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Default Stress in Unpredictable Stress Languages: Evidence from Russian and Hebrew

Thesis submitted in partial fulfillment of the requirements for the M.A. degree in Linguistics at Tel Aviv University

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October 2008

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ACKNOWLEDGEMENTS

First and foremost I would like to express my deep gratitude to my supervisor, Professor Outi Bat-El. I am grateful to Outi for providing me both the freedom to pursue the type of research that I was drawn to and the necessary structure to ensure the highest quality of my work. I thank her for the dedication to the job of being a thesis supervisor, for constant availability, for being a source of inspiration and knowledge, for close involvement in every stage of the research and the writing of the thesis. And lastly, I would like to thank Outi for creating an environment where the students of the faculty including myself could develop their skills in presenting information, such as their own research, and where positive collaboration was encouraged.

I am grateful to Professor Naama Friedmann for her valuable input regarding the design of my experiment in Hebrew. I am also grateful to Professor Shmuel Bolozky and Professor Iris Berent for reviewing my thesis and for their very helpful comments and suggestions. A special thank you goes to Evan Cohen for the editing and for additional comments which contributed to the clarity of my thesis.

I would also like to thank the students of Tel-Aviv Faculty of Linguistics of years 2005-2008, for providing an encouraging and accepting environment during my studies. Many thanks go to my friends and family for their love and support. And finally, I wish to thank all the native speakers of Russian and Hebrew who contributed to this work by participating in my research.

1. Introduction

This study explores the default stress system in two languages with unpredictable stress: Russian and Hebrew. In Russian, stress is marked specifically for each word (§3.1), and in Hebrew different word groups are stressed according to different principles (§4.1). The question addressed in the study is whether Russian and Hebrew have a default stress assignment system, and what the factors affecting the default stress assignment are. The answers to these questions are based on quantitative data obtained from experiments specifically designed for this purpose.

In languages whose stress assignment is not uniform, it is not trivial to deduce the default placement of stress based solely on theoretical analysis (§2.1). However, experimental studies using novel words (i.e. stimuli which are unmarked for stress) have shown that the participants tend to stress unfamiliar stimuli in a uniform method (§2.2).

Novel words have been proved to be a good method for assessing the underlying properties of the speakers' knowledge of grammar, since they lack a lexical entry and therefore lack specific "instructions" on how to be dealt with.[1] In addition, they can also be manipulated easily for properties such as similarity or non-similarity to existing words, so different linguistic mechanisms can be activated while processing them. For example, Berent et al. (2008) used novel words to test universal restrictions on word initial clusters in Korean, which are not otherwise present in this language. Another study by Berent and Shimron (1997) used novel words with specifically designed consonant structure in order to gain evidence for the effect of OCP in Hebrew words and Becker (2009: 73-142) used novel words with specific combinations of vowels to test the ranking of constraints in an Optimality Theoretical framework (Prince and Smolensky 1993) in

[1] The term "novel words" indicates here words that are unfamiliar to the participants of studies. It can refer both to existing words in some language (yet not familiar to the participants of the studies) and to non existing words, which were artificially constructed.

Hebrew plural inflection. This method of using novel words was also adapted for this study.

The general design of the experiments performed in this study was the same for Russian and Hebrew, but was adjusted to consider the unique properties of each language. For each of the languages, I examined whether there was a tendency for uniform stress placement and if there was, then: whether the stress placement was affected by (a) prosodic factors: syllable structure and the number of syllables in the word and (b) morphological factors: whether the novel word was a bare stem or bore a suffix. Additionally for Hebrew, I examined whether the default stress is influenced by similarity to high or low frequency word patterns.

The results supported the existence of default stress systems for both Russian and Hebrew. In both languages, stress placement was affected by prosodic factors – the structure of the words' last syllable and also by morphological structure of the novel words. In addition, the emerging stress patterns were identical to the ones found in low frequency word groups (see §3.3.2 for Russian and §4.3.2 for Hebrew).

This thesis is organized as follows: in §2, I present the relevant data on the existing stress systems and the experiments which served as a background to this study. In §3, I describe the experiment which was done on Russian together with the relevant background on the language and in §4, I present the same information for Hebrew. In §5, I present a comparison between the findings from the experiments on both languages, the basic theoretical analysis of the default stress systems for Russian and Hebrew, and the concluding remarks.

2. Background

In this section, I present the relevant background for the research. In §2.1, I give a short overview of stress systems with an emphasis on lexical and mixed stress systems. In addition, I describe problems in researching these systems. In §2.2, I give an overview of studies which served as a background for the current work.

2.1. Stress systems

Languages exhibit different stress systems. One group of languages which is the subject of this study is lexical stress languages, i.e. Russian (1a) and Greek in which the lexemes are stored in the lexicon already bearing a feature specifying where their stress should be. In these languages, the position of stress is unpredictable in the word.[2] Another group of languages has a mixed stress system i.e. Hebrew and Spanish, in which some words are stressed by rules and other words are marked for lexical stress. In both abovementioned language groups, prosody plays no role in stress assignment, therefore it is not affected by factors such as syllable structure (weight) or the number of syllables in the word. As a result, in these languages there are words with identical prosodic structures (or even identical segments) and contrastive stress. The only deciding factors for stress assignment are lexical stress marking or stress rules (see §3.1 for Russian and §4.1 for Hebrew).

The situation is different in the so-called fixed stress languages, in which the stress is assigned on the basis of prosodic properties such as syllable weight, as in Swiss dialect of German (1b), or on a uniform syllable position with reference to the edge of the prosodic word, as in French (1c). Therefore, in these languages, the position of the stress is predictable.

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[2] By "in the word", I refer to "in the stem". The stress placement in a word which consists of a stem and suffix(es) is affected by interactions of stressing of its morphological constituents (Hayes 1995, Revithiadou 1999, Alderete 2001).

(1) *Examples from different stress systems*

a. Lexical stress system: prosody is not considered (Russian)

ʒá.vo.ro.nok	'lark'
sko.vo.ro.dá	'frying pan'
ko.ló.dʲec	'well'

b. Fixed stress system: syllable weight is considered (Swiss German)

eé.ri.k͡xa	'heather'
ha.loó.tʀi	'rogue'
fa.saán	'pheasant'

c. Fixed stress system: prosodic word edge is considered (French)

ku.pé	'cut-IMP-PL'
ku.pe.lé	'cut-IMP-PL-them'
ku.pe.vu.zɑ̃́	'cut-IMP-PL-yourself-PL-DAT-of them

Research on languages with unpredictable stress has found evidence that these languages have words which lack an indication for stress. Since words cannot be pronounced without stress, it is assumed that there is a default stress system which takes care of these cases. For example, for Greek, it is hypothesized that its default stress system assigns stress on the penultimate syllable (Revithiadou, 1999).

However, since the majority of words in languages whose stress is not assigned by rules is not uniformly stressed, various researches may come to different conclusions about the position of the default stress in these languages. For example, for Russian, Halle and Vergnaud (1987) argue that the default stress resides on the word's leftmost vowel (i.e. word initial syllable), and Revithiadou (1999) claims that the default stress resides on the initial syllable only in native Russian words, while in loan words, it resides on the stem final syllable.[3] Alderete (2001) takes a different view, arguing that the default stress in Russian is placed on the syllable immediately following the stem. Also, some approaches are "morphology-sensitive" and some are not: Revithiadou (1999) and Alderete (2001) claim that the stressing mechanism is sensitive to word-internal morphological structure, distinguishing between stem and suffixes. On the other hand, Halle and Vergnaud's (1987) analysis considers only the vowels in the whole word.

2.2. Research background

This research follows two experimental studies of Russian stress, both of which used novel words as an instrument to access a default stress system. In both experiments, the novel words were presented as if they were nouns. The first experiment was done by Nikolaeva (1971), in which native speakers of Russian, who did not know any foreign languages, were presented with unknown words of foreign origin, which they were asked to read. The goal of the experiment was to determine whether the stress placement in borrowed words was affected not only by analogy as association, but also by purely phonetic principles of word organization. The results identified several trends, one of which was the tendency for penultimate stress in vowel final words and final stress in consonant final words.

The second research was of Crosswhite et al. (2003) and was based on Nikolaeva's (1971). They hypothesized that given the morphology of Russian (see §3.1.2), in which every word final vowel can be treated as some inflectional suffix and most stems are consonant final, that the participants of Nikolaeva's (1971) experiment uniformly placed stress on the final syllable of the stem (or more specifically, what they perceived to be a stem of the novel word). To test this assumption, they conducted their own experiment, in

[3] However, according to Alderete (2001), words that Revithiadou defines as "native Russian" belong to a declension group which constitutes less than a tenth of a percent, and therefore should be treated as exceptions.

which they used randomly generated novel words in the template of CV.CVC, which concurred with general Russian phonotactics. These words were augmented with mono or disyllabic suffixes, which either matched existing Russian case suffixes or did not. These words were placed in sentences, which were divided into three different contexts: (a) a context which supported the existence of a case suffix, (b) a context which did not support the existence of a case suffix, and (c) a context which neither required nor precluded case marking interpretation. The responses of the participants were as follows: collapsing over all conditions, 80% of the responses were stem final, meaning that in context (a), the stress tended to be **word** penultimate, while in context (b), it tended to be **word** final. The authors' interpretation of these results is that default stress is encoded directly into the phonology of Russian and its default position is the right edge of the **stem**.

The above two experiments thus support the existence of a default stress system in a language in which stress placement is usually specified in the lexicon. In addition, both experiments received similar results about the default stress position and its consideration of the language's morphology.

Although not serving a direct background for this work, I would like to mention another research which used novel nouns to reveal whether the language in question has a default stressing mechanism and what its properties are. The research is of Protopapas et al. (2007) on Greek. In this language, the position of stress is indicated in the writing system by a diacritic. The participants were presented with written novel words, in which the stress diacritic was either: (a) not indicated, (b) indicated in the hypothesized default penultimate position (Revithiadou 1999), or (c) placed elsewhere. The result showed that with stimuli unmarked for stress, the participants preferred to place their stress on the penultimate position. When the stimuli were marked for stress, the participants made more mistakes when the stress was not indicated to be on the penultimate syllable. Therefore, the findings of this experiment, similarly to these of Nikolaeva (1971) and

Crosswhite et al. (2003) support the existence of the default stress preference in a lexical stress language. In addition, these findings concur with the theoretical study of Revithiadou (1999).

All the above mentioned experiments reassure the validity of using novel words as a good instrument to assess the properties of default stress systems in languages in which most stress is not assigned by a uniform rule. The advantage in using novel words is that they lack any indication of where their stress should be as they are not stored in the lexicon. Therefore, upon receiving an unknown string of phonemes, the participants of the experiment have to activate the default system of stress assignment.

3. Russian

In this chapter, I discuss the experiment that was done on Russian. In §3.1, I present relevant Russian language background, in §3.2, I describe the experiment and the results and in §3.3, I bring the conclusions and the further discussion. All the examples from the language are presented in broad phonological transcription.

3.1. Relevant language background

3.1.1. Stress

Stress in Russian is specified in the lexicon for each word entry (Avanesov 1958). Its position is not restricted to a specific syllable in the word, syllable structure (2a) or specific type of morpheme (like always on the stem). The vowels ([i], [u], [e], [o], [a]) do not display a phonological contrast in length; therefore weight is not a factor affecting stress. Since the stress is an individualizing feature of the word, it often serves as the only feature distinguishing between two otherwise identical words (2b).

(2) *Examples of noun stress*

a. Word structure minimal pairs

kú.bok	'cup'	*no.sók*	'sock'		
mór.da	'animal face'	*pur.gá*	'snow storm'		
zó.lo.to	'gold'	*bo.ló.to*	'swamp'	*mo.lo.kó*	'milk'

b. Contrastive stress minimal pairs

mu.ká	'flour'	*mú.ka*	'torment'
za.mók	'lock'	*zá.mok*	'castle'
go.lo.vî	'head-GEN-SG'	*gó.lo.vi*	'head-PL'

The position of stress may change when the word is suffixed. There are certain derivational suffixes which are obligatorily stressed, but with inflectional suffixes (4), the situation is different. For example, in case inflections, the stress can be fixed on the stem

(3a), fixed on the inflectional suffix (3b), or placed on the stem in certain cases and on the suffix in others (3c).

(3) *Noun stress in inflections*

a. Stress fixed on the stem

ʒîtʲelʲ-u	‘inhabitant-DAT-SG’	*ʒîtʲelʲ-am*	‘inhabitant-DAT-PL’
ʒîtʲelʲ-em	‘inhabitant-INSTR-SG’	*ʒîtʲelʲ-ami*	‘inhabitant-INSTR-PL’

b. Stress fixed on the suffix

morʲak-ú	‘sailor-DAT-SG’	*morʲak-ám*	‘sailor-DAT-PL’
morʲak-óm	‘sailor-INSTR-SG’	*morʲak-ámi*	‘sailor-INSTR-PL’

c. Stress with different placement in inflection

vólk-u	‘wolf-DAT-SG’	*volk-ám*	‘wolf- DAT-PL’
vólk-om	‘wolf-INSTR-SG’	*volk-ámi*	‘wolf- INSTR-PL’

3.1.2. Morphology

Russian makes extensive use of inflectional morphology, which takes the form of affixation to the stem of a large inventory of suffixes. The nominal suffixes relevant for this study are of gender and case. The language has three genders, masculine, feminine and neutral. The masculine does not usually require suffixation, and therefore is the bare stem (Golanov 1965). The other two genders are usually indicated by suffixes. There are six cases, with the nominative case being unmarked, and other five cases requiring various suffixes. Therefore, as can be seen in the table below, words in masculine nominative singular are bare stems.

(4) *Russian inflectional case suffixes*

	Nominative	**Accusative**	**Dative**	**Genitive**	**Prepositional**	**Instrumental**
Masculine	∅	∅, -u	-u	∅, -a	-e, -u, -i	-em, -om
Feminine	-a	-u	-e, -i	-i, -ej	-e, -i	-oj, -ej, -oju
Neutral	-o, -e	-o, -e, -ja	-u	-a	-e	-om, -em
Plural	-i	∅, -i, -ej	-am	-ej, -ov	-ax	-ami

The system of case inflection has several exceptions. There are words in masculine singular nominative which end in *a*, such as *júnoʃa* 'lad-MS', *dʲádʲa* 'uncle-MS'. Another group of words which ends in *a* are so-called "genderless" words (Golanov 1965), which can be used to refer to both masculine and feminine genders, such as *sirotá* 'orphan-MS/FEM', *skrʲága* 'scrooge-MS/FEM'. Also, there are words of foreign origin which are not changed (i.e. are not suffixed) during the inflection, such as *kʲengurú* 'kangaroo', *kófʲe* 'coffee'.

In addition to nouns, adjectives are also marked for gender, number, and case, which have to agree with those of the nouns. This property of Russian became useful in constructing the phrasal frame of the experiment.

