertheless, the prominence pattern even within such phrases follows the general prediction for head-complement languages: it is final. There are several languages in which the Head - Complement parameter is set differently in different phrasal types within the same language. For example, in German, main clauses are SVO, but subordinate clauses are SOV. In these languages, the relative prominence relations within the phonological phrase also vary accordingly, and thus give a cue to specific syntactic properties of the language (cf. Nespor, Guasti and Christophe, 1996). We are concerned here with the basic word order pattern -- which we assume to be determined by the normal order of verb with respect to object, and the order of main clause with respect to subordinate clause -- and its relation to the basic prominence pattern, as formulated in (5). [6]

This correlation between the location of prominence within the phonological phrase and the basic word order properties of a language motivates the bootstrapping hypothesis mentioned in the introduction. The prediction is that it is precisely the rhythmic pattern created by the prominence relations established within the phonological phrase that is responsible for the setting of the Head - Complement parameter in infants.[7] In fact, an intonational phrase (I) in Head - Complement languages is comprised of a sequence of Ps with main prominence at their rightmost edges, while in Complement - Head languages, it is comprised of Ps with main prominence at their leftmost edges. The Rhythmic Activation Principle, proposed to be responsible for the setting of the Head - Complement parameter is stated in (7), where *w* stands for weak and *s* for strong.

(7) Rythmic Activation Principle (RAP) (Nespor, Guasti and Christophe 1996)

When you hear a sequence of (*w*s*) within I, set the Recursivity Parameter to the right. When you hear a sequence of (*sw*) within I, set the Recursivity Parameter to the left.[8]

In addition to the basic mapping rule in (3), phonological phrases may result from restructuring, at least in some languages. Restructuring is optional and it may be triggered by different factors, such as contrastive focus (cf. among others, Frascarelli 1997) or the weight of a string measured either in terms of whether it is constituted by a branching or a nonbranching constituent (cf. Nespor and Vogel

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[6] ,

[7] See Peperkamp and Mehler (this volume) for a discussion of the role of prosody in the earliest stages of language acquisition.

[8] A star marking the possible iteration of weak elements is missing from the second part of (7) because complement - head languages generally do not have more than one element in that position (Greenberg 1963).

1986) or in relation to ts sister nodes (cf. Ghini 1993). We will restrict our attention here to one type of restructuring triggered by the geometry of the tree. The conditions on this restructuring may vary slightly from language to language (Hayes 1989). In several languages restructuring is defined as in (8), originally proposed for Italian. An Italian sentence analyzed into phonological phrases before and after restructuring is given in (9), where the most prominent element of the relevant P is in bold face.

(8) Phonological Phrase Restructuring (adapted from Nespor and Vogel 1986)

A nonbranching P which is the first complement or modifier of X on its recursive side is joined into the P that contains X.

(9) a. [Hanno **parlato**]$_P$ [**bene**]$_P$ [dell'ultimo lavoro]$_P$ [storico]$_P$
[del tuo gruppo]$_P$
b. [Hanno parlato **bene**]$_P$ [dell'ultimo lavoro storico]$_P$
[del tuo gruppo]$_P$

'(They) have talked favorably about the last historical work
of your group'

In (10) it is shown that if the first complement of the head is branching (*molto bene* instead of *bene)*, restructuring is blocked.

(10) a. [Hanno **parlato**]$_P$ [molto **bene**]$_P$ [dell'ultimo lavoro]$_P$
[storico]$_P$ [del tuo gruppo]$_P$
b. *[Hanno parlato molto **bene**]$_P$ [dell'ultimo lavoro storico]$_P$
[del tuo gruppo]$_P$

'(They) have talked very favorably about the last historical work
of your group'

It is noteworthy that, though phonological phrase prominence after restructuring is not always on the head of the phrase, since it can also be on its restructured nonbranching complement or modifier, it is always rightmost. As far as the Rhythmic Activation Principle in (7) is concerned, the rhythmic pattern on which the bootstrapping of the Head - Complement parameter is based is unaltered.

Let us pause and consider what we might look for at the level of the phonological phrase in a sign language. Since the grammar of sign languages has been shown to share many abstract structural properties with the grammar of spoken languages, we might expect that the domain and relative prominence of the phonological phrase in sign languages are also similar to those of spoken languages. We would like to test that prediction. Since the development of sign language in deaf children of deaf parents appears to proceed along stages that parallel those of hearing children, the principle in (8) may be responsible for bootstrapping of the Head - Complement parameter in sign language as well. We hope that the results of our study will help make it possible to investigate that idea.

Since our study of ISL indicates that it is basically a Head - Complement language, the phonological phrase domain mapping rule in (3) predicts that the phonological phrase in ISL extends from the head of a syntactic phrase to its left until the end of its maximal projection is reached. From the principle in (5), we predict that the relative prominence among the signs that constitute a phonological phrase, however instantiated, is weak-strong. We aim to verify these predictions in

section 3.2. below. But first we turn to the second prosodic constituent to be analyzed here, the intonational phrase.

1.2. The Intonational Phrase

The constituent that dominates the phonological phrase in the prosodic hierarchy is the intonational phrase (I). Certain syntactic constituents - namely, parentheticals, nonrestrictive relative clauses, topicalizations and other types of extraposed elements - exhaustively form intonational phrases in a variety of languages, as exemplified in (11) on the basis of English.

(11) *a. parenthetical*:

[These books]I [as you must know]I [are all very boring]I

b. nonrestrictive rel cl.:

[His books,]I [which I liked a lot,]I [are out of print]I

c. right dislocated element:

[They are all very boring]I [our professors]I

d. topicalized element:

[That movie]I [I would never see]I

Apart from these structures, the domain of I is quite variable in nature, in that it is largely dependent on the length of a string as well as on the speech rate. An I, in fact, is uttered in one breath group: whenever a new breath group begins, a new I begins as well. Therefore, if a sentence is very long and requires more than one breath, the breath will occur at the intonational phrase boundary, even if the complete string consists syntactically of a single matrix sentence and could on purely syntactic grounds be included into just one I. In (12) two sentences with the same basic syntactic structure (a subject NP and a VP) are given, which differ in their analysis into Is because of their different lengths.

(12) a. [John left]$_I$
b. [All the kids who were here yesterday for the party]$_I$
[left before dawn]$_I$

Rate of speech influences the I constituency in that at fast rates, more material can be pronounced in one breath group than in slow rates, given the amount of air the lungs may contain (cf. Nespor 1987). This means that in fast speech, the same string will contain fewer Is than in slower speech.

As far as the relative prominence relations within I are concerned, we assume the generalization given in (13).

(13) Intonational Phrase Relative Prominence (Hayes & Lahiri 1991)
a. A P with a narrow focus receives the strongest stress of its I-phrase
b. Under neutral focus, the rightmost P-phrase within I is the strongest

That is, in case of neutral or broad focus, the main prominence appears to fall on its rightmost phonological phrase as stated in (13b), independently of a language's syntactic characteristics such as the basic word order. It is rightmost in languages such as English or Italian (Nespor and Vogel 1986), where the head generally precedes its complements and the main clause the subordinate clauses, but also in Bengali (Hayes and Lahiri 1991), where a head follows its complements and the main clause its subordinates.

