Journal of Experimental Psychology:
Learning, Memory, and Cognition
2005, Vol. 31, No. 6, 1293–1326

0278-7393/05/$12.00 DOI: 10.1037/0278-7393.31.6.1293

Orthographic Structure Versus Morphological Structure: Principles of Lexical Organization in a Given Language

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Most models of visual word recognition in alphabetic orthographies assume that words are lexically organized according to orthographic similarity. Support for this is provided by form-priming experiments that demonstrate robust facilitation when primes and targets share similar sequences of letters. The authors examined form-orthographic priming effects in Hebrew, Arabic, and English. Hebrew and Arabic have an alphabetic writing system but a Semitic morphological structure. Hebrew morphemic units are composed of noncontiguous phonemic (and letter) sequences in a given word. Results demonstrate that form-priming effects in Hebrew or Arabic are unreliable, whereas morphological priming effects with minimal letter overlap are robust. Hebrew bilingual subjects, by contrast, showed robust form-priming effects with English material, suggesting that Semitic words are lexically organized by morphological rather than orthographic principles. The authors conclude that morphology can constrain lexical organization even in alphabetic orthographies and that visual processing of words is first determined by morphological characteristics.

Keywords: orthography, morphology, lexical organization, form priming

In the present article, we focus on mapping the major principles of lexical organization in a language. We promote an ecological approach to visual word recognition by focusing on how the linguistic environment of the native speaker shapes the internal structure of lexical knowledge. We thus put forward the final conclusion of our investigation: The principle of organization and processing of words in alphabetic orthographies are primarily determined by the language's morphological characteristics.

In the literature on visual word recognition, it is often assumed that words are represented as points in a high-dimensional perceptual space that is defined in terms of orthographic, phonological, and semantic properties (e.g., Rueckl, 2002). Words that are close together in this perceptual space will tend to overlap in orthography, phonology, or meaning. The process of word recognition is then described in terms of a trajectory of the system through its state space. The initial point of this trajectory is some random position in the state space, and the final point is an attractor basin corresponding to the input word. The time taken to recognize a word is determined by the time it takes to traverse this path. Each word has a unique attractor, and the positions of the attractors in the state space are organized to reflect similarities in spelling, pronunciation, and meaning.

The most promising method of studying the properties of this space is to use a priming paradigm. Priming effects in this approach are seen as the consequence of a change in the initial starting position. When the prime is presented, the system moves toward the attractor for the prime (if the prime is a nonword, the system moves toward the location dictated by its form alone). If the properties of the prime overlap with those of the target, then their attractors will be near each other, and, hence, moving toward the attractor for the prime also involves moving toward the attractor for the target. When the prime is replaced by the target, the starting point for the new trajectory will be closer to the final destination than if the prime had been completely unrelated to the target. Such a network has been used to simulate priming that is due to semantic similarity (Masson, 1995; Plaut & Booth, 2000), and the same principles apply to priming that is due to similarity of form.

Surprisingly, the first attempts to demonstrate priming that was due to orthographic similarity (i.e., form priming) failed to detect any facilitatory effects (Martin & Jensen, 1988; Meyer, Schvaneveldt, & Ruddy, 1975), and later experiments confirmed these results (Humphreys, Evett, Quinlan, & Besner, 1987; Lupker & Colombo, 1994). In these experiments, the duration of the prime was long enough for the prime to be plainly visible. However, later research revealed that if the prime was presented very briefly immediately prior to the target, and was heavily masked, positive benefits of the prime could be detected (Forster, Davis, Schoknecht, & Carter, 1987), although only under certain conditions. For example, Segui and Grainger (1990) found that if the prime was much higher in frequency than the target, the effects were inhibitory, but facilitation was obtained if the frequencies of prime and target were similar. In addition, facilitatory effects appear to be restricted to targets that are located in sparsely populated regions of lexical space. Forster et al. (1987) found strong facilitation for longer words (e.g., *altitude–ATTITUDE*), but either no effect or an inhibitory effect for short words (e.g., *fact–FACE*). This was attributed to the fact that short words tend

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This study was supported in part by Binational Science Foundation Grant 00-00056 and in part by National Institute of Child Health and Human Development Grant HD-01994 to Haskins Laboratories.

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to have many more neighbors than long words (a neighbor being a word with similar spelling). Subsequently, facilitatory effects have been repeatedly demonstrated across many languages (e.g., in English: Forster & Taft, 1994; Forster & Veres, 1998; in French: Ferrand & Grainger, 1994; in Spanish: Perea & Rosa, 2000; in Dutch: Brysbaert, 2001). It should be noted that none of these effects occurs reliably for nonword targets, suggesting that the priming effect depends crucially on the existence of a lexical representation for the target.

Although the precise conditions that control form priming are not completely understood, it is clear that words that are located in adjacent regions of lexical space somehow interact, so that activation of the central correlates of one word has an effect on the central correlates of the other word. To find out more about this process, it is necessary to consider carefully how *similarity* should be defined. The definition adopted by most researchers is that two words are to be considered as neighbors if they are of the same length but differ by a single letter, for example, *face* and *race* (Coltheart, Davelaar, Jonasson, & Besner, 1977). A critical assumption involved in these definitions is that words can be specified in terms of a position-specific letter code (Grainger & Jacobs, 1996). Thus the word *face* is said to consist of the units F1, A2, C3, and E4, where F1 means the letter *F* in first position, and so forth. Most models of visual word recognition in alphabetic orthographies[1] implicitly assume that the sublexical units mediating recognition of printed whole words have this sequential and contiguous characteristic. The most prominent current examples are the classical localist models such as the interactive activation model (IA; McClelland & Rumelhart, 1981), the dual-route-cascaded model (DRC; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001), and the multiple read-out model (MROM; Grainger & Jacobs, 1996). The IA and MROM models are based on absolute position-specific letter detectors, whereas in the DRC computational model, letter position is coded relative to the beginning of the letter string. An alternative view proposed by Ziegler and Perry (1998) is that words are neighbors if they share the body (the vowel plus the following consonants of the first syllable). This allows words of different lengths to be treated as neighbors (e.g., *trace*, *space*, and *race* would all be considered neighbors). Support for this view is provided by the priming effects observed by Forster and Taft (1994), who found that the number of words with the same body as the target word had to be taken into account as well. Such an approach requires a different code that can express structural properties, although relative position is still an important property. Thus, the word *speak* might be coded as follows: (Onset [S1 P1], Body [Vowel {E1 A2}, Coda [K1]). The claim that relative position is important involves predicting that the prime *psaek* would have no priming effect on the target work *speak*. Similar coding schemes have been used in more recent connectionist models (e.g., Harm & Seidenberg, 1999; Plaut & Gonnerman, 2000; Plaut, Seidenberg, McClelland, & Patterson, 1996; see Grainger & Jacobs, 1996, for a discussion).

Some recent studies using masked priming have provided an interesting challenge for these models. First, Humphreys, Evett, and Quinlan (1990) reported that form priming may be obtained when primes are composed only of a subset of the target word's letters. Furthermore, these letters need not be adjacent, as shown by Peressotti and Grainger (1999), who found that *blcn* was a satisfactory prime for the French target *balcon*. Second, when primes share all their letters with the targets, robust form priming is found with small changes in letter order (e.g., Perea & Lupker, 2003; Schoonbaert & Grainger, 2004; and see, for a discussion, Grainger & van Heuven, 2003). These priming effects create difficulties for computational models that encode letter position in absolute terms. To account for the letter-transposition effect, (Grainger and Whitney, 2004; Whitney, 2001) have offered a new approach to letter position coding, which is based on "open bigram" units. Open bigrams do not contain precise information about which letter is adjacent to which (i.e., contiguity). For example, the word *FORM* would be represented by activation of the bigram units *FO*, *FR*, *OR*, *OM*, and *RM*. A transposition prime such as *from* would then share all but one of these units, namely *FR*, *FO*, *RM*, and *OM*. However, note that although the open-bigram scheme codes for noncontiguous letter pairs, sequentiality is still critical, because the open bigrams preserve the relative order of letters (i.e., *FORM* does not contain *OF*, *RF*, etc., as open bigrams). Moreover, contiguity is not entirely abandoned, because only fairly close pairs of letters get coded, that is, anything up to a maximum of two intervening letters. Although it is possible to get priming from noncontiguous sets of letters, the level of contiguity affects priming, and priming should always be greater with completely contiguous letter combinations. Last, sequentiality and contiguity seem to be dependent. When primes are composed of a subset of the target's letters, the shared letters must be in the same order in the prime and the target to obtain a priming effect.

We now come to the central issue addressed in this article, namely, that these definitions of similarity, as a general rule, do not consider morphologically complex words, and if they do, they are all based on the notion that morphemes are formed by constructing a linear sequence of letters–phonemes and that morphologically complex words can be formed by constructing linear sequences of morphemes. This is true of all Indo-European languages. However, it is not true for Semitic languages, such as Hebrew and Arabic, which involve a nonlinear morphology.

Morphological complexity[2] is created in different languages according to different principles. As a rough approximation, the morphological structure of Indo-European languages can be characterized by a linear and sequential concatenation of morphemic units to form multimorphemic words. Thus, both inflectional and derivational morphologies are based on appending prefixes or suffixes to a base morpheme. In some languages these morphological variations may result in phonological variations in the base form (such as *heal* and *health*), but as a general rule the orthographic integrity of the base form remains intact. In fact, in most languages with concatenated morphology, the base forms function not only as morphemes in complex forms but are also free word forms on their own account (such as *dark* in *darkness*). Note that in Indo-European languages the principle that creates morphological complexity is, again, a principle of sequentiality that mimics

[1] It seems obvious that the principles of lexical organization should be different for alphabetic and for logographic orthographies. The article is concerned mainly with alphabetic systems, in which graphemes represent phonological units.

[2] Not all languages necessarily involve morphological complexity, as some languages like Chinese or Vietnamese are monomorphemic. This article focuses on those languages that are morphologically complex.

the alphabetic principle: Similar to simple words, which are created by aligning a sequential string of letters, morphologically complex words are created by aligning a sequential string of morphemes. Some languages with alphabetic orthographies, however, have a different morphological structure. The most evident examples are the Semitic languages such as Hebrew and Arabic.

In Hebrew, most words can be decomposed into two abstract morphemes: the root and the word pattern. Roots in most cases consist of three consonants, whereas word patterns can be either a sequence of vowels or a sequence consisting of both vowels and consonants. The most salient feature of Semitic languages' morphology concerns, however, the special manner with which morphemic units are combined to form morphological complexity. Roots and word patterns are not appended one to the other linearly, as in languages with concatenated morphology. Rather, the consonants of the root are intertwined with the phonemes (and therefore, the corresponding letters) of the word pattern. Roots and word patterns are abstract structures because only their joint combination results in specific phonemic word forms with specific meanings. For example, the Hebrew word *TI***ZMORET** ("orchestra") is a derivation of the root **ZMR** (root letters appear in bold). This root is mounted on the phonological pattern TI- -O-ET (each dash indicates the position of a root consonant). The root **ZMR** alludes to anything related to the concept of singing, whereas the phonological pattern TI- -O-ET is often (but not always) used to form feminine nouns. It is the merging of the root with the word pattern that forms the word meaning "orchestra." Other phonological word patterns may combine with the same root to form different words with different meanings that can be either closely or remotely related to the notion of singing, and other roots may be combined with the word pattern TI- -O-ET, to form feminine nouns. For example, the word **ZAMAR** ("a singer") is formed by combining the root **ZMR** with the phonologic pattern –A–A–, which carries the information that the word is a noun that signifies a profession. Similarly, the root **LBS** (conveying the action of dressing) can be combined with TI- -O-ET, to form the word **TILBOSET** ("a costume").