3.1.3. Writing system

The symbols of the Russian writing system include both vowels and consonants and the direction of writing is from left to right. The symbols usually bear quite close correspondence to the sounds, but not always in a 1:1 manner. One of the instances in which the sound system and the writing system differ is in the representation of vowels. In addition to five symbols that represent Russian vowel phonemes ([a], [e], [u], [i], [o] = *а, э, у, и, о*), there are four symbols (*я, е, ю, ё*) that represent the following sound combinations which involve vowels:[4]

1. Glide-vowel sequences [ja], [je], [ju], [jo] at the beginning of the word, or after a vowel, thus two sounds are encoded with one symbol.
2. A vowel which is preceded by a palatalized consonant, i.e. Cя = [C^ja] (C = consonant).

There are also two additional symbols that encode the quality of consonants: (1) letter *ь* ("soft sign") indicates that the consonant is palatalized, i.e. Cь = [C^j] (C = consonant); (2) letter *ъ* ("hard sign") indicates that the consonant is not palatalized when followed by

[4] The symbol *ы*, which marks the allophone /ɨ/ was not used in this study.

a glide-vowel sequence. Therefore, one sound is represented with two letters. These deviations between the sound and the written representation needed to be considered in constructing the novel word stimuli.

3.2. The experiment

In this section, I describe the experiment which was done on Russian. It was conducted in two stages, the initial stage being the basis for the final and improved design of the experiment, which, in turn, served as the basis for the Hebrew experiment, described in §4.2.

3.2.1. Design of the experiment

The experiment was designed to have two parts, each testing the placement of Russian stress from a different aspect. In both parts, the same novel words were used. As in the experiments of Nikolaeva (1971) and Crosswhite et al. (2003), the novel words were used as if they were nouns. In the first part of the experiment, the words were presented in a context that suggested that the word is a bare stem, i.e. it does not require an inflectional suffix. In the second part, the words were presented in a context that suggested the need to inflect them in either accusative or dative case (4). The participants in the experiment had to inflect the novel word, an action that usually requires an addition of a morpheme, thus acknowledging that the word has a stem and another morpheme. In this way, the experiment imitated the natural process of word inflection and stress assignment, and made the testing of the influence of morphology on the position of default stress more precise, since the participants had to create the morpheme boundary intentionally.

3.2.2. Pilot experiment

A pilot experiment was conducted on a small sample of native Russian speakers using a reduced sample of planned word shapes (Fainleib 2006). The pilot was designed to test the following issues:

a. To test the method of the experiment: whether it was clear to the participants what they were expected to do.
b. To test inflection: whether the participants could inflect the novel words.
c. To test whether there would be the tendencies for specific stress placement and if such tendencies would emerge, whether they would concur with Nikolaeva's (1971) and Crosswhite et al.'s (2003) findings.

3.2.2.1. Design of the pilot: The pilot was designed to combine the experiments of Nikolaeva (1971) and Crosswhite et al. (2003). The first part was parallel to Nikolaeva (1971): the participants were presented with words in isolation. However, there was an addition: the words were preceded by an adjective in masculine nominative (as shown in (6a)), since in Russian, this is the form of a bare stem (4). This was done in order to prevent the participants from perceiving the novel word stem as consisting of more than one morpheme, a possibility pointed out in Crosswhite et al. (2003). The second part of the experiment was parallel to Crosswhite et al. (2003): the participants were presented with sentences whose syntactic structure implied the need for case assignment (as shown in (6b) and (6c)).

3.2.2.2. Stimuli used in the pilot: Two types of stimuli were required for the purpose of the experiment: the novel word stem templates and the appropriate syntactic context for each part of the experiment. The novel word stem templates are presented in (5) below:

(5) *Novel words stem templates used in the pilot*

	2 syllables	**3 syllables (CV initial)**
V-final	CV.CV	CV.CV.CV
	CVC.CV	CV.CVC.CV
C-final	CV.CVC	CV.CV.CVC
	CVC.CVC	CV.CVC.CVC

The purpose of composing novel stems of different shapes was to test whether the default stress rule in Russian is sensitive to syllable structure (CV vs. CVC syllables) and to word length (two vs. three syllables). The structure of the final syllable was given special attention, since its final segments could be perceived as either belonging to the stem or being a suffix (a possibility that could have occurred in Nikolaeva's (1971) experiment). The number of syllables in the word was varied in order to receive a more precise picture of the nature of default stress with reference to the word edges. For example, if in trisyllabic words the default stress were placed on the middle syllable, its position in disyllabic words would help to determine whether its reference is the left or the right word edge.

The bases for novel word stems were rare loanwords selected from the Modern Dictionary of Loanwords (Apresyan, Landa, Smislov and Tcherniy 1992).[5] The majority of these words were then altered, in order to suit them to one of the eight patterns of words (5) that were chosen for the experiment. These alternations involved adding, omitting and altering the original segments, thus resulting in completely new nonexistent words. Seven words were assigned into each one of the word patterns. Since the stimuli were going to be presented to the participants in the written form, there was a need to bring their written representation as close as possible to their phonetic representation. Therefore, each written symbol corresponded to one and only one sound.[6]

[5] By rare words, I mean words that were not assimilated into everyday language and are thus hardly ever used, such *varikap,* which is "a type of diode which has a variable capacitance that is a function of the voltage impressed on its terminals".

[6] For example, there were no palatalized consonants at the end of the words, since that would require the usage of an additional written symbol (see §3.1.3).

In addition to the word length and syllable structure, the segments at the end of the novel words were also controlled: both V-final and C-final novel word stems either did or did not match Russian nominal suffixes. The purpose of this manipulation was to add another dimension to the testing of the possible influence of morphology on the placement of the default stress. In addition, it might help to shed light on whether the participants perceive V-final words as having a morphological boundary, despite them being presented as bare stems. For V-final stems, this manipulation was only visual (Crosswhite et al. 2003): while phonologically, all the Russian vowels serve as nominal suffixes (Golanov 1965, table (4)), in writing, the letter that indicates the phoneme [*e*] which does not stand after palatalized consonants (the **symbol** э vs. the **symbol** *e*) is **not** used to mark a nominal suffix in writing. Therefore, in the V-final group, 7 words ended in this symbol (э), while the remaining 19 words ended in one of the three symbols, indicating the vowels *a, o, u*. In the C-final group, 11 words ended in the vowel-consonant sequences *ax*, *om*, *an*, which are noun suffixes in Russian, while the remaining 15 ended in vowel-consonant sequences which are not noun suffixes in Russian.

For the second part of the experiment, 56 different sentences were composed, one for each of the stimuli. Half of the sentences suggested the need to inflect the novel word into Accusative case (6b) and the other half, into Dative case (6c).

(6) *Syntactic context for the novel word stems (novel word underlined)*

a. Nominative

Krasivij <u>varikap</u>.
Beautiful-NOM-SG-MS <u>varikap</u> (novel word).

b. Accusative

Storoʒ zap^{j}er____________ (kobom).
(A/the) keeper locked __________ (kobom).

c. Dative

Xoz^{j}ain skormil _______ (varukap) ostatki zavtraka.
(The) master fed __________ (varikap) remains breakfast-GEN.

The stimuli were written on the Power Point slides, each phrase on a different slide. The words were presented in random order, which was identical in the bare stem part of the experiment and the inflectional part.

3.2.2.3. Participants: The participants were 7 Russian native speakers, immigrants from the former USSR and CIS, mean age 47, 3 males and 4 females. All of them had acquired a high education in Russian in their native land, and used Russian extensively in their everyday lives, in several different contexts such as work, home, and with friends. All of them preferred watching Russian TV programs and reading literature in Russian. 5 of the participants came to Israel after the age of 30, having also worked for at least 10 years in the former USSR. The remaining 2 had only been in Israel for 6 years, which, according to L2 acquisition studies, is not enough to fully acquire an L2 (Alfi-Shabtay 2005). None of the participants self assessed his knowledge of Hebrew as native-like or felt that it had become their main language.

3.2.2.4. Procedure: The participants were told that the goal of the experiment was to determine how people treat novel words. They sat in front of the computer and read the input from the screen, when each phrase was presented on a different Power Point slide. Each time they saw only one stimulus and it was switched to the next one after they had finished reading it. Since the participants tended to read the new words slowly and syllable by syllable (as it turned out, in this case it would be impossible to determine the stress position, since each syllable would have been uniformly stressed), they were encouraged to read the whole stimulus to themselves and only then, to say it out loud, uttering the whole word at once. All the participants saw the first part of the experiment (6a) before the second part (6b, c) and participated in both parts of the experiment, which took about 10 minutes. The output of the participants was audio recorded and later transcribed, indicating the stress placement and alternations made to the word when inflected. Both the recording and the transcription were conducted by the author.

3.2.2.5. Results: As to understanding the procedure of the experiment, all the seven participants understood what they were asked to do and were also able to read and inflect the novel words. Considering their placement of stress in the unknown stimuli: as can be seen from table (7) below, **in the first part of the experiment** (novel words as bare stems), in ~70% novel words had final stress (7e), percentage repeated in both disyllabic (7c) and trisyllabic (7d) word groups.

(7) *General counts for novel words as bare stems*

	Stem type	Final stress		Other stress		No. words
a.	Total V-final	113	57.65%	83	42.35%	196
b.	Total C-final	166	85.70%	30	14.30%	196
c.	Total 2 σs	138	70.40%	58	29.30%	196
d.	Total 3 σs	141	71.93%	55	28.07%	196
e.	Total words	279	71.17%	113	28.83%	392

From the above table it is also possible to see that although in both V-final and C-final novel word stems the majority of stress fell on the final syllable, there was a large difference in the distribution of stress in these two word groups. In V-final words, the stress was final in ~58% (7a), while in C-final words the stress was final in ~86% (7b). This difference was also replicated for disyllabic and trisyllabic stems, as can be seen from table (8) below:

(8) *Stress division according to number of syllables and final segments*

	Stem type	Final stress		Other stress		No. words
a.	Total 2 σs V-final	58	59.18%	40	40.82%	98
b.	Total 2 σs C-final	80	81.63%	18	18.37%	98
c.	Total 3 σs V-final	55	56.12%	43	43.88%	98
d.	Total 3 σs C-final	86	87.76%	12	12.24%	98

The table above shows that not only was the stress distribution in V-final and C-final stems of the same pattern in both disyllabic and trisyllabic stems, but the numeric percentages were also similar both in these word groups and in the general counts (7a, 7b).

(9) *Stress distribution according to novel stems final segments*

	Word suffixes	Final stress		Other stress		No. words
V-final	An existing suffix	72	48.98%	75	51.02%	147
	Not an existing suffix	41	83.67%	8	16.33%	49
C-final	An existing suffix	76	83.52%	15	16.48%	91
	Not an existing suffix	91	86.67%	14	13.33%	105

The above table describes the distribution of stress according to the novel word stem final segments. It is possible to see that in both V-final and C-final novel word stems, when the final segments did not match an existing suffix, there was more final stress than when the final segments matched an existing suffix.

In the second part of the experiment (novel word stems in inflection), the following tendencies were established: in the case of C-final novel word stems, in ~72%, the participants added a vowel to the stem of the novel word. Out of these cases, in ~96%, the participants placed the stress on the penultimate syllable i.e. one syllable before the suffix, which is the final syllable of the **stem**. In the remaining outputs, the stems were left unchanged, and in ~80% the stress fell on the final syllable. In the case of V-final word stems, only in ~13% were they assigned a suffix. Out of these instances, one participant chose to suffix the novel word stem as is, and all the productions bore penultimate stress; in the rest of the instances, the original vowel of the novel word stem was replaced with the suffix vowel. In these cases, 8 out of 14 productions (~58%) bore final stress. In the remaining cases, (in which the participants chose not to make any alternation to the novel word stem), in ~50% the stress was final and in the rest of the cases it was penultimate.

3.2.2.6. Conclusions: The most prominent finding of this pilot experiment was that the participants displayed a tendency for specific stress placement, when presented with stimuli unmarked for stress. Additionally, the tendency for final stress in the novel bare stems and in C-final suffixed stems (which were stressed on the stem final syllable in ~86%) seems to replicate the findings of Nikolaeva's (1971) and Crosswhite et al.'s (2003) experiments. The numbers were also close to those in Crosswhite et al.'s experiment: ~70% vs. 80%. However, these findings are not uniform. For example, in V-final novel stems, the most stress was still final. Even if we subtract the stems which ended in the symbol э, which is not used to encode a suffix vowel, the stress distribution would be virtually random (table 9), and still not mostly penultimate. It is possible, though, to assume that the participants perceived the last vowels of the V-final stems as part of the stem (thus adding to the success of the experiment design). However, in the second part of the experiment, which required inflection, in V-final stems which were not suffixed, the stress distribution was also random, although it would be "logical" to assume that the participants could have stressed the penultimate syllable, thus indicating that the last vowel is a suffix.

In addition, the design of the pilot experiment could have contributed to the lack of clarity regarding the stress tendencies. In the second part, where novel word stems were placed in sentences, some of the participants openly stated that they were trying to guess the meaning of the novel word according to the context of the sentence, and inflect (and assign stress) it according to the inflection of the word, which the novel word "substituted". All those were taken into consideration in the design of the main experiment.

3.2.3. Main experiment

Having established that there is indeed evidence for a default stress mechanism in Russian, which emerges at the presence of lexically unstressed stimuli, it was possible to expand the experiment and conduct it on more people and include more word shapes (10), in order to obtain more defined stress tendencies, especially for V-final word stems. Also, in order to gain further insight into the default stressing mechanism of Russian, there was a need to alter the design of the experiment, and reduce the factors that would make the participants assign stress by analogy. Therefore, it was decided to use in both parts of the experiment uniform sentence templates (presented in (11)), which would also be as general as possible, in order to avoid giving the participants any clues as to what the novel word can be. For the sake of uniformity, it was also decided to use these templates for the first part of the experiment (novel words as bare stems) as well.

3.2.3.1. Stimuli used in the main experiment: Two types of stimuli were required for the purpose of research: the novel words stem templates and the sentence templates with the appropriate syntactic context. The novel word stem templates are presented below in (10):

(10) *Novel words stem templates used in the experiment*

	2 syllables	**3 syllables – CV initial**	**3 syllables – CVC initial**
V-final	CV.CV	CV.CV.CV	CVC.CV.CV
	CVC.CV	CV.CVC.CV	CVC.CVC.CV
C-final	CV.CVC	CV.CV.CVC	CVC.CV.CVC
	CVC.CVC	CV.CVC.CVC	CVC.CVC.CVC

The words were constructing according to the same principle as in the pilot experiment (§3.2.2.2). 6 words were assigned to each of the templates, thus increasing the number of the words to 72.

As in the pilot experiment, final segments of the words were controlled. In the V-final group, 9 words had a final vowel which is not a valid suffix in Russian (vowel represented by the symbol э). The remaining 27 words ended in one of the three vowels *a, o, u* that are nominal suffixes in Russian. In the C-final group, 17 words ended in sequences of a vowel and a consonant *ax*, *om*, *an*, which are nominal suffixes in Russian, while the remaining 19 words ended in some other segment. For a complete list of the novel stems used in the experiment, see Appendix A.

