Phonological effects on word order: AB constructions in Hebrew

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The literature on what we call AB constructions (freezes, irreversible binomials), such as odds and ends and copy paste, attributes the fixed word order to both phonological and nonphonological, mostly semantic constraints. However, some researchers attribute a prominent role to phonology, while others view semantics as the major contributor to word order of AB constructions. In this paper we evaluate the role of phonology in Hebrew AB constructions with reference to a harmonic grammar with weighted constraints, where constraint weight is calculated on the basis of its effect in our corpus. The grammar reveals that semantic constraints weigh more than phonological constraints in both the cumulative weight and the average weight. Nevertheless, phonology affects a great number of data items, in particular those where semantic constraints are mute. We thus conclude that although syntax and semantics are responsible for word order, phonology determines word order when the other modules do not have a say.

Keywords: binomials; fixed word order; phonology–semantics interaction; weighted constraints; Hebrew

1 Introduction: AB constructions

Word order is usually assigned by syntax. The phrases queens chase kings in the park and kings chase queens in the park are semantically different, as syntax assigns agent–patient relations according to the noun’s position within the phrase. However, the phrases queens and kings walk in the park and kings and queens walk in the park are semantically identical. Despite the semantic identity, kings and queens is used much more often than queens and kings, to the extent that the order between the elements may be considered irreversible. Similarly, Malkiel (1959) notes with regard to odds and ends that “… an inversion of the two kernels – *ends and odds – would be barely understandable to listeners caught by surprise” (p. 113).

There are several terms referring to this type of constructions, including ‘fixed order coordinates’ (Abraham 1950), ‘irreversible binomials’ (Malkiel 1959), and ‘freezes’ (Cooper and Ross 1975), all denoting fixed word order, and ‘lexical pairs’ (Kaye 2009), which does not. However, scholars agree that irreversibility is scalar; for example, 5.7% of the 2,720 binomials in Gustafsson (1976) were reversible. For this reason, Mollin (2014) proposed an (ir)reversibility scale, whereby each lexical pair is assigned an irreversibility score. In Mollin’s corpus-based study, king and queen is positioned at one edge of the scale with the highest irreversibility score (100), together with law and order and many others, while beliefs and
values is at the other edge with the lowest score (50). In-between, one can find fish and chips (99.05), salt and pepper (82.45), and family and friends (76.62).

In this paper we use the general term AB constructions. We include under this term binomials (1a,b), which include a linker, and copulative compounds (hereafter: copulatives), also known as dvandva compounds (1c).

(1) AB constructions
   a. and-constructions odds and ends
   b. or-constructions heads or tails
   c. copulatives copy paste

There is an extensive literature on AB constructions (see reviews on English AB constructions in Mollin 2014 as well as Kopaczyk and Sauer 2017), beginning with Sanskrit dvandva compounds (e.g. mātā-pitarau ‘parents; lit. mother-father’) in Pāṇini’s grammatical treatise Aṣṭādhyāyi. There are many studies on English AB constructions (Jespersen 1905, Malkiel 1959, Cooper and Ross 1975, Gustafsson 1976, Gil 1989, McDonald, Bock and Kelly 1993, Benor and Levy 2006, Copestake and Herbelot 2011, Lohman 2014, Mollin 2014, Renner 2014, Kopaczyk and Sauer 2017), sometimes with a comparative orientation (Abraham 1950). Studies on other languages are limited to one or two for each language; e.g. Ancient Hebrew (Kaddari 1966, Avishur 1976), Basque (Jacobsen 1982), German (Lambrecht 1984), Hungarian (Pordány 1986), Arabic (Gorgis and Al Tamimi 2005, Kaye 2009), Italian (Masini 2006), Korean and Japanese (Kwon and Masuda 2019). In this paper we add Modern Hebrew to this list, with a comparative glimpse at the end.

Our study focuses on the principles that determine the preferred and sometimes irreversible order between the elements, and in particular on the interaction among them. There is a consensus with respect to the wide range of factors affecting word order in AB constructions – phonological and semantic, as well as pragmatic and psycholinguistic. However, some researchers attribute a prominent role to phonology (Renner 2014), or more specifically prosodic phonology (Jespersen 1905, Gil 1989), while others view semantics as the major contributor to word order of AB constructions, where semantics is often a cover term for all non-phonological principles (Abraham 1950, Cooper and Ross 1975, McDonald, Bock and Kelly 1993, Benor and Levy 2006).

In addition to the linguistic factors, various studies suggest a frequency-based principle, stating that the first element in an AB construction is more frequent than the second (Kaddari 1966, Wright, Hay and Bent 2005). Fenk-Oczlon (1989) argues that frequency alone is sufficient because it overlaps, at least partially, with other constraints (see §4 below), such as SHORT-LONG (frequent words are often shorter than infrequent ones) and PROTOTYPE FIRST (prototypical words are often frequent). This follows form Zipf’s (1935/1965) principle of least effort, which connects between structural complexity and the frequency of its use. Although most linguists agree that frequency plays a role in language knowledge, the extent of its effect in the construction of grammar is controversial (see studies in Gülzow and Gagarina 2007).

We do not deny the potential role of frequency, but find it unlikely to play a major role in our model. First, Fenk-Oczlon (1989) acknowledges that frequency has a larger impact when the constructions are reversible, while the AB constructions in our database were irreversible, or with low degree of reversibility. Fenk-Oczlon (1989) also claims that frequency overlaps, at least partially, with other constraints (e.g. PROTOTYPE FIRST, SHORT-LONG) which are addressed in our paper. Moreover, Pinker and Birdsong (1979) managed to eliminate the effect of frequency in their experimental study by using nonce-words, showing that SHORT-LONG is active without the effect of frequency.¹

¹ In addition, there are methodological reasons for not addressing frequency. First, the AB constructions in our database were coined during different time periods, and therefore a corpus-based frequency check of each element in a construction would be misleading; for example, both words in kro u xtov ‘reading and writing’ are rarely used today,
We present here a study of Hebrew AB constructions, aiming to shed light on the role of phonology in determining word order. We show that although the most prominent constraints in the grammar are semantic, the power of phonology emerges to a great extent. More specifically, the effect of phonology emerges when semantics is indifferent, i.e., in data items where there are no relevant semantic constraints; apparently, there are quite a few such data items. This state of affairs, where phonology does the job of other modules when they are mute, is introduced in Golston (1995), where prosody selects one out of two syntactically well-formed structures.