Given the large number of nominal and verbal patterns that include consonants or vowel letters, the root letters appear in many words as noncontiguous units. Note that the order of the root letters is always preserved, because altering it could form a different root. However, letter contiguity is a different matter. The specific characteristics of each nominal or verbal pattern create forms in which the root letters are either contiguous or not. For example, out of the seven verbal patterns that exist in Hebrew, three patterns constitute the root-letter contiguity, in past-tense forms. This statistic changes, however, in forms inflected in the present and future tenses. Thus, it is difficult to give an accurate estimate of how often root letters are contiguous units in the language. Taking the root **ZMR**, as an example, and considering all its possible inflections and derivations, we find that it has about 90 different printed forms, and in 45 of them the root letters are noncontiguous. In most of these cases, one letter is to be inserted into the root morpheme, although it is also possible that two letters would be placed in between the three root consonants. It should be noted that the distribution of letters into those that can form a root and those that can form a word pattern is highly biased. For example, word patterns typically begin with the letters *H, M, T,* or *N,* whereas some letters like *G* or *S* never belong to any word pattern so they must belong to the root.

The morphological structure of Hebrew (and other Semitic languages) poses a critical problem for any model of lexical organization. On the one hand, Hebrew has an alphabetic orthography, so that the manner with which printed words represent their spoken forms is similar to English.[3] From this perspective, the processing units that are meant to process Hebrew print should have sequentiality and contiguity characteristics. On the other hand, Hebrew morphology considers morphemic elements that are noncontiguous. If these morphemic elements were to be integrated into a model of word recognition, the definition of *perceptual space* for Hebrew would not obey contiguity constraints.

In operational terms, an interesting issue that has not been addressed so far is how to simultaneously model form priming and morphological priming. Perhaps a convincing illustration of this problem can be seen in our previous work on Hebrew morphology, which focused on morphological priming but not on form priming. In a series of recent studies, we have used both masked priming and cross-modal priming to examine the role of roots and word patterns in Hebrew lexical organization and lexical access (Deutsch, Frost, & Forster, 1998; Frost, Deutsch, & Forster, 2000; Frost, Deutsch, Gilboa, Tannenbaum, & Marslen-Wilson, 2000; Frost, Forster, & Deutsch, 1997). We found that within the nominal system, when primes and targets shared an identical word pattern, no priming was observed, either with a lexical decision or a naming task. In contrast, root primes facilitated both lexical decision and the naming of target words that were derived from these roots. In contrast, however, in an additional series of experiments within the verbal system, clear evidence was found for a facilitatory priming effect induced by the word patterns as well as by roots (Deutsch et al., 1998). Our results led us to suggest that Hebrew words are decomposed into their constituent morphemes in the course of word recognition and that these morphemic units determine lexical organization and govern lexical access. According to our model of processing words in Hebrew, all words derived from the same root are clustered through a shared representation of the root morpheme. For conjugated verbs, both the verbal pattern morphemes and the roots are represented on the subword morphological level, and all verbal forms derived from the same verbal pattern morpheme are linked to that shared morphological unit. Thus, according to our model (see Deutsch et al., 1998, for detailed description), there is a system of multiple connections between the word level and the subword morphological level. One set of links connects word units with root units, and another set connects word units with word-pattern units.

One possible interpretation of these findings is that the Hebrew lexical space may be organized in a radically different manner to that of English and other Indo-European languages. In the latter case, the orthographic dimensions of the space specify words in terms of the constituent letters and their absolute and relative positions. In contrast, the Hebrew lexical space may be structured according to the morphological roots. This would mean that all

[3] Admittedly, Hebrew is often considered a deeper orthography because it does not explicitly represent most of its vowel information in print (e.g., Frost, 1995; Frost, Katz, & Bentin, 1987). However, the alphabetic principle of aligning letters representing phonemes remains the same.

words that contained the same root would be clustered together, and the perceptual distance between two words containing different roots would be uncorrelated with their overall orthographic similarity. It should be noted that in regards to this view, the organization is based on the entire root, not the individual letters of the root. This means that words containing similar roots may not be located near each other at all. That is, the roots **Sh.L.X** (meaning "to send") and **L.X.Sh** (meaning "to whisper") are no more similar than **Sh.L.X** and **D.B.R** (meaning "to speak").

To access a word in such a lexicon, it would obviously be necessary to first extract the root, because without the root, the location of the word in lexical space would be completely unknown. Once having identified the root, the precise trajectory is determined by also taking into account the letters of the pattern. This approach is broadly compatible with the known properties of masked priming in Hebrew. We have never observed priming between two words that did not share the same root, even when the root letters overlapped. However, in these cases, the overall orthographic overlap would have been less than is typically used in form-priming experiments. The far more critical test of this theoretical approach would be to examine form priming between words that differ by only one letter. This letter obviously has to be a root letter; otherwise, we would expect a morphological priming effect. The prediction is that there should be no priming at all. That is, even though overall orthographic similarity is high, the difference in the root letters prevents any possibility of priming.

We designed the experiments to test this hypothesis. Unfortunately, to demonstrate a difference between the Hebrew lexicon and the English lexicon, we were forced to try to prove that something does not exist. For this reason, in some experiments we included either an identity condition (the prime is the same word as the target) or a morphological priming condition, in which the root letters are shared, but the overall orthographic overlap is less than in the form-priming condition. Thus, experiments demonstrating clear priming in these conditions but no significant priming in the form priming condition will provide additional strong support for the hypothesis.

Methodological Considerations

All the experiments in the present study were conducted using the masked priming paradigm. The application of this procedure to Hebrew requires the elucidation of several important methodological issues that are relevant to the interpretation of the data.

Print

In Hebrew (see Appendix A for a list of the Hebrew alphabet), letters mostly represent consonants whereas most of the vowels can optionally be superimposed on the consonants as diacritical marks ("points"). The diacritical marks are, however, omitted from most reading material and can be found only in poetry, children's literature, and religious scriptures. The stimuli in our study were presented in unpointed Hebrew characters. This is because adult readers read unpointed print almost exclusively. However, all words selected for the experiments were phonologically unambiguous and could be read as a meaningful word in one way only.

Prime–Target Separation

If the primes and the targets are not cognitively separated, the masked presentation consists virtually of displaying the mask and the target as one prolonged, single presentation. Practically, such a display procedure is equivalent to measuring latencies to the targets from primes rather than from target onsets. In English the separation of primes and targets is often achieved by using uppercase and lowercase scripts. Although Hebrew has two forms of scripts (square and cursive), the cursive script is rarely used in printed material; therefore, we adopted the manipulation of size rather than form. Thus, two versions of the same square font, which differed in their relative size, were used. Targets were always presented in the larger font (20% larger than the primes; font type and sizes: David 20 and 24 for primes and targets, respectively). This guaranteed complete visual masking of the primes by the targets, and also made the primes and the targets physically distinct stimuli (see for a detailed description, Frost, Ahissar, Gotesman, & Tayeb, 2003).

Frequency Factors

In general, Hebrew does not have a computerized database for computing frequency as English, French, or Dutch has. However, previous findings have indicated that masked priming effects are independent of the frequency of the target word (Forster & Davis, 1984; Rajaram & Neely, 1992). One possible concern is that if the prime is very low in frequency, then with very short stimulus onset asynchronies (SOAs), its processing might be insufficiently advanced by the time the target has occurred to produce a normal priming effect. This seems unlikely, because this would lead to weaker repetition priming for low-frequency words compared with high-frequency words, and this is not the case (e.g., Forster & Davis, 1984; Rajaram & Neely, 1992; see Frost et al., 1997, for a detailed discussion). Another concern is that the relative frequencies of primes and targets affect masked priming. Segui and Grainger (1990) have reported such results in French; however, the SOA used by Segui and Grainger was 60 ms, and at 60 ms, some inhibition has been reported from the primes, as subjects may become aware of them. To our knowledge, the findings in French were not replicated in English. Nevertheless, as a precaution, in all experiments reported here, the assignment of words to the roles of prime and target was made at random. More important, all experiments used a within-stimulus design such that identical targets were presented in all experimental conditions.

Experiments 1A and 1B

Form Priming With and Without Identity Priming

Our purpose in Experiments 1A and 1B was to examine whether simple form priming is obtained in Hebrew. Our experiments were similar in their design and methodology to those reported by Forster et al. (1987). The extent of form priming was measured by comparing performance when primes and targets differed from each other by a single letter (the *form-related* condition) to a baseline condition in which the primes were orthographically different from the targets at all or most letter positions. In Experiment 1A, we included a condition in which the primes contained exactly the same letters as the targets, (the *identity* condition) so

we could estimate, as a point of reference, the maximal facilitation that may be obtained in our paradigm given our exposure parameters. Experiment 1B was a replication of Experiment 1A, omitting the identity condition. This was done to avoid possible effects of scaling of orthographic similarity, so that the form-related primes and targets would not appear dissimilar given their contrast with the full repetition condition.

Method

Subjects. The subjects were 96 undergraduate students at The Hebrew University, who were all native speakers of Hebrew and participated in the experiment for course credit or for payment (48 in Experiments 1A and 48 in Experiment 1B).

Stimuli and design. The stimuli consisted of 48 Hebrew target nouns, which were four to six letters long and contained two or three syllables with five to eight phonemes (Appendix B). The mean number of letters was 5.0, and the mean number of phonemes was 6.5. Each target word was paired with three different word primes to create the three experimental conditions: identity, related, and control. Primes and targets in the related condition differed by one letter. The position and number of the substituted letter could be initial, middle, or final, and were always one of the root letters. Primes and targets in the control condition differed by most or all of their letters. An example of the stimuli used in the experiment is presented in Table 1. Forty-eight target nonwords were introduced as fillers. The nonwords were constructed by altering letters of real words so that they were pronounceable but did not resemble existing words and did not contain real roots. An identical procedure for nonword construction was used in all experiments of the present study. Similar to the word targets, the nonwords were also divided into three experimental conditions (identity, related, control). The primes for the nonword targets were nonwords as well.

The stimuli were divided into three lists in Experiment 1A and into two lists in Experiment 1B. Each list contained 16 words and 16 nonwords in each of the three experimental conditions in the first experiment and 24 words and nonwords in each of the two experimental conditions in the second experiment. The stimuli were rotated within the conditions in each list by a Latin square design. Sixteen and 24 subjects were tested in each list in Experiments 1A and 1B, respectively, allowing each subject to provide data points in each condition, yet avoiding stimulus repetition effects.

Procedure and apparatus. The experiment was conducted on an IBM Pentium III. The software used for presentation of stimuli and for measuring the reaction times (RTs) was the DMDX display system developed by K. I. Forster and J. C. Forster at the University of Arizona. Each trial consisted of three visual events. The first was a forward mask consisting of a row of eight hash marks that appeared for 500 ms. The mask was immediately followed by the prime with an exposure duration of 43 ms. The prime was in turn immediately followed by the target word, which remained on the screen until subjects responded. All visual stimuli were centered in the viewing screen and were superimposed on the preceding stimuli. Two versions of David font were used for primes and targets, differing in their size by 20%. The procedure and apparatus were identical in all the experiments reported in the present article.

Subjects were instructed to make lexical decisions to the targets by pressing a "yes" or a "no" key on the computer keyboard. Their responses were immediately followed by feedback, printed on the screen, that indicated whether the response was correct and the latency of the response. The initiation of each trial was controlled by the subjects who pressed the space bar when they were ready. No mention was made of the existence of the primes.

Results

RTs for correct responses in the experimental conditions were averaged across subjects and across items. Within subject, RTs that were outside a range of two standard deviations from the subject's mean were curtailed. The effect of outliers was minimized by establishing cut-offs of two standard deviation units above and below the mean for each subject. Any RTs exceeding these cutoffs were replaced by the appropriate cutoff value. Trials on which an error occurred were discarded. This procedure was repeated in all of the following experiments. The effects of the identity and related primes were assessed relative to the control baseline. The results are presented in Table 2.