The sentence templates, in which the novel words were embedded, provided the desired syntactic context for the two parts of the experiment. There was one template for each type of task, one for introducing the novel word in an uninflected context (11a) and another for assessing accusative (11b) and dative inflection (11c).

(11) a. Nominative

U doma stojal krasivij varikap.

Near (a/the) house stood (a) beautiful-NOM-SG-MS varikap (novel word).

b. Accusative

Chelov^{j}ek osmotr^{j}el krasivogo _______ (varikap).

(A) person inspected (a/the) beautiful-ACC-SG-MS _______ (novel word).

c. Dative

Chelov^{j}ek prishol k krasivomu _______ (varikap).

(A) person came/arrived to (a/the) beautiful-DAT-SG-MS ________ (novel word).

As it is possible to see from the above, in all the sentence templates, the novel word is preceded by an adjective, inflected in the relevant gender, number and case, thus indicating that the novel noun bears the same features (see §3.1.2). The novel words were randomly assigned for accusative or dative template.

The sentences were printed on A4 paper sheets, in Arial font size 32, each sentence on a separate sheet. The sheets were arranged in random order into two folders, but the order was the same for both parts of the experiment.

3.2.3.2. Participants: The participants were 12 native speakers of Russian, immigrants from the former USSR and CIS, mean age 59, 5 males and 7 females. 6 of them had participated in the pilot experiment, which was conducted a year prior to the current study. All of them had acquired a high education in Russian in their native land and for all of them, Russian was their primary language and was used extensively in different everyday contexts such as at home, with family, friends and at work. All of them preferred watching Russian TV programs and reading literature in Russian. 5 of the participants immigrated to Israel after the age of 60 and had never acquired Hebrew, another 5 immigrated after the age of 30, having worked for at least 10 years in the USSR and the remaining two came to Israel after the age of 20 and had been in Israel for only seven years; which means that they could not yet have acquired Hebrew at a native-like level (Alfi-Shabtay 2005). None of the participants self assessed his knowledge of Hebrew as native-like or felt that it had become their main language.

3.2.3.3. Procedure: The participants were given two folders containing stimulus sentences of the experiment and were asked to read what was written on each of the 72 sheets of each folder. Both parts of the experiment were conducted in one session, which took about 20 minutes. In the bare stem part of the experiment, they were asked to simply read each sentence. In the inflection part they were asked to put the novel word in Accusative or Dative case, according to the context. They were also told that there is no right and wrong answer and that all their productions are acceptable. All the participants participated in both parts of the experiment, and did the first part of the experiment (novel words as bare stems) before the second part (novel words in inflections). The participants' output was audio recorded on a Sony digital recorder and later transcribed, indicating the stress placement and alternations made to the word when inflected. Recording, transcription and statistical analysis were conducted by the author.

3.2.3.4. Results for the first part of the experiment – bare stems: I start in (12) below with the general tendencies of the stress placement in uninflected forms (12e), grouped by number of syllables (12c-d) and the type of word final segment (12a-b).[7]

(12) *General counts for novel words as bare stems*

	Stem type	Final		Penultimate		No. words
a.	Total V-final	292	67.75%	139	32.25%	431
b.	Total C-final	395	92.29%	33	7.71%	428
c.	Total 2 σs	226	79.58%	58	20.42%	284
d.	Total 3 σs	461	80.17%	114	19.83%	575
e.	Total words	687	79.98%	172	20.02%	859

The last row of the table (12e) shows that when the participants had to stress a word without lexical stress marking, in ~80%, the stress fell on the last syllable. The exact same stress placement division was true for disyllabic and trisyllabic stems (rows (12c) and (12d) respectively). In V-final and C-final stems (rows (12a) and (12b) respectively), placing of stress is different: in C-final stems, stress was final in ~92%, which is more that the general 80% tendency. In V-final stems, the stress was placed on the final syllable in ~68%; less than the general 80% tendency, and considerably less than 92% final stress in C-final words. A chi-square test testing the correlation between the final segment (consonant or vowel) and stress placement gave significant results, with $\chi_2 = 80.08$, $p < 0.001$.

In (13) and (14), I present more detailed tendencies of uninflected word stressing for each of the 12 word shapes, divided for convenience into disyllabic stems (13) and trisyllabic stems (14).

[7] Five productions were omitted from the bare stems counts. In four instances the participants, recognized the novel word and in one instance, the word was missed in the reading.

(13) *Counts for disyllabic bare stems*

	Word template		Final		Penultimate		No. words
a.	V-final	CV.CV	49	68.05%	23	31.95%	72
b.		CVC.CV	50	69.44%	22	30.66%	72
c.		Total V-final	99	68.75%	45	31.25%	144
d.	C-final	CV.CVC	64	92.75%	5	7.25%	69
e.		CVC.CVC	63	88.73%	8	11.27%	71
f.		Total C-final	127	90.71%	13	9.29%	140

In disyllabic stems, the stress distribution patterns in total V-final (13c) and total C-final (13f) stems mirror the respective patterns for general stress placement in V-final (12a) and C-final (12b) stems with ~69% for V-final and over 90% for C-final words. In the grouping by the word templates, in V-final stems, both CV.CV (13d) and CVC.CV (13e) shapes had virtually the same stress patterns: ~70% final stress (which is also equal to general V-final stress patterns). In the grouping by the word templates in C-final words, both CV.CVC and CVC.CVC templates had similar stress patterns: ~93% and ~89% final stress respectively (which is also similar to general C-final stress patterns). A chi square test on the correlation between the final segments (consonant or vowel) and the stress placement gave significant results, $\chi_2 = 19.74$, $p < 0.001$.

(14) *Counts for trisyllabic bare stems*

	Word template		Final		Penultimate		Antepenult.		No. words
a.	V-final	CV.CV.CV	51	70.83%	20	27.78%	1	1.39%	72
b.		CV.CVC.CV	52	72.22%	19	26.39%	1	1.39%	72
c.		CVC.CV.CV	38	53.52%	28	39.44%	5	7.04%	71
d.		CVC.CVC.CV	52	72.22%	18	25%	2	2.78%	72
e.		Total V-final	193	67.24%	85	29.62%	9	3.14%	287
f.	C-final	CV.CV.CVC	68	94.44%	2	2.78%	2	2.78%	72
g.		CV.CVC.CVC	69	95.83%	0	0%	3	4.17%	72
h.		CVC.CV.CVC	69	95.83%	0	0%	3	4.17%	72
i.		CVC.CVC.CVC	62	86.11%	9	12.50%	1	1.39%	72
j.		Total C-final	268	93.05%	11	3.82%	9	3.13%	288

The stress placing tendencies in total V-final (14e) and total C-final (14j) trisyllabic stems are identical to the general C-final and V-final stress placing tendencies (as also in disyllabic stems (13)). A closer look at the stress patterns reveals that in ~97%, the stress was either final or penultimate. V-final templates, CV.CV.CV (14a), CV.CVC.CV (14b) and CVC.CVC.CV (14d), display similar stress distribution, around 70% final stress, a pattern similar to distribution of stress in other V-final stems. The template CVC.CV.CV (14c), however, displays a somewhat different pattern, with ~54% final and ~39% penultimate stress. However, this difference turned out to be statistically insignificant $\chi_2 = 7.68$, $p = 0.26$. In C-final trisyllabic templates, the amount of penultimate stress was around 95%, except for the CVC.CVC.CVC (14i) template, in which it was penultimate in ~86%. This deviation was found to be significant $\chi_2 = 16.08$, $p = 0.01$. However, this deviation does not point at any systematic difference between different CV-templates. Therefore, it is possible that this difference is random, perhaps, due to specific words which were assigned to this template. A chi square test on the correlation between the final segments (consonant vs. vowel) and the stress placement gave significant results, $\chi_2 = 72.08$, $p < 0.001$.

Another dimension controlled in this experiment was the final segments of the novel word stems, which could either match Russian nominal suffixes or not. The stress placement division according to this parameter is presented in the table below:

(15) *Stress distribution according to word final segments.*

	Word suffixes	**Final**		**Other**		**No. words**
V-final	An existing suffix	198	60.92%	127	39.08%	325
	Not an existing suffix	94	87.85%	13	12.15%	107
C-final	An existing suffix	189	93.10%	14	6.90%	203
	Not an existing suffix	221	98.22%	4	1.88%	225

From the table above, it is possible to see that in V-final stems which ended in a vowel that matched an existing Russian suffix, the stress was placed on the final syllable in ~61%, which is slightly lower than the general V-final final stress placement percentage.

In V-final stems which ended with a symbol which is not used to encode the word final vowel, in ~88% the stress placement was on the final syllable of the word, a percentage which is closer to the C-final words' stress patterns. A chi square test on the correlation between the final vowel segments (whether they correspond to the nominal suffix or not) and the stress placement gave significant results, $\chi_2 = 19.74$, $p < 0.001$. In C-final words, the difference between words ending with segments that match nominal suffixes and words whose segments do not match nominal suffixes was also significant. Although the distribution of stress looks close, ~93% for stems whose final segments match a nominal suffix and ~98% for stems with final segments not matching a nominal suffix, chi square test on the correlation between the final consonant segments (whether they correspond to a nominal suffix or not) and the stress placement gave significant results $\chi_2 = 6.94$, $p < 0.01$.

3.2.3.5. Results for the second part of the experiment – inflected stems: I begin this section with the data in (16) summarizing the changes in length which were made to the novel word stems as a result of their inflection.[8] Inflection could increase the number of the syllables in the word (when a suffix was added) or the number of syllables in the final output could remain the same as in the stem (mostly in V-final stems, when the word final vowel was replaced with the vowel of the case suffix or when no morphological changes were made to the word, which is also an option for inflection as shown in §3.1.2). Therefore, when examining the stress placement in inflected stems, it was necessary to treat them according to the processes they had undergone.

[8] Four words which were recognized by the participants were removed from the counts for the second part of the experiment.

(16) *Inflection patterns of novel stems*

	Stem type	Word length changed (syllable added)		Word length unchanged		No. of words
a	Total V-final	92	21.35%	339	78.65%	431
b	Total C-final	418	97.44%	11	2.56%	429
c	Total 2 σs	163	57.39%	121	42.61%	284
d	Total 3 σs	347	60.24%	229	39.76%	576
e	Total words	510	59.30%	350	40.60%	860

From the last row of the table (16e), it seems that in ~60%, the participants chose to add a suffix to the novel word stem such that the number of syllables increased. Similar stress distribution emerged in both disyllabic and trisyllabic words ((16c) and (16d) respectively). From rows (16a) and (16b) of the table, we see that the inflection pattern was different for V-final and C-final stems: V-final stems were added a syllable in only ~21% of the times, while C-final stems were added a syllable in ~97% (almost all the time).

In the following tables, I present the distribution of stress in stems to which a syllable was added, divided for convenience into disyllabic (17) and trisyllabic stems (18).

(17) *Stress distribution in disyllabic suffixed stems*

		Word template	Final		Penultimate		Antepenult.		No. words
a.	V-final	CV.CV	0	0%	17	100%	0	0%	17
b.		CVC.CV	4	30.77%	9	69.23%	0	0%	13
c.		Total V-final	4	13.33%	26	86.67%	0	0%	30
d.	C-final	CV.CVC	3	4.55%	61	92.42%	2	3.03%	66
e.		CVC.CVC	10	14.71%	57	83.82%	1	1.47%	68
f.		Total C-final	13	9.70%	118	88.06%	3	2.24%	134
g.		Total words	17	10.37%	144	87.80%	3	1.83%	164

The results in (17) show that the majority of stress in novel word stems to which a syllable was added was penultimate ~88% (17g), which means that it was placed on the last syllable of the original novel word stem. Rows (17c) for V-final stems and (17f) for C-final stems show similar patterns of stressing: more than 85% of word penultimate stress. The pattern of preference for penultimate word stress is present in all disyllabic word templates (rows (17a)-(17b) and (17d)-(17e)).

(18) *Stress distribution in trisyllabic suffixed stems*

	Word template		Final		Penultimate		Antepenult		No. words
a.	V-final	CV.CV.CV	0	0%	16	100%	0	0%	16
b.		CV.CVC.CV	1	6.67%	14	92.33%	0	0%	15
c.		CVC.CV.CV	0	0%	13	92.86%	1	7.14%	14
d.		CVC.CVC.CV	1	5.88%	15	88.24%	1	5.88%	17
e.		Total V-final	2	3.22%	58	93.56%	2	3.22%	62
f.	C-final	CV.CV.CVC	6	8.33%	66	91.67%	0	0%	72
g.		CV.CVC.CVC	3	4.23%	67	94.37%	1	1.40%	71
h.		CVC.CV.CVC	6	8.57%	64	91.43%	0	0%	70
i.		CVC.CVC.CVC	3	4.23%	65	91.54%	3	4.23%	71
j.		Total C-final	18	6.34%	262	92.25%	4	1.41%	284
k.		Total suffixed words	20	5.78%	320	92.49%	6	1.73%	346

The results in (18) are consistent with the results from disyllabic suffixed stems in table (17). Most stress placement was on the penultimate syllable, i.e. on the final syllable of a novel stem (18k). The stress distribution was the same for V-final and C-final words (rows (18e) and (18j) respectively) and was penultimate in over 90%, slightly higher than in disyllabic suffixed stems in (17). The pattern of preference for penultimate stress was present in all trisyllabic word templates (rows (18a)-(18d) and (18f)-(18i)).

Now I turn to the percentages of stress placement in novel stems, whose length remained unchanged. Since for C-final stems only 11 stems were treated this way (3% out of all C-final stems), I will make these calculations for V-final stems only. I will also not distinguish between the cases in which the final vowel was changed with respect to the original stem vowel, and stems to which no segmental change was made, since the former occurred in just 51 cases, which constitutes only 12% of the total V-final words.

(19) *Counts and percentages for inflected stems with word length unchanged*

	Stem type		Final		Penultimate		Antepenult.		No. words
a.	2σ	CV.CV	39	70.90%	16	29.10%	0	0%	55
b.		CVC.CV	47	81.03%	11	18.97%	0	0%	58
c.		Total 2σ	86	76.11%	27	23.89%	0	0%	113
d.	3σ	CV.CV.CV	30	53.57%	26	46.43%	0	0%	56
e.		CV.CVC.CV	36	63.16%	21	36.84%	0	0%	57
f.		CVC.CV.CV	29	50%	29	50%	0	0%	58
g.		CVC.CVC.CV	39	70.91%	15	27.27%	1	1.82%	55
h.		Total 3σ	134	59.29%	91	40.27%	1	0.44%	226
i.		Total unchanged	220	64.90%	118	34.81%	1	0.29%	339

From the above table it is possible to see that when the inflected novel stem was not changed in length, the general tendency seems to be stressing the word final syllable, with ~76% for disyllabic stems (row 19c) and ~59% for trisyllabic stems (row 19h).

3.3. Discussion

Section 3.3.1 summarizes the observed stress tendencies and draws conclusions about the results of the experiment. Section 3.3.2 offers a further discussion of the stress tendencies displayed in the experiment.