The principle for assignment of the main prominence in I in cases of narrow focus, given in (13a), accounts for the fact that prosodic structure does more than mark syntactic structure by means of signalling the edges of syntactic constituents. The principle states that prosodic structure also interprets some aspects of the informational structure of a sentence, such as the possible set of focus interpretations, by establishing certain relative prominence relations among its constituents. At the level of the intonational phrase, main prominence always falls on the focus of a sentence, as established by Jackendoff's constraint given in (14), where the highest stress assigned by the regular stress rule corresponds, in prosodic phonology terms, to the rightmost phonological phrase of an intonational phrase. In this constraint, P stands for a syntactic phrase.

(14) Jackendoff's constraint (1972)
If a P is chosen as the focus of a sentence S, the highest stress in S will be on the syllable of P that is assigned highest stress by the regular stress rule.

The location of prominence in narrow focus (distinct from contrastive focus) contexts conforms to Jackendoff's constraint, i.e., it falls on the focussed constituent. Languages vary, however, as to the location of focus. In some, such as English and Bengali, the narrowly focussed constituent is stressed *in situ*, as exemplified in (15) on the basis of English. In others, like Italian or Spanish, the I main prominence is always final, and a word order is chosen which moves the narrow focus constituent into final position, as exemplified in (16) (cf., Vallduví, (1992).

(15) a. (What happened?/Who did you give a book to?)
I gave a book **to John**
b. (What did you give to John?)
I gave **a book** to John

(16) a. Ho dato un libro **a Marta**
'(I) have given a book **to Martha**'
b. Ho dato a Marta **un libro**
'(I) have given to Martha **a book**'

The option chosen in English is ungrammatical in Italian and that chosen in Italian is ungrammatical in English, as shown in (17a) and (17b), respectively.

(17) a. * Marta ha dato **un libro** a Paolo
'Marta gave **a book** to Paolo'
b. * Martha gave to Paul **a book**

It appears that these two ways of marking narrow focus are mutually exclusive in languages. Specifically, if a language has the possibility of moving a focus constituent to I-final position, the option to have stress on the focus constituent *in situ* is not chosen. That is, stress is not moved unless it is the only option for

meeting Jackendoff's constraint (Nespor and Guasti, submitted).[9]

The intonational phrase has also been shown to be crucial in determining where a melody is anchored to the text. Specifically, a pitch accent is anchored to the most prominent element of an intonational phrase (Pierrehumbert, 1980). In addition, the edges of both the phonological phrase and the intonational phrase determine where the boundary tones may be anchored to the text (Hayes and Lahiri 1991) . Pitch accents and boundary tones may each consist of a sequence of tones, and these together constitute the different melodies of the phonology of intonation.

The different aspects of the intonational phrase described above, all proposed for spoken language, provide the basis for a hypothesis about this constituent in sign languages. The hypothesis is that both the domain of I and the assignment of relative prominence among the phonological phrases it contains are defined in similar ways. Regarding focus, since ISL has different possibilities as far as word order is concerned, the prediction may be made that focus *in situ* is not part of its grammar (cf. Wilbur, to appear, this volume, for an analysis of these phenomena in American Sign Language). We might also expect the intonational phrase to play a role in the anchoring of the melodies - whatever their phonetic properties - to the text. We now turn to a brief description of ISL structure, and then to our investigation of prosody in that language.

2. Phonological structure in Sign language.

When we talk about the notions of prominence or of intonation in spoken language, we can assume some general and intuitive understanding of what is meant by stress or tone, and of how these are mapped onto the rest of the phonology. But in sign languages, it may be very difficult to conceive of what is meant by phonology at all, let alone of what the correlates of prosody may be in such languages. The field of sign language phonology is relatively small and new, yet there is already a variety of substantively different models of phonological structure in sign language (e.g., Liddell 1984, Liddell and Johnson 1989, Sandler 1989, 1993a,b, 1996a,b, Corina 1989, Brentari 1990, 1999, Wilbur 1993, Uyechi 1994, van der Hulst 1993).[10] Most of the controversies are irrelevant to our discussion of prosody, and we ignore them here. We shall adopt the model of Sandler in order to illustrate those aspects of sign language phonology that are related to our analysis of prosody in ISL. While much of the motivation for this model comes from American Sign Language (ASL), it appears that this basic phonological structure characterizes sign languages in general, though more research is needed to confirm this claim.[11] In this section, we will give a brief introduction to those aspects of the phonology of ISL at the level of the sign and below it that are necessary to follow the analysis of the prosodic system of ISL, to be offered in section 3.

2.1. The sign in Israeli sign language

As in ASL, signs in ISL are described in terms of three basic categories (Stokoe

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[9] For a different analysis, cf. Zubizarreta (1996), where it is porposed that movement of stres is the unmarked, rather than the marked option.

[10] For overviews, see Corina and Sandler (1993), Brentari (1995), Sandler (in press).

[11] Research shows that the phonological and morphological structure of sign languages has much in common with that of spoken languages. At the same time, sign languages appear to be more similar to each other grammatically than spoken languages are -- an issue that ultimately must be accounted for by a comprehensive theory of language (Sandler and Lillo-Martin, in press).

1960): hand configuration (HC) (consisting of handshape and palm orientation), location (L), and movement (M). (18) is a schematic representation of a canonical sign in the model we are adopting:

(18) HC

L M L

According to this model, the handshape is further subdivided to selected fingers features, and specification of their position. The location category includes places of articulation, such as the head, the trunk, or the nondominant hand, and finer settings, such as high and low, within each of those. It is generally agreed that the phonology of sign language includes a syllable-like unit and that the movement corresponds to the syllable peak (Coulter 1982; Wilbur 1982; this volume; Brentari 1990, 1999; Perlmutter, 1992; Sandler 1993a). Taken together with constraints on the structure of signs, these observations mean that most signs are monosyllabic. It is argued, in Sandler (1999) that this monosyllabic unit is the optimal form of the prosodic word in sign languages.[12]

Reduplication of these monosyllables is common in sign languages. Since reduplication figures in our treatment of prosodic prominence, a word about it is in order here. Reduplication may be contrastive, and many signs are, in fact, lexically reduplicated (Sandler 1996a). If a sign is reduplicated in citation form, we assume that it is lexically specified for reduplication. In addition, verbs that are nonpunctual are also reduplicated both in ASL (Supalla and Newport 1978) and in ISL. Finally, temporal aspect inflection may require reduplication (e.g., Sandler 1990). Reduplication generally involves complete repetition of the monosyllabic base. Lexical reduplication, as well as the reduplication of nonpunctual verbs, is characterized by only one repetition in addition to the base in citation form, while temporal aspect reduplication typically involves more iterations. As we shall see, prosody can have an effect on these basic reduplication patterns.