Experiment 1A. Lexical decisions to targets were facilitated in the identity condition (33 ms) when the primes and the targets were the same word. The more interesting result, however, concerns lexical decisions to target words with form-related primes. Facilitation in this condition was relatively small and nonsignificant (8 ms).

The results were subjected to a two-way analysis of variance (ANOVA) in which the prime condition was one factor and the word list was the other. This procedure was used in all of the following experiments, but we only report the main effect of the prime because the list factor was introduced merely to extract any variance that was due to counterbalancing.

Table 1
Examples of Phonological Form, Semantic Meaning, Orthographic Transliteration, and Hebrew Printed For Words and Nonwords Used in Experiment 1

	Words[a]			Nonwords[a]		
Stimulus	Identity	Form	Control	Identity	Form	Control
Prime	/sipur/ (story)	/sidur/ (arrangement)	/hanhaga/ (leadership)	/miglat/	/mirlat/	/silur/
	SIPUR	**SIDUR**	**HNHGH**	MIGLT	MIRLT	SILUR
	סיפור	סידור	הנהגה	מיגלט	מירלט	סילור
Target	**SIPUR**	**SIPUR**	**SIPUR**	MIGLT	MIGLT	MIGLT
	סיפור	סיפור	סיפור	מיגלט	מיגלט	מיגלט

Note. The letters in the target that constitute the root are in bold but were not so presented.
[a] ######## was used as a mask for both words and nonwords.

Table 2
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to Target Words and Nonwords in the Identity, Form-Related, and Control Conditions in Experiment 1A and Related and Control Conditions in Experiment 1B

Words			Nonwords		
Identity	Form related	Control	Identity	Related	Control
Experiment 1A					
498	523	531	563	566	577
5.3%	6.4%	8.8%	5.6%	6.1%	8.2%
+33	**+8**		**+14**	**+11**	

Experiment 1B

Words		Nonwords	
Form related	Control	Form related	Control
547	552	583	587
6.5%	8.2%	6.4%	6.8%
+5		**+4**	

Note. Boldface values indicate priming effects.

The prime condition factor was significant in both subject and item analyses, $F1(2, 90) = 28.3$, $MSE = 531.0$, $p < .001$, and $F2(2, 90) = 22.8$, $MSE = 790.0$, $p < .001$. This was due to the much faster latencies in the identity condition. Planned comparisons revealed that the difference between the form-related and the control conditions was not significant for subjects or for items, $F1(1, 45) = 2.6$, $MSE = 639.0$, $p < .1$, and $F2(1, 45) = 3.0$, $MSE = 842.0$, $p < .09$. The error analysis revealed a significant prime condition factor, $F1(2, 90) = 3.5$, $MSE = 44.0$, $p < .03$, and $F2(2, 90) = 3.8$, $MSE = 41.0$, $p < .03$. This, again, was mainly due to fewer errors in the identity condition. The number of errors in the related and the control conditions did not differ significantly, $F1(1, 45) = 2.8$, $MSE = 53.0$, $p < .1$, and $F2(1, 45) = 3.7$, $MSE = 39.0$, $p < .06$. The prime condition effect for nonwords was significant in the RT analysis, $F1(2, 90) = 6.6$, $MSE = 426.0$, $p < .002$, and $F2(2, 90) = 5.7$, $MSE = 553.0$, $p < .005$, and was again mainly due to the difference between the identity and the control conditions. The number of errors in the three conditions did not differ significantly for nonwords ($F1 = 2.3$ and $F2 = 2.2$, $p < .1$). The striking result of Experiment 1A is that the effect of form priming for words was smaller than the respective effect for nonwords. Because priming in the forward-masking paradigm depends crucially on the existence of a lexical representation (Forster, 1987; Forster & Davis, 1984; Forster et al., 1987), it seems that the small effect obtained for words is not the typical lexical form-priming effect reported in masked priming experiments in English.

Experiment 1B. The inclusion of a condition in which primes and targets are virtually identical may cause the primes and the targets in the form-related condition to be perceived as relatively more dissimilar. To avoid the possible effect of unconscious scaling of similarity by our subjects and to allow maximal chances for obtaining form priming, we conducted Experiment 1B in which the identity condition was eliminated.

Similar to Experiment 1A, facilitation in the form-related condition was small (5 ms) and nonsignificant, $F1(1, 46) = 1.3$, $MSE = 486.0$, $p < .3$, and $F2(1, 46) = 2.0$, $MSE = 519.0$, $p < .2$. Similarly, the error analysis revealed a small and nonsignificant difference between the form-related and the control conditions, $F1(1, 46) = 2.7$, $MSE = 24.0$, $p < .1$, and $F2(1, 46) = 2.5$, $MSE = 26.0$, $p < .12$. No effects were found for nonwords in both the RTs and error analyses ($F1$ and $F2 < 1.0$). As in Experiment 1A, the priming effects for words and nonwords were virtually identical. Thus, Experiment 1B provides a replication of the results of Experiment 1A, suggesting that no form priming is obtained in Hebrew. It should be noted that an important feature of the design was that the letter that differed was always a root letter. If this had not been the case, any priming effect could have been attributed to the shared root, which would then be a morphological effect, not an orthographic effect.

Experiment 2

Form Priming for Words With Productive and Nonproductive Roots

Although from a pure linguistic perspective, all Hebrew words are considered to be composed of a root and a word pattern, some words have roots that are nonproductive. These words do not have a morphological family, because the specific consonantal sequence of their root appears only in a single word. Because these roots do not provide productive derivations, the words containing them cannot benefit from morphological decomposition. Thus, it is possible that because nonproductive words are not processed through a root unit, they could reveal form-priming effects just as English words do. Indeed, most words used in Experiment 1 contained productive roots. The purpose of Experiment 2 was to examine whether the lack of form priming in Hebrew characterizes only morphologically productive words or whether it extends to any word in the Hebrew lexicon. For this purpose we contrasted two sets of words. In the first set we examined form priming for words having productive roots, and in the second set we examined form priming for words having nonproductive roots.

Method

Subjects. The subjects were 60 undergraduate students at The Hebrew University, all native speakers of Hebrew, who participated in the experiment for course credit or for payment. None of the subjects participated in Experiments 1A or 1B.

Stimuli and design. The stimuli consisted of 72 target words. Thirty-six words were productive root derivations, and 36 words contained nonproductive roots. The words were four to five letters long, having two or three syllables with five to eight phonemes (Appendix C). The mean number of letters was 5.0 for productive roots and 4.5 for nonproductive roots, and the mean number of phonemes was 5.5 and 5.4 for productive and nonproductive root words, respectively. The target words were paired with 72 prime words to create the identity, related, and control conditions for each set of target words. Primes and targets in the related condition always differed by one letter (a root letter) only. The position and number of the substituted letter could be initial, middle, or final. Primes and targets in the control condition differed by most or all of their letters.

Seventy-two target nonwords were introduced as fillers with identical experimental conditions (identity, related, control). The primes for the nonwords were nonwords as well. The stimuli were divided into three lists, with each list containing 12 words and 12 nonwords in each of the three experimental conditions in each set of target words. The stimuli were rotated within the conditions in each list by a Latin square design. Twenty subjects were tested in each list. An example of the stimuli used in the experiment is presented in Table 3.

Results

RTs for correct responses in the six experimental conditions were averaged across subjects and across items. The results are presented in Table 4. Lexical decisions to targets with productive roots were facilitated in the identity condition by 47 ms. In contrast, facilitation in the form-related condition was very small (2 ms). A similar pattern of results was revealed for nonproductive targets, where the effect of identity priming was 39 s, whereas form priming was only 4 ms.

The results were subjected to a three-way ANOVA in which the target productivity (productive, nonproductive) was one factor, prime condition (identity, related, control) was another factor, and the word list was the third factor. The main factor of productivity was not significant. Overall response latencies were 573 ms and 579 ms to productive and nonproductive targets, respectively, $F1(1, 57) = 3.4$, $MSE = 1{,}117.0$, $p < .07$ ($F2 < 1.0$). This suggests that the two samples of target words had similar characteristics. The prime condition factor was significant in both subject and item analyses, $F1(2, 114) = 76.4$, $MSE = 893.0$, $p < .001$, and $F2(2, 66) = 36.8$, $MSE = 1{,}156.0$, $p < .001$. Again, this was due to the much faster latencies in the identity condition. Planned comparisons revealed that the difference between the form-related and the control conditions were not significant for subjects or for items for both productive and nonproductive root targets ($F1$ and $F2 < 1.0$). The interaction of productivity and prime condition was not significant ($F1$ and $F2 < 1.0$). The error analysis revealed only a significant prime condition factor, $F1(2, 114) = 6.9$, $MSE = 49.0$, $p < .001$, and $F2(2, 66) = 7.6$, $MSE = 26.0$, $p < .001$, which was due to fewer errors in the identity condition. The number of errors in the related and the control conditions did not differ significantly ($F1$ and $F2 < 1.0$). The prime condition effect for nonwords was significant, $F1(2, 114) = 12.6$, $MSE = 749.0$, $p < .002$, and $F2(2, 66) = 15.0$, $MSE = 736.0$, $p < .001$. This was mainly due to slower RTs in the control condition relative to the identity and related conditions, which did not differ. There were no significant effects in the error analysis for nonwords ($F1$ and $F2 < 1.0$).

The results of Experiment 2 suggest that the absence of morphological productivity does not produce form priming in Hebrew. Whether targets are composed of productive roots or not, they cannot be primed by word primes having a similar orthographic structure. Once again, the effects of related primes for word targets were smaller than the effects for nonword targets, which in this experiment, actually reached significance.

Experiment 3A

Form Priming With Hebrew–English Bilingual Participants

An obvious question to ask at this point is whether the form-priming effects obtained in Experiments 1 and 2 in Hebrew differ qualitatively from those obtained in English or other Indo-European languages. Because in the many studies conducted in English some weak effects have been reported as well, it could be argued that the nonsignificant results of Experiments 1 and 2 simply emerged from subjects variability, reflecting the extreme end of a single distribution where language is not a determining factor. The purpose of Experiment 3 was to examine this hypothesis, by comparing directly form-priming effects in Hebrew and English, in a within-subject design. To this end, Hebrew–English

Table 3
Examples of Phonological Form, Semantic Meaning, Orthographic Transliteration, and Hebrew Printed For the Stimuli Used in Experiment 2

Stimulus	Productive root	Control	Nonproductive root	Control
Prime	/miklaxat/ (shower) M**KLXT** מקלחת	/hafska/ (recess) **HPSKH** הפסקה	/midron/ (slope) MDRON מדרון	/xacait/ (skirt) XC?IT חצאית
Target	/miSlaxat/ (delegation) M**SLXT** משלחת	/miSlaxat/ (delegation) **MSLXT** משלחת	/mizron/ (mattress) MZRON מזרון	/mizron/ (mattress) MZRON מזרון

Table 4
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to Productive and Nonproductive Root Words and in the Identity, Related, and Control Conditions of Experiment 2

Words					
Productive root words			Nonproductive root words		
Identity	Related	Control	Identity	Related	Control
543 3.6% **+47**	588 7.5% **+2**	590 6.3%	555 5.6% **+39**	590 7.9% **+4**	594 8.1%

Nonwords		
Identity	Related	Control
628 7.4% **+15**	628 8.7% **+15**	643 9.4%

Note. Boldface values indicate priming effects.

bilingual subjects were presented with two sets of prime–target pairs, one set in Hebrew and the other in English. The target words in the two languages were equated in terms of frequency, number of letters, and neighborhood density. The experimental procedure in the two languages was identical: Primes and targets differed in size in English as in Hebrew. Each subject participated in both the Hebrew experiment and the English experiment. This allowed us to compare directly form-priming effects for a given subject, in an Indo-European language and in a Semitic language, when identical experimental procedures were used.