3.3.1. Summary of stress tendencies

The experiment was designed to test whether there is evidence for a default stress system in Russian and if there is, whether it is influenced by the following factors:

a. Number of syllables in the word (2 vs. 3).

b. The structure of syllables (CV vs. CVC).

c. Word final segments (C vs. V).

d. The morphological status of the word (bare stem vs. suffixed/inflected form).

The results indeed suggest an existence of a default stressing system (tables (12), (13), (14), (15), (17), (18)). The data show a clear preference for specific stress placement tendencies, which are consistent across various word groups. The overall position of the stress is at the right word edge.

As to the factors presented in a-d: the results suggest that the number of syllables in the word and the structure of the syllables (when non-final) do not play a role in stress assignment (see (13) for disyllabic stems, (14) for trisyllabic stems). Both disyllabic and trisyllabic stems displayed similar percentages of stress distribution and there were no systematic differences in stressing among words of the same length and the same final segment but different non-final syllable structure. If syllable weight did play a role in stress assignment, then stems of CV.CVC.CV template would have significantly more penultimate stress than stems of CV.CV.CV template. The only instance in which there was a significant deviation in distribution of stress (template CVC.CVC.CVC, (14i)) cannot be explained by the influence of syllable weight or word length, since all the other word shapes conformed to the general stress patterns. This deviation can be attributed perhaps to the specific choice of words assigned to this specific template.

The final segment (the structure of the final syllable), however, did play a role in stress assignment: in V-final stems the amount of penultimate stress was significantly larger than in C-final stems. This result was consistent across all the word stem templates. It should be stressed though that despite this difference, even in V-final stems, most stress was final.

The morphological status of the word was also found to be significant in influencing the placement of the default stress. Table (15) shows that when the novel stems ended in segments that matched existing suffixes, the amount of penultimate stress was significantly higher than when the stem ended in some other segment. In addition, tables (17) and (18) show, that when the participants chose to inflect the novel stems by the simple addition of a suffix (as opposed to resolving vowel hiatus in V-final novel stems or leaving the novel stem as it is), most stress was **word** penultimate i.e. **stem** final.

3.3.2. Russian default stress

The results obtained from the experiment described above seem to be consistent with those of Nikolaeva (1971) and Crosswhite et al. (2003) in suggesting that the default stress in Russian is stem final. These findings were especially evident from the data of C-final novel stems both bare and inflected. The data from V-final bare stems and inflected V-final stems whose length remained unchanged may seem to contradict the assumption of stem final stress. Considering that most Russian stems are C-final, we could expect the stress in V-final stems to be mostly penultimate in both bare stems and inflected stems (when their length remained unchanged), however, the stress in these conditions turned out to be mostly final. On the other hand, this expectation might not be so necessary. As was already stated in §3.1.2, Russian has V-final words of foreign origin, which do not change during the inflection. Many of them bear final stress such as already mentioned *kʲengurú* 'kangaroo', *palʲtó* 'coat', *dominó* 'domino game', *kinó* 'movie theater', *referî* 'referee' (Superanskaja 1968). It is possible that the participants chose to treat the novel stems analogically. In addition, examples in (3) show that Russian has more than one inflection pattern, and in one presented in (3b), the stress is consistently on the suffix, which is also a word final syllable. Theoretically, the participants could have chosen this strategy as well.

The findings of Russian default stress being stem final are also supported by the work of Andreev (2004) on Russian acronyms. Although the acronyms are based on written representations, they are governed by the same rules as the rest of the words in the language (Bat-El 1994, 2000, Zadok 2002, Andreev 2004). Andreev (2004) shows than Russian acronyms, both V-final and C-final, are perceived as bare stems, and the majority of them bear final stress.

Another feature that Russian acronyms share with the novel words in this study is the immobility of stress in inflectional paradigms (Zaliznjak 1977). According to this author, stress in masculine nouns is influenced by a "pragmatic factor", which is the degree of familiarity of a specific word with the speakers. Words with a high degree of familiarity have mobile stress in inflectional paradigm, while items with a low degree of familiarity have fixed stress. For example, among non-professionals, the stress of *bótsman* 'boatswain' is fixed on the stem *(bótsmani* 'boatswain-PL'*)*, while for people for whom this word is a part of everyday experience, the stress is mobile *(botsmaná* 'boatswain-PL'). Moreover, a noun can gain or lose stress mobility if its degree of familiarity changes, both for a specific person and for larger groups of speakers (for example, the stress in the word *paʒ* 'page' lost its mobility in the paradigm, since the word now exists only as an historical term (Shapiro 1986)). In the current experiment (§3.2), all the nouns were both unfamiliar to the participants and presented to be of masculine gender (§3.2.3.1), which, according to Zaliznjak's (1977), guarantees fixed stress in inflection.

Shapiro (1986) expands the connection between stress mobility and familiarity of words to be the overall property of Russian. He claims that stress in Russian has an iconic value and reflects the semantic property of words throughout the whole language. For example, on the aspect of gender, stress exhibits the most mobility in masculine stems, than in feminine and neutral ones, since the masculine stems are more "basic". Also, stress tends to be mobile in words which refer to numerable substances, as opposed to words which reflect non numerable substances, where stress tends to be fixed, since the former are more "approachable". In addition, he stresses the importance of the stem and its final syllable and observes that stress tends to be stem final and fixed when the word is semantically, morphologically or morphophonemically "uncommon", which is exactly what the novel words in this study were.

Another explanation which can explain the stress immobility in inflectional paradigms is found in the analyses of Revithiadou (1999) and Alderete (2001). According to these researchers, the placement of stress in Russian is determined by the importance of morphological constituents of the words. Meaning, that the constituent which represents the grammatical, semantic and other classes to which the word belongs, would be preferred over other constituents which bear less grammatical information. According to both researches, this constituent is often the word stem. In the experiment, despite bearing no meaning, it was the novel word stems that were the main constituent of the inflected word, therefore they received the stress. Despite them not referring to an actual or even an abstract concept, they were still assigned the grammatical properties of being the "main" constituent of the word (over inflectional suffixes).

To conclude this chapter: it is possible to see that there is more than one explanation for the default patterns of stress which emerged in this experiment. However, the general impression is that the stress system that emerged in this experiment is similar to the one found in the more peripheral word groups.

4. Hebrew

In this chapter, I discuss the experiment that was done on Hebrew. The original experiment had to be altered and adapted in order to suit Hebrew's specific characteristics which are different from Russian. In §4.1, I present relevant Hebrew language background, in §4.2, I describe the experiment and the results and in §4.3, I present the conclusions and the further discussion. As in Russian, the language data brought here is transcribed in broad phonological transcription.

4.1. Relevant language background

4.1.1. Noun stress

With regard to stress patterns, Modern Hebrew distinguishes among three types of noun paradigms (Bat-El 1993):

(20) *Stress patterns in Modern Hebrew nouns*

a. Final mobile stress: final in bare stem and final in suffixed form (e.g. *xatúl* 'cat-MS-SG' – *xatulîm* 'cat-MS-PL'

b. Penultimate mobile stress: penultimate in bare stem and final in suffixed form (e.g *mélex* 'king-MS-SG' – *melaxîm* 'king MS-PL')

c. Lexical stress: the position of stress is constant throughout the paradigm, with no particular position in the stem (e.g. *tîras* 'corn-MS-SG' – *tîrasim* 'corn-MS-PL', *xamsîn* 'hot weather-MS-SG'- *xamsînim* 'hot weather-MS-PL')

Two properties relevant for the experiment are (a) the position of stress in the bare stem, i.e. whether it is final or non-final (where non-final is mostly penultimate), and (b) the mobility of stress in the paradigm, i.e. whether it is immobile or mobile. Based on Bolozky and Becker's (2006) online dictionary, final mobile stress is by far the most common. Final stress appears in 74.69% (8904/11920) of the stems in the dictionary, regardless of stress mobility, and mobile stress is found in 76.73% (9147/11920) of the paradigms, regardless of stress position.

Other than conforming to one of the three paradigms in (20), stress in Modern Hebrew is not influenced by any other factors, such as syllable structure or word length (Bat-El 1993, Graf and Ussishkin 2003). The Hebrew five vowel system ([i], [u], [e], [o], [a]) does not display a phonological contrast in length, and as the examples in (21) below suggest, a coda consonant does not contribute to syllable weight. There are also minimal pairs which differ only in the position of stress.

(21) *Examples of noun stress*

a. Fixed final stress

Initial CV:	*ka.lá*	'bride'	*ma.kóm*	'place'
Initial CVC:	*sim.lá*	'dress'	*mis.pár*	'number'

b. Word structure minimal pairs

ta.xa.ná	'stop'	*ba.ná.na*	'banana'
me.si.bá	'party'	*ta.kî.la*	'tekila'

c. Contrastive stress minimal pairs

bi.rá	'capital city'	*bî.ra*	'beer'
xo.réʃ	'plow-MS-SG'	*xó.reʃ*	'thicket'

To conclude, Hebrew stress is mostly mobile (non-lexical) and final, and oblivious to syllable structure.

4.1.2. Morphology

The morphology relevant to the present study is that of suffixation, though the suffix inventory is not as rich as in Russian; out of the five vowels, only the vowel [a] serves as a noun suffix (cf. all vowels in Russian §3.1.2).[9] The stems and the suffixes tend to be consonant final, and the majority of the suffixes are vowel initial. An assortment of Hebrew nominal suffixes is shown below in (22a). Regarding plural inflection, when the

[9] The possessives markers, which can be vowels (e.g. *sus-ó* 'his horse', *sus-í* 'my horse'), are clitics rather than suffixes (see Anderson 1992 for the distinction between suffixes and clitics).

stem is V-final, in most cases the stem vowel is deleted when a suffix is added and only in a few, it is maintained as can be seen below in (22b):

(22) *Modern Hebrew inflection suffixes and patterns*

a. Nominal suffixes

Masculine suffixes: *an, nik, on, im*

Feminine suffixes: *a, it, ut, et, ot*

b. Plural inflection patterns:

Hiatus resolution:	*xult͡sá – xult͡sót*	‘shirt SG-PL’
	moré – morîm	‘teacher-MS SG-PL’
Hiatus non resolution:	*dugmá – dugmaót*	‘example SG-PL’
	maʃkánta – maʃkantaót	‘mortgage SG-PL’

In addition, Hebrew nouns can be identified by specific prosodic and vocalic templates traditionally called *mishqal* (plural – *mishqalim*). In many cases, nouns in a certain *mishqal* possess specific semantic properties; for example, the *mishqal* CaCáC is a very common template for nouns which mark occupations, such as *nagár* ‘carpenter’, *zamár* ‘singer’ (Berman 1978). Therefore, nouns that differ in their specific semantic properties differ in their prosodic structure and vocalic pattern, as well as lexical affixes (e.g. *t͡sórex* ‘need’ – *tit͡sróxet* ‘consumption’ – *t͡sarxán* ‘customer’), even if they are related. Borrowed nouns do not have to fit into one of the *mishqalim*, but can maintain their original shape, provided they comply with segmental and prosodic restrictions in Hebrew (Cohen in progress). Therefore, the inflectional suffixes can be attached directly to the word’s basic shape (Bat-El 2006).

As already shown in (22a), Hebrew has two genders, masculine and feminine. In addition to nouns, gender and number are marked also on adjectives which have to agree with these of the nouns. Gender is also marked on numerals, and also has to agree with this of the nouns. This property of Hebrew will become useful in constructing the phrasal frame of the experiment.

4.1.3. Writing system

The Hebrew writing system includes only consonants and glides and the direction of writing is from right to left. The vowels are indicated by a system of diacritics, however their use is usually restricted to Biblical materials, poetry and children's books; most of the everyday written material is diacritic-less. Since today's Hebrew lacks the distinctions in vowel length which existed in its previous incarnation, the Tiberian Hebrew, diacritics which historically indicated vowels of same quality but different length, correspond now to one and only one specific vowel phoneme. Therefore for the Hebrew experiment (see next section), it was possible to use only one diacritic to represent a specific vowel sound. The following diacritics were used in the experiment: *kamat͡s* (ָ) for [a], *segol* (ֶ) for [e], *hiriq* (ִ) for [i], *ʃuruk* (ֻ) for [u], *xolam male* (ֹ) for [o] and a *schwa* (ְ) to indicate a lack of a vowel.

4.2. The experiment

4.2.1. Experiment design

As in the Russian experiment, the experiment described in this section was designed to have two parts, each part testing the placement of Hebrew stress from another aspect. In the first part, the words were presented in a context that suggested that the word is a bare stem, i.e. it does not require an inflectional suffix. In the second part, the words were presented in a syntactic context that suggested the need to inflect them into plural, an action that requires an addition of a suffix. The participants in the experiment had to inflect the novel word, i.e. add an inflectional suffix, thus acknowledging that the word has a stem and another morpheme. In this way, the experiment imitated the natural process of word inflection and stress assignment, and made the testing of the possible influence of morphology on Hebrew default stress more precise, since the participants had to consciously refer to a morpheme boundary. In both parts of the experiment the same novel words were used.

4.2.2. Stimuli

Two types of stimulus templates were required for the purpose of the experiments: the novel word stem templates and the sentence templates with the appropriate syntactic context. The novel word stem templates were the same ones used in the Russian experiment (repeated below for convenience):

(23) *Novel word stem templates*

	2 syllables	**3 syllables – CV initial**	**3 syllables – CVC initial**
V-final	CV.CV	CV.CV.CV	CVC.CV.CV
	CVC.CV	CV.CVC.CV	CVC.CVC.CV
C-final	CV.CVC	CV.CV.CVC	CVC.CV.CVC
	CVC.CVC	CV.CVC.CVC	CVC.CVC.CVC

These templates allowed testing whether the default stress pattern in Hebrew is sensitive to the structure of the syllable (CV vs. CVC syllables) and to the length of the word (two vs. three syllables). As in the experiment on Russian, the structure of the final syllable was given special attention, since its final segments could be perceived as either belonging to the stem or being a suffix.

The words were constructed by randomly combining consonants with vocalic patterns or selecting a word base from Russian which was further altered, with the intention that the novel word stem would not trigger immediate associations with any existing word. In order to ensure that the words were realized as stems, their first consonant was not any existing Hebrew prefix: *ʔ, t, m, n, y, b, l, v, h* (א,ת, מ, נ, י, ב, ל, ו, ה) (Naama Friedmann, personal communication). Because of these restrictions, the novel words had to be constructed with great caution, since many of the letter sequences that were possible to arrange with the above limitations appear in the existing words of the language. Therefore, the possible combinations of consonants which could be used for constructing the novel words were very limited (§4.1.3). Six words were assigned to each of the templates. The words were written in Hebrew, and the placement of vowels was indicated by diacritics.[10]

A factor which was examined uniquely in the Hebrew experiment was whether the placement of stress is influenced by frequency. This was achieved by matching the vowels of the novel word stem to either a high frequency or a low frequency vocalic pattern. The relative frequency of Hebrew vocalic patterns was determined from Bolozky and Becker's (2006) dictionary. The following vocalic patterns were used:

(24) *Vocalic patterns used in the experiment*

	High frequency	**Low frequency**
Disyllabic	ai	ui
	aa	oo
	ao	ou
Trisyllabic	aaa	oae
	iao	auu
	aua	iei

The high frequency vocalic patterns that were chosen for the experiment appear in more than one grammatical category and can have different stress placements in different words (Naama Friedmann, personal communication). For example, the pattern *ai* can appear in nouns (e.g. *karît* 'pillow') and adjectives (e.g. *xarîg* 'unusual'), and the stress in the pattern *aaa* can appear either on the final syllable (e.g. *mataná* 'gift') or on the penultimate (e.g. *banána* 'banana'). Therefore, by choosing vowels and not consonants to be manipulated for similarity, novel words were set to resemble not one specific word, but several word groups, some of them with different stress patterns. On the other hand, presenting vowel combinations of different frequency made the manipulation possible, since the speakers of Hebrew are sensitive to vocalic patterns and prosodic templates of their words (§4.1.2).