Our account of the interaction of semantics and phonology in the grammar of Hebrew AB constructions is couched within the framework of Optimality Theory (OT; Prince and Smolensky 2004 [1993]), which not only provides a solid infrastructure for constraint interaction, but also allows the interaction of constraints from different modules of grammar. We use Harmonic Grammar with weighted constraints (Legendre, Miyata and Smolensky 1990, Smolensky and Legendre 2006, Pater 2009, 2016), where the weight of the constraints is calculated on the basis of its violation/satisfaction in our corpus.

We continue this introduction with a brief review of studies on phonology and word order (§2) and then move on to our methodology (§3). First, we present our corpus (§3.1), and then discuss two tests that were essential to set the constraints: prototypicality test (§3.2) and syllabification test (§3.3). We then introduce all the constraints that were found to be relevant to our corpus (§4), distinguishing between non-phonological (§4.1) and phonological (§4.2) constraints. With the constraints at hand, we turn to the grammar of Hebrew AB constructions (§5), starting with the basic tenets of Harmonic Grammar and its unique properties compared to classic OT. We then introduce the model we used to assign constraint weight and provide the list of the relevant constraints and their weight (§5.1). At this point, we highlight the role of phonology in the grammar of Hebrew AB constructions, pointing out the conditions under which phonology prevails (§5.2), and continue with evaluating our grammar against new data items (§5.3). At the end, we provide a summary of constraint interaction, again highlighting the role of phonology (§5.4). Finally, we raise two questions that require further study (§6) and then conclude (§7).

2 Phonology and word order

The impact of phonology on word order is reflected in a general end-weight tendency (Wasow 1997; attributed to Behaghel 1909), whereby long constituents are pushed towards the end of the sentence. As in many cases of phonology–syntax interface (Inkelas and Zec 1990), the impact of phonology, in particular prosody, often arises when the syntax is mute (Golston 1995), although there is often a default structure.

The most well-known phenomenon of the end-weight tendency is Heavy NP shift, whereby a long direct object lands at the end of the phrase rather than next to the verb (Hawkins 1983, Siewierska 1988, Stallings and Macdonald 2011). As exemplified below, the direct object usually precedes the indirect object (2a), unless the direct object is long, in which case it is shifted to the end of the sentence (2b); crucially, there is no NP shift when the direct object is short (2a).

(2) Heavy NP shift
   a. Direct object precedes indirect object – default
      i. Jack sent the book to Jill
      ii. ?Jack sent to Jill the book
b. Indirect object precedes direct object – when direct object is long

i. I VP [introduced PP [to Mary] NP [some friends that John had brought to the party]]

ii. ? I VP [introduced NP [some friends that John had brought to the party] PP [to Mary]]

The function of Heavy NP shift is parsing facilitation (Hawkins 1990, 1994) and utterance planning (Wasow 1997), where the measuring units of length are phonological (segments or syllables, though some argue for grammatical length, where the measuring units are words (McDonald, Bock, and Kelly 1993)). Word length is, of course, one of several non-syntactic factors determining word order, as shown in Bresnan et al.’s (2007) study of English dative constructions (e.g. … gave books to all the children vs. … gave all the children books); here, the length of the recipient interacts with other factors such as givenness, definiteness and animacy.

The selection between English s-genitive and of-genitive (e.g. (e.g. the man’s computer vs. the computer of the man) is shown to be affected by phonology, particularly rhythm and stress pattern. Shih et al. (2015) argue that in addition to semantic, pragmatic and processing factors, the Principle of Rhythmic Alternation (Selkirk 1984) is a reliable predictor of the selection of genitive construction in their corpus of spoken English.

The effect of phonology on word order is also found in Tagalog. In their corpus-based study of adjective–noun phrases, Shih and Zuraw (2017) found that the free variation in the order of adjectives and nouns in Tagalog is not at all free, but rather imposed by segmental and prosodic constraints. For example, the default adjective–noun order in sawíŋ báyan ‘unfortunate country/people’ leads to stress clash, and therefore the reverse order báyang sawíʔ arises.

The topic of the present study is the effect of phonology on word order in AB constructions. While in Tagalog there is a default word order that phonology can adjust, in AB constructions there is no default order – word order is determined by phonological and semantic constraints. For example, in art and design the short element precedes the long one (phonology), and in right and wrong the positive element precedes the negative (semantics). Cooper and Ross (1975) propose the cover principle me first, stating that “first conjuncts refer to those factors which describe the prototypical speaker” (p. 67). This principle includes various semantic subprinciples, many of which adopted from earlier studies (Abraham 1950, Malkiel 1959); for example, positive–negative, light–dark, male–female, animate–inanimate, near–far, present–future, top–bottom (where X–Y means X comes before Y).2 These principles interact with various phonological principles, including short–long, which falls under the above-mentioned end-weight tendency.

There is a consensus among the researchers with regard to the interaction of phonological and semantic principles in determining the order in AB constructions. However, it is not yet clear which of these two modules is the major contributor. While some researchers claim that semantic factors prevail (McDonald, Bock and Kelly 1993, Benor and Levy 2006, Mollin 2012), others assert that phonology, in particular prosody is the major contributor to word order in AB constructions (Gil 1989, Wright, Hay and Bent 2005, Renner 2014).

In this paper, we present a study of Hebrew AB constructions, aiming to shed light on the role of phonology in determining word order. We show that although some semantic constraints are rarely violated (e.g. MALE-FEMALE), the power of phonology may emerge to the extent that in some data items phonology is the major contributor.

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2 It must be said out loud that the correlations implied from Me First (e.g. positive–negative, light–dark, male–female) are, at best, inappropriate.
3 Methodology

In this section we provide details on the selection of the data items on the basis of the irreversibility score (§3.1), and introduce two preliminary tests which were conducted in order to determine how to set some of the constraints: the prototypicality test (§3.2) and the syllabification test (§3.3).

3.1 The data

In order to determine which AB constructions are in fact irreversible, we adopted Mollin’s (2012) notion of (ir)reversibility scale, whereby AB constructions are assigned with a reversibility score. Our corpus, which was initially comprised of 95 Hebrew AB constructions, was drawn from written material and native speakers’ intuition. For each of the 95 items, the frequency of both possible orders was indicated on the basis of google search results. Then, the reversibility score was calculated with Mollin’s (2012) formula \( \frac{\text{freq}}{(\text{freq} + \text{revfreq})} \times 100 \), where \( \text{freq} \) corresponds with the frozen order, and \( \text{revfreq} \) corresponds with the reverse order. For example, \( \text{mukdám o meuχáʁ} \) ‘early or late’ had 19,700 hits on a google search, while the reverse \( \text{meuχaʁ o mukdam} \) had 3220 hits; the irreversibility score given to this binomial was thus 86 \( (\frac{19,700}{19,700+3220}) \times 100 \). The distribution of the 95 data items on the scale is given in Table 1.