Method

Subjects. The subjects were 48 students at The Hebrew University, who were all native speakers of Hebrew, but who had extensive knowledge of English as a second language. Their proficiency in English was verified through self-report in a questionnaire that assessed their level in speaking, writing, and reading English. The subjects participated in the experiment for course credit or for payment.

Stimuli and design. The stimuli consisted of 36 target Hebrew words and 36 target English words (Appendix D). The sets of target words in the two languages were equated in terms of frequency, number of letters, and neighborhood density. Because there is not a published frequency-count corpus in Hebrew, to ensure an identical procedure for assessing frequency in the two languages, 50 native speakers of English and 50 native speakers of Hebrew provided frequency estimations (FEs) by completing a questionnaire that assessed noun-frequency ratings of printed words in their native language on a scale from 1 (*very infrequent*) to 7 (*very frequent*). The comparability of FEs and frequency in predicting RTs and error rates has been evaluated by a number of investigators (e.g., Gernsbacher, 1984). A summary of these measures is presented in Table 5. As in the previous form-priming experiments, the target words were paired with 36 word primes to create three experimental conditions: identity, form related, and control. Primes in the form-related condition in both languages were words that differed from the targets by one letter, and primes in the control condition were words that differed from the targets by all of their letters. The altered letter positions were similar for the Hebrew and English stimuli. Thirty-six prime–target nonword pairs were introduced as fillers, creating identical experimental conditions for the nonwords. Two independent subexperiments were constructed, one in English the other in Hebrew. Within each subexperiment, the stimuli were divided into three lists, and each list contained 12 words and 12 nonwords in each of the three experimental conditions. The stimuli were rotated within the conditions in each list by a Latin square design. Each subject participated in each subexperiment and was, therefore, tested in one Hebrew list and one English list. Half of the subjects were first tested in the Hebrew subexperiment and half in the English subexperiment.

Procedure. The procedure was identical in the Hebrew and English blocks. Because it was important to make the conditions in the two languages as similar as possible, the usual method of using lowercase primes and uppercase targets in English was avoided. Instead, both prime and target were in lowercase, but the target was larger than the prime, as in the Hebrew condition.

Results

RTs for correct responses in the three experimental conditions were averaged across subjects and across items in each language. The effects of the identity and form-related primes were assessed relative to the control baseline. The results are presented in Table 6.

Both the Hebrew and the English subexperiments produced a significant identity priming effect of 24 ms and 53 ms, respectively. The form-related primes produced a small and nonsignificant priming effect of 8 ms in Hebrew but an exceedingly large effect in English (32 ms), which is quite typical of the results obtained in earlier studies in English (e.g., Forster et al., 1987). It should be noted that the size of the priming effect in the identity condition in Hebrew was smaller than that obtained in English. Nevertheless, even if this reduction is considered by measuring the

Table 5
Characteristics of the Hebrew and English Stimuli Used in Experiment 3

Target	Mean subjective frequency	Mean no. of neighbors	No. of letters
Hebrew	4.6	3.7	5.1
English	4.9	3.4	5.2

Table 6
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to Target Words and Nonwords in the Identity, Form-Related, and Control Conditions in Hebrew and in English

Hebrew			English		
Identity	Form related	Control	Identity	Form related	Control
		Words			
549	565	573	635	656	688
4.2%	7.6%	6.6%	7.2%	10.8%	9.6%
+24	**+8**		**+53**	**+32**	
		Nonwords			
621	625	638	777	788	782
6.9%	6.1%	7.8%	12.8%	11.6%	19.1%
+17	**+13**		**+5**	**−6**	

Note. Subjects were Hebrew–English bilinguals. Boldface values indicate priming effects.

ratio of the identity and the form-priming effects, a clear difference between Hebrew and English emerges.

The results were subjected to a two-way ANOVA in each language in which the prime condition was one factor and the word list was the other. For Hebrew, the prime condition factor was significant in both subject and item analyses, $F1(2, 90) = 7.5$, $MSE = 1{,}061.0$, $p < .001$, and $F2(2, 66) = 3.6$. $MSE = 1{,}549.0$, $p < .03$. This effect, however, was due to the faster responses in the identity condition. Planned comparisons revealed that the facilitation produced by the form-related primes was not significant in both subjects and item analyses ($F1 < 1.5$, $F2 < 1.0$). For English, the prime condition factor was significant in both subject and item analyses, $F1(2, 90) = 19.4$, $MSE = 1{,}772.0$, $p < .001$, and $F2(2, 66) = 17.1$, $MSE = 1{,}603.0$, $p < .001$. Planned comparisons revealed that the facilitation produced by the form-related primes was highly significant in both the subjects and the item analyses, $F1(1, 45) = 13.1$, $MSE = 1{,}906.0$, $p < .001$, and $F2(1, 33) = 13.0$, $MSE = 1{,}482.0$, $p < .001$. The error analysis did not reveal a significant difference between the form-related and control conditions in Hebrew or in English ($F1$ and $F2 < 1.0$, in both languages).

Turning to the effects obtained for nonwords, priming was significant for Hebrew, $F1(2, 90) = 6.5$, $MSE = 904.0$, $p < .002$, and $F2(2, 55) = 4.0$, $MSE = 779.0$, $p < .02$, and not for English ($F1$ and $F2 < 1.0$). However, note that the effect obtained for nonwords in Hebrew in the form-related condition was once again larger than the effect obtained for words, suggesting that the small effect revealed for words is not the typical lexical form-priming effect reported in masked priming experiments. We also obtained exceedingly large identity priming effects for the nonwords.

Thus, Experiment 3A clearly establishes that form-priming effects are qualitatively different in Hebrew and English. Because the same subjects and identical procedures were used for English and Hebrew, the difference between the Hebrew and English blocks can only be related to a linguistic origin, not to experimental procedures or to individual differences between the speakers of the two languages.

Experiment 3B

Form Priming With English–Hebrew Bilingual Subjects

A possible concern regarding the interpretation of Experiment 3A is that the differences in form-priming effects for Hebrew and English stimuli stemmed from differences in language proficiency. By this view, the stronger priming effects in English could simply reflect a by-product of the longer latencies that occurred for English stimuli, because our subjects were Hebrew-dominant bilinguals. To examine this possibility we replicated Experiment 3A by testing a parallel group of English-dominant bilinguals.

Method

Subjects. The subjects were 33 students at The Hebrew University who were all native speakers of English but with extensive knowledge of Hebrew as a second language. Their proficiency in Hebrew was verified through self-report in a questionnaire that assessed their level in speaking, writing, and reading Hebrew. The subjects participated in the experiment for course credit or for payment.

Stimuli and design. The stimuli, design, and apparatus were identical to those of Experiment 3A.

Results

RTs for correct responses in the three experimental conditions were averaged across subjects and across items in each language. The results are presented in Table 7.

The identity priming effects were 40 and 47 ms, for Hebrew and English, respectively. Similar to Experiment 3A, the form-related primes produced a large effect in English (26 ms). In contrast, a small and nonsignificant priming effect of 8 ms was obtained in Hebrew.

The results were subjected to a two-way ANOVA in each language in which the prime condition was one factor and the word list was the other. For Hebrew, the prime condition factor was significant in both subject and item analyses, $F1(2, 60) = 14.8$, $MSE = 2{,}661.0$, $p < .001$, and $F2(2, 66) = 6.8$, $MSE = 2{,}377.0$, $p < .002$. This effect, however, was due only to the faster re-

Table 7
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to Target Words and Nonwords in the Identity, Form-Related, and Control Conditions in Hebrew and in English

Hebrew			English		
Identity	Form related	Control	Identity	Form related	Control
		Words			
542	574	582	533	554	580
5.0%	6.1%	8.3%	3.5%	6.8%	6.6%
+40	**+8**		**+47**	**+26**	
		Nonwords			
649	654	653	641	644	656
8.8%	6.3%	8.1%	9.3%	8.1%	10.6%
+4	**−1**		**+15**	**+12**	

Note. Subjects were English-dominant bilinguals. Boldface values indicate priming effects.

sponses in the identity condition. Planned comparisons revealed that the facilitation produced by the form-related primes was not significant in both subjects and item analyses ($F1$ and $F2 < 1.0$). For English, the prime condition factor was significant in both subject and item analyses, $F1(2, 60) = 21.1$, $MSE = 834.0$, $p < .001$, and $F2(2, 66) = 8.0$, $MSE = 2{,}352.0$, $p < .001$. Planned comparisons revealed that the facilitation produced by the form-related primes was significant in both the subjects and the item analyses, $F1(1, 30) = 12.8$, $MSE = 857.0$, and $F2(1, 33) = 3.4$, $MSE = 3{,}008.0$, $p < .05$. The error analysis did not reveal a significant difference between the form-related and control conditions in Hebrew or in English. Turning to the effects obtained for nonwords, priming was not significant for Hebrew ($F1$ and $F2 < 1.0$) or English ($F1 < 2.3$, $F2 < 1.0$).

Thus, Experiment 3B provides a clear replication of Experiment 3A. Moreover, because the identity priming effects obtained in the two languages were almost identical, the results unequivocally demonstrate that the differences in form-priming effects in English and Hebrew are indeed linguistic in nature and are not the product of differences in baselines that are due to language proficiency.

Experiment 4

Form Priming Versus Morphological Priming

In Experiment 4 we compared the effects of primes sharing the same root as the targets with the effects of primes sharing simple form with the targets. Thus, the purpose of this experiment was to contrast directly the effects of form priming with the effects of morphological priming in Hebrew. For this purpose the same target word was primed by a form-related prime that differed from the target by one root letter and by a morphologically related prime that shared fewer letters with the target but consistently contained the root letters. This contrast allowed us to examine the relative effectiveness of form overlap and morphological overlap on masked priming.

Method

Subjects. The subjects were 48 undergraduate students at The Hebrew University who were all native speakers of Hebrew and who participated in the experiment for course credit or for payment. None of the subjects participated in the previous experiments.

Stimuli and design. The stimuli consisted of 48 target words, five letters long, having two or three syllables with five to eight phonemes (Appendix E). The target words were paired with 48 primes to create four experimental conditions: identity, form related, morphologically related, and control. Primes and targets in the form-related condition differed by one root letter and, thus, were never morphologically related. In contrast, primes and targets in the morphologically related condition shared the three root letters but differed by the remaining two letters. The position and number of the substituted letters could be initial, middle, or final.

Forty-eight prime–target nonword pairs were introduced as fillers with identical experimental conditions. The nonwords were composed from pseudoroots. The stimuli were divided into four lists, and each list contained 12 words and 12 nonwords in each of the four experimental conditions. The stimuli were rotated within the conditions in each list by a Latin square design. Twelve subjects were tested in each list. An example of the stimuli used in the experiment is presented in Table 8.

Results

RTs for correct responses in the four experimental conditions were averaged across subjects and across items. The effects of the identity, form-related, and morphologically related primes were

Table 8
Examples of Phonological Form, Semantic Meaning, Orthographic Transliteration, and Hebrew Printed For the Stimuli Used in the Form-Related, Morphologically Related, and Control Conditions of Experiment 4

Stimulus	Form	Morphology	Control
Prime	/ripud/ (upholstry) **RIPUD** ריפוד	/hrkda/ (lead to dance) **HRKDH** הרקדה	/maxmaa/ (compliment) **MXM?H** מחמאה
Target	/rikud/ (dance) **RIKUD** ריקוד	/rikud/ (dance) **RIKUD** ריקוד	/rikud/ (dance) **RIKUD** ריקוד

assessed relative to the control baseline. The results are presented in Table 9.

There was an identity priming effect of 34 ms. The morphologically related primes produced a priming effect of 13 ms. In contrast, the form-related primes produced a small facilitation of 6 ms.