[10] The diacritics were not assigned according to the Hebrew rules of diacritic positioning, but merely indicated the placement and the quality of the vowel. This, I believe, had no effect on the performance in the test, since most speakers do not know the rules.

All the vocalic patterns appeared in all the templates, two words for each template. That is, there were two sets of 72 words (12 word templates x 6 words in each group): one consisting only of words with high frequency vocalic patterns and another consisting only of words with low frequency vocalic patterns. The consonants of all the words were different from one another, meaning that there were no words that differed only in vocalic pattern.

As in the Russian experiment (§3.2), segments at the end of the novel word stems were controlled. In the V-final group of the high frequency vocalic patterns, 24 words ended in the vowels *o* or *i* which are not noun suffix vowels in Hebrew. The remaining 12 words ended in a vowel *a*, which is a noun suffix in Hebrew. In the V-final group of the low frequency vocalic patterns, all the words ended in vowels that are not a Hebrew noun suffix, since there were no low frequency vocalic patterns which ended in *a*. In the C-final group of the high frequency vocalic patterns, 18 words ended in the vowel-consonant sequences *on*, *it*, *an*, which are noun suffixes in Hebrew, while the remaining 18 ended in vowel-consonant sequences which are not noun suffixes in Hebrew. In the C-final group of the low frequency vocalic patterns, 19 words ended in the vowel-consonant sequences *on*, *it*, *ut*, *et*, which are noun suffixes in Hebrew, while the remaining 17 ended in vowel-consonant sequences which are not noun suffixes in Hebrew. For a complete list of the novel stems used in the experiment, see Appendix B.

The sentence templates in which the novel word stems were embedded provided the desired syntactic context for the two parts of the experiment. There was one template for each type of task, one for introducing the novel word in an uninflected context (25a) and another for assessing plural inflection (25b). The templates were as general as possible, so as not to give the participants any idea of what the novel word can be, and thus, reduce the chance that they will stress the word by semantical analogy.

(25) *Sentences templates used in the experiment*

a. Sentence template for uninflected context (novel word underlined)

ani roe/roa[11] *rak zasag exad.*

I see-MS/FM only zasag one-MS-SG.

b. Sentence template for inflected context (novel word in parenthesis)

ani roe/roa xamiʃa__________(zasag) yafim.

I see-MS/FM five-MS_________(novel word) beautiful-MS-PL.

In the template in (25a), the novel word is followed by the masculine form of the numeral one, in order to ensure that the participants recognize the novel word as a bare stem (given that plural and feminine take suffixes). In the template in (25b), the novel word is preceded by a 'five', in masculine and followed by an adjective in masculine plural, implying a masculine plural agreement with the novel word.

The sentences were printed on A4 paper in Arial font size 44 and arranged into two folders, one folder for each of the two parts of the experiment. The words were presented in random order, both high and low frequency vocalic patterns together, but the order was identical in the bare stem folder and the inflection folder.

4.2.3. Pilot experiment

A pilot experiment was conducted on four native Hebrew speakers, using a reduced sample of planned word templates, which were identical to the templates used in the Russian pilot experiment (5). The pilot was designed to test two issues:

a. To test the method of the experiment: whether it is clear to the participants what they are expected to do.

b. To test inflection: whether the participants can inflect novel words.

[11] The sentence templates did not have diacritics; therefore the participants could read the word רואה 'see' according to their own gender, since the written diacritic-less form is applicable to both masculine and feminine.

4.2.3.1. Participants: The participants were four native speakers of Hebrew, mean age 28.5, two males and two females. All four were students of Tel-Aviv University who volunteered to participate in the experiment.

4.2.3.2. Procedure: The participants were given two folders containing stimulus sentences of the experiment and were asked to read what is written on each of the 96 sheets of each folder. Both parts of the experiment were conducted in one session, which lasted about 20 minutes. In the bare stem part of the experiment, they were asked to simply read each sentence. In the inflection part, they were asked to put the novel word in plural, as the context requires. They were told that the words are not taken from any language and that the diacritics merely indicate the placement and the nature of the vowels, so they will know how to read the unfamiliar words. They were also told that there are no right and wrong answers and that all their productions are acceptable. All the participants participated in both parts of the experiment, and did the first part of the experiment (novel words as bare stems) before the second part (novel words in inflections). The participants' output was audio recorded on a Sony digital recorder and later transcribed, indicating the stress placement and alternations made to the word when inflected. Both the recording and the transcription were conducted by the author.

4.2.3.3. Results: All four participants understood what they were required to do and displayed no difficulty in both reading the novel words and inflecting them into plural form. Only one participant displayed problems reading diacritics (since she did not remember how to read them), but upon being reminded how each diacritic is read, she was able to perform well in the pilot. All the participants were able to read the diacritics correctly. The stress tendencies were not examined in the pilot experiment, since its purpose was only to test whether the experiment “works”.

4.2.4. Main experiment

In the experiment, all the stem templates from table (23) were used, thus increasing the number of stimuli in each part of the experiment to 144.

4.2.4.1. Participants: The participants of the main experiment were 12 native speakers of Hebrew, eight males and four females, students of Tel-Aviv University, mean age 23. They were either paid 20 NIS for participation, or participated voluntarily.

4.2.4.2. Procedure: As in the pilot experiment, each participant was given two folders containing stimulus sentences of the experiment and was asked to read what is written on each of 144 sheets of each folder. Both parts of the experiment were conducted in one session, which lasted about 30 minutes. In the bare stem part of the experiment, they were asked to simply read each sentence. In the inflection part, they were asked to inflect the novel word in plural. They were told that the words are not taken from any language and that the diacritics merely indicate the placement and the nature of vowels, so they will know how to read the unfamiliar words. They were also told that there are no right and wrong answers and all their productions are acceptable. All the participants did the first part of the experiment (bare stems) before the second part (inflections) and participated in both parts of the experiment. The participants' output was audio recorded on a Sony digital recorder and later transcribed, indicating the stress placement and alternations made to the word when inflected. The recording, transcription and statistical analysis were conducted by the author.

4.2.5. Experiment results

In this section, I present the results from the experiment, starting with the first part of the experiment, where bare stems were studied, and then continuing with the inflected forms of the second part. For each type of result, there are separate tables for high frequency and low frequency vocalic pattern stems.

4.2.5.1. Results for the first part of the experiment – bare stems: I start in (26) and (27) below with the general tendencies of the stress placement in uninflected bare stems.[12]

(26) *General counts for stems with high frequency V-patterns*

	Stem type	Final stress		Penultimate stress		No. words
a.	Total V-final	93	21.67%	336	78.32%	429
b.	Total C-final	374	86.98%	56	13.02%	430
c.	Total 2 σs	161	55.90%	127	44.10%	288
d.	Total 3 σs	306	53.59%	265	46.41%	571
e.	Total words	467	54.37%	392	45.63%	859

From the last row of the table (26e), it seems that the placement of stress was almost random: in ~54% of the cases, stress was on the final syllable, and in ~46%, it was on the penultimate syllable. However, the chi-square test found this result to be statistically significant, $\chi_2 = 6.548$, $p = 0.0105$. The results for disyllabic and trisyllabic stems were very similar: ~56% final and ~44% penultimate in disyllabic stems (26c); ~54% final and ~46% penultimate for trisyllabic stems (26d). The chi-square test proved to be significant for disyllabic words, $\chi_2 = 4.0451$, $p = 0.0451$ and approaching non-significance for trisyllabic words, $\chi_2 = 2.944$, $p = 0.0862$.

The distribution of stress in V-final and C-final novel stems was different. For V-final stems, in ~22% of the cases, stress was final and in ~78%, it penultimate (26a), while for C-final stems, in ~87% of the cases stress was final, and in ~13%, it was penultimate (26b). A chi-square test testing the correlation between the final segment of the novel word stem (consonant or vowel) and the position of stress gave significant results, $\chi_2 = 367.24$, $p < 0.0001$.

[12] Since there were only seven productions in total that were stressed on the antepenultimate syllable in both high frequency and low frequency vocalic pattern word groups, I did not include them in the counts. Additional production was omitted since the participant failed to read the novel word correctly.

(27) *General counts for stems with low frequency V-patterns*

	Stem type	Final		Penultimate		No. words
a.	Total V-final	75	17.40%	356	82.60%	431
b.	Total C-final	291	67.67%	139	32.36%	430
c.	Total 2 σs	124	43.06%	164	56.94%	288
d.	Total 3 σs	242	42.23%	331	57.77%	573
e.	Total words	366	42.51%	495	57.49%	861

From the last row of the table (27e), it is possible to see that in ~43% of the cases, stress was placed on the final syllable, and in ~57%, it was placed on the penultimate syllable. The chi-square test found this result to be significant, $\chi_2 = 30.422$, $p < 0.0001$. The results for disyllabic and trisyllabic stems were very similar: 43% final and 57% penultimate stress in disyllabic words (27c); ~42% final and ~58% penultimate for trisyllabic words (27d). The chi-square test results were found to be significant for both stem types: for disyllabic stems $\chi_2 = 5.556$, $p = 0.0184$, and for trisyllabic stems $\chi_2 = 13.824$, $p < 0.0002$.

In V-final low frequency V-pattern words stems, ~17% of stress placement was final and ~83% penultimate (27a), while in C-final low frequency V-pattern stems, ~68% of stress was final and ~32% was penultimate (27b). A chi-square test testing the correlation between the final segment of the novel word stem (consonant or vowel) and the position of stress gave significant results, $\chi_2 = 222.604$, $p < 0.0001$.

A comparison between the general counts of stems with high frequency (26) and low frequency (27) V-pattern novel stems reveals the following tendencies:

a. While in the **high** frequency V-pattern stems, the distribution of stress placement revealed a tendency towards final stress, in the **low** frequency V-pattern stems, there was a preference towards penultimate stress. The above pattern was also present in disyllabic and trisyllabic counts in each of the V-pattern word groups.
b. For both high and low frequency V-patterns, there was a significant difference in stress pattern between V-final and C-final stems. For the V-final stems, a significant

majority of the stress patterns was **penultimate**. For the C-final stems, a significant majority of the stress patterns was **final**.

In (28), (29), (30) and (31), I present more detailed stress distributions according to each of the 12 stem templates (23), divided for clarity into disyllabic stems in tables (28) and (29) and trisyllabic stems in tables (30) and (31).

(28) *Disyllabic high frequency V-patterns bare stems*

	Word pattern		Final		Penultimate		No. words
a.	V-final	CV.CV	12	16.67%	60	83.33%	72
b.		CVC.CV	9	12.50%	63	87.50%	72
c.		Total V-final	21	14.58%	123	85.42%	144
d.	C-final	CV.CVC	72	100%	0	0%	72
e.		CVC.CVC	68	94.44%	4	5.56%	72
f.		Total C-final	140	97.22%	4	2.78%	144

In the V-final high frequency disyllabic stems, only ~15% of stress fell on the final syllable, while the remaining ~85% fell on the penultimate syllable (28c). Both V-final stem templates, CV.CV (28a) and CVC.CV (28b) had percentages of stress division similar to the total V-final words (28c). In C-final stems, the pattern of stress was the reverse: ~97% of stress fell on the final syllable, while the remaining ~3% fell on the penultimate syllable (28f). Both C-final stem templates, CV.CVC (28d) and CVC.CVC (28e) displayed similar stress division, with 100% final stress in CV.CVC template (28d) and 94% final stress in CVC.CVC template (28e). A chi-square test on the correlation between the final segments (consonant or vowel) and the stress placement gave significant results, $\chi_2 = 199.460$, $p < 0.0001$.

(29) *Disyllabic low frequency V-patterns bare stems*

		Word pattern	Final		Penultimate		No. words
a.	V-final	CV.CV	8	11.11%	64	88.89%	72
b.		CVC.CV	8	11.11%	64	88.89%	72
c.		Total V-final	16	11.11%	128	88.89%	144
d.	C-final	CV.CVC	57	79.17%	15	20.83%	72
e.		CVC.CVC	51	70.83%	21	29.17%	72
f.		Total C-final	108	75%	36	25%	144

In the low frequency disyllabic V-patterns (29), the stress distribution was similar to high frequency disyllabic V-patterns (28). In V-final stems, ~11% of stress fell on the final syllable, while the remaining ~89% fell on the penultimate syllable (29c). Both V-final templates, CV.CV (29a) and CVC.CV (29b) had the same percentages of stress distribution as the total of V-final stems (29c). In C-final stems the pattern, was the reverse: 75% of stress fell on the final syllable, while the remaining 25% fell on the penultimate syllable (29f). Both C-final templates, CV.CVC (29d) and CVC.CVC (29e) displayed similar stress division, with 79% final stress in CV.CVC template (29d) and 70% final stress in CVC.CVC template (29e). A chi-square test on the correlation between the final segments (consonant or vowel) and the stress placement gave significant results, $\chi_2 = 119.860$, $p < 0.0001$.

(30) *Trisyllabic high frequency V-patterns bare stems*

		Word pattern	Final		Penultimate		No. words
a.	V-final	CV.CV.CV	19	26.39%	53	73.71%	72
b.		CV.CVC.CV	16	22.54%	55	77.46%	71
c.		CVC.CV.CV	21	30%	49	70%	70
d.		CVC.CVC.CV	16	22.22%	56	77.78%	72
e.		**Total V-final**	72	25.26%	213	74.74%	285
f.	C-final	CV.CV.CVC	54	75%	18	25%	72
g.		CV.CVC.CVC	54	76.06%	17	23.93%	71
h.		CVC.CV.CVC	68	95.77%	3	4.23%	71
i.		CVC.CVC.CVC	58	80.56%	14	19.44%	72
j.		**Total C-final**	234	81.82%	52	18.18%	286

In V-final high frequency V-pattern stems, the majority of the stress, ~75%, fell on the penultimate syllable and ~25% fell on the final syllable (30e). At closer inspection, it was found that all the V-final templates displayed similar stress patterns, around 75% penultimate stress, which is also similar to the stress distribution in V-final stem templates in disyllabic stems (28) and in the general counts (26). In C-final stems, the stress patterns were reversed (also similarly to disyllabic stems and to the general stress distributions) with ~82% final and ~18% penultimate stress (30j). In templates CV.CV.CVC (30f), CV.CVC.CVC (30g) and CVC.CVC.CVC (30i), the distribution of stress was similar, with ~77% final stress, while CVC.CV.CVC (30h) displays a percentage of 96% final stress. This difference turned out to be significant, $\chi_2 = 13.69$, $p = 0.003$. However, this deviation does not indicate any systematic pattern. Therefore, it is possible that this difference is random, perhaps, stimulus specific, which could raise more analogies to stress final exiting words. A chi-square test on the correlation between the final segments (consonant or vowel) and the stress placement gave significant results, $\chi_2 = 183.570$, $p < 0.0001$.