2.2. Nonlinear structure.

While sign languages are typically complex morphologically, morphemes are generally not concatenated. Rather, they are usually integrated nonconcatenatively (Sandler 1989, 1993a), avoiding sequences of movements, and therefore not disturbing the canonical monosyllabic form. For example, the phonological realization of verb agreement morphemes in ASL, ISL, and other sign languages involves nonconcatenative association of the agreement morpheme to the first and last locations of the sign, rendering the canonical LML form seen in (19).

(19) verb agreement

[12] The structure of the sign language syllable is dealt with in some depth in this volume. See articles by Wilbur, Kingston, and the introductory article by Sandler. For a detailed theory of the structure of the syllable in sign language, see Brentari (1999).

While this process is nonconcatenative, there is a sense in which it is also linear, since it distinguishes between the first and last location of the sign.

Similarly, temporal aspect morphology involves altering the quality of the movement, again without adding any concatenative morphology, and again resulting in monosyllabic bases. These bases may then reduplicate, but no nonredundant sequential material is added (Sandler 1990). The inflection for durational aspect in ASL, for example, changes the typically straight path movement of the base sign to an arc movement, as seen in (20). The sign is then reduplicated. No nonredundant sequential movements are added to the base. While sign languages share nonconcatenative morphology with many oral languages, sign languages form a class by themselves in that their words are often morphologically complex yet monosyllabic (e.g., Sandler and Lillo-Martin, in press).

(20) durational temporal aspect marked by [arc]

L M L

|

[arc]

A verb may be inflected both for agreement and for durational aspect, and such inflected forms still result in a monosyllabic sign:

(21)

L M L

/ | \

subj. agr. marker [arc] obj. agr. marker

This sort of noncatenative morphology is one of the characteristics of sign languages that gives the impression of simultaneity of structure, an impression that led Stokoe (1960) to claim that the phoneme-like elements of sign languages are produced simultaneously, unlike those of spoken languages. As the LML representations here show, canonical signs may be analyzed as having sequential structure as well, comparable to CVC (Liddell 1984, Sandler 1989). Similarly, morphological complexity that seems simultaneous lends itself to a more familiar explanation as nonconcatenative morphology. Nevertheless, it is important to point out that the tendency toward monosyllabicity regardless of morphological complexity, and this particular type of nonconcatenative morphology, side by side with a dearth of concatenative morphology, appear to be sign language universal (Gee and Woodhart, 1988; Newport, 1996; Sandler and Lillo-Martin, to appear). The conclusion is inescapable, therefore, that the modality favors a layering of information that is in some sense more simultaneous than linear (Fischer and Bellugi 1972, Gee and Goodhart 1988). We will return to this issue in our discussion of intonation in section 3.4.

2.3. The nondominant hand

The last structural element of interest in the context of the present investigation is the nondominant hand (normally the left hand in right-handed people and the right hand in left-handed people). In a language which uses two

anatomically identical, motorically independent elements, one might expect each to function as an independent articulator within lexical items. However, this is generally not the case.

The nondominant hand —- let us call it h2 -- may assume one of two roles, neither of which is particular to it. Either it acts like a shadow articulator, assuming the same shape and articulating the same locations and movements as the dominant hand, or it behaves like an immobile place of articulation like the head or the trunk, and the dominant hand articulates on or near it. In either case, the nondominant hand is not an independent articulator, and its existence does not motivate a proliferation of phonological categories.[13]

Since the model we are assuming provides a representation of the HC articulator as well as of places of articulation, there is no need to make any substantial changes or additions to accommodate the nondominant hand as a phonological element. This is seen as desirable, as it reflects the fact that h2 functions either as part of the HC articulator -- in signs we will call type A -- or as one of the possible places of articulation -- in signs of type B (Sandler, 1993b). Despite its secondary status in lexical items, we shall see that the nondominant hand can play an independent role in delineating prosodic constituents. Figure (1) shows the ISL type A sign, 'shout', and figure (2) the ISL type B sign, 'already' (perfect marker).

Figure 1. Type A sign: 'shout'

Figure 2. Type B sign 'already'

As far as the basic lexicon of sign languages is concerned, then, the fact that there are two anatomically identical elements does not create a phonological structure in which there are two identical articulators, a structure that would be anomalous compared to that of spoken language. This is because in sign language lexicons, only one of these elements is an independent articulator: the dominant hand. In fact, where the nondominant hand behaves as a shadow articulator, in

[13] There is, however, a subsystem within the grammar of sign languages in which the two hands do have a significant degree of autonomy: the system of complex verbs of motion and location (VML) (Supalla 1982), in which each handshape may represent an independent classifier and combine with motion and location roots.

type A signs, it freely deletes (Padden and Perlmutter, 1987; Brentari, 1999). [14] Even in type B signs, a table-top or steering wheel can take the place of h2 if it is otherwise occupied. It is all the more interesting, then, that the nondominant hand does have a significant role to play at the prosodic level, participating in the delineation of prosodic categories, as we show in Section 3.2.[15]

3. Prosodic structure in Israeli Sign Language.

3.1. Data and coding

In order to determine the basic word order of a sentence in Israeli Sign Language, a list of 30 sentences was elicited with three native signers, i.e., deaf people whose parents are deaf and also signers of ISL. More specifically, these sentences were meant to test the relative order of head and complements within phrases and sentences, i.e., to determine whether the syntax of ISL is right or left recursive. The subjects were presented sentences written in Hebrew and were asked to sign their meaning in as natural a way as possible, without paying attention to the specific word order of the written sentences. All sentences were recorded on videotape.

In addition to word order, special attention was paid to prosodic grouping, in particular to whether we could identify any physical realization of edges and/or prominence within both the phonological phrase and the intonational phrase. We developed a coding system that was designed to characterize and quantify the phonetic correlates of phrasing and prominence. Beneath the glosses for the signs, the sentences were coded for several features of facial expression (e.g., brow raise, eye squint, mouth shape, etc.), for head and torso movement, as well as for several features of hand movement (speed, size, duration, number of iterations). Separate lines and colors were used for each of the features that occurred in an utterance, and these lines of color were drawn so as to indicate temporal cooccurrence with the signs they accompanied. In this way, phrase boundaries emerged as places where lines were broken, and the most prominent elements, those that were accompanied by several different features, were made visually salient in the coding system by a spectrum of colours. For particular recurrent facial articulations of the mouth, eye, and brow, we developed a system of iconic symbols. Each sentence was coded by two people working together: a trained linguist who is conversant in ISL and a native signer. The patterns that emerged were clear and very robust, though not every cue was found in every appropriate context.[16]

The prosodic system that we are about to describe is extremely rich and complex. While patterns of rhythm and intonation are clearly systematic, a fully

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[14] There are vanishingly few lexical contrasts that are minimally distinguished by the presence or absence of two hands. The pair, 'like' (one-handed) and 'interested (two-handed type A) are so contrasted in ASL, and 'take' and 'adopt' in ISL. By far the usual case is that the nondominant hand in type A signs can optionally delete with no change in meaning.