The results were subjected to a two-way ANOVA in which the prime condition was one factor and the word list was the other. The prime condition factor was significant in both subject and item analyses, $F1(3, 132) = 14.6$, $MSE = 745.0$, $p < .001$, and $F2(3, 132) = 8.8$, $MSE = 1{,}221.0$, $p < .001$. This was due to better performance in the identity and the morphologically related conditions. Planned comparisons revealed that the facilitation produced by morphologically related primes was significant in both subjects and item analyses for RTs, $F1(1, 44) = 5.2$, $MSE = 751.0$, $p < .03$, and $F2(1, 44) = 3.8$, $MSE = 1{,}205.0$, $p < .05$, and marginally significant for errors, $F1(1, 44) = 3.7$, $MSE = 44.0$, $p < .06$, and $F2(1, 44) = 2.7$, $MSE = 60.0$, $p < .1$. In contrast, the difference between the form-related and the control conditions was not significant for subjects or items in the RTs analyses or the error analyses ($F1 = 1.1$; $F2$s < 1.0, in both). There was a marginal effect of prime condition for nonwords in the RT analysis, which was mainly due to slower latencies in the control condition, $F1(3, 132) = 2.5$, $MSE = 784.0$, $p < .06$, and $F2(3, 132) = 2.5$, $MSE = 894.0$, $p < .06$, but not in the error analysis ($F1$ and $F2 = 1.5$).

The results of Experiment 4 revealed morphological priming effects that were virtually identical in size to the morphological effects reported by Frost and his colleagues (Deutsch et al., 1998; Frost et al., 1997, 2000). However, in contrast to the morphological manipulation, once again, significant form-priming effects were not obtained, and the small effects that were obtained for word targets were actually smaller than the effects obtained for nonword targets, suggesting that these effects might have a nonlexical source.

One possible concern regarding the interpretation of our results is that the superior priming effect obtained in the morphological condition might have stemmed from the fact that these word pairs had formed overlap as well as some degree of semantic overlap, whereas the word pairs used in the form-priming condition had formed overlap only. This interpretation, however, is not supported by many recent studies in Hebrew showing that masked morphological priming effects are independent of meaning similarity and that no priming is found when primes and targets are semantically but not morphologically related (Frost et al., 1997, 2000; see Plaut & Gonnerman, 2000, for a discussion). In particular, Frost et al. (1997, Experiment 5) showed that masked morphological priming effects for semantically transparent and semantically opaque derivations did not significantly differ (see Longtin, Segui, & Halle, 2003 [French]; Rastle & Davis, 2003 [English]; Rastle, Davis, & New, 2004 [English], for similar findings). Hence, the priming obtained in the morphological condition reflects lexical structure rather than a semantic effect.

Table 9
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to Target Words and Nonwords in the Identity, Form-Related, Morphologically Related, and Control Conditions of Experiment 4

Identity	Form related	Morphologically related	Control
		Words	
524 (3.1%)	552 (6.4%)	545 (4.2%)	558 (6.8%)
+34	**+6**	**+13**	
		Nonwords	
Identity	Form related	Pseudo-morphologically related	Control
606 (9.6%)	607 (6.8%)	611 (8.9%)	620 (7.5%)
+14	**+13**	**+9**	

Note. Boldface values indicate priming effects.

Experiment 5: Extension to Arabic

Our theoretical claims regarding the effects of form priming versus morphological priming are not specific to Hebrew. Rather, they concern all languages having nonconcatenated morphology. If our assumptions regarding lexical structure in Hebrew are correct, a similar pattern of results should emerge in another language with an identical morphological structure. The purpose of Experiment 5 was to obtain converging evidence from Arabic, which is another Semitic language in which words are composed through infixation of roots into nominal or verbal patterns (see Appendix F). Similar to Hebrew, Arabic orthography has vowel letters, but some vowels can be optionally added as diacritical points under or above the letter. Like in Hebrew, the vowel letters /u/, /i/, and /a/ often disrupt root-letter contiguity (see Bentin & Ibrahim, 1996, for a description of Arabic orthography; Boudelaa & Gaskell, 2002, for a detailed description of modern standard Arabic [MSA] morphology).

To date, little research has been published on morphological processing in MSA. In two recent studies, however, Boudelaa and Marslen-Wilson (Boudelaa & Marslen-Wilson, 2001a, 2001b) found evidence for morphological decomposition in Arabic. Their evidence suggested that two morphemic units, the triconsonantal root and a biconsonantal structure labeled *etymon*, mediate word recognition in MSA (but see Bentin & Frost, 2001, for a discussion of the etymon validity). These results suggest that similar cognitive operations are involved in language processing of Hebrew and Arabic.

In Experiment 5 we repeated the design of Experiment 4 and compared directly form priming with morphological priming in MSA. We expected that in MSA, as in Hebrew, form-orthographic priming would not be obtained, whereas robust morphological priming would be obtained.

Method

Subjects. The subjects were 32 undergraduate students at The Hebrew University who were all native speakers of Arabic coming from villages or towns within Israel. The subjects participated in the experiment for course credit or for payment.

Stimuli and design. The design of the experiment was identical to that of Experiment 4, which was conducted in Hebrew. The stimuli consisted of 64 target words, four to six letters long, having two or three syllables with five to eight phonemes (Appendix G). The target words were paired with 64 primes to create the four experimental conditions: identity, form related,

morphologically related, and control. Primes and targets in the form-related condition differed by one letter only but were never morphologically related. In contrast, primes and targets in the morphologically related condition shared the three root letters but differed by the remaining two letters. The position and number of the substituted letters could be initial, middle, or final.

Sixty-four prime–target nonword pairs were introduced as fillers with identical experimental conditions. The stimuli were divided into four lists, and each list contained 16 words and 16 nonwords in each of the four experimental conditions. The stimuli were rotated within the conditions in each list by a Latin square design. Four subjects were tested in each list.

Results

RTs for correct responses in the four experimental conditions were averaged across subjects and across items. The effects of the identity, form-related, and morphologically related primes were assessed relative to the control baseline. The results are presented in Table 10.

There was an identity priming effect of 39 ms. The morphologically related primes produced a priming effect of 21 ms. In contrast, the form-related primes produced a small facilitation of 8 ms.

The results were subjected to a two-way ANOVA in which the prime condition was one factor and the word list was the other. The prime condition factor was significant in both subject and item analyses, $F1(3, 84) = 11.1$, $MSE = 841.0$, $p < .001$, and $F2(3, 180) = 9.9$, $MSE = 1{,}746.0$, $p < .001$. Planned comparisons revealed that the facilitation produced by morphologically related primes was significant in both subjects and item analyses for RTs, $F1(1, 28) = 7.8$, $MSE = 880.0$, $p < .009$, and $F2(1, 60) = 9.8$, $MSE = 1{,}856.0$, $p < .002$, and not for errors ($F1$ and $F2 < 1.0$). In contrast, the difference between the form-related and the control conditions was not significant for subjects or for items in the RT analyses, $F1(1, 28) = 1.9$, $MSE = 533.0$, $p < .2$, and $F2(3, 60) = 1.5$, $MSE = 1{,}849.0$, $p < .23$, or the error analyses ($F1$ and $F2 < 1.0$). There was no effect of prime condition for nonwords in the RT analysis, $F1(3, 84) = 1.9$, $MSE = 993.0$, $p < .13$, and $F2(3, 180) = 1.3$, $MSE = 2{,}517.0$, $p < .3$, or in the error analysis ($F1$ and $F2 < 1.0$).

Table 10
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to Target Words and Nonwords in the Identity, Form-Related, Morphologically Related, and Control Conditions of Experiment 5

Identity	Form related	Morphologically related	Control
		Words	
585 (10.1%)	616 (9.4%)	603 (8.2%)	624 (9.7%)
+39	**+8**	**+21**	
		Nonwords	
Identity	Form related	Pseudo-morphologically related	Control
673 (14.8%)	677 (14.4%)	687 (15.9%)	689 (16.8%)
+16	**+12**	**+2**	

Note. Boldface values indicate priming effects.

Experiment 5, which we conducted in Arabic, provides almost an exact parallel of the corresponding experiment conducted in Hebrew. Orthographic overlap of primes and targets did not facilitate target recognition, whereas morphological relatedness produced robust facilitation.

Experiment 6

Form Priming and the Effect of Neighborhood Density

In general, the effects of form priming have been shown to be modulated by the neighborhood density of the target. Thus, when the prime's orthographic structure overlaps with a target that has many neighbors, its beneficial effect on target processing is drastically reduced (Forster et al., 1987). In a more recent study, Forster and Taft (1994) have shown that a full and refined account of neighborhood density effects also needs to consider the density of the target's body (i.e., how many other words share the same body, regardless of onset). However, as a general approximation, strong facilitation is obtained for word targets having few orthographic neighbors, whether defined at a letter level or the body level, and weak facilitation is obtained for words having many neighbors. The implication of this result is that the detectors for high-density words are more narrowly tuned than for low-density words.

Therefore, it is possible that the absence of form priming in the previous experiments may reflect an effect of density, that is, the tendency for Hebrew words to cluster together is higher than in other languages. This account, however, assumes a lexical organization that is based on orthographic principles. If our theory of morphological organization in Semitic languages is correct, then neighborhood density defined orthographically should have no impact on priming. The purpose of Experiment 6 was to explore this possibility.

Method

Subjects. The subjects were 42 undergraduate students at The Hebrew University who were all native speakers of Hebrew and who participated in the experiment for course credit or for payment.

Stimuli and design. The stimuli consisted of 72 target words, five to six letters long, having two or three syllables with five to eight phonemes (Appendix H). Thirty-six words were low-density neighborhood (LDN) targets, and 36 were high-density neighborhood (HDN) targets. The mean neighbors for LDN targets was 3.6 (range = 1–6), and the mean neighbors for HDN targets was 10.6 (range = 7–16).[4] Each target word was paired with three word primes to create the identity, form-related, and control conditions. Seventy-two prime–target nonword pairs were introduced as well, with identical experimental conditions. The stimuli were divided into three lists, and each list contained 12 LDN words,12 HDN words, and 24 nonwords, in each of the three experimental conditions. The stimuli were rotated within the conditions in each list by a Latin square design, and 14 subjects were tested in each list.

[4] Hebrew, in contrast to English, does not have a computerized database that provides neighborhood estimations. The stimuli of Experiment 6 were constructed by generating all letter sequences that could be derived by altering one letter of a given word that was taken from a base list. These were then inspected for lexicality to compute the number of neighbors for that target word.

Results

RTs for correct responses in the six experimental conditions were averaged across subjects and across items. The effects of the identity and form-related conditions were assessed relative to the control baseline. The results are presented in Table 11.

There was an identity priming effect of 27 ms for the LDN targets and 32 ms for the HDN targets. However the interesting outcome of the experiment concerns the absence of interaction of form priming with neighborhood density. The priming effects for LDN and HDN targets were almost identical: Small and nonsignificant facilitations of 9 ms and 7 ms were obtained for LDN and HDN words, respectively.

The results were subjected to a three-way ANOVA with the factors of neighborhood density (high–low), prime condition (identity, related, control), and word list. The main effect of neighborhood density was significant in the subject analysis, $F1(1, 39) = 17.4$, $MSE = 860.0$, $p < .001$, but marginal in the item analysis, $F2(1, 33) = 3.5$, $MSE = 3{,}781.0$, $p < .06$. This was due to faster responses to HDN words. The prime condition factor was significant in both subject and item analyses, $F1(2, 78) = 20.3$, $MSE = 817.0$, $p < .001$, and $F2(2, 66) = 17.6$, $MSE = 942.0$, $p < .001$. However, this was mainly due to the faster decisions to targets in the identity condition. Planned comparisons revealed that the facilitation produced by form-related primes was small and nonsignificant for both the LDN words, $F1(1, 39) = 2.2$, $MSE = 1{,}042.0$, $p < .15$, and $F2(1, 33) = 1.3$, $MSE = 1{,}182.0$, $p < .26$, and the HDN words ($F1$ and $F2 < 1.0$). Last, there was no interaction of neighborhood density and prime condition ($F1$ and $F2 < 1.0$). There was no effect for nonwords for RTs or errors (all $Fs < 1.0$).