| Score   | AB Constructions |
|---------|------------------|
| 100     | Absolute         | 10 | 11%   |
| 85-99   | Strong           | 56 | 59%   |
| 65-84   | Moderate         | 18 | 19%   |
| 51-64   | Weak             | 5  | 5%    |
| 0-50    | Reversible       | 6  | 6%    |

For the purpose of our study, we eliminated the 6 reversible data items (score 0-50) and analyzed a total of 89 items (see Appendix A) with an average irreversibility score of 90. The data items are distributed as follows:

(2) The corpus of Hebrew AB constructions (n =89)

a. Binomials

\( And \) constructions 54 (e.g. \( \text{mélaχ ve-pilpel} \) ‘salt and pepper’)

\( Or \) constructions    7  (e.g. \( \text{paχót o-jotéχ} \) ‘less or more’)

b. Copulatives

28 (e.g. \( \text{aaték adbéχ} \) ‘copy paste’)

In addition to the 89 items which were used to calculate the weight of the constraints, we examined 17 and-constructions consisting of personal names (listed in Table 4). Since all but two of the relevant constraints in binomial names are phonological, these 17 items allowed us to evaluate the model with emphasis on the phonological constraints (§5.3).

3.2 Prototypicality test

As will be elaborated in §4, the grammar presented in this paper consists of phonological and non-phonological constraints. One of the non-phonological constraints is the PROTOTYPE FIRST, which requires the first word in the AB construction be more prototypical than the second one. In order to determine which of our AB constructions satisfies this constraint, a prototypicality test was conducted.

Participants: 30 native speakers of Hebrew (age 20-40), with no previous knowledge of the study, participated in the test.
**Procedure:** The participants were given a written form with a list of all the AB constructions, and were asked to choose, within each construction, the element that is more central in the world (the term prototypical was not used). The participants were requested to be as objective as possible, disregarding their own personal preferences. In order to control the effect of word order on the participants’ choice, 15 participants took the test where the order of constructions was AB, and another 15 participants took the test where the order of constructions was BA.

**Results:** Prototypicality was assigned to an item only when a statistically significant majority of the participants agreed upon it ($p<0.05$; a binomial test). For example, in item (a) in Table 2, A was significantly more central than B, and in item (b) it was the other way around; in item (c) there was no significant difference in the centrality of the two elements.

| Table 2: Prototypicality test results |
|--------------------------------------|
| a. klavím ve ganavím  | klavím ‘dogs’  | 21  | $p = .013$ |
|                       | ganavím ‘thieves’ | 8   |             |
| b. báal ve ıfá         | báal ‘husband’  | 9   | $p = .044$  |
|                       | ıfá ‘wife’      | 19  |             |
| c. áχ ve aχót          | áχ ‘brother’    | 12  | $p = .285$  |
|                       | aχót ‘sister’   | 16  |             |

Accordingly, the constraint PROTOTYPE FIRST was considered satisfied in (a), violated in (b), and not relevant in (c).

### 3.3 Syllabification test

We identified two cases of potential variation in syllabification, which could affect our model, since some of the phonological constraints refer to syllable structure.

The first case appears in constructions where a word with an initial consonant cluster is preceded by a vowel-final word (e.g. *neʃíka stiɾá* ‘kiss slap’) or a linker (e.g. *ıɢel ve ʃtíjá* ‘food and drinks’). There are two ways to syllabify such a sequence: (a) morphologically-sensitive syllabification, whereby the left edge of the word is aligned with a left edge of a syllable, thus preserving the cluster – …ve.ʃtíjá; (b) morphologically-insensitive syllabification, whereby the two consonants of the input cluster are heterosyllabic – …veʃ.tíjá. This variation is relevant to the constraint ALIGNLEFT(IC, PHPH), which requires the input initial cluster to reside at the edge of the AB construction (see §4.2). ALIGNLEFT is violated in morphologically-sensitive syllabification, where the cluster is at the middle of the AB construction – …ve.ʃtíjá, but not in the morphologically-insensitive syllabification, where there is no cluster – …veʃ.tíjá.

The second case of variation is found with the linker *ve* ‘and’, which has a normative allomorph *u* before labials and consonant clusters (Amir Coffin and Bolozky 2005:246).³ The variation between *u* and *ve* is relevant to the constraint *VV*, which prohibits two adjacent vowels; e.g. *kɾó u ɣtón* ‘reading and writing’ violates *VV* but *kɾó ve ɣtón* does not. The *u* allomorph is limited to normative Hebrew and rarely used in casual speech. However, most speakers have knowledge of the allomorph, and therefore we had to eliminate this potential variation.

**Participants:** 10 Hebrew native speakers (ages of 22-35), with no previous knowledge of the study, participated in the test.

**Material:** All participants were presented with a list of 28 AB constructions from the corpus. The data items met the following conditions (i) an initial cluster in one of the two words (or final cluster, relevant to

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³ There is actually a third allomorph, *va*, but since we do not have constraints that refer to vowel quality, the difference between *ve* and *va* is not relevant.
only one data item) or (ii) the conjunctive marker appeared in the environment of u in normative Hebrew. That is, all items were subject to resyllabification.

Procedure: The participants were asked to read each item out loud 4 times: Two times in each order – AB vs BA, and within each order one time in a normal pace and another in a slow pace; the latter pace potentially provides syllable boundaries. In the slow pace mode, participants were requested to read slowly, following an audio example, but were not requested to syllabify the words. All participants performed 2 tryout readings prior to the test. All 270 readings were transcribed and examined for (i) resyllabification and (ii) the u allomorph of ve.

Results: Resyllabification occurred in only 2 items (out of 270 readings), in both the normal and the slow reading paces. Hence, we concluded that no resyllabification occurs and initial clusters remain intact, preserving morphology-sensitive syllabification.

The allomorph u appeared conclusively in two constructions only: χomá u migdál ‘wall and tower’ and kró u χtóv ‘reading and writing’. Within these two AB constructions, the constraint *VV is violated (χomá u migdál and kró u χtóv) and hence its weight was calculated accordingly.

Relevant to *VV is our transcription method with regard to glottals. Since they are rarely produced in casual speech, orthographic glottals were not transcribed, giving rise to vowel initial words (e.g. ód ve adáʁ ‘majesty and glory’, ów ve atsámót ‘skin and bones’). Note that a literate speaker “knows” that ód ve adáʁ is actually hód ve hadáʁ, since the initial glottal fricative has a corresponding letter in the alphabet. However, the decision to eliminate glottals from the phonetic script is based on their poor representation in speech, to the extent that their phonemic status is questionable. Faust (2005) argues that a glottal in Modern Hebrew is actually the vowel /a/ thus supporting our glottal-less transcription.