[15] The theory of the nondominant hand adopted here is developed in detail in Sandler (1993b). It is not uncontroversial (for other views, see Brentari and Goldsmith (1993), van der Hulst (1996), Brentari (1999) and, for a discussion of two opposing views in one paper, van der Hulst and Sandler (1994).

[16] The coding was accomplished while viewing the sentences many times in slow motion. The judge of the cues was the human eye, which is of course quite reliable, since it is the eye that perceives the language in its actual use. Nevertheless, instruments that are the equivalent of the spectrograph in spoken language should be developed as a tool for finer and more objective phonetic recording.

satisfactory treatment will require a great deal of further study with larger and more varied corpora, statistical analyses, and experimental verification. We will try to indicate as we go along which of the results we report are most clearly supported by the data and analysis, and which require more rigorous investigation and verification.

3.2. The phonological phrase in ISL

3.2.1. Grouping and prominence

In ISL, the basic word order of the phrasal constituents is similar to that of many right recursive languages: the phrasal head precedes its complements or modifiers and main clauses subordinate ones. Some examples are given in (22).[17]

(22) a. dog small]NP
b. buy bicycle]VP
c. tired really] AdjP
d. I persuade him study] complex clause

It should be noted that word order in ISL is quite flexible, and that topicalization by movement, especially of objects, is very common in the language. The frequent fronting of objects is taken to be the result of movement rather than to represent a basic word order, both because of the judgements of informants, and because topicalized constituents are accompanied by a particular prosodic marking, while objects *in situ* are normally prosodically unmarked. Topicalized constituents, in fact, form their own intonational phrases, as in spoken languages. The pragmatic and modality-specific explanations for changes from basic word order are beyond the scope of this investigation. We point out that little is known about the syntactic structure of ISL, and that a complete and rigorous account of the prosody in this language will require an in-depth study of its syntax. Even in our corpus, which intentionally limited the types of sentences that were elicited, there was variability in word order and sometimes indeterminateness of lexical categoryhood. We are aware that spontaneous utterances may yield an even wider variety of structures. It is sufficient for our purposes to describe the prosodic behavior of basic word orders, which was consistent. The basic word order is globally similar to that of Hebrew, though different in its details.

We would like to know if the prosodic structure of ISL follows the principles independently established for spoken language, given above as (3) and (5), and repeated here for convenience

(3') Phonological Phrase Domain (modified from Nespor and Vogel 1986)

The domain of a P consists of a lexical head (X) and all elements on its nonrecursive side up to another head outside of the maximal projection of X.

(5') Phonological Phrase Relative Prominence (adapted from Nespor and Vogel 1986)

[17] We attempt to offer faithful sign-for-sign glosses, but have taken some liberties in the interest of clarity and brevity. For example, the indexing (pointing) gesture is variously translated as a deictic, a demonstrative, or a personal pronoun, according to its use in the particular sentence; pronouns are translated with gender, although ISL pronouns do not mark gender; etc.

In Head-Complement languages the rightmost node of a P is labelled strong; in Complement-Head languages the leftmost node of a P is labelled strong. All sister nodes of strong are labelled weak.

If we assume that the principle in (3) governs the grouping of phonological phrases in sign languages, as it does in spoken languages, then the sample sentences from our data are analyzed into phonological phrases as indicated in (23).

The deictic 'there' and the possessive pronouns often cliticize (Sandler, 1999), but they do not always do so. Clitic-host forms are connected with hyphens in the glosses (e.g., son-my in (23b). We indicate both phonological and intonational phrases in the examples for completeness, but will discuss the intonational phrase in the next section.

(23) a. [[cake there] P [I bake] P] I [[tasty very] P] I

'The cake I baked is very tasty.'

b. [[son-my] P [dog his] P] I [[sleep] P] I

'My son's dog is sleeping.'

c. [[house my] P [garden down outside area] P] I
[[burned]P]I

'The garden of my house burned.'

d. [[shop] P [side corner] P] I [[bankrupt] P]I

'The shop around the corner went bankrupt.'

Of the 247 syntactically determined phonological phrases in our corpus, all but 11 were characterized by one or more of the following phonetic markings: reduplication, hold, pause, separate facial articulation. Reduplication and hold characterize the last sign of the phonological phrase; pause occurs after the last sign of the phrase; and facial articulation characterizes all the signs in the phrase. By 'hold' we mean freezing the hand in its specified hand configuration at one location.[18] If the hand(s) relax their configuration and location for a moment between signs, this is counted as a pause. A sign is counted as reduplicated in our coding if it gets more iterations than it is lexically specified for. This correlation of phonological phrases with particular phonetic markings, which is statistically very high, is strong evidence for this level of structure in ISL.

If the establishment of the prominence relations among the sister constituents

[18] Such holds figured prominently in Liddell's (1984) sequential model of American Sign Language structure, where it was claimed that the two major classes of segments are holds and movements. Others have since argued that holds are either related to prosody or are morphologically derived, and have suggested that the nonmovement category is more properly labeled locations (Sandler 1989) or positions (Perlmutter 1992).

of the phonological phrase is governed by (5) in sign languages, as in spoken languages, and if the basic order of ISL is head-complement, as shown in (22), then the rightmost sign of P should be strong and its sister signs weak. This appears to be the case. We are considering the physical correlates of phonological phrase prominence, all realized with the hands, to be the following: hold, reduplication, and pause. This is based on the impression of salience that these phonetic characteristics give to the last sign of these phrases, an impression confirmed informally by our consultant. These three markers almost never cooccur, which seems to indicate that in some way they belong to the same phenomenon, perhaps lengthening. Nevertheless, we do not see this phenomemon as akin to the phonetic effect of phrase final lengthening in spoken language, since the latter does not correspond to prominence, while in ISL we suggest that these markers do lend prominence to the last sign in the phonological phrase. Clearly, this claim needs to be confirmed experimentally. All but 30 of the 247 potential phonological phrases had one of these markers on the last word. If these are indeed prominence markers, then the vast majority of phonological phrases in our corpus had prominence at the end.

The fact that these purported prominence markers do not cooccur in ISL might be seen as a difference from spoken language, in which prominence markers such as greater duration and increased amplitude often do cooccur. However, this does not present a problem for the analogy we are making between the two modalities, since it is conceivable that each independent sign language cue is sufficiently salient perceptually, so that less redundancy is necessary. This too requires confirmation in future research.