The results of Experiment 6 show that the absence of form-priming effects in previous experiments cannot be attributed to the targets' neighborhood density. More important, the results suggest that neighborhood density, which is a major determinant of form priming in Indo-European languages, does not exert its influence on the perception of Hebrew words. Apparently, high-density and low-density targets are similarly unaffected by orthographically related primes.

Experiment 7

Form Priming With Word Versus Nonword Primes

Previous research in English has shown that words and nonwords may be equally effective as form primes in the lexical decision task. For example, Forster (1987) showed that both *headline* and *seadline* prime *DEADLINE* to the same extent. In some cases, however, it has been argued that nonword primes may be more effective than word primes. This is due to the fact that the activation of the target word produced by a word prime is offset by the increased competition from the prime itself. Segui and Grainger (1990) reported such inhibition when the prime was a high-frequency neighbor and the target low-frequency, although with a relatively long SOA of 60 ms. Prime–target inhibition when primes and targets varied in relative frequency was also reported in Dutch (De Moor & Brysbaert, 2000). In a recent study, Forster and Veres (1998) found that if the word–nonword discrimination is made particularly difficult, priming from word primes collapses, whereas nonword primes are unaffected. This phenomenon is referred to as a prime lexicality effect.

One interesting possibility is that the absence of form priming in Hebrew is somehow connected with this phenomenon, because all of the experiments reported so far have used words as primes. The purpose of Experiment 7 was to determine whether the lexical status of the prime affects form priming and whether nonword primes are more effective than word primes. If strong priming is obtained with nonword primes but not with word primes, the results would parallel those obtained by Forster and Veres (1998), and it could then be argued that the previous findings merely indicate that the word–nonword discrimination in Hebrew must somehow be harder than in English. Another possibility might be that when the prime is a word, any benefit that the processing of the target receives is offset by an increase in competition from a neighbor. However, if nonwords also are ineffective as form primes, then these alternative interpretations can be excluded.

Table 11
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to LDN and HDN Target Words and Nonwords in the Identity, Form-Related, and Control Conditions of Experiment 6

LDN words			HDN words		
Identity	Form related	Control	Identity	Form related	Control
555	573	582	535	560	567
3.8%	5.9%	6.3%	4.4%	6.1%	7.3%
+27	**+9**		**+32**	**+7**	

Nonwords		
Identity	Form related	Control
630	618	640
7.5%	7.5%	7.0%
+10	**+22**	

Note. Boldface values indicate priming effects. LDN = low-density neighborhood; HDN = high-density neighborhood.

Method

Subjects. The subjects were 48 undergraduate students at The Hebrew University, who were all native speakers of Hebrew and who participated in the experiment for course credit or for payment. None of the subjects participated in the previous experiment.

Stimuli and design. The stimuli consisted of 48 target words, four to six letters long, having two or three syllables with five to eight phonemes (Appendix I). Targets were derivations of productive roots. The target words were paired with 48 primes to create four experimental conditions: 12 form-related word primes and 12 form-related nonword primes, which differed from the targets by one letter. Twelve unrelated word primes and 12 unrelated nonword primes served as the control condition. Unrelated primes did not share letters with the targets. The position of the replaced letters in the form-related primes could be initial, middle, or final. Forty-eight target nonwords were introduced as fillers for the lexical decision task.

The stimuli were divided into four lists, and each list contained 12 target words and 12 target nonwords in each of the four experimental conditions. The stimuli were rotated within the conditions in each list by a Latin square design, and 12 subjects were tested in each list.

Results

RTs for correct responses in the four experimental conditions were averaged across subjects and across items. The results were subjected to a three-way ANOVA in which the prime lexicality was one factor (word or nonword primes), prime condition (form related, control) was another factor, and the word list was the third factor. The results are presented in Table 12.

There was no main effect of prime lexicality. Because the same targets were tested with word or nonword primes, responses to these targets were almost identical in the two control conditions. More important, however, is the form-priming effect obtained with word primes versus nonword primes. The facilitation for word primes was 4 ms, whereas the facilitation for nonword primes was 9 ms. The main effect of relatedness was marginal but did not reach significance in the subject, $F1(1, 44) = 3.8$, $MSE = 721.0$, $p < .06$, or the item analyses, $F2(1, 44) = 2.9$, $MSE = 1{,}051.0$, $p < .1$. The separate analyses for word primes and nonword primes revealed that neither of the priming effects was significant. Moreover, the interaction of prime lexicality and relatedness was not significant ($F1$ and $F2 < 1.0$), suggesting that word and nonword primes had a similar effect on the targets. No significant effects were found in the error analyses. The nonword analysis revealed a significant facilitation in the related condition in RTs, $F1(1, 44) = 13.8$, $MSE = 634.0$, $p < .01$, and $F2(1, 44) = 11.8$, $MSE = 815.0$, $p < .001$, but not for errors ($F1$ and $F2 < 1.0$). Once again, the priming effect obtained for nonword targets exceeded the effect obtained for word targets.

Table 12
Reaction Times (in Milliseconds) and Percent Errors for Lexical Decisions to Target Words With Word or Nonword Primes in the Form-Related and Control Conditions of Experiment 7

Words			
Word primes		Nonword primes	
Form related	Control	Form related	Control
558	562	555	564
4.5%	2.4%	3.6%	5.2%
+4		**+9**	

Nonwords	
Form related	Control
611	625
6.1%	6.3%
+14	

Note. Boldface values indicate priming effects.

The results of Experiment 7 thus suggest that nonword primes do not produce significantly better form priming than word primes. These findings do not support the interpretation that lexical competition or inhibition between primes and targets is responsible for the absence of form priming in Hebrew. Moreover, because in our previous experiments only the nonword targets were preceded by nonword primes, prime lexicality predicted target lexicality. This correlation could have perhaps speeded the responses to the targets, thereby reducing the priming effect. The similar findings of Experiment 7 when primes' and targets' lexicality were not correlated, demonstrated that this was not the case.

General Discussion

In the present article we raise a fundamental question in visual word recognition: By what principle are the words of a given language lexically organized? Two main axioms guided our theoretical approach. First, we assumed that some lexical organization must exist and that it should allow optimal processing and access to the words of the language. Second, we assumed that linguistic considerations should be the source of main constraints on our theory of lexical organization.

The pattern of results across the eight experiments reported in this article reveals a consistent difference between Hebrew and Arabic on the one hand and English on the other. The difference is that priming that was due to orthographic overlap is apparently small and unreliable in Semitic languages, whereas it is quite robust in English. We interpret this to mean that the orthographic (and possibly phonological) lexicons of Hebrew speakers are organized in a fundamentally different manner.

The basis for this conclusion rests on the following demonstrations: In Experiment 1A and 1B, no significant masked priming was obtained with Hebrew primes that differed from their targets by a single letter (a root letter), regardless of list composition (i.e., whether an identity condition was included). Experiment 2 showed that a similar result was obtained when the root of the target word was nonproductive. This outcome demonstrates that even words that are not morphologically complex are not stored according to a purely orthographic code. Experiment 3A showed that the lexical organization of Hebrew–English bilingual subjects clearly diverges for the two languages. When tested in English, these Hebrew-dominant bilingual speakers demonstrated robust form priming, but no such effect was obtained in Hebrew. It is important to emphasize that the target words in this experiment were as similar as possible across languages. In addition, although the bilingual subjects in this experiment were Hebrew-language dominant, their response latencies and error rates in the English experiment demonstrated an adequate knowledge of English. In Experiment 3B, with English-dominant bilingual subjects, it was

revealed that the stronger form-priming effects in English are independent of language dominance, because identical results were obtained for the Hebrew- and the English-dominant subjects. In Experiment 4 we contrasted form priming with morphological priming for words that were derived from productive roots. We found that morphological overlap predicted priming, whereas orthographic overlap did not. These results show that words in Hebrew are indeed organized according to a morphological, not orthographic, principle. In Experiment 5 we extended the investigation to the Arabic language, which has a similar, nonconcatenative morphology. Once again, we obtained no significant form priming, despite strong identity priming, whereas similar to Hebrew, a strong morphological relatedness effect was observed. It should be noted that the morphologically related words used in these experiments generally differed by more than a single letter, emphasizing that overall similarity of form is not a determinant of priming in Hebrew or Arabic. It should also be noted that previous studies in Hebrew demonstrated that this facilitation cannot be attributed to the semantic overlap between the morphologically related primes and targets. For example, Frost et al. (1997) showed that, in contrast to English, similar morphological priming effects were obtained with semantically transparent and semantically opaque primes. Moreover, semantically related primes, which were not morphologically related to the targets, did not produce priming under masked conditions in Hebrew.

In Experiment 6 we considered the possibility that the neighborhood density of the targets might be a factor that contributes for the present results. The interaction of form priming and neighborhood density is a well-documented finding obtained not only in English (Forster et al., 1987) but in other Indo-European languages as well (e.g., Perea & Rosa, 2000, for Spanish; Ferrand & Granger, 1992, for French). In general, form priming appears to be much stronger for low-density targets. However, no form priming was obtained in Experiment 6 for both high- and low-density targets. The modulation of form priming by neighborhood density derives from a lexical organization, which is based on orthographic principles, and clusters together words with similar sequences of letters. Because lexical organization in Semitic languages seems to follow a morphological principle, no interaction of form priming and neighborhood density is indeed expected. In fact, the theoretical construct of orthographic neighborhood seems irrelevant in Hebrew, if words are clustered according to their root morpheme. This finding has both theoretical and methodological implications. It suggests that variables that are traditionally considered as necessary controls in visual word-recognition experiments may be language specific.

In Experiment 7 we examined another possible reason for the absence of form priming in Hebrew, namely that the primes were always words rather than nonwords. Under some conditions, the lexical status of the prime has been shown to be important in English, such that nonwords words are more effective than words (Forster & Veres, 1998). However, in Hebrew, nonword primes produced similar effects as word primes. This indicates that the unreliable form-priming effects in Hebrew are not the product of increased competition between word primes and their targets.

Table 13 presents a summary of all seven experiments. The most striking aspect of this table is the extraordinary consistency of the results for form priming across all experiments. In no case did form priming exceed 10 ms. Admittedly, the effect was never negative, and hence it could be argued that there must be an effect present that is too small to be detected in any single experiment. However, it should be noted that the same thing is true for nonword targets, and in no experiment did the form-priming effect for words exceed the priming effects observed for nonword targets, in sharp contrast to parallel findings in Indo-European languages (e.g., Forster, 1987). This suggests that there must be a prelexical component to masked form priming that accounts for about 6–8 ms of the total priming effect for words and nonwords alike. Note that a similar conclusion applies in English, where a small priming effect is consistently found across many experiments for nonword targets (Forster, 1998). This facilitation is considered prelexical, as it is probably related to peripheral factors, such as the registering of letter similarities between primes and targets, which may have some effect on response latencies to the targets. As Frost et al. (2003) argued, the priming effect in masked presentation has indeed a prelexical computation component, which is similar for words and nonwords. Our results lead us to the conclusion that such prelexical factors are involved in producing the small effects of form priming in Hebrew.