4 The relevant constraints

In this section, we present the constraints relevant to the grammar of word order in the AB constructions in our corpus. There are two measures of relevancy – relevant to the corpus and relevant to the data item. A constraint is considered relevant to the corpus if the corpus includes one or more data items whose order cannot be accounted for without this constraint. A constraint is considered relevant to a data item if it does not obtain the same result in the two possible orders, AB and BA. All the constraints but one (NATIVE-LOAN; see §4.1) are drawn from the literature on AB constructions and/or the general literature on universal constraints. We assume that the constraints are universal; for some there is evidence in Pinker and Birdsong’s (1979) experimental study and for others there is evidence in general linguistic studies.

As our main interest here is the role of phonology in determining word order, the constraints are divided into phonological and non-phonological constraints, where the latter ones are mostly semantic. Some of the constraints are presented in a A–B scheme, which indicates that A appears before B.

4.1 Non-phonological constraints

Below is the list of non-phonological constraints that were found relevant to the data items in our corpus.

TEMPORAL SEQUENCING (Tai 1985), also referred to as ‘iconic sequencing constraint’ (Malkiel 1959): A appears before B within the real-world referents (e.g. avót ve baním ‘fathers and sons’).

MALE-FEMALE (Cooper and Ross 1975): A is male and B is female (e.g. áχ ve aχót ‘brother and sister’).

Note that this constraint specifically refers to male and female, and not to masculine and feminine, as the latter include grammatical gender. Thus, the constraint is relevant to aχ ve aχót ‘brother and sister’ but not to léχem ve χemá ‘bread and butter’, where léχem is grammatically masculine and χemá is grammatically feminine.

POSITIVE NEGATIVE (Cooper and Ross 1975): A is objectively more positive than B (e.g. kén o ló ‘yes or no’).

PROTOTYPIC FIRST (Kelly, Bock and Keil 1986): A is more prototypical than B within the same semantic field (e.g. mélaχ ve plípel ‘salt and pepper’).

NATIVE LOAN: A is a native word and B is a loanword (e.g. tashbúve spóst ‘culture and sports’).
We limit loanwords to those exhibiting salient non-native features (Schwarzwald 1998). For example, spòrt is a loanword since there are no Hebrew words with both initial and final clusters, but salát ‘salad’ is not considered a loanword because it is similar to native words like falát ‘remote control’ and gamád ‘dwarf’.4

4 In Hebrew, word similarity is based on configurations (Bat-El 2011), which consist of prosodic structure, vocalic pattern and affixes (if any). For example, mataná ‘gift’ and maxalá ‘disease’ are similar, and so are kèlev ‘dog’ and bétén ‘abdomen’.

4.2 Phonological constraints

Seven phonological constraints were found relevant to our corpus, most of which fall under syllable structure optimization (Benor and Levy 2006, Shih and Zuraw 2017). The constraints are defined below, accompanied with examples of the two possible orders, indicating with > that the first order is the most common one, and sometimes irreversible.

SHORT LONG (Cooper and Ross 1975): A is shorter than B in syllabic and/or segmental terms (e.g. smól jamin ‘left right’ < jamin smól).

In most studies, the units considered for the evaluation of SHORT-LONG are syllables, and in a few they are segments (Sobkowiak 1993). In most cases, the two measuring units converge (e.g. ţút ve máţat ‘thread and needle’), in some only the syllable is relevant (e.g. lév seá ‘heart lung’), and in yet others only the segments are relevant (e.g. bujá ve źeṗá ‘shame and disgrace’). There is no data item in our corpus that respects SHORT-LONG with reference to one measure and violates it with reference to another (hypothetical ţíps reá ‘chips lung’). Therefore, we combined the two measuring units into one constraint.

ALIGNL (IC, PHPH) (ALIGNL; McCarthy and Prince 1993, Benor and Levy 2006): A word initial cluster (IC) is aligned with the left edge of the phonological phrase (e.g. gvinót ve jáin ‘cheeses and wine’ > jáin ve gvinót).5

ALIGNL disfavors word initial clusters in the middle of the AB constructions, pushing the cluster to the left edge.6 Recall from §3.3 that word boundary aligns with syllable boundary, and thus, an initial cluster in the second element persists when preceded by a vowel-final element (e.g. ó.χel . ve.ʃtijá ‘food and drinks’).

Cooper and Ross (1975) proposed a constraint with the opposite effect, giving priority to fewer consonants at the edges. However, based on experimental data from English and French, Pinker and Birdsong (1979) restate this constraint, which like ALIGNL, gives priority to complexity at the margins. This effect is universally more plausible since the left edge is known for its unique status in adult languages (Nelson 2003); it resists weakening caused by phonological alternation (Beckman 1998), and in some cases it also induces strengthening (Bat-El 2014).

*VV (Casali 1997, Benor and Levy 2006, Shih and Zuraw 2017): A sequence of two adjacent vowels is prohibited (e.g. emét o ẓová ‘truth or dare’ < ẓová o emét).

Vowel hiatus in Hebrew often persists (e.g. foēs ‘gate keeper’, maēs ‘fast’, jaavód ‘to work 3.MS.SG.FUT’), more so in careful than in causal speech. However, there are derived environments where the constraint is active, and the VV sequence is resolved via vowel deletion (e.g. /asa-u/ → asú ‘to do 3.PL.PAST’) or glide epenthesis (e.g. /dati-a/ → datijá ‘religious FM.SG’). We expect *VV to be active in AB constructions, not only because of the derived environment, but also because AB constructions reside in the periphery of the lexicon, where the effect of universal markedness constraints tends to emerge (McCarthy and Prince 1994, Bat-El 2005).

*CLASH (Liberman and Prince 1977, Hayes 1995, Kager 1993, 1999): A sequence of two adjacent stressed syllables is prohibited (e.g. bétén gáv ‘stomach back’ > gáv bétén).

5 Note that we consider an AB construction a phonological phrase (PhPh) since the two words in the phrase preserve their primary stress. We also assume that the domain of ALIGNL is both the prosodic word and the phonological word.

6 A parallel constraint, ALIGNR, disfavors word final clusters. For our purposes, only the left edge is relevant since there are very few word final clusters in Hebrew (Asherov and Bat-El 2019).
The effect of *CLASH emerges only in copulative compounds; in the other types of AB constructions there is an unstressed linker between the two elements.

*LAPSE (Selkirk 1984, McDonald, Bock and Kelly 1993, Benor and Levy 2006): A sequence of two or more adjacent unstressed syllables is prohibited (e.g. *milím ve láxan ‘lyrics and melody’ > láxan ve milím).