Our suggestion that these markers indicate prominence is lent support by the behavior of reduplication in particular. Reduplication of a whole word cannot be seen as analogous to the phonetic effect of phrase final lengthening, which is involuntary, and explainable by the basic physiology of the system. In our corpus, signs in the last position in the phonological phrase are often characterized by more than one iteration, whether they are lexically specified for reduplication or not. Conversely, signs which are lexically reduplicated consistently drop their reduplication when they are not the last sign in a phonological phrase. This means that in spontaneous signing, it is often impossible to tell whether signs are lexically reduplicated or not, since lexical reduplication is neutralized by prosodic position. If it is the case that reduplication corresponds to prominence, which seems intuitively plausible and is confirmed by the intuition of a native signer, and if hold and pause are in complementary distribution with reduplication, then we can hypothesize that all three are markers of prominence. All three occur at the end of phonological phrases, as predicted by the algorithm in (5).

Other markers of phonological phrases in ISL may in fact cooccur with the elements that mark prominence. For example, some aspect of facial expression often characterizes a whole phonological phrase together with either pause, hold, or reduplication which occur at the end. We will deal more with facial expression, and with other prosodic markers, in our discussion of the intonational phrase below.

As an example of phonological phrasing, prominence, and our coding system, consider sentence (24).

(24) 'The book he wrote is interesting.'

	[[book-there] P	[he write] P] I	[[interesting] P] I
brows	up----------		down--------
eyes	squint----------		droop-------
cheeks			
mouth		'O'----------	down --------
tongue			
head	tilt----------		
mouthing	'book'---------		'interesting'
torso	lean----------		
hold	=		
reduplication	-1	x 3	x 4
pause			
speed			slow
size		big	big

The facial expression patterns as follows. The brows are raised from neutral position over the first two phonological phrases and lowered from neutral position on the last. The eyes are squinted for the first phonological phrase only, neutral on the second phonological phrase, and droopy on the last phonological phrase. The mouth takes on a particular shape on the second phonological phrase and a different one on the third. The signer stretches the mouthing of the Hebrew word for 'book' (*sefer*) over the whole first phonological phrase, which consists of a host and clitic, but does not mouth the Hebrew word corresponding to the clitic.[19] He also mouths the Hebrew word for 'interesting' (*me'anyen'*) over the last phonological phrase, which consists of only one word. Thus, we see that these nonmanual markers extend over whole prosodic constituents.

The coding shows how the behavior of the hands marks phonological phrase boundaries as well. The second (last) sign of the first phonological phrase is characterized by a hold. The first sign in that phrase, which is lexically reduplicated, loses its reduplication and is only signed once. The last sign in each of the other two phonological phrases, each of which is reduplicated only once in citation form, is reduplicated twice (three iterations) and three times (four iterations), respectively, at the ends of phonological phrases.

3.2.2. External sandhi

In addition to phonological phrasing and the pattern of relative prominence just described, there is additional evidence for the phonological phrase category in ISL. There is a phenomenon that may be considered an optional rule of external sandhi (i.e., between-word assimilation) that is bound to the phonological phrase: the spreading of the nondominant hand beyond the domain of the word for which it is lexically specified. The spreading is triggered by a two-handed sign. Recall that signs may be either one- or two-handed in their lexical representation. Under spreading, the nondominant hand (h2) articulates the hand configuration and location specified by the triggering sign, while the dominant hand simultaneously signs other signs within a phonological phrase. The nondominant hand may spread either leftwards or rightwards from the triggering two-handed sign, or in both directions, until it reaches a phonological phrase boundary. An example is the sentence shown in (23a) and repeated below for convenience.

[19] See Sandler, 1999, for a discussion of mouthing and clitics.

(25) [[cake there] P [I bake] P] I [[tasty very] P] I

'The cake I baked is very tasty'

The sign 'bake' is a type B two-handed sign. In the example, the nondominant hand assumes its shape and location for 'bake' at the beginning of the phonological phrase, while the dominant hand is signing the word 'I' . That is, during the articulation of I BAKE in (25) and figure (3), the nondominant hand is already in the place required by the sign, BAKE during the articulation of the sign, I. It is not, however, in that place during the articulation of the sign, THERE, which belongs to another phonological phrase. That is, the phonological phrase boundary prevents further spreading. The video pictures below show first the citation form of the sign 'I' , then the same word as it is signed in sentence (25), followed by the sign 'bake' taken from the same sentence.

'I' 'I' with h2 sandhi 'bake'

Figure 3.

In other examples in our corpus, the sandhi spans more than one sign, and in more than one direction, but not beyond a phonological phrase boundary.

Let us look more closely at this phenomenon. There were 53 instances of h2 spread in our corpus. They were all contained within phonological phrases, with a few very particular exceptions. First, let us deal with those exceptions so that they can be eliminated from our consideration.

Due in part to the iconic basis of much of the lexicon, some signs may be decomposed in such a way that h2 is reinterpreted as a classifier morpheme, rather than simply being a meaningless phonological element (see footnote 11). For example, the sign for 'street' is made by the two hands held parallel to each other with palms facing each other, and the hands move away from the body of the signer. For one signer, the sentence 'I crossed the street' was signed with 'street' topicalized: 'The street, I crossed.' The nondominant hand was reinterpreted as a side of the street, as such spreading throughout the entire utterance, and the dominant hand signed 'cross' by literally crossing over it. When reinterpreted as a classifier in this way, h2 may spread beyond any boundary up to the level of a discourse unit. There were only a few such instances in our corpus, and we will have no more to say about them.

As for all the rest of the spreadings, most were interrupted either by another

two-handed sign, or by a phonological phrase boundary that coincided with an intonational phrase boundary. In the first case, h2 was prevented from spreading further by the necessity of articulating another sign. In the second case, it is impossible to conclude absolutely that it is the phonological phrase boundary that stops the spread, since one could claim that it is the intonational phrase boundary that does so, that the domain of h2 spread is the intonational phrase rather than the phonological phrase. So, the conclusive cases are those where neither another two-handed sign nor an intonational phrase boundary stops the spread, that is, at the junction of two phonological phrases within an intonational phrase, where the closest sign in the neighboring phonological phrase is one-handed. Because of the structure of the language and statistical probability, there were only 9 such cases, of which example (25)/figure (3) is one. Crucially, all were stopped by a phonological phrase boundary. We conclude that it is the phonological phrase that is the domain of this external sandhi rule.

Recall that in our discussion in Section 2.3., it was explained that the nondominant hand does not act as an independent articulator in the sign language lexicon. Yet ISL exploits this phonological element in its delineation of the prosodic constituent, the phonological phrase. This is a striking example of the way in which a sign language recruits an utterly different phonetic system from that of spoken languages, in the service of a prosodic structure which is the same. In this example, the nondominant hand (h2) neatly divides the intonational phrase into two phonological phrases.[20]

3.2.3. Summary

Summing up thus far, ISL is a language in which the phrasal head precedes its complements, and the basic domain of the phonological phrase extends from the left edge of the syntactic phrase till the head. The fact that phonological phrases are nearly always accompanied by phonetic correlates indicates strongly that phonological phrases exist in ISL. In addition, in our corpus the rule of h2 spread has the phonological phrase as its domain. The prediction of the theory of prosodic phonology is that in a head-complement language such as this one, the most prominent node is the rightmost. Our interpretation of the role of reduplication, hold and pause suggests that this prediction is borne out.