(31) *Trisyllabic low frequency V-patterns bare stems*

			Final		**Penultimate**		**No. words**
a.	V - final	CV.CV.CV	9	12.50%	63	87.50%	72
b.		CV.CVC.CV	15	21.27%	56	78.87%	71
c.		CVC.CV.CV	18	25%	54	75%	72
d.		CVC.CVC.CV	17	23.61%	55	76.39%	72
e.		**Total V-final**	59	20.56%	228	79.44%	287
f.	C - final	CV.CV.CVC	43	60.56%	28	39.44%	71
g.		CV.CVC.CVC	48	66.67%	24	33.33%	72
h.		CVC.CV.CVC	46	64.79%	25	35.21%	71
i.		CVC.CVC.CVC	46	63.89%	26	36.11%	72
j.		**Total C-final**	183	64%	103	36%	286

In the V-final stems in the table above, the majority of the stress, ~79%, fell on the penultimate syllable, and in ~21% fell on the final syllable (31e). At closer inspection, CV.CVC.CV, CVC.CV.CV and CVC.CVC.CV templates (31b, 31c, 31d) displayed similar stress distribution, around 22% final stress, which is also similar to other V-final stress assignment tendencies. The pattern CV.CV.CV (31a) displays a lesser percentage of final stress, only 12.5%. Statistically, this difference was also non significant $\chi_2 = 4.16$, $p = 0.24$. In C-final stems, the patterns of stress were reversed (also similarly to disyllabic words and to the general stress patterns) and 64% of stress was final, 36% penultimate (31j). In all the C-final stem templates, the distribution of stress was virtually the same, with ~60% final stress, ~40% penultimate stress. A chi-square test on the correlation between the final segments (consonant or vowel) gave significant results $\chi_2 = 110.741$, $p < 0.001$.

My next step is to examine the distribution of stress according to the vocalic patterns. As in the previous examinations, I divide them into disyllabic and trisyllabic tables for convenience.

(32) *Stress distribution in disyllabic V-patterns*

	Vocalic pattern		**Final**		**Penultimate**		**No. words**
a	High frequency	ai	51	53.13%	45	46.87%	96
b.		aa	56	58.33%	40	41.67%	96
c.		ao	54	56.25%	42	43.75%	96
d.	Low frequency	ui	35	36.46%	61	63.54%	96
e.		oo	43	44.79%	53	55.21%	96
f.		ou	45	46.88%	51	53.12%	96

From the table above, it is possible to see that the patterns of high frequency and low frequency vocalic patterns display the previously observed tendency of low frequency patterns having a higher percentage of stress on the penultimate syllable. When inspecting each pattern, all three high frequency patterns show similar percentages of ~55% final and ~45% penultimate stress (32a, 32b, 32c). In the low frequency patterns, *oo* (32e) and *ou* (32f) display similar tendencies of 43% and 45% final stress respectively, ~55% and ~53% penultimate stress respectively, while *ui* (32d) pattern displays a slightly different pattern of ~36% final and ~64% penultimate stress. A chi-square test showed this difference to be insignificant: $\chi_2 = 2.38$, $p = 0.1229$.

(33) *Stress distribution in trisyllabic V-patterns*

	Vocalic pattern		Final		Penultimate		Antepenult.		No. words
a	High frequency	aaa	106	55.50%	83	43.46%	2	1.04%	191
b.		iao	109	56.77%	82	42.71%	1	0.52%	192
c.		aua	91	47.40%	100	52.08%	1	0.52%	192
d.	Low frequency	oae	70	36.46%	121	63.02%	1	0.52%	192
e.		auu	94	48.96%	98	51.04%	0	0%	192
f.		iei	78	40.63%	112	58.33%	2	1.04%	192

In this table, the words that received antepenultimate stress were included in order to show that their division was virtually uniform and did not occur in a specific vocalic pattern. In the trisyllabic words, the patterns of high frequency and low frequency display the previously observed tendency of low frequency patterns having a larger percentage of stress on the penultimate syllable. When inspecting each pattern, high frequency patterns *aaa* (33a) and *iao* (33b) displayed similar percentages of ~56% final stress, while pattern *aua* (33c) displayed ~47% of final stress. The chi-square analysis showed that this difference is not significant with $\chi_2 = 4.63$, $p = 0.327$. In the low frequency patterns, each pattern displays a different stress distribution, however the chi-square test showed that there is no significance to this difference: $\chi_2 = 7.123$, $p = 0.13$.

An additional dimension controlled in this experiment was the final segments of the novel word stems, which could either match the Hebrew nominal suffixes or not. The stress placement division according to this parameter is presented in tables (34) and (35) below:

(34) *Stress distribution in high frequency V-pattern stems according to word ending*

	Word ending	Final		Penultimate		No. words
V-final	An existing suffix	58	24.37%	180	75.63%	238
	Not an existing suffix	35	18.52%	154	81.48%	189
C-final	An existing suffix	185	86.45%	29	13.55%	214
	Not an existing suffix	189	87.50%	27	12.50%	216

It is possible to see that the nature of the final segment played no role for both V-final and C-final stems. For the V-final stems, the stress distribution was ~24% for stems whose final segments matched Hebrew nominal suffixes and ~18% final stress for stems whose final segments did not match Hebrew nominal suffixes. (χ_2 = 2.117, p = 0.1457). For C-final stems, the percentages were ~86% final stress for stems whose final segments matched Hebrew nominal suffixes and ~87% final stress for stems whose final segments did not match Hebrew nominal suffixes ($\chi_2 < 0$). The previously seen tendency of V-final stems having mostly penultimate stress was preserved in these calculations as well.

(35) *Stress distribution in low frequency V-pattern stems according to word ending*

	Word ending	**Final**		**Penultimate**		**No. words**
C-final	An existing suffix	155	68.58%	71	31.42%	226
	Not an existing suffix	136	66.67%	68	33.33%	204

Recall that in low frequency V-patterns only for C-final stems, it was possible to manipulate the final segments (§4.2.2.1). The stress distribution in stems with final segments matching existing Hebrew suffixes and those that did not match existing Hebrew suffixes was virtually the same, as can be see from the table above ($\chi_2 < 0$). It is also possible to see, again, that C-final stems in table (35) had a larger percent of penultimate stress than C-final stems in table (34), a tendency also observed in previous counts.

4.2.5.2. Results for the second part of the experiment – inflected stems: I begin this section with the data in (36) and (37) summarizing the changes in length which were made to the novel word stems as a result of their inflection.[13] As can be seen from these tables, inflection could increase the number of syllables in the final word (when a suffix was added), or the number of syllables in the final output could remain the same as in the stem (in V-final stems, when a suffix was added and vowel hiatus was resolved, as

[13] Productions in which the novel stem was left in its bare form (no suffixation) or in which the stem was altered were excluded from the counts.

described in §4.1.2). Therefore, when examining the stress placement in inflected stems, it was necessary to treat them according to the changes they have undergone.

(36) *Inflection patterns in high frequency V-pattern novel stems*

	Stem type	Word length changed (syllable added)		Word length unchanged		No. words
a.	Total V-final	209	48.83%	219	51.17%	428
b.	Total C-final	429	100%	0	0%	429
c.	Total 2 σs	196	68.53%	90	31.47%	286
d.	Total 3 σs	442	77.41%	129	22.59%	571
e.	Total words	638	74.45%	219	25.55%	857

From the last row of the table (36e) we can see that in ~74% of the cases, the participants added a syllable to the novel word stem, thus increasing its length. From the first two rows of the table, we can see that these results come largely from the C-final stems, to which the participants added another syllable in 100% of the cases. For the V-final stems, the results were less obvious, and there the participants chose to add another syllable in roughly 50%. In trisyllabic stems (36d), there was a somewhat bigger tendency to add a syllable than there was in disyllabic stems (36c): ~77% vs. ~69% respectively.

(37) *Inflected low frequency V-pattern novel stems*

	Stem type	Word length changed (syllable added)		Word length unchanged		No. words
a.	Total V-final	169	40.14%	252	59.86%	421
b.	Total C-final	418	100%	0	0%	418
c.	Total 2 σs	206	71.78%	81	28.22%	287
d.	Total 3 σs	381	69.02%	171	30.98%	552
e.	Total words	587	69.96%	252	30.04%	839

The patterns are largely similar to those in high frequency V-patterns: in 70% overall, a syllable was added for the sake of morphological inflection (37e). In V-final stems (37a) the syllable was added in 40% and in C-final stems in 100% (37b). In both disyllabic (37c) and trisyllabic stems (37d), a syllable was added in ~70%, similarly to the percentage of total stems in (37e).

In the following tables, I examine the patterns of stress in stems to which a syllable was added, divided for convenience into disyllabic and trisyllabic stems.

(38) *Disyllabic high frequency V-pattern stems – word length changed*

	Stem type		Final		Penultimate		Antepenult.		No. words
a.	V-final	CV.CV	6	27.27%	7	31.82%	9	40.91%	22
b.		CVC.CV	10	33.33%	12	40%	8	26.67%	30
c.		Total V-final	16	30.77%	19	36.54%	17	32.69%	52
d.	C-final	CV.CVC	23	31.94%	49	68.06%	0	0%	72
e.		CVC.CVC	21	29.17%	49	68.06%	2	2.77%	72
f.		Total C-final	44	30.56%	98	68.06%	2	1.38%	144
g.		Total suffixed words	60	30.61%	117	59.70%	19	9.69%	196

The division of stress in V-final inflected stems (38c) was distributed virtually equally between all three syllables of the suffixed stem. In C-final suffixed stems, the stress fell mostly on the word's antepenultimate syllable, i.e. the last syllable of the stem, ~68% of the cases, followed by the final stress, i.e. stress on the suffix ~31% (38f).

(39) *Disyllabic low frequency V-pattern suffixed stems – word length changed*

	Stem type		Final		Penultimate		Antepenult.		No. words
a.	V-final	CV.CV	9	29.03%	7	22.58%	15	48.39%	31
b.		CVC.CV	11	35.48%	11	35.48%	9	29.04%	31
c.		Total V-final	20	32.26%	18	29.03%	24	38.71%	62
d.	C-final	CV.CVC	22	30.56%	44	61.11%	6	8.33%	72
e.		CVC.CVC	22	30.56%	42	58.33%	8	11.11%	72
f.		Total C-final	44	30.56%	86	59.72%	14	9.72%	144
g.		Total suffixed words	64	31.07%	104	50.49%	38	18.44%	206

In V-final suffixed stems (39c), the larger percentage of stress was on the word antepenultimate syllable, i.e. stem penultimate syllable, ~39%, closely followed by the word final stress, i.e. stress on the suffix ~32%. However, since the actual counts are very similar, it is impossible to say whether this result is random or whether it is a display of penultimate stress pattern observed earlier in low frequency V-pattern bare stems. The majority of stress on C-final suffixed stems (39f) fell on the word's penultimate syllable, i.e. stem final syllable, ~60%, followed by stress on the word's final syllable, i.e. on the suffix, ~31%, and the remaining ~9% fell on the initial syllable.

And now I present the same counts for the trisyllabic stems:[14]

(40) *Trisyllabic high frequency V-pattern suffixed stems – word length changed*

	Stem type		Final		Penultimate		Antepenult.		No. words
a.	V-final	CV.CV.CV	6	16.67%	16	44.44%	14	38.89%	36
b.		CV.CVC.CV	12	26.09%	21	45.65%	13	28.26%	46
c.		CVC.CV.CV	8	24.24%	15	45.46%	10	30.30%	33
d.		CVC.CVC.CV	12	28.57%	17	40.48%	13	30.95%	42
e.		Total V-final	38	24.20%	69	43.95%	50	31.85%	157
f.	C-final	CV.CV.CVC	18	25.71%	43	61.43%	9	12.86%	70
g.		CV.CVC.CVC	18	25%	43	59.72%	11	15.28%	72
h.		CVC.CV.CVC	22	31%	45	63.37%	4	5.63%	71
i.		CVC.CVC.CVC	18	25.71%	44	62.86%	8	11.43%	70
j.		Total C-final	76	26.86%	175	61.84%	32	11.30%	283
k.		Total suffixed words	114	25.91%	244	55.45%	82	18.64%	440

In the V-final suffixed stems, the largest stress group, ~44%, was on the word's penultimate syllable, i.e. stem final syllable, followed by word antepenultimate stress, i.e. stem penultimate stress, ~32%, while word final stress, i.e. stress on the suffix, took ~24% of the total counts (40e). In C-final suffixed stems, the majority of stress, ~62%, fell on the penultimate word syllable, i.e. final syllable of the stem, followed by the final syllable stress, i.e. stress on the suffix, ~27%, and stress on the antepenultimate syllable, i.e. the penultimate syllable of the stem took ~11% of the total counts (40j).

[14] Since there was only one instance in which the fourth syllable from the end of the word was stressed, I am not including it in the counts.

(41) *Trisyllabic low frequency V-pattern suffixed stems – word length changed*

	Stem type		Final		Penultimate		Antepenult.		No. words
a.	V-final	CV.CV.CV	5	20%	7	28%	13	52%	25
b.		CV.CVC.CV	8	30.76%	9	34.62%	9	34.62%	26
c.		CVC.CV.CV	7	25.92%	10	37.04%	10	37.04%	27
d.		CVC.CVC.CV	8	28%	11	38%	10	34%	29
e.		Total V-final	28	26.17%	37	34.58%	42	39.25%	107
f.	C-final	CV.CV.CVC	15	24.59%	34	55.74%	12	19.67%	61
g.		CV.CVC.CVC	13	18.06%	46	63.69%	13	18.05%	72
h.		CVC.CV.CVC	17	23.94%	44	61.98%	10	14.08%	71
i.		CVC.CVC.CVC	14	20%	42	60%	14	20%	70
j.		Total C-final	59	21.53%	166	60.58%	49	17.88%	274
k.		Total suffixed words	87	22.83%	203	53.28%	91	23.88%	381

In V-final suffixed stems, the majority of stress, ~39%, fell on the antepenultimate syllable, i.e. on the penultimate syllable of the stem, closely followed by penultimate stress, i.e. stem final stress, ~35%, while word final stress, i.e. stress on the suffix, took ~26% of the total counts (41e). In C-final suffixed stems, the majority of stress, ~61%, fell on the penultimate syllable, i.e. the final syllable of the stem, followed by the final stress, i.e. stress on the suffix, ~22%, while the stress on the antepenultimate syllable, i.e. the penultimate syllable of the stem, took ~17% of the total counts (41j).