There is no secondary stress in Hebrew (Becker 2002, Cohen, Silber-Varod and Amir 2018) and thus all syllables that do not carry main stress, including the syllable of the linker, are unstressed. *LAPSE violations were counted in derived environment only, i.e. when the sequence of two unstressed syllables was at a word boundary. For example, there is one violation of *LAPSE in ón ve filtón ‘wealth and authorities’, and two violations in óxel ve fitjá ‘food and drinks’. In nísím ve niflaót ‘miracles and wonders’ there is a sequence of three unstressed syllables, as in óxel ve fitjá, but only two of the unstressed syllables is at a word boundary and therefore nísím ve niflaót has only one *LAPSE violation.

**THE OBLIGATORY CONTOUR PRINCIPLE (OCP; Goldsmith 1976):** Adjacent segment sharing place of articulation are prohibited (e.g. ñamûts matók ‘sour sweet’ > matók ñamûts).

5 The grammar of AB constructions

The formal analysis of Hebrew AB constructions presented in this section adopts the framework of Harmonic Grammar (HG; Legendre, Miyata and Smolensky 1990, Smolensky and Legendre 2006, Pater 2009, 2016), which differs from classic OT (Prince and Smolensky 2004[1993]) in the constraint scheme; in classic OT the constraints are strictly ranked while in HG they are weighted.

Consider the schematic tableaux in (3) below. In (3a), A is the optimal candidate because its competitor B violates the dominant constraint CON1 and thus eliminated. The fact that candidate A violates more constraints than candidate B is irrelevant, as the strict ranking is the significant factor. This OT tableau contrasts with the HG tableau in (3b), as in the latter candidate B is optimal. Here we see the gang effect (Pater 2009); although CON1 weighs more than CON2 and CON3 independently, the cumulative weight value of the latter two allows them to gang up against CON1.

(3) Ranked vs. weighted constraints

|   | CON1 | CON2 | CON3 |
|---|------|------|------|
| a. | Candidate A | * | * |
| b. | Candidate B | *! | * | ** |

|   | CON1 | CON2 | CON3 |
|---|------|------|------|
| a. | Candidate A | -1 | -1 | -2 |
| b. | Candidate B | -1 | -1.5 |

In HG tableaux, the weight of constraints appears below their names, and a violation is indicated by the negative integer -1. The cumulative value of violations for each candidate is on the rightmost column, under \( H \), where the winning candidate is the one with the cumulative value closest to 0.

5.1 The weight of the constraints

Weight value is often assigned with arbitrary integers (Pater 2009, 2016), but here we drew the weight values from the corpus. Each constraint in the two lists in §4 was assigned a numerical weight according to the formula \( X:Y \), where \( X \) is the number of times the constraint was satisfied in the data items, and \( Y \) is the
number of times the constraint was relevant, i.e. satisfied and/or violated. A constraint is irrelevant when its environment is not met (e.g. the environment of MALE-FEMALE is not met in měłaχ ve pílpel ‘salt and pepper’), or when both AB and BA equally fare with respect to a constraint (e.g. *VV is equally violated in áχ ve aχót ‘brother and sister’ and aχót ve áχ). Constraint weight could be any number between 0 (never satisfied in our corpus) to 1 (never violated in our corpus). For example, SHORT-LONG is satisfied by 53 data items and violated by 18, and its weight value is thus 0.75 (=53:(53+18)). Similarly, 0.83 (=38:(38+6)) is the weight value of PROTOTYPE FIRST, and 0.41 (=13:(13+19)) of *LAPSE. We used 89 data items to assign weight, all with two elements, with or without a linker (see the list in Appendix A).

We started the analysis with a wide range of constraints from the literature on AB constructions, and gradually eliminated those that are not relevant to the data or do not add the efficiency of the grammar (i.e. the results are identical with and without them). The constraints that were eventually found relevant for our data items are provided in Table 3 below (see §4 for definitions), with their weights at the rightmost column (from the highest to the lowest value).

**Table 3: Constraint weight (phonological constraints are shaded)**

| Constraint         | Satisfactions | Violations | Weight |
|--------------------|---------------|------------|--------|
| MALE-FEMALE        | 5             | 0          | 1.00   |
| TEMPORAL ICONICITY | 16            | 1          | 0.94   |
| POSITIVE-NEGATIVE  | 12            | 2          | 0.86   |
| PROTOTYPE FIRST    | 38            | 6          | 0.83   |
| *CLASH             | 8             | 2          | 0.80   |
| SHORT-LONG         | 53            | 18         | 0.75   |
| ALIGN LEFT         | 7             | 4          | 0.64   |
| NATIVE LOAN        | 3             | 2          | 0.60   |
| OCP                | 12            | 12         | 0.50   |
| *VV                | 9             | 10         | 0.47   |
| *LAPSE             | 13            | 19         | 0.41   |

There are 11 active constraints in the grammar of Hebrew AB constructions – 5 non-phonological, mostly semantic, with an overall weight of 4.23, and 6 phonological with an overall weight of 3.57. At the top of the list are four semantic constraints – MALE-FEMALE, TEMPORAL-ICONICITY, POSITIVE-NEGATIVE and PROTOTYPE FIRST, where the first one is never violated in this corpus. These details alone support the studies that attribute word order in AB constructions primarily to semantic/pragmatic factors (Cooper and Ross 1975, Benor and Levy 2006, Mollin 2012). However, as we show in §5.2 below, the effect of phonology emerges under several circumstances.

5.2 Where does phonology prevail?

As noted, there is a consensus in the literature that both phonological and non-phonological factors play a role in determining word order in AB constructions, and this is also true for Hebrew AB constructions. As shown below, there are cases where semantics prevails (4a) and others phonology prevails (4b).
(4) Constraint interaction

a. Semantics prevails: *yatul ve aṣbāṣ* ‘cat and mouse’

|        | Prototype First [0.83] | *VV [0.47] | H |
|--------|------------------------|------------|---|
| a. ḍf  | *yatul ve aṣbāṣ*       | -1         | -0.47 |
| b.     | aṣbāṣ ve *yatul*       | -1         | -0.83 |

b. Phonology prevails: *bāṣ misadā* ‘bar-restaurant’

|        | *CLASH [0.80] | SHORT-LONG [0.75] | NATIVE-LOAN [0.60] | H |
|--------|---------------|-------------------|---------------------|---|
| a. ḍf  | *bāṣ misadā*  |                   | -1                  | -0.60 |
| b.     | *misa* ḍadā  | -1                | -1                  | -1.55 |

Here we focus on the role of phonology in determining word order in Hebrew AB constructions, and thus consider the cases where phonology prevails. We start with the cases where only phonological constraints are relevant, either without constraint interaction (5a), or with interaction between them (5b).