3.2.4. Nonisomorphism

An important part of the theory of prosodic phonology is that phonological and syntactic constituents are not always isomorphic, motivating a prosodic level of structure in addition to the syntactic level. Examples of restructuring of phrases with nonbranching complements are shown in (26 a and b). In (26a), 'small' is the head of an adjective phrase, but since it does not branch, it is restructured into the P of the preceding noun, 'dog'. 'My' here is a clitic. The adverbial expression 'completely' forms a nonbranching adverb phrase and is restructured together with the verb 'eat'.

(26) a. M21 [[dog small]P [son-my] P] I [[sleep] P] I

'My son's small dog sleeps.'

b. D7 [[cake] P] I [I eat completely] P] I

[20] The nondominant hand also plays a role in delimiting phonological words consisting of a host and a clitic (Sandler 1999).

'I ate the cake up completely'

Contrast these with the adjective phrases 'very pretty' and 'very tasty' in (27a,b). The modifier 'very', restructured into a P with the preceding adjective, creates branching structure in the adjective phrase, so there is no restructuring into the previous P. 'There' in (27b) is a clitic, and we analyze the sequence 'outside-garden-area' (27a) as a compound which includes a classifier.

(27) a. [[house my]P [outside-garden-area]P [pretty very]P]I
[[burned]P]I

'My house's pretty garden burned.'

b. [[cake-there] P [I bake] P] I [[tasty very] P] I

'The cake I baked is very tasty'

We turn now to an analysis of the next phrasal constituent of the prosodic hierarchy: the intonational phrase.

3.3. The intonational phrase in ISL

As is the case with spoken languages, we observed that in ISL too, parentheticals, nonrestrictive relative clauses, topicalized elements and extraposed elements obligatorily form intonational phrases of their own. The examples in (28) are translations of ISL sentences which demonstrate this.

(28) a. *Parenthetical:*
'Dogs, as you know, like cookies'
[dogs those] I [you know] I [like eat cookies] I

b. *Nonrestrictive relative claus:e:*
'The books he wrote, which I like, are sold out'
[books he write past] I [I like] I [deplete] I

c. *Right dislocated element:*
'They are tired, the soccer players'
[they tired] I [players soccer] I

d. *Topicalized element:*
'I ate the cake up completely'
[[cake] P]I [I eat-up deplete]P]I

Two characteristics clearly mark edges of intonational phrases: a change in head position and a radical change in facial expression along all its major parameters. These two cues were ubiquitous in our coded data, where all the colored lines we used in our coding system are either discontinued or changed at I boundaries.

Head position may offer a rhythmic cue to intonational phrasing. During a conversation, the addressee focuses on the face of the signer (Siple 1978), and not on the hands. Since the head position remains constant throughout an intonational phrase, and reliably changes at the boundary between intonational phrases, the

head provides a rhythmic envelope for the phrases, whose words are articulated by the hands. As we will explain, the hands, which are seen only in the peripheral vision of the addressee, also may phonetically mark intonational phrases. Thus, there is a correlation between phonetic cues of intonatonal phrases made by the hands and the head. We suggest that facial expressions, which are meaningful, are comparable to the tones that make up melodies in the intonational phonology of spoken language. We will examine facial expression more closely in the next section.

Where there is eyeblink, it also occurs following intonational phrase boundaries. Wilbur (to appear) reports the same behavior for eyeblink in ASL, leading to the expectation that eyeblink might be more generally a mark for I boundaries in sign languages.[21] There is a similarity between the occurrence of eye blink in sign language and of breathing in spoken language. Both are a function of the physical system independent of language, but during linguistic production, both are restricted to occurring only at intonational phrase boundaries. In this way the physiological system is recruited to augment the phonological organization of utterances into constituents.

As an example of intonational phrasing, consider the topicalized example (28d), coded in (29). Blinks are coded with the symbol 'X'. The behavior of the mouth is determined by the lexical items in this example: the open/closed movement (O->o), and the lack of lexical reduplication, distinguishes 'eat-up' from 'eat'. The lip sputter has an aspectual interpretation, usually designating an iterated telic activity.

(29)	[[cake] P]I		[I eat-up deplete]P]I	
brows	up-----			
eyes	squint---	X		X
cheeks				
mouth	O-> o		lip sputter	
tongue				
head	forward		tilt ----------	
mouthing	'cake'			
torso				
hold	=		=	
reduplication				
pause				
speed				
size				

Apart from constructions of the types shown in (28), which require I formation, the domain of I is quite variable, presumably determined by pragmatic/semantic factors and/or sign rate. Thus, the same syntactic structure may be analyzed into either one or two Is, as exemplified by the same sentence uttered by two different signers, shown in (30) and (31).

[21] See also Baker and Padden (1978) for an analysis of the roles of eyeblink in ASL.

(30)	[[present there] P	[for you] P] I		[[disappear] P] I
brows	up----------			
eyes	squint----------		X	wide-------
cheeks		raised-----		
mouth				
tongue				
head				up---------
mouthing	'present'	'for-you'		'disappear'
torso		forward---		
hold	=	=		=
reduplication		x 2		
pause				
speed				
size				big

Here, the main active facial articulators, the brows and eyes, have the same articulation throughout the first intonational phrase, and change for the second. The raised cheeks on the second phonological phrase are seen as an example of the intensification of the eye squint articulation. The other major cue to I phrases is the position of the head. It is neutral in I-1 and up in I-2.

(31)	[[present] P] I	[[for you] P] I		[[disappear] P] I
brows	up---------	down------		
eyes	squint----		X	droop-----
mouth				down -----
tongue				
head	up---------	down-----		tilt -------
mouthing	'present'--	'for'------		'disappear'
torso				
hold	=	=		=
reduplication				
pause				
speed				
size				

For this signer, the same string is divided into three I phrases. Brows have different positions in each phrase: up, down, and neutral. Eyes squint in I-1 and are neutral in I-2 and I-3. Again, the most reliable indicator of I phrasing, the head, has a different position in each I: up, down, and tilt.

The mere existence of such variability in intonational phrasing that is not determined by syntax indicates nonisomorphism between phonological and syntactic structure, thus supporting the overall theory. Both in the phonological characteristics of Is, and in their variability, our sign language data show that the intonational phrase is a prosodic universal, regardless of modality.

It appears that main prominence within the intonational phrase is at the end. Where there are two phonological phrases within an intonational phrase, the rightmost one is sometimes characterized by intensification of the same facial articulations that characterize the first phrase. For example, if the bottom eyelids

are contracted in the first phrase, the top eyelids may be added in the second phrase. The cheeks may contract for still further intensification, as in (30) above. Our preliminary investigation indicates that all three versions have the same semantic function, indicating information that is shared by the signer and the addressee, but each articulator (the upper eyelids and the cheeks) adds intensity.