Now, I present the distribution of stress placement in words, whose number of syllables after the inflection was the same as before the inflection. This is relevant only for V-final stems for which the hiatus of stem final and suffix initial vowels was resolved by removing the stem final vowel.

(42) *High frequency V-pattern inflected stems – word length unchanged*

	Stem type		Final		Penultimate		Antepenult.		No. words
a.	2σ	CV.CV	26	53.06%	23	46.94%	0	0%	49
b.		CVC.CV	17	41.46%	24	58.54%	0	0%	41
c.		Total 2σ	43	47.78%	47	52.22%	0	0%	90
d.	3σ	CV.CV.CV	21	58.33%	14	38.89%	1	2.78%	36
e.		CV.CVC.CV	15	60%	10	40%	0	0%	25
f.		CVC.CV.CV	23	60.53%	15	39.47%	0	0%	38
g.		CVC.CVC.CV	18	60%	12	40%	0	0%	30
h.		Total 3σ	77	59.69%	51	39.53%	1	0.78%	129
i.		Total unchanged	120	54.79%	98	44.75%	1	0.46%	219

In the disyllabic stems, the division of stress was ~48% final and ~52% penultimate (42c), which, considering the actual counts, is random. In trisyllabic stems (42h), the division of stress was distributed between two final syllables: ~60% on the final and ~44.5% on the penultimate syllable, meaning that the majority of stress was on the suffix which was added to the stems (while the initial stem final vowel was dropped).

(43) *Low frequency V-pattern inflected stems – word length unchanged*

	Stem type		Final		Penultimate		Antepenult.		No. words
a.	2σ	CV.CV	20	48.78%	21	51.22%	0	0%	41
b.		CVC.CV	20	50%	20	50%	0	0%	40
c.		Total 2σ	40	49.38%	41	50.62%	0	0%	81
d.	3σ	CV.CV.CV	25	54.35%	21	45.65%	0	0%	46
e.		CV.CVC.CV	17	38.64%	27	61.36%	0	0%	44
f.		CVC.CV.CV	17	42.50%	23	57.50%	0	0%	40
g.		CVC.CVC.CV	21	50%	21	50%	0	0%	42
h.		Total 3σ	80	46.51%	92	53.49%	0	0%	172
i.		Total unchanged	120	47.43%	133	52.57%	0	0%	253

In disyllabic stems, the division of stress was virtually equal between final and penultimate syllables (43c). In trisyllabic words the division of stress was also very similar for final and penultimate syllables with ~47% final and ~53% penultimate stress

(43h). A result of a chi-square test showed that there is no significance to this difference, $\chi^2 = 0.837$, $p = 0.3602$

4.3. Discussion

Section 4.3.1 summarizes the tendencies of stress observed in both the high frequency vocalic pattern group and the low frequency vocalic pattern group and draws conclusions about the experiment's results. Section 4.3.2 offers further discussion of the stress tendencies displayed in the experiment.

4.3.1. Summary of stress tendencies

The experiment was designed to test whether there would evidence for a default stress mechanism in Hebrew and if there is, whether it would be influenced by the following factors:

a. Number of syllables in the word (2 vs. 3).

b. The structure of (non-final) syllables (CV vs. CVC).

c. Word final segment (C vs. V).

d. The morphological status of the word (bare stem vs. suffixed/inflected form).

e. Specifically for Hebrew, the novel words were divided into two groups on the basis of the frequency of the V-pattern (high vs. low frequency), in order to control stress assignment by analogy to existing word groups.

The results suggest the existence of a default stressing system (tables (26)-(31), (38)-(41)). The data show preference for specific stress placements tendencies, which are consistent across various word groups. The overall position of the stress is at the right word edge.

As to the factors presented in a-e: the results suggest that the number of syllables in the word and the structure of syllable (when non-final) do not play a role in stress assignment (tables (28) and (29) for disyllabic stems, tables (30) and (31) for trisyllabic stems). Both disyllabic and trisyllabic stems displayed similar percentages of stress distribution and there were no systematic differences in stressing among words of same length and same final segment but different non-final syllable structure. The only instance in which there was a significant deviation in distribution of stress (30h) cannot be explained by the influence of syllable weight or word length, since all the other word shapes conformed to the general stress patterns. This deviation can be attributed perhaps to the specific choice of words assigned to this specific template.

The final segment (the structure of the final syllable), however, did play a role in stress assignment: in V-final stems stress was mostly penultimate, while in C-final stems, the stress was mostly final. This result was consistent across all the different stem templates and V-pattern frequencies.

Frequency proved to be another factor that influenced the assignment of stress. From the comparison of matching rows of the general bare stems counts tables ((26) and (27)), it is possible to see that the high frequency V-pattern stems had significantly more final stress than the low frequency V-pattern stems. The results of this comparison using a chi-square test are brought in (44) below:

(44) *Chi-square analysis: high vs. low frequency V-patterns*

	Stem type	**χ^2 value**	**p value**	**significant**
a.	Total V-final	2.61	0.106	X
b.	Total C-final	45.668	0	√
c.	Total 2 σs	9.508	0.002	√
d.	Total 3 σs	15.245	0	√
e.	Total words	24.695	0	√

The table shows, that the difference in stress pattern between high frequency V-pattern and low frequency V-pattern words is significant (rows b-e). The only instance in which the difference in stress pattern was not significant was in V-final stems (43a), presumably because of the general need to stress V-final stems on the penultimate syllable. Therefore, it was the C-final stems in which the most difference between stress patterns of high frequency V-patterns and low frequency V-patterns was observed (43b). No significant differences in stress patterns between various vocalic patterns of the same frequency were found (see tables (32) and (33)).

When considering the effects of morphology on stress placement, tables (34) and (35) show that for both high frequency and low frequency V-pattern novel stems, there was no significant difference regardless of whether the novel word stem final segments matched an existing noun suffix or not. The second part of the experiment (novel stems in inflection §4.2.5.2) revealed the following tendencies: C-final inflected stems exhibited a consistent pattern of placing the majority of stress on the stem final (suffixed word penultimate) syllable, followed by stress on the suffix ((38)-(41)). V-final inflected stems, however, did not exhibit a clear stressing pattern, no matter whether they simply had a suffix added (38-41) or, in addition, the vowel hiatus was resolved (42). In several instances, the stress was distributed almost equally between two or more syllables ((38c), (39c), (41e), (42c), (43)).

These results suggest that inflectional morphology does play a role in stress assignment and when the speakers are aware of the morpheme boundary, as in morphologically "simple" C-final novel stems, they tend to preserve stress in its position on the stem (38)-(41), rather than shift it to the suffix, as is usually the case in Hebrew (see §4.1.1, §4.1.2). Although, it must also be noted that when choosing between stressing stem penultimate syllables and the suffix, the tendency was to stress the suffix, which might be an indication that there was some influence of existing high frequency stress patterns. When the morpheme boundary was not clear, as in V-final stems which could have been morphologically "complex" in the first place, there was usually no clear stressing tendency. This finding could be an indication that when unable to clearly identify the morphological boundary, the participants were stressing by analogy to similar words, thus resulting in non-uniform stress patterns.

4.3.2. Hebrew default stress

The data obtained from the experiment suggest the following default stress system for Hebrew:

a. Pattern: stress is final in C-final stems and penultimate in V-final stems.
b. Paradigm: stress is immobile, i.e. it stays in its original position in the stem when a suffix is added (given that a morphological boundary is evident).

The default stress pattern does not seem to conform with the existing stress patterns in Hebrew (§4.1.1), which are not sensitive to the word final segments (e.g. *ʃaná* ‘year’, *zanáv* ‘tail’, *pére* ‘wild’, *pérek* ‘chapter’). Also, immobile stress is rather marginal in Hebrew, limited to about 23% of the words in the dictionary.

However, Hebrew acronym words do exhibit a stress system which emerged in this experiment, namely that stress is final in C-final words, and penultimate in V-final words, and immobile in inflection (Bat-El 1994). Note that although the formation of acronym words is based on written representation, they respect language-specific restrictions even with greater tendencies towards the unmarked universal structures (Bat-El 1994, 2000, Zadok 2002). For example, Hebrew acronym words allow only CV and CVC syllables, while other nouns in the language allow complex onsets (restricted mostly to word initial onset). The convergence of the default stress pattern with that of the acronym words, rather than with the most frequent stress system (i.e. final stress) is an indication that penultimate stress in V-final and final stress in C-final words are the default stress patterns.

The question that arises is whether this stress pattern is because the final vowels in V-final words are treated as suffixes and stress is stem final. The results of the experiment and the analysis of acronym words (Bat-El 1994) suggest that this might not be the case. Tables (34) and (35) show that the difference in stress distribution between novel word stems whose final segments matched nominal Hebrew suffixes vs. novel word stems whose final segments did not match nominal suffixes was not statistically significant.

That is, the results from the second part of the experiment suggest that when a morpheme boundary is evident, stress tends to be placed on the syllable immediately preceding the suffix. In addition, in V-final acronym words, the final vowel does not correspond to a vowel suffix but rather to a glottal consonant. Therefore, it is possible to suggest that the placement of Hebrew default stress is indeed not identical in V-final and C-final words.

The immobility of stress in paradigms being the default stress pattern is supported by study of Pariente and Bolozky (2007). The authors state, that although mobile final stress is the most frequent pattern in Hebrew (see also §4.2.5.2), new loan words tend to retain their initial stress placement, which also remains in its original place when the word is being inflected (added a suffix). In addition, Pariente and Bolozky (2007) state that immobile stress is also present in other word groups such as loan words, children's word plays, informal familiar register, and already mentioned acronym words. Therefore, the authors conclude, immobile stress is the default productive stress paradigm of Modern Hebrew.

The results of the experiment also suggest that analogy to existing words plays a role in the speakers' assignment of stress to novel words. In words with high frequency V-patterns, there is a greater tendency towards final stress, which is the predominant stress pattern in Hebrew. This suggests that speakers assign stress on the basis of similarity with existing words, and the default stress pattern emerges mostly with novel words, which are dissimilar from existing words. Therefore, the question is whether the penultimate or trochaic stress, percentages of which were significantly higher in low frequency V-pattern words (44), is the "true" default stress pattern in Hebrew.

As of now, there is no consensus about the answer to this question and different researches come to different conclusions, depending on the framework they adopt. For example, Pariente and Bolozky (2007) state that immobile stress, which they consider to be default in Hebrew, often corresponds with a trochaic stress pattern, i.e. a final trochaic foot. The study of Becker (2003a) based on acoustic studies of phrases reaches the same conclusion. In addition, Hebrew hypocoristics (Bat-El 2005), another peripheral word group, which, like the acronym words, exhibits the emergence of the unmarked (McCarthy and Prince 1994), exhibit an obligatory trochaic foot. On the other hand, Graf and Ussishkin (2003) propose a system, according to which Hebrew does not have a preference for a particular foot, but the emerging stress is the result of interactions of constraints.

Studies in child language acquisition by Ben David (2001), Adam and Bat-El (2007), and Levinger-Gottlieb (2007) show, that trochaic stress is the one to emerge initially in children's productions, before they acquire the actual stress pattern distributions in Hebrew, which are mostly final or iambic (Bolozky and Becker 2006). However, this instance of emergence of the trochaic stress is considered to be an expression of the universal preference for trochees (Hayes 1995). Therefore, another question that can be asked here, is whether the preference for trochees in the default stress system of Hebrew, which emerged in these other studies, is, in fact, evidence of universal principles. This question requires further research.

5. General discussion

In the following §5.1, I compare the findings from the experiments on Russian and Hebrew, in §5.2, I propose a basic theoretical analysis of the default stress systems for Russian and Hebrew, and in § 5.3, I provide my concluding remarks.

5.1. Comparison of stress patterns emerging from the experiments

In this study, two languages with unpredictable stress were examined in order to find evidence for a default stress system in these languages and to examine the factors that affect the default stress assignment. For both languages evidence of such systems was found. The comparison between these systems reveals the following:

a. In both languages, the position of the default stress was at the right edge of the word.
b. In both languages, the assignment of default stress was not affected by the structure of the non-final syllables or the number of the syllables in the word.
c. In both languages, the position of stress was affected by the structure of the final syllable, i.e. whether the final segment of the word was a consonant or a vowel. In both languages, V-final words exhibited significantly more penultimate stress than the C-final words. However, in Russian, the majority of V-final words still bore final stress, while in Hebrew the majority of V-final words bore penultimate stress.
d. In both languages, the morphological status of the word (whether it was a bare stem or had a morpheme boundary) affected the placement of stress. In the second part of the experiments (novel words in inflection), both languages preferred to maintain the stress in its original position on the stem, if a morpheme boundary was evident. Thus, in both languages C-final novel stems were easier to inflect than V-final stems and their patterns of stress were more uniform. The inflection of V-final stems, which could potentially consist of more than one morpheme, proved to be more difficult for the participants, something which resulted in stress assignment which was close to random.

e. In both languages, the emerging default patterns of stress, both in the bare stems and in the inflection condition, resembled those found in some of the periperal word groups within each language (see §3.3.2 for Russian and §4.3.2 for Hebrew).

5.2. Theoretical analysis

In this section, I propose a basic theoretical analysis for the default stress systems which emerged in this study. For the purpose of the analysis, I use the framework of Optimality Theory (Prince and Smolensky 1993). According to this framework, the grammar consists of a set of universal, violable constraints on output representations. The constraints are ranked by a hierarchy specific to each language. A higher ranked constraint takes precedence over a lower ranked constraint in determining the ultimate shape of the output. The actual output results from the process where a set of universal operations (GEN) maps a given input representation into a large set of potential outputs. These candidate outputs are evaluated against a ranked set of constraints, and the one that best satisfies the constraints is selected as the actual output (Myers 1997).

In this analysis, I examine possible constraints that determine the default stressing systems in Russian and Hebrew. I begin with the following constraint:

(45) *μ_{CODA}

Consonants cannot be parsed as moraic (Sherer 1994).

This constraint ensures the lack of weight distinction between CV and CVC syllables in default stress systems of both Russian and Hebrew. Considering that both languages do not show distinction in syllable weight in all their word groups, it is possible to assume that this constraint is never violated.

Another constraint which is prominent in default stress systems of both languages is presented below:

(46) FINAL-C$]_{\text{stem}}$

A stem ends in a consonant (McCarthy and Prince 1994).

The prominence of the above constraint in default stress systems of Russian and Hebrew is supported by data from the experiments in this study and by the linguistic data from both languages. The results from both Russian and Hebrew experiments (§3.3.1 and §4.3.1) show that C-final novel stems were easier to inflect, and in both parts of Russian and Hebrew experiments, they had much more consistent stress tendencies than the V-final stems. In both languages, C-final stems had significantly more final stress than V-final stems, suggesting that it was easier for the participants to perceive them as one morphological unit, as opposed to V-final stems. The linguistic data of both Russian and Hebrew shows that the majority of word stems in these languages are C-final (see §3.1.2 for Russian, §4.1.2 for Hebrew), a fact that supports the prominence of the above constraint in the linguistic system of both languages.