(5) Only phonological constraints are active

a. All constraints are satisfied: *χūṭ ve máχat* ‘thread and needle’

|        | SHORT-LONG [0.75] | *LAPSE [0.41] | H |
|--------|-------------------|---------------|---|
| a. ḍf  | *χūṭ ve máχat*    |               | 0 |
| b.     | máχat ve *χūṭ*    | -1            | -1.16 |

b. Constraint interaction: *bēten gav* ‘stomach back’

|        | *CLASH [0.80] | SHORT-LONG [0.75] | OCP [0.50] | H |
|--------|---------------|-------------------|------------|---|
| a. ḍf  | *bēten gav*   | -1                |            | -0.75 |
| b.     | gav *bēten*   | -1                | -1         | -1.3 |

Despite the fact that the top four constraints on the weight list are semantic constraints (Table 3), there are two conditions under which phonology prevails in its interaction with semantics. The first condition is when the weight of the semantic constraint is relatively low (6a), and the second is a gang effect (see §5), whereby the cumulative weight of the phonological constraints outweighs the weight of the semantic constraint (6b).

(6) Phonology – semantics interaction

a. *bāṣ misadā* ‘bar restaurant’

|        | *CLASH [0.80] | SHORT-LONG [0.75] | NATIVE-LOAN [0.60] | H |
|--------|---------------|-------------------|---------------------|---|
| a. ḍf  | *bāṣ misadā*  | -1                | -1                  | -0.60 |
| b.     | *misa* ḍadā  | -1                | -1                  | -1.55 |
b. bejšá ve tašnególet ‘egg and chicken’ – gang effect

|          | Prototype First | Short-Long | *Lapse | H  |
|----------|-----------------|------------|--------|----|
| a. aff   | bejšá ve tašnególet | -1         | -1     | -1.24 |
| b.       | tašnególet ve bejšá | -1         | -2     | -1.57 |

To summarize, phonology plays a role in determining word order in three cases: in data items where only phonological constraints are relevant (5); in data items where the relevant non-phonological constraint is outweighed by phonological constraints (6a); and in data items exhibiting gang effect (6b).

5.3 Focusing on the phonological constraints: Binomial names

In order to further evaluate the role of phonology in determining word order in Hebrew AB constructions, we examined binomial names, where only two non-phonological constraints are potentially active – MALE-FEMALE and NATIVE-LOAN; all other relevant constraints are phonological. The corpus, presented in Table 4 below, consists of 17 binomial names, including celebrities and characters known as a duo (cf. English *Tom and Jerry, Romeo and Juliette, Will and Grace*; Wright, Hay and Bent 2005, Tachihara and Goldberg 2020).

| M-M (n=8) | F-F (n=2) | M-F (n=6) | F-M (n=1) |
|-----------|-----------|-----------|-----------|
| N-N       | íjí ve dańś | tsili ve gili | dāts ve dātsa ilan ve ilanit |
|           | tál ve aviád | ōrana ve éla | amnón ve tamás adám ve čavá ámi ve támi jímjón ve dílá |
| L-L       | lónódon ve kisjińbaum grájnik ve álterman tájres ve zawjóvitj | | |
| N-L       | eli ve mariáno | ofisa ve běškovítj | |

The data items in Table 4 are grouped with reference to the two non-phonological constraints, thus allowing to highlight those that involve only phonological constraints (shaded). Overall, 77% (13/17) binomial names were accounted for by our grammar (cf. 83% (74/89); see (13) below). The four data items that were not accounted for were ísili ve gíli, where none of the constraints were relevant; ôrana ve éla, where the only relevant constraints – SHORT-LONG – is violated (with reference to the number of segments); and jímjón ve dílá and tál ve aviád, where the expected gang effect is not borne out.

Note that there are two binomial names under the M-F column in Table 4, where MALE-FEMALE converges with SHORT-LONG: dāts ve dātsa and ilan ve ilanit. This is due to the feminine suffixes -a and -i, which often appear in feminine names (e.g. masculine ron vs. feminine róna or ronít). This is also true for āx ve aģot ‘brother and sister’ from the general data, but not for bën o bát ‘boy or girl’ or báal ve ifá ‘husband and wife’. That is, MALE-FEMALE is independently required.

In 7 out of the 8 binomial names of mixed gender, the constraint MALE-FEMALE determines the order. However, there is one – ofisa ve běškovítj – where the female name appears first. As shown in (7) below, this is due to a gang effect, whereby the low-valued phonological constraints gang against the high-valued semantic constraint.
5.4 Summary of constraint interaction

We developed the grammar of Hebrew AB constructions on the basis of 89 data items – 61 binomials and 28 copulatives, and examined it against 17 binomial names. However, as summarized in Table 5 below, different data items provided different types of information.

Table 5: Distribution of constraint interaction

| Type of constraint interaction | General | Names | Total |
|-------------------------------|---------|-------|-------|
| a. No interaction – all constraints are respected | 30 | 6 | 36 (33.9%) |
| □ Only phonological constraints | 10 | 3 | |
| □ Only semantic constraints | 5 | 0 | |
| □ Phonological and semantic constraints | 15 | 3 | |
| b. Interaction | 44 | 7 | 51 (48.1%) |
| □ Only phonological constraints | 12 | 3 | |
| □ Only semantic constraints | 0 | 0 | |
| □ Phonological and semantic constraints | 32 | 4 | |
| c. Not accounted for | 15 | 4 | 19 (17.9%) |
| □ No relevant constraint | 1 | 1 | |
| □ The loser is the actual form | 4 | 3 | |
| Total | 89 | 17 | 106 |
(8) The loser is the actual form (☞ marks the optimal candidate and ☺ the actual form)

a. óʁ ve atsamót ‘skin and bones’

|                | PROTOTYPE FIRST [0.83] | SHORT-LONG [0.75] | *LAPSE [0.41] | Χ |
|----------------|------------------------|-------------------|---------------|---|
| a. ☺ óʁ ve atsamót | -1                     | -1                | -1.24         |   |
| b. ☞ atsamót ve óʁ | -1                     | -1                | -0.75         |   |

b. χúmus tχína ‘hummus tahini’

|                | PROTOTYPE FIRST [0.83] | ALIGN LEFT [0.64] | OCP [0.50] | Χ |
|----------------|------------------------|-------------------|-----------|---|
| a. ☺ χúmus tχína | -1                     | -1                | -1.14     |   |
| b. ☞ tχína χúmus | -1                     | -1                | -0.83     |   |

Note that in (8a), also a traditional OT analysis would fail, since the actual form violates the dominating constraint PROTOTYPE FIRST. In (8b), however, a traditional OT analysis would derive the actual form, because the actual form respects the dominating constraint PROTOTYPE FIRST, while our harmonic OT analysis predicts a gang effect. Only 4 out of the 17 data items where the loser is the actual form are correctly derived by a classic OT analysis. This result does not give advantage to classic OT since an examination of the data items predicted by our analysis reveals that 6 data items would not be predicted within a classic OT analysis. That is, the two analytical approaches have (almost) similar results.