Finally, phonological phrase prominence cues are often perceptively greater at the end of intonational phrases. That is, holds and pauses may be longer; reduplication occasionally involves more iterations; rate may be slowed; and size may be increased more. These signals are sometimes used affectively or paralinguistically for emphasis, supporting our suggestion that they add prominence. These physical correlates of prominence at edges of intonational phrases are similar to the physical correlates that intonational phrases have in spoken languages in that both are incremental along certain variables: the most prominent elements of intonational phrases are enlarged and/or intensified in sign language and are longer and more stressed in spoken language.

Final prominence within an intonational phrase has been observed in our ISL data, both in cases of broad focus and in cases of narrow focus on the last P of I, as seen in (32b), which can be an answer to both of the questions in (32a). If the focus constituent is not I final in the basic word order, a different order is chosen so that focus is I final in the surface structure. This is shown in (33b) which is a possible answer to (33a): the new information is the direct object which is now in final position. As is the case for those spoken languages in which different word orders are permitted by the syntax, narrow focus *in situ* is not opted for (Vallduví, 1992; Nespor and Guasti submitted). This finding replicates findings by Wilbur (to appear) for ASL, also a language whose syntax permits different orders. In the following examples, we use English translations for clarity and simplicity, but maintain the basic word order of the ISL sentences. The phrase in bold letters bears narrow (noncontrastive) focus. For contrastive focus, however, prosodic marking of focus *in situ* may remain an option in spoken and sign languages. (32) and (33) are examples of focus that is noncontrastive.

(32a) (What happened? To whom did the boy give a cookie?)
(b) The boy gave a cookie **to the dog**

(33a) (What did the boy give to the dog?)
(b) The boy gave the dog **a cookie.**

In the next section, we turn to a discussion of the ISL equivalent of melodies and their alignment to the text.

3.4. Melody and its sign language equivalent

In addition to rhythmic structure and prominence relations established within prosodic constituents, prosody includes intonation. The grammar of intonation contains a limited set of melodies, each characterized by a specific meaning. The melodies are associated to the most prominent element in an intonational phrase, and to the edges of phonological phrases and intonational phrases. One of the intriguing findings of this investigation is that facial expressions in ISL seem to correspond in many ways to the tonal melodies in spoken language. While a detailed treatment of the grammar of these facial articulations is beyond the scope of this paper, some significant preliminary findings are relevant to the claim that ISL has the equivalent of melodies associated to intonational phrases, and we will discuss these here.

It has long been known that particular facial expressions in American Sign Language span corresponding syntactic constituents, such as yes/no questions, wh-questions, topicalized elements, and relative clauses (e.g., Liddell 1978, 1980, Coulter 1979, Baker-Shenk 1983, Aarons, Bahan, Kegl and Neidle 1992, Petronio and Lillo-Martin 1997) and in Sign Language of the Netherlands, Coerts, 1992). Reilly, McIntire and Bellugi (1990), Wilbur (to appear and sources cited there), and others have suggested that these facial expressions are intonational. Our ISL findings are compatible with this claim, as opposed to the more common claim that facial expresssions are syntactic markers.

Although the theory and analysis we adopt are somewhat different, many of our conclusions are compatible with findings of Wilbur in her numerous investigations of ASL prosody (e.g., Veinberg and Wilbur 1990, Wilbur 1991, 1994, overviewed in Wilbur, to appear, and Wilbur, this volume). A partial comparison is offered in the introductory article to this volume. Like Wilbur, we find evidence for intonational phrases, with some of the same phonetic correlates. One difference between the present study and the studies of Wilbur and her colleagues on ASL is the proposal that ISL has phonological phrases, in addition to intonational phrases. Having made that distinction, we are able to track differences in the distribution of facial articulations over each type of constituent, as we now explain.

The tones of spoken languages are anchored to phonological and intonational phrase boundaries, and the facial articulations in ISL span phonological and intonational phrases. If there are two phonological phrases in an intonational phrase, they are generally both characterized by some facial articulation, such as raised brows, but an additional facial articulation, such as a mouth shape, may characterize only one of them. We have seen that each of two phonological phrases within an intonational phrase may have somewhat different facial expresssions. Under these circumstances, it is usually the case that some facial articulation remains constant over both phonological phrases, and an additional articulation characterizes only one of them. A typical example is brow raise over the entire intonational phrase, and an addition of a mouth gesture or an eye gesture in the second phrase, as in (24) above, where a mouth gesture is added to the brow raise. [22] Unlike the addition of the top lid or the cheek, it seems that the addition of each independent articulator such as the mouth or eyes to the eyebrows does have an independent semantic function. This distribution indicates that these facial equivalents of tones are also anchored to both P and I boundaries.

Now that we have discussed all the ingredients of prosody, we repeat example (24) here in (34) to illustrate them.

[22] An additional area for future research raised by this study is the anatomy of facial expression and its relation to grammatical use in sign language. Such a study will shed light on the question of which facial articulators are mutually dependent or independent, a question that is relevant for issues such as a possible difference between intensification versus addition of articulation.

(34) 'The book he wrote is interesting.'

	[[book-there] P	[he write] P] I	[[interesting] P] I
brows	up----------		down--------
eyes	squint----------		droop-------
cheeks			
mouth		'O'----------	down --------
tongue			
head	tilt----------		
mouthing	'book'---------		'interesting'
torso	lean----------		
hold	=		
reduplication	-1	x 3	x 4
pause			
speed			slow
size		big	big

In section 2.2, we demonstrated that linguistic complexity in sign language is often added to the word in a way that is in some sense more simultaneous than sequential. We now turn to a similar phenomenon at the level of intonation. In spoken language, tonal melodies are produced with a single articulator, the vocal cords, whose frequency is varied to create different pitches. The pitch accents of tonal melodies occur in a sequence, and the boundary tones which complete the tonal inventory are also sequenced. In sign languages, the facial equivalents of tones are produced by several articulators -- for example, the eyebrows, the eyelids, the mouth -- and these facial articulations may be simultaneously layered on one another within an intonational phrase. In (34), the head position and brow configuration characterize the whole I, while eyes characterize only the first P, and mouth only characterizes the second P in the I. It appears that the explanation for this difference -- simultaneous layering rather than linear sequencing -- lies in the physical modality. First, the production system of sign language has at its disposal many articulators that are independent of those that produce the words of the language (the hands). Second, the visual perception system, unlike the auditory perception system, is capable of perceiving several disparate signals simultaneously (Meier 1993). This means that the physical production and perception system of sign languages determine the sort of organization of intonational structure that we now describe in more detail.

We present as an example the facial expressions (and other nonmanual markers) associated with yes/no questions and with shared information. We will offer an example of each of these facial articulations independently, with translations of the sentences in which they occurred, and of what happens when the two are combined. In each example, the string that is characterized by the facial expression is marked with a line over the words in translation. We begin with yes/no questions, characterized by raised eyebrows and widened eyes, and forward head position.[23] The sign shown in the picture is YOU, but the facial expression extends over the whole question, meaning 'Did you eat?'.