Table 13
Summary of Form Priming Effects and Morphological Priming Effects in the Seven Experiments

Experiment	Form priming (ms)	Morphological priming (ms)
1A	+8	—
1B	+5	—
2		
Productive roots	+2	—
Nonproductive roots	+4	—
3A	+8	—
3B	+8	—
4	+6	+13**
5	+8	+21**
6		
Low-density neighborhood	+9	—
High-density neighborhood	+7	—
7		
Word primes	+4	—
Nonword primes	+9	—
Mean effect	**+6**	**+17**

**$p < .05$.

This conclusion is well supported by the contrasting large and reliable effects obtained in the present study, as well as previous studies when primes and targets were morphologically rather than form related (e.g., Deutsch et al., 1998; Frost et al., 1997; Velan, Frost, Deutsch, & Plaut 2005). Thus, in contrast to the elusive form-priming effect, masked morphological priming was consistently obtained in Hebrew or Arabic, even with minimal orthographic overlap. Obviously, one could ask whether in a given experiment the difference between form-priming and morphological priming effects indeed reached significance. However, the large number of experiments conducted in the present study as well as previous ones (e.g., Deutsch et al., 1998; Frost et al., 1997, 2000; Velan et al., 2005) permit us to be confident regarding the overall pattern of results emerging from dozens of experiments: In Hebrew masked morphological priming is always obtained, regardless of orthographic overlap and regardless of semantic sim-

ilarity between prime and targets. The size of this effect is about 13–20 ms on the average, and it is always highly significant by subjects and items. In contrast, simple form-priming effects in the present study were always small and never reached significance.

Implications for Models of Word Recognition

Perhaps the simplest way to account for these results is in terms of an attractor-based model (Rueckl, 2002). A possible argument would be that the positioning of the attractors in lexical space is determined by all the letters in languages such as English, Dutch, French, and Spanish, but by just the root letters in Hebrew. Thus, two Hebrew words with the same root would be located near each other, and hence any movement of the system toward one of those words would also bring the system closer to the other. On this account, the same principles are at work in Hebrew and English, namely orthographic similarity. The only difference is that in Hebrew, similarity is defined in terms of the root letters alone. However, this cannot be the whole story, because this would mean that Hebrew words that had similar root letters would prime each other, because they would be located in adjacent regions. This is clearly not the case, because primes and targets in the present experiments always shared two root letters. Instead, our results lead us to suggest that the location of a Hebrew word would have to be determined by a holistic representation of the root, in which the individual letters by themselves do not make any individual contribution to the location of the attractor. Thus, a word derived from the root *KRB* would not be located any closer to a word derived from *KSB* as a root than to a word derived from *GDL* as a root. One might suggest that this result could be achieved if the location of words was determined by semantic properties alone. That is, words with the same root are located near each other because they have similar meanings. However, this predicts no priming between words that share a root but have no obvious semantic overlap (e.g., MERAGEL–spy, and TARGIL–exercise). This is clearly not the case in Hebrew (Frost et al., 1997).

Thus, it appears that fundamentally different principles must be involved in the organization of the Hebrew and English mental lexicons. This suggestion raises the question of how two quite different lexical systems could exist within the one bilingual mind? Why would a person adopt one system to organize their knowledge of Hebrew words and a different system to organize their knowledge of English words? It surely seems more sensible to assume that one common process is involved. Indeed, in a connectionist net, exactly the same principles could be involved, resulting in different lexical structure. How the lexicon is structured is determined by what correlates with what. If form and meaning are highly correlated, as they are in Hebrew, both factors will jointly determine how the lexicon is structured. However, if form and meaning are largely uncorrelated, as they are in English, form alone will determine the structure. One might object that form and meaning are not uncorrelated in English, because words that share a common stem also have similar meanings (e.g., *constrict* and *restrict*, *sail* and *sailor*). However, this partial correlation is offset by the thousands of cases in which a common stem does not involve semantic overlap (e.g., *constrict* and *district*, *depart* and *department*, or even *race* and *face*). Such is not the case in Hebrew. Thus, the structure that eventually develops is determined by properties of the language itself.

For parallel activation models containing local word unit, such as the IA, DRC, and MROM models, it is more difficult to explain why there is no priming between orthographically similar forms that differ only in a single root letter. Generally speaking, the simplest explanation of form priming in this type of model is that it is the result of cross-activation (e.g., Perea & Rosa, 2000). The very nature of the access architecture in parallel activation models guarantees that the input stimulus will activate a wide range of word units to varying degrees, depending on the amount of orthographic overlap. Although the nonlinear dynamics of parallel distributed processing systems make it difficult to determine precisely how different dimensions of similarity interact, at a first blush the results from Hebrew seem to present a challenge for such models on two levels. First, it is necessary to explain why the nonroot letters do not activate word units that contain those letters. Second, we must also explain why the shared root letters do not produce cross-activation. One option might be to weight the letter-to-word connections so that no word unit is activated unless all three of its root letters are present. This could be achieved by including a strong inhibitory letter-to-word connection between each root letter and all word units that do not contain that letter. This would cancel any activation from shared root letters and from the pattern. Thus, two letters shared out of three are not sufficient to produce above-threshold activation, but six out of seven letters shared might be, if these contain all the root letters. Hence, this solution reverts as well to a lexical structure in Hebrew that is based on the explicit representation of root morphemes. Support for this conclusion comes from a recent experiment conducted in our laboratory in which we monitored priming effects when primes consisted of presenting two letters of the root rather than three (Velan et al., 2005). These experiments showed that primes consisting of only two root letters did not produce priming. An obvious problem with this account is that the connections need to be specially tailored for each individual word, because the root letters do not occupy fixed positions across different words, and some letters can function both as root letters and as word-pattern letters. Obviously, any pattern of priming at all could be simulated by such a model, and it is virtually just a redescription of the findings.

A better solution would be to introduce a layer of morphological units between the letter units and the word unit, as proposed by Taft (1994). These units would be of two types—roots and patterns. The root units would be activated by root letters only, and all three root letters would need to be present to produce any activation. The pattern units would be activated by pattern letters only, and the combined action of a root unit and a pattern unit would activate a word unit. As before, this solution requires a preliminary parsing to determine which letters belong to the root and which belong to the pattern. Even this arrangement still has problems. The failure of shared patterns to produce priming in the nominal system (Frost et al., 1997) still needs to be explained, as does the fact that shared patterns produce priming in the verbal system (Deutsch et al., 1998). What is missing from this account is an explanation of why the system has these properties. This problem is very clear in the case of the bilingual experiments. Why should a Hebrew–English bilingual person adopt such a system for Hebrew, while adopting a rather different system for English?

An alternative to a parallel activation approach is the extension of the serial search model of priming designed to account for masked priming effects, termed the *entry-opening model* (Forster,

1999; Forster & Davis, 1984). This model assumes that lexical entries are organized into bins that are based on their orthographic form. The orthographic properties of the input are used to calculate an approximate address (i.e., a bin number), and a frequency-ordered search within that bin is required to locate the matching entry. Form priming is assumed to occur because the entry for the target is registered as a close match during the search for the prime given their orthographic overlap. This facilitates subsequent retrieval of information from the target's entry and is an essential prerequisite for recognition. To explain our present results, it is only necessary to propose that in Hebrew, the grouping of entries into bins is based on the root letters only. That is, all words that contain the same root letters will be in the same bin. Obviously, for priming to occur, the entry for both the prime and the target needs to be in the same bin, or the search for the prime will never encounter the entry for the target (it is assumed that the search never extends to other bins). However, if the prime contains a different root to the target, their entries must be in different bins, and hence no form priming is possible.

This account has the advantage that the mechanisms that produce priming are the same in both Hebrew and English, and hence it is easier to see how two different systems could coexist in the one brain–mind. The only difference is the principle on which the grouping of lexical entries is based. In Hebrew, all words with the same root are grouped together, but in English, overall orthographic similarity determines the grouping. On this account grouping of words into bins is based on whatever commonalities are available in the language. Although many English words contain a recognizable morpheme, the majority do not, and even if they do, the correlation with meaning has been lost (e.g., the meaning of *mit* in *admit, permit, submit, commit,* and *remit*). Hence, a morphological grouping has no advantage whatsoever.

The importance of a correlation with meaning may explain why verbs show different priming effects to nouns in Hebrew. As shown by Deutsch et al. (1998), verbs that share a common pattern show priming, whereas nouns do not. One possible explanation is that the verbal pattern contributes substantially to the semantic interpretation of the verb phrase, conveying tense, aspect, and so forth. The analogy in English might be the use of "he is running" as a prime for "he is dreaming." This proposal could also explain why there is no pattern priming in the nominal system, as shown in the present results as well as those we previously reported (Frost et al., 1997). In most cases, the word pattern for nouns carries nothing more than word-class information (part of speech), and there is no semantic content per se.

Prelexical Root Extraction

As argued earlier, it appears that a parallel activation account and especially a search model account require that the system must be able to extract the root letters in advance. To solve this problem, we propose that Hebrew readers possess a parsing routine that is capable of parsing the input into a root plus a pattern. A similar proposal is required for English to explain prefix stripping effects (Taft & Forster, 1975), but in this case, the location of the prefix is known in advance. However, the locations of the root letters in a Hebrew word are not known, because they depend on the pattern. Considering the distribution of word patterns, it seems possible to offer a simple enough algorithm that separates the root letters from the word-pattern letters. Such an algorithm will be based on the very biased distribution of the word-pattern letters. For example, most word patterns begin with the letters *H, M, T,* or *N*. If the second letter of the word belongs to the pattern then in all probability it is a *T*, and final pattern letters are also *H, T,* or *N*. Some letters never belong to any word pattern so they must belong to the root, and so forth Obviously, such a simple parsing algorithm may not be foolproof and in some cases may still provide ambiguous taxonomies. This, however, does not present a problem for the current approach, as native speakers do produce parsing errors. Perhaps the best example would be the case of the weak roots, roots in which, for some phonetic reason, one consonant is missing in the verbal form. Such forms are indeed extremely difficult to process and parse (see Frost et al., 2000, for a discussion). It is clear, however, that to gain accurate insights regarding the processes involved in parsing printed Hebrew words, it is necessary to investigate the statistical properties of Hebrew orthography. These properties include, among other things, patterns of orthographic redundancies, statistics of root letters' contiguity, and their distribution within words.

Concluding Remarks

Our research contrasting form priming with morphological priming in Semitic languages addresses a major theoretical issue in the domain of visual word recognition. The issue concerns the basic principles governing lexical architecture in different orthographies. From a historical perspective, many if not most studies of visual word recognition and morphological processing have been conducted in English. In recent years, however, it has been widely acknowledged that studies in other languages could produce converging or contrasting evidence that would allow the formulation of a general theory of lexical organization. The role of morphology is particularly relevant in this context. Morphological complexity is created in different languages according to different principles; thus, it seems clear that models of representation, storage, and processing of words in a language should be tuned to these principles. We should, therefore, emphasize that our research was not aimed at merely providing other descriptions of other lexical systems. Rather, we used Semitic languages for the purpose of advancing toward a metatheory of lexical organization, a theory that should be able to predict systematic variations in lexical structures given systematic variations in morphological structures.

Although our discussions extended to the descriptive adequacy of current models of visual word recognition, the conclusions from our research focus mainly on one theoretical point: Lexical architecture for visually presented words in Semitic languages is primarily determined by morphological constraints rather than by orthographic constraints. Thus, although Semitic languages and Indo-European languages have adopted the alphabetic principle, their organization of the orthographic lexicon is inherently different. This implies that factors affecting word recognition in different languages have different impact and that the dynamic process of locating printed words in the mental lexicon is language dependent. Current attempts to provide adequate modeling of lexical processes should take this fact into consideration.

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(Appendixes follow)

Appendix A

The Hebrew Alphabet

Hebrew Print	*Orthographic Transcription*	*Phonetic Transcription*
א	?	?
ב	b	b / v
ג	g	g
ד	d	d
ה	h	h
ו	w	o / u / v
ז	z	z
ח	x	x
ט	T	t
י	y	i / y
כ	k	k / x
ך[a]	K	x
ל	l	l
מ	m	m
ם[a]	M	m
נ	n	n
ן[a]	N	n
ס	S	s
ע	∂	?
פ	p	p / f
ף[a]	P	f
צ	c	ts
ץ[a]	C	ts
ק	q	k
ר	r	r
ש	s	s / Σ
ת	t	t

[a] The letters k, m, n, p and c have different orthographic forms when they appear at the end of the word.