Finally, it is important to highlight the correlation between the percentage of unaccounted forms and the degree of irreversibility (see Table 1 for the irreversibility scale). As shown in Table 6 below, the higher the degree of irreversibility the lesser the percentage of unaccounted forms.

Table 6: Irreversibility score and unaccounted forms

|                | Total | Unaccounted |
|----------------|-------|-------------|
| Absolute       | 10    | 0%          |
| Strong         | 56    | 6%          |
| Moderate       | 18    | 5%          |
| Weak           | 5     | 3%          |

The correlation in Table 6 thus shows that our model is better suited for AB constructions with a low degree of reversibility, i.e. for irreversible AB constructions.

6 Questions for future study

In the course of our research, we have encountered two questions that require further study, in particular with reference to other languages; one question relates to ABC constructions (§6.1) and the other to the universal status of the grammar of AB constructions (§6.2).

6.1 ABC constructions

We found 5 ABC constructions in Hebrew – 3 and-constructions and 2 copulatives.
We expected the grammar developed on the basis of constructions with two elements to account for constructions with three elements as well, taking into consideration the six possible orders. However, our grammar accounted for only one of the five in (9), much below the ~82% success rate encountered with the general corpus (§5.2) and the binomial names corpus (§5.3).

Below we provide two tableaux, one where the ABC construction is derived by the proposed grammar (10a) and one where it does not (10b). There are three (out of six) candidates in each tableau, the winner and the two runner ups. The optimal candidate is marked with ☜ and the actual form with ☺.

|   |   | *CLASH | SHORT-Long | *LAPSE | OCP |   |
|---|---|--------|------------|--------|-----|---|
| a. | éven nijář ve mispařáim | -2 | -1 | -1.32 |
| b. | nijář éven ve mispařáim | -1 | -1 | -2.37 |
| c. | nijář mispařáim ve éven | -2 | -1 | -2.38 |

|   | *CLASH | SHORT-Long | *LAPSE |   |
|---|--------|------------|--------|---|
| a. | ažen ář gařon | -1 | -0.75 |
| b. | ář gařon ažen | -1 | -0.80 |
| ☺ c. | ář ažen gařon | -1 | -1.21 |

There are no sufficient data to understand the failure of the proposed grammar, but we have some thoughts that should be perused with more data, probably experimental. ABC constructions, like compounds, have three potential syntactic structures – [ABC], [A[BC]] and [[AB]C]. It is possible that different types of constructions, for examples, trinomials (e.g. dát géza ve mín) vs. triplets (e.g. ář ažen gařon), would have different syntactic structures, and it is also possible that some of the constraints are restricted to apply only within a constituent and not across constituents; e.g. within BC in [A[BC]] but not across AB.

### 6.2 Is the grammar of AB constructions universal?

Cross-linguistic variation lies in the different constraint rankings each language adopts, or in the different relative constraint weights it assigns. However, specific phenomena found in different languages may, at least partially, share a grammar. For example, the ranking WORD=FOOT » MAX characterizes hypocoristics in many languages, thus yielding disyllabic forms (e.g. English ëëlks, Hebrew smádi, Spanish kónðe; Bat-El 2005). It is thus reasonable to ask whether the grammar of AB constructions is universal.

Based on Abraham’s (1950) comparative study, this line of research does not look promising. For example, several semantically identical AB constructions in German and English display a reverse order despite the similarities in prosodic structure (e.g. Butter und Brot vs. bread and butter, Wasser und Brot vs.
bread and water). More examples are given in the table below, which provides a comparative sample of parallel AB constructions in English, Hebrew, and Arabic. In Table 7, the order is identical in all three languages; and in the rest of the examples there is an odd one out (shaded) – in Arabic (b), Hebrew (c), and English (d).

Table 7: A comparative sample

|          | English        | Hebrew          | Arabic          |
|----------|----------------|-----------------|-----------------|
| a.       | life and death | χαίμ ve mávet   | alhajá:t wa lmáwt | ‘life and death’ |
|          |                | ‘life and death’ | ‘life and death’ |
| b.       | day and night  | jóm ve lájla    | leːl w inahá:r  | ‘day and night’  |
|          |                | ‘day and night’ | night and day’  |
| c.       | sweet and sour | χámúts matók   | hiliw u haːmið | ‘sweet sweet’ |
|          |                | ‘sour sweet’    | ‘sweet and bitter’ |
| d.       | bride and groom| χatán ve kalá  | ?išārís w išārú:s | ‘groom and bride’ |
|          |                | ‘groom and bride’ | ‘the groom and the bride’ |

Compared to English and Hebrew, Arabic displays a reverse order in ‘day and night’ (b), which could probably be attributed to SHORT-LONG; if this is the case, we have to say that SHORT-LONG outranks (or weighs more than) POSITIVE-NEGATIVE. However, the ranking SHORT-LONG ∪ POSITIVE-NEGATIVE does not hold for Arabic alhajá:t wa lmáwt ‘life and death’ (a).

Despite such potential conflicting evidence (which may diminish when more constraints are taken into consideration and in a harmonic grammar), it is worth perusing the question as to whether the grammar of AB constructions is universal. This may involve language-specific effects, phonological and perhaps also cultural, but the core grammar could be universal.  

7  Concluding remarks

Most studies agree that the grammar determining word order in AB constructions consists of the interaction of phonological and non-phonological, mostly semantic constraints. However, there is a disagreement with regard to the prominent module in this interaction – is it phonology or semantics? Our study suggests that there is no quantitative primary module, but rather different spaces. We reached this conclusion on the basis of a grammar we developed for Hebrew AB constructions (§5) – a harmonic grammar with weighted constraints, where weight was determined on the basis of the function of the constraint in the corpus. Our grammar predicts 83% (74/89) of the main corpus (§5.2) and 76% (13/17) of the binomial names (§5.3).

Some of the forms that are incompatible with our grammar may reflect the influence of English (e.g. fa\jóːr laván ‘black white’, sakin ve mazlég ‘knife and fork’, gviʁotáj ve ʁabotáj ‘ladies and gentlemen’) and others, as noted in §5.4, are rather low on the scale of irreversibility (e.g. sakin ve mazlég ‘knife and fork’).