[23] The same facial expression is reported to characterize yes/no questions in ASL (e.g., Liddell 1980).

brows up
widened eyes _____
head forward 'Did you eat?'

Figure 4: yes/no questions

Information that is shared by signer and addressee is signalled by contracted top and bottom eyelids, and optionally by raised cheeks.[24] The sign pictured is a deictic THERE referring to the movie, using the typical sign language device of establishing points in space for reference to arguments in the discourse. The facial expression characterizes the whole phrase meaning, 'That movie that we were talking about'.

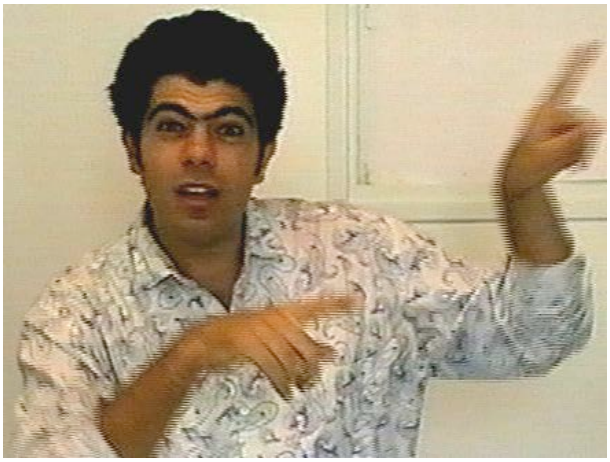
contracted eyelids
(raised cheeks)

_____
That movie that we were talking about
is now playing in Haifa'

Figure 5: shared information

[24] Pierrehumbert and Hirschberg (1990) argue that there is a particular melody that signals information which the speaker assumes is shared by the hearer in English.

In a sentence involving a yes/no question as well as shared information, the facial expressions are combined in simultaneous fashion. The sign pictured is again the deictic, and the facial expression characterizes the whole question, 'Have you seen that movie?' (referring to the movie already established in the discourse, and thus constituting shared information).



brows up
widened (top) eyelids
head forward
contracted (bottom) eyelids
(raised cheeks)

_____
'Have you seen that movie?'
(that we were talking about)

Figure 6: yes/no question + shared information

Telltale indications of these facial expressions are lines in the forehead, in the case of raised eyebrows, and a line under the eyes for lower lid contraction. In the combined expression, both are present. In sum, we support earlier findings that facial expressions of sign languge have meanings, and we propose that they have as their domains Ps and Is.

Our findings suggest, then, that the existence of intonation -- its function and its relationship to prosodic organization -- is a human language universal.[25] However, we conclude that the two different modalities determine the form of 'melodies'. In particular, simultaneous intonational units within the intonational phrase are a sign language modality effect. This implies that sequential melodies are a spoken language modality effect, and that linear sequences of high and low tones - those associated to prominent elements and those associated to boundaries at the level of the intonational phrase - are not universals of human language

[25] Corina et al (this volume) report that grammaticalized and affective facial expression in American Sign Language are controlled in different areas of the brain. In the introductory article, Sandler (this volume) interprets these results in terms of an analogy with spoken language intonation.

intonation. We intend to continue the investigation of sign language intonation in future research.

4. Summary and Conclusion.

This analysis supports the existence of the phonological phrase and the intonational phrase as prosodic constituents common to both spoken and signed utterances. The results described thus indicate that these levels of representation may be universals of prosodic structure. In addition, the existence of Ps and Is in the representation of signed prosody lends support to the theory of Prosodic Phonology.

Evidence was provided for phonological phrases with a domain similar to that found in spoken head - complement languages and with the same right edge prominence pattern. Rhythmic prominence is expressed manually, with hold, reduplication, or pause. An external sandhi rule of nondominant hand spread was shown to have the phonological phrase as its domain, providing further evidence for the existence of this prosodic constituent.

Examples of restructuring of phonological phrasing under similar conditions that prompt restructuring in some spoken languages showed nonisomorphism between syntactic and prosodic constituency. Nonisomorphism of this sort in both signed and spoken languages supports the idea that there are independent properties of phonological organization, such as a requirement for rhythmic structure consisting of the regular recurrence of similar elements. These organizational properties are not bound to any modality-specific characteristic of the physical channel in which a language is transmitted.

Intonational phrases are clearly marked rhythmically with stronger prominence at the right edge, and intonationally with changes in head position and facial expression, and optionally with eye blinks. The right edges of intonational phrases may be marked with enlarged size or slowed duration. Common candidates for intonational phrases, such as parentheticals, extraposed elements, and topicalized elements, were found to constitute separate Is in ISL as they do in spoken languages. In addition, we found the variability typical of intonational phrasing. This is exemplified in examples (31) and (32) above -- the same sentence with three phonological phrases broken up into three Is for one signer, and only two for another. As the term suggests, intonational phrases are the domain for intonational melodies, a generalization which was also attested in our sign language data. The role and organization of facial expression and its articulatory components suggest that it is the equivalent of intonational melodies.

Certain phonetic differences between languages in the two modalities were highlighted in this study. One is the existence in sign language of two anatomically identical potential articulators -- the two hands. It was shown that, while the nondominant hand is generally not an independent articulator in the words of the language, its existence provides a phonetic option that is indeed exploited in the prosodic structure. Specifically, the nondominant hand can spread within the phonological phrase. The other difference is the existence of several articulators for the transmission of intonational melodies, all of which are essentially independent of the ones used for the transmission of words. This difference is also exploited for prosodic purposes, by creating complex melodies that have simultaneous in addition to sequential structure. In both cases, the prosodic structure signalled by these modality specific phonetic elements is the same as that of spoken languages. This discovery has potentially significant implications for general linguistic theory,

namely, that more of what has been attributted to abstract linguistic structuring (e.g., sequential tonal melodies, boundary tones) may be a modality-determined phonetic interpretation of such structure.

Future research issues emerge clearly as a result of this study. As this is a preliminary study into relatively uncharted territory, our findings should be verified by more studies of this and other sign languages, using a larger and more varied corpus. One important issue for future research is the role of prosody in language acquisition. Once the prosody of the adult sign languages is understood, it will be possible to investigate whether children identify prosodic properties of their language, and whether these facilitate bootstrapping of syntactic characteristics, as proposed for spoken language.

In the introduction to this paper, we made some general statements about spoken language prosody, and set as our goal to determine whether these generalizations are universals of human language, regardless of modality. The investigation reported here, we believe, makes it possible to take the words 'speech' and spoken' out of those generalizations, and to substitute the word, 'language'. To paraphrase:

The human language signal is broken up into constituents, and these constituents are characterized by patterns of rhythmic and intonational structure. Through these patterns, phonology interprets morphosyntactic and semantic structure in systematic ways that appear to be characterized by properties universal to all human language, regardless of modality.

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PROSODY IN ISRAELI SIGN LANGUAGE

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