I continue with a constraint which assigns stress at the right edge of the stem, a property that emerged in both Russian and Hebrew default stress systems:

(47) RIGHTMOST($\acute{\sigma}$)$]_{stem}$

Rightmost syllable of the stem has to be stressed (Cohn and McCarthy 1994).

At this point the difference between two default stress systems should be considered. Recall that in Russian, both C-final and V-final words had final stress, while in Hebrew, C-final words had final stress and V-final words had penultimate stress (§5.1). The results from both experiments suggest that the exact placement of the stress is dependent on the degree of alignment of the right edge of the stem (as perceived by the participants) with the right edge of the novel word. Therefore, the following constraint is needed:

(48) ALIGNR (STEM, PRWD)

The right edge of the stem coincides with the right edge of the prosodic word (McCarthy & Prince 1993a).

I propose that the ranking of constraints in (46) and (48) is different in Russian and Hebrew default stress systems. In Russian, ALIGNR is ranked above FINAL-C$]_{stem}$, resulting in alignment of the perceived novel word stem with the final segment of the novel prosodic word, be it a consonant or a vowel i.e. …CV]} (where] indicates a stem edge and } a prosodic word edge). In Hebrew, the ranking is reversed, resulting in the misalignment of the stem with the final segment of a prosodic word, in case of V-final input i.e. …C]V}, but respecting FINAL-C]stem. I support my proposal with tableaux (49) and (50) for Russian and with tableaux (51) and (52) for Hebrew.[15]

(49) *Russian V-final bare stems*

Input: lʲem.pi.ra	**RIGHTMOST(σ́)]stem**	**ALIGNR**	**FINAL-C]stem**
a. ☞[lʲem.pi.rá]}			*
b. [lʲem.pí.r]a}		*!	
c. [lʲem.pí.ra]}	*!		*

The above tableau correctly predicts the most frequent output for a Russian V-final novel word (49a). Candidate (49b), despite respecting both FINAL-C]stem and RIGHTMOST(σ́)]stem violates ALIGNR and candidate (49c) does not have the obligatory stem final stress.

(50) *Russian C-final bare stems*

Input: ru.dʲer.pis	**RIGHTMOST(σ́)]stem**	**ALIGNR**	**FINAL-C]stem**
a. ☞[ru.dʲer.pís]}			
b. [ru.dʲer.pí]s}		*!	*
c. [ru.dʲér.pis]}	*!		

The above tableau demonstrates that this ranking of constraints predicts the correct output for a C-final novel stem as well. Candidate (50b) violates both ALIGNR and FINAL-C]stem and candidate (50c) violates the need for a rightmost stress, while candidate (50a) does not violate any constraint and therefore is chosen as the final output.

[15] I do not include the *μ CODA in the tableaux, since there was no evidence whatsoever that it could be violated and therefore, it is not relevant to the rankings of other constraints.

(51) *Hebrew V-final bare stems*

Input: xin.ba.do	**RIGHTMOST(σ́)]stem**	**FINAL-C]stem**	**ALIGNR**
a. [xinbadó]}		*!	
b. ☞[xinbád]o}			*
c. [xinbádo]}	*!	*	

The above tableau shows that reversed ranking of ALIGNR and FINAL-C]stem (from that of Russian (49),(50)) correctly predicts the output of a V-final Hebrew novel word. Candidate (51a), which could be a valid output for Russian (see (49a)) is eliminated in Hebrew because it violates FINAL-C]stem. Candidate (51b) which respects FINAL-C]stem and RIGHTMOST(σ́)]stem is the chosen one, despite violating ALIGNR, (compare with (49b) in Russian). Candidate (51c) does not respect the obligatory RIGHTMOST(σ́)]stem and therefore is invalid.

(52) *Hebrew C-final bare stems*

Input: ri.ken.dil	**RIGHTMOST(σ́)]stem**	**FINAL-C]stem**	**ALIGNR**
a. ☞ [ri.ken.díl]}			
b. [ri.ken.dí]l}		*!	*
c. [ri.kén.dil]}	*!	*	

The above tableau shows that this ranking correctly predicts the stress placement for C-final Hebrew stems as well. Candidate (52b) violates both FINAL-C]stem and ALIGNR and candidate (52c) violates the need for a rightmost stress, while candidate (52a) does not violate any constraint and therefore is chosen as the final output.

And now I address the default stress placement in inflectional paradigms. In both Russian and Hebrew stress tends to retain its original place on the stem when the novel word is inflected. Therefore, a constraint demanding identity of stress between the base form and the derived form is needed:

(53) Paradigm Uniformity (stress) = PU(stress)

Let F be a form exhaustively analyzable into the constituents A(F), an affix, and S(F), a stem. If a realization of S(F) occurs as a free word W, then, for every syllable s in S(F), if s has a correspondent s' in W then s has the same stress category (stressed or stressless) as s' (Steriade 2000).

PU(stress) demands that the correspondent syllables in related words be stressed identically. It is worth mentioning, that despite being prominent in the default stress systems of Russian and Hebrew, this constraint does not account for all the inflectional paradigms in Russian (§3.1.1) and most of the inflectional paradigms in Hebrew (§4.1.1). The data from the experiments from this study, however, suggests that in the default stress systems of these languages, this constraint is ranked above those in (46)-(48).

In this section, I have shown that the difference between the default stress systems of Russian and Hebrew stems from the different ranking of two constraints which are prominent in these systems.

5.3. Concluding remarks

The default stress systems of Russian and Hebrew, as they emerged from this study, turned out to have both similar and distinctive properties (see §5.1). Considering the fact that besides having unpredictable stress these languages are otherwise very different, the following question arises: do the properties that are shared by default stress systems of these languages exist in default stress systems of every language with unpredictable stress? In other words, are these properties universal?

This question needs to be examined with great precision. On the surface, the answer seems to be “no”. Findings from similar experiments in other languages with unpredictable stress revealed that their default stress systems may have different properties from those which emerged in this study. For example, studies on Greek (Protopapas et al 2007) and Italian (Colombo 1992, Krämer 2006) show that when being presented with unstressed stimuli, the participants tended to choose the statistically most prominent stress, which happens to be penultimate in both languages. This is different from the findings of this study, in which default stress patterns were mostly associated with statistically non-frequent word groups (such as acronym words). However, languages where frequency converges with universal tendencies cannot provide evidence for either (Adam and Bat-El in progress).

In addition, certain traits of default stress systems in this study seem to violate universal generalizations. Iambic-Trochaic law proposed by Hayes (1995) states that iambic stress can only be found in languages in which syllable weight is distinctive. In languages where syllable weight is not distinctive, the stress pattern tends to be trochaic. The Russian default stress system (§3.3.1) seems to violate Hayes' (1995) proposal, since its major stress pattern was stem final and therefore iambic, while there is no evidence of syllable weight being distinctive. Hebrew, on the other hand, does seem to concur with Hayes' (1995) proposal, since its default stress system showed evidence that a trochaic stress pattern might be the default one (§4.3.1).

However, under closer examination, the above facts might not necessarily contradict the universal generalization. Hayes' (1995) Iambic-Trochaic law is restricted to **bounded** and **rhythmic** stress systems, or in the case of mixed systems, the parts of systems that are **bounded** and **rhythmic** (Hayes 1995: 33). The question is, therefore, whether default stress systems of Russian and Hebrew are bounded and rhythmical, and therefore, have to "obey" Hayes' (1995) generalization.

I propose that the answer to this question lies in the secondary stress systems of both languages. In Russian, secondary stress is a purely phonetic feature and its location is restricted to the first syllable of the word (Kuznetsova 2006), i.e. its distance from the location of primary stress is not constant.[16] In Hebrew, on the other hand, secondary

[16] I speak strictly of Russian secondary stress which is a result of phonetic factors and not the one which bears semantical properties in compound words (Kuznetsova 2006).

stress is of rhythmic alternating type (Bolozky 1982), and is assigned to every other syllable to the left of the main stressed syllable. These data show that there is no evidence for the Russian stress system being rhythmical, while the Hebrew stress system does have rhythmical parts. Therefore, it is possible to expect to observe Hayes' (1995) generalization in Hebrew but not in Russian.

The above facts stress again the need to approach the topic of universal properties which can surface in experimental studies with caution. In addition to which universal properties can be uncovered, the question of how to uncover them in experimental studies should also be considered. Although the method of experiments in this study and those previously mentioned for Greek (Protopapas et al 2007) and Italian (Colombo 1992, Krämer 2006) was similar in that they used novel words, it was still not identical, and the stimuli were constructed and presented differently in each experiment. Therefore, it is possible that due to methodological differences, each experiment triggered different components of the languages' default stress systems.

To conclude, the current experimental study revealed that both Russian and Hebrew have a default stress system. Both languages assign stress at the right edge of the stem, and preserve its placement in inflectional paradigms. However, the languages differ with respect to the designation of the end of the stem. Studies of other languages with lexical stress need to be conducted to reveal if this is indeed the default stress pattern adopted by languages with unpredictable stress.

APPENDIX A: **Stimulus words used in the Russian experiment** (the underlined segments are identical to Russian nominal suffixes).

a. Disyllabic words

i. V-Final

CV.CV	CVC.CV
vo.na	nal.ba
lo.ro	pʲen.go
lʲufu	t͡san.vo
t͡ʃa.fu	bar.ʃe
xo.ta	t͡ʃom.pe
sa.ge	fʲen.su

ii. C-Final

CV.CVC	CVC.CVC
ka.lam	pʲen.tan
ra.don	sar.dax
ko.bom	nan.sam
xu.rax	lir.vom
di.nas	mar.mit
sʲe.t͡sir	mak.vis

b. Trisyllabic words

i. V-Final

CV.CV.CV	CV.CVC.CV	CVC.CV.CV	CVC.CVC.CV
sa.pa.ʒu	mo.lib.de	kol.ʃi.da	mor.sun.ke
ga.ri.ga	lʲa.dun.ke	lʲem.pi.ra	sin.tan.vu
la.nu.go	ka.bar.go	sʲen.ta.vo	ben.tar.me
ga.ko.nu	ba.ran.tu	sol.pu.go	sam.sar.do
mu.lʲu.re	t͡ʃu.rin.ga	kan.dʲe.lu	pam.kʲer.tu
sʲe.mʲe.ma	ʃa.xin.ʃo	t͡ʃar.va.ke	far.ʃin.za

ii. C-Final

CV.CV.CVC	CV.CVC.CVC	CVC.CV.CVC	CVC.CVC.CVC
ka.ni.fax	nʲe.pʲen.tax	gam.zi.kaz	gan.zol.dʲer
sʲa.mi.sam	gʲe.lʲer.tom	san.da.ram	tʲer.pʲen.tam
bʲe.dʲe.xox	dʲe.tan.dam	min.ta.got͡s	tʲer.pon.sax
va.ri.kap	pa.ran.gon	gar.no.kit	vʲer.bun.kom
ba.ri.bal	pa.kʲer.bod	fʲel.sa.tax	fom.sal.kid
fi.za.lig	ru.dʲer.pis	lad.ro.pom	dam.zol.ʃan

APPENDIX B: Stimulus words used in the Hebrew experiment (the underlined segments are similar to Hebrew nominal suffixes)

(1) High frequency V-pattern words

a. Disyllabic words

i. V-final

CV.CV	CVC.CV
pa.mi	ral.di
ga.ʃi	gar.xi
ra.la	zal.ʃa
sa.t͡sa	dal.za
t͡sa.ko	ran.to
za.to	san.go

ii. C-final

CV.CVC	CVC.CVC
ga.xib	zam.fit
ʃa.ʃit	gan.din
za.sag	pan.gan
fa.ban	sam.ʃax
sa.kod	kam.dol
ka.bon	zar.von

b. Trisyllabic words

i. V-final

CV.CV.CV	CV.CVC.CV	CVC.CV.CV	CVC.CVC.CV
ʃa.ga.fa	sa.gan.ta	kam.ʃa.ta	gal.ban.da
t͡sa.ta.ma	ga.nal.ga	gar.ga.na	kar.zan.da
gi.t͡sa.zo	ki.gan.ʃo	dim.ka.ro	ʃir.man.do
gi.ra.go	di.lan.t͡so	xin.ba.do	kir.mar.so
ra.du.ga	ka.run.fa	san.pu.xa	kal.dun.fa
ka.lu.ra	ga.lun.ba	fal.gu.za	zar.guz.ka

ii. C-final

CV.CV.CVC	CV.CVC.CVC	CVC.CV.CVC	CVC.CVC.CVC
da.na.tas	ga.lan.kaf	ʃam.sa.fan	ʃal.kal.dat
ʃa.da.t͡san	ʃa.ram.ʃan	gan.xa.saf	gal.sam.tan
fi.ba.rot	si.pal.don	kil.da.zok	dir.tal.xon
ri.ma.gon	si.ram.koʃ	dir.ka.ʃon	sir.dal.dor
t͡sa.bu.daz	da.mur.lan	sar.pu.dar	par.kur.kar
ga.gu.ʃan	ra.nun.fak	gar.tu.lan	ʃan.sur.tan

(2) Low frequency V-pattern words

a. Disyllabic words

i. V-final

CV.CV	**CVC.CV**
ru.ki	zur.di
du.ni	dum.zi
ko.to	zol.ko
ʃo.zo	ʃon.ko
fo.xu	gon.ʃu
go.ku	kol.ku

ii. C-final

CV.CVC	**CVC.CVC**
su.t͡ʃit	ʃur.sit
xu.diz	zum.kiʃ
fo.ron	xor.t͡ʃon
ʃo.rox	gor.ʃok
go.lub	kol.tun
do.fut	ron.kut

b. Disyllabic

i. V-final

CV.CV.CV	**CV.CVC.CV**	**CVC.CV.CV**	**CVC.CVC.CV**
ko.ga.me	ro.man.de	dor.ga.me	for.kan.de
po.za.te	go.mam.te	kor.ka.te	gon.t͡ʃar.fe
ra.lu.du	ʃa.bun.du	sal.tu.mu	t͡sar.dum.gu
xa.ru.ku	ra.zum.xu	dar.zu.ru	xal.bul.du
zi.te.li	gi.t͡ser.si	ʃin.fe.si	kil.zer.fi
ri.t͡se.ri	pi.ler.gi	ril.de.ti	sir.del.gi

ii. C-final

CV.CV.CVC	**CV.CVC.CVC**	**CVC.CV.CVC**	**CVC.CVC.CVC**
ro.sa.let	ko.mar.ket	zor.ba.led	ʃor.ban.deʃ
so.va.rek	so.ban.kes	ʃom.da.ʃet	zot.bal.bet
t͡sa.tu.ruf	da.mun.xul	fal.gu.lud	kar.bun.kut
sa.mu.lut	ra.fum.dut	gar.du.mut	dal.bun.zur
fi.ge.t͡sit	ri.ken.dil	gil.ke.rix	zil.ber.nit
ʃi.le.zim	zi.ler.tit	ʃim.ke.xit	ʃim.zel.xis

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