We found that the semantic constraints are much heavier than the phonological constraints; the top four constraints were semantic, and the cumulative weight of the semantic constraints was higher than that of the phonological constraints. Thus, in the interaction between phonology and semantics, the semantic constraints often determined word order in most cases. This alone may suggest that phonology is only second to semantics when it comes to word order in AB constructions (Benor and Levy 2006, Mollin 2012, Shih et al. 2015).

However, the prominent role of phonology emerges when semantics (and, of course, also syntax) is mute, and this happens quite often in our corpus. In addition to the two cases of phonological gang effect

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7 The Arabic data were drawn from Gorgis and Al Tamimi (2005) and Kaye (2009). However, due to dialectal variation within and across in these studies, we adjusted all forms to the dialect of Palestinian Arabic spoken in the center of Israel. We thank Suma Samara for the help with these data.

8 An example of a cultural effect can be drawn from Kaye (2009), who attributes the order in albá:rid wa lхаːrr ‘cold and hot’ to POSITIVE-NEGATIVE, since cold is better than hot if one lives in the dessert.
((6) and (7)), there were 28 data items where only phonological constraints were relevant, as opposed to 5 data items where only semantic constraints were relevant (Table 5).

The module responsible for word order is not phonology, and we thus do not expect phonology to determine word order; nevertheless, it seems that it does. Phonology selects the order AB when both syntax and semantics equally accept both AB and BA.

Appendix A

DATA ITEMS

| Binomials (n=61) | Reversibility score |
|------------------|---------------------|
| 1. á ve dá        | ‘this and that’     | 93   |
| 2. avót u baním   | ‘fathers and sons’  | 98   |
| 3. áχ ve áχót     | ‘brother and sister’| 91   |
| 4. báál ve ijá    | ‘husband and wife’  | 73   |
| 5. béád ve néged  | ‘pros and cons’     | 99   |
| 6. bejštá sa tañnególet | ‘egg and chicken’ | 96   |
| 7. bén o bát      | ‘boy or girl’       | 90   |
| 8. bráxót ve ixúlim | ‘blessings and greetings’ | 92 |
| 9. buřá sa χerpá  | ‘shame and disgrace’| 99   |
| 10. dáf ve ét     | ‘paper and pen’     | 77   |
| 11. dáf ve ipakón | ‘paper and pencil’  | 84   |
| 12. dín ve χefbón  | ‘report (lit. law and bill’) | 99 |
| 13. emé t o χová  | ‘truth or duty (lit. truth or dare’) | 100 |
| 14. gvinót ve jain | ‘cheeses and wine’ | 65   |
| 15. itsúv ve χitúv | ‘body shaping (lit. design and carving’) | 81 |
| 16. jóm ve lájla  | ‘day and night’     | 87   |
| 17. káfe ve mafé   | ‘coffee and pastry’ | 96   |
| 18. kalkalá ve niúl | ‘economics and management’ | 62 |
| 19. kán ve aχfáv   | ‘here and now’      | 99   |
| 20. kéfél ve χilúk | ‘multiplication and division’ | 97 |
| 21. kén o ló      | ‘yes or no’         | 96   |
| 22. kéjev ve ríkúz | ‘attention and focus’ | 99 |
| 23. klavím ve ganavim | ‘dogs and thieves’ | 100 |
| 24. kó u χtáv     | ‘reading and writing’| 96   |
| 25. léjém ve χemá  | ‘bread and butter’  | 92   |
| 26. mádá ve teñzológia | ‘science and technology’ | 93 |
| 27. masá ve matán  | ‘negotiation’       | 100  |
| 28. mélaχ ve pílpel | ‘salt and pepper’   | 91   |
| 29. milím ve láxán | ‘lyrics and melody’ | 72   |
| 30. móén ve nimán  | ‘sender and addresssee’| 93 |
| 31. mukdám o meuχáx | ‘sooner or later’   | 86   |
| 32. nisím ve níflaót | ‘miracles and wonders’ | 99 |
| 33. ód va adáx   | ‘majesty and glory’ | 99   |
| 34. ómoim ve lesbijót | ‘homosexuals and lesbians’ | 78 |
| 35. ón ve jíltón  | ‘wealth and authorities’ | 93 |
| 36. óř ve atsamót | ‘skin and bones’    | 53   |
| 37. ovés ve jáv   | ‘checking account (lit. pass and back)’ | 99 |
| 38. óxel ve fíjá   | ‘food and drinks’   | 95   |
| 39. páám o pàamním | ‘once or twice’     | 100  |
| 40. páxót o jótéx  | ‘less or more’      | 82   |
| 41. pipí ve káki  | ‘pee and poop’      | 81   |
| 42. pó ve jám     | ‘here and there’    | 100  |
| 43. sòxág ve baxíaχ | ‘grate and bolt’    | 100  |
| Copulatives (n=28) | Reversibility score |
|-------------------|---------------------|
| 62. aaték adbék   | ‘copy paste’         | 99   |
| 63. báw misadá    | ‘bar restaurant’     | 52   |
| 64. bětén gáv     | ‘stomach back’       | 90   |
| 65. dźín tónik    | ‘gin tonic’          | 89   |
| 66. gomśim holźim | ‘finish go’          | 97   |
| 67. ìks igúl      | ‘tic-tac-toe (lit. ex circle)’ | 97   |
| 68. jám jahbájá   | ‘sea land’           | 95   |
| 69. kadima ačóka  | ‘forward backward’   | 92   |
| 70. káč tén       | ‘take give’          | 89   |
| 71. lemála lemáta | ‘up down’            | 97   |
| 72. lěv sēa       | ‘heart lung’         | 99   |
| 73. limonit luíza | ‘lemon grass verbena’| 71   |
| 74. měláč máim    | ‘salt water’         | 93   |
| 75. mizkáč maaráv | ‘east west’          | 88   |
| 76. nagáta nasáta | ‘touch drive’        | 100  |
| 77. neshiká stixá | ‘kiss slap’          | 76   |
| 78. pinúj binúj   | ‘evict build’        | 99   |
| 79. plús minus    | ‘plus minus’         | 97   |
| 80. sámle lód     | ‘Ramla Lod’          | 81   |
| 81. smöl jamín     | ‘left right’         | 79   |
| 82. solél boné     | ‘construction company’| 98   |
| 83. fáyós laván    | ‘black white’        | 90   |
| 84. fóko banána    | ‘chocolate banana’   | 82   |
| 85. fóko vanil     | ‘chocolate vanilla’  | 87   |
| 86. tśfon mizkáč  | ‘north east’         | 98   |
| 87. tút banána     | ‘strawberry banana’  | 92   |
| 88. žamúš matók    | ‘sour sweet’         | 98   |
| 89. žúmus tćiña    | ‘hummus tahini’      | 80   |

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