Appendix B

Stimuli used in Experiments 1 and 1a

Target				Form-Related				Control			
Word	*Orth. Trans.*	*Phon. Trans.*	*Meaning*	*Word*	*Orth. Trans.*	*Phon. Trans.*	*Meaning*	*Word*	*Orth. Trans.*	*Phon. Trans.*	*Meaning*
רסיס	rSyS	/r≡sis/	shard	עסיס	∂SyS	/asis/	nectar	צנון	cnwN	/t͡snon/	radish
פרוע	prw∂	/paro?a/	wild	פגוע	pgw∂	/pagu?a/	hurt	שביל	sbyl	/Σvil/	path
קטטה	kTTh	/ktata/	brawl	קטנה	ktnh	/ktana/	little	שומר	swmr	/Σomer/	guard
משפט	mspT	/miΣpat/	sentence	משפך	mspK	/maΣpex/	funnel	תאנה	t?nh	/t≡?ena/	fig
זכרון	zkrwN	/zikaron/	memory	שכרון	skrwN	/Σikaron/	drunkenness	מסקנה	mSqnh	/maskana/	conclusion
הנעלה	hn∂lh	/han?ala/	footwear	הפעלה	hp∂lh	/haf?ala/	activation	סרדין	SrdyN	/sardine/	sardine
הפלגה	hplgh	/haflaga/	sailing	הפוגה	hpwgh	/hafuga/	pause	ציבור	cybwr	/t͡sibur/	public
פלוגה	plwgh	/pluga/	company	פלומה	plwmh	/pluma/	feathers	חשבון	xsbwN	/xeΣbon/	arithmetic
משונן	mswnN	/m≡Σonan/	toothed	משתנה	mswnh	/m≡shune/	strange	בליטה	blyTa	/blita/	bulge
צמיד	cmyd	/t͡samid/	bracelet	עמיד	∂myd	/amid/	durable	רכבת	rkbt	/rakevet/	train
הסקה	hSqh	/hasaka/	heating	הפקה	hpkh	/hafaka/	production	שופר	swpr	/Σofar/	Shofar
מפרש	mprs	/mifras/	sail	מגרש	mgrs	/migraΣ/	field	קסדה	qSdh	/kasda/	helmet
שבוי	sbwy	/Σavuy/	captive	שבור	sbwr	/Σavur/	broken	מגדל	mgdl	/migdal/	tower
גסיסה	gSySh	/gsisa/	dying	תסיסה	tSySh	/tsisa/	fermentation	מכשול	mkswl	/mixΣol/	obstacle
בשורה	bswrh	/bsora/	news	בחורה	bxwrh	/baxura/	girl	ממציא	mmcy?	/mamt͡si/	inventor
פציעה	Pcy∂h	/pt͡si?a/	injury	פצירה	pcyrh	/pt͡sira/	nail file	ארגון	?rgwN	/irgun/	organization
שעון	s∂wN	/Σa?on/	clock	מעון	m∂wN	/ma?on/	kindergarten	פצצה	pcch	/pt͡sat͡sa/	bomb
עגלה	∂glh	/agala/	cart	עמלה	∂mlh	/amla/	commission	פמוט	pmwt	/pamot/	candle stick
חובש	xwbs	/xuveΣ/	paramedic	חודש	xwds	/xodeΣ/	month	רקפת	rqpt	/rakefet/	cyclamen
ארנב	arnb	/arnav/	rabbit	ארנק	?rnk	/arnak/	wallet	תמים	tmyM	/tamim/	naive
גלמוד	glmwd	/galmud/	lonely	תלמוד	tlmwd	/talmud/	Talmud	ינשוף	ynswP	/yanΣuf/	owl
עפרון	∂prwN	/iparon/	pencil	עקרון	∂qrwn	/ikaron/	principle	מנהרה	mnhrh	/minhara/	tunnel
מחשבה	mxsbh	/maxΣava/	thought	מחצבה	mxcbh	/maxt͡seva/	quarry	סגנון	SgnwN	/signun/	style
חתונה	xtwnh	/xatona/	wedding	חתולה	xtwlh	/xatula/	kitten	שלילי	slyly	/Σlili/	negative
ציפוי	cypwy	/t͡sipuy/	coating	ציפור	cypwr	/t͡sipor/	bird	כלכלה	klklh	/kalkala/	economy
סולם	SwlM	/sulam/	ladder	אולם	?wlM	/ulam/	hall	פטיש	pTys	/patiΣ/	hammer
נשיא	nsy?	/nasi/	president	נביא	nby?	/navi/	prophet	קוסם	qwSm	/kosem/	magician
הנאה	hn?h	/hana?a/	enjoyment	הנחה	hnxh	/hanaxa/	discount	קרחת	qrxt	/karaxat/	baldness
צריח	cryx	/t͡sariax/	tower	צריף	cryP	/t͡srif/	hut	לולב	lwlb	/lulav/	Lulav
גופני	gwpny	/gufani/	physical	סופני	swpny	/sofani/	terminal	מקטרת	mqTrt	/mikteret/	smoking pipe
כלימה	klymh	/klima/	shame	כנימה	knymh	/knima/	aphid	אגרוף	?grwP	/egrof/	fist
מחברת	mxbrt	/maxberet/	notebook	מחתרת	mxtrt	/maxteret/	underground	גופיה	gwpyh	/gufia/	undershirt
ארון	?rwN	/aron/	closet	קרון	qrwn	/karon/	(train) coach	קבצן	qbcN	/kabt͡san/	beggar
חמאה	xm?h	/xem?a/	butter	חלאה	xl?h	/xel?a/	scum	פושע	pws∂	/poΣe?a/	criminal
דרגה	drgh	/darga/	rank	דרשה	drsh	/draΣa/	sermon	שלכת	slkt	/Σalexet/	exfoliation
חופה	xwph	/xupa/	Huppah	חופש	xwps	/xopeΣ/	freedom	תירס	tyrS	/tiras/	corn
תמונה	tmwnh	/tmuna/	picture	ממונה	mmwnh	/m≡mone/	supervisor	ילקוט	ylqwt	/yalkut/	knapsack
מערכה	m∂rkh	/ma?araxa/	battle	מדרכה	mdrkh	/midraxa/	sidewalk	אבטיח	?bTyx	/avatix/	watermelon
סיפור	Sypwr	/sipur/	story	סידור	Sydwr	/sidur/	arrangement	הנהגה	hnhgh	/hanhaga/	leadership
נביעה	Nby∂h	/nevi?a/	(water) spring	נביחה	nbyxh	/n≡vixa/	bark	כורסא	kwrS?	/kursa/	armchair
מענב	M∂wnb	/me?nav/	wearing a tie	מענן	m?wnN	/m≡?unan/	cloudy	קרפדה	qrpdh	/karpada/	toad
תפוז	tpwz	/tapuz/	orange	חפוז	xpwz	/xafuz/	hasty	קללה	qllh	/klala/	curse
הקפה	hkph	/hakafa/	encircling	הצפה	hcph	/hat͡safa/	flooding	שועל	sw∂l	/Σu?al/	fox
דרדר	drdr	/dardar/	thorn	דרור	drwr	/dror/	liberty	שתיל	styl	/Σtil/	seedling
מחול	mxwl	/maxol/	dance	מחוג	mxwg	/maxog/	dial	תנין	tnyN	/tanin/	crocodile
מיסוי	mySwy	/misuy/	taxation	מיפוי	mypwy	/mipuy/	mapping	צפרדע	cprd∂	/t͡sfarde?a/	frog
נדידה	ndydh	/n≡dida/	migration	נדירה	ndyrh	/n≡dira/	vowing	פעמון	p∂mwN	/pa?amon/	bell
פיתוח	pytux	/pitux/	development	פיתול	pytul	/pitul/	winding	מרכבה	mrkbh	/merkava/	chariot

(*Appendixes continue*)

Appendix C

Stimuli used in Experiment 2

Productive Roots

Target				*Form-Related*				*Control*			
Word	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***
מגרעת	mgr∂t	/migra?at/	disadvantage	מגבעת	mgb∂t	/migba?at/	top hat	יהלום	yhlwM	/yahalom/	diamond
תצלום	tclwM	/tat͡slum/	photograph	תשלום	tslwM	/taΣlum/	payment	משענת	ms∂nt	/miΣ?enet/	backrest
שיעור	sy∂wr	/Σi?ur/	lesson	שידור	sydwr	/Σidur/	broadcast	ממלכה	mmlkh	/mamlaxa/	kingdom
מותתן	mwtxN	/motxan/	thriller	פותתן	pwtxN	/potxan/	can opener	קליפה	qlyph	/klipa/	peel
מחלקה	mxlqh	/maxlaka/	division	מחלבה	mxlbh	/maxleva/	dairy	בצורת	bcwrt	/bat͡suret/	drought
חריטה	xryTh	/xarita/	carving	חריגה	xrygh	/xariga/	divergence	מקלעת	mqlθt	/mikla?at/	slingshot
נעילה	n∂ylh	/n≡?ila/	locking	נפילה	npylh	/n≡fila/	fall	מסגרת	mSgrt	/misgeret/	frame
משלחת	mslxt	/miΣlaxat/	delegation	מקלחת	mqlxt	/miklaxat/	shower	הפסקה	hpSqh	/hafsaka/	intermission
שיבוץ	sybwc	/Σibut͡s/	placement	קיבוץ	qybwC	/kibut͡s/	Kibbutz	מקדחה	mqdxh	/makdexa/	drill
פעימה	p∂ymh	/p≡?ima/	throbbing	נעימה	n∂ymh	/n≡?ima/	melody	חסרון	xSrwN	/xisaron/	disadvantage
חיזור	xyzwr	/xizur/	courtship	חיסור	xySwr	/xisur/	subtraction	מעטפה	MθTph	/ma?atafa/	envelope
קידוש	qydws	/kidu͡Σ/	Kiddush	קידום	qydwM	/kidum/	promotion	מלכוד	mlkwd	/milkud/	trapping
השפעה	hsp∂h	/haΣpa?a/	influence	השקעה	hsq∂h	/haΣka?a/	investment	מטמון	mTmwN	/matmon/	treasure
ריקוד	rykwd	/rikud/	dance	ריפוד	rypwd	/ripud/	upholstery	מבחנה	mbxnh	/mavxena/	test tube
קפיצה	qpych	/kfit͡sa/	jump	קריצה	qrych	/krit͡sa/	wink	תעלול	tθlwl	/ta?alul/	prank
כיבוד	kybwd	/kibud/	refreshment	כיבוש	kybws	/kibu͡Σ/	occupation	מספרה	mSprh	/mispara/	barber shop
הדרכה	hdrxh	/hadraxh/	guidance	הערכה	h∂rkh	/ha?araxa/	evaluation	תחמיץ	txmyC	/taxmit͡s/	silage
פירוט	pyrwt	/perut/	itemization	פירוש	pyrws	/peru͡Σ/	meaning	מכשלה	mkslh	/maxΣela/	obstacle
נימוק	nymwq	/nimuk/	argument	נימוס	nymwS	/nimus/	politeness	הפתעה	hpTθh	/hafta?a/	surprise
החלטה	hxlTh	/haxlata/	decision	החלפה	hxlph	/haxlafa/	exchange	מעצור	mθcwr	/ma?at͡sor/	block
בישול	byswl	/biΣul/	cooking	ביטול	bytwl	/bitul/	cancellation	חטיפה	xTyph	/xatifa/	abduction
פיזור	pyzwr	/pizur/	dispersal	פיגור	pygwr	/pigur/	retardation	אבטלה	?bTlh	/avtala/	unemployment
שיקול	syqwl	/Σikul/	consideration	שיקוף	syqwP	/Σikuf/	mirroring	מאפרה	m?prh	/ma?afera/	ashtray
עבודה	∂bwdh	/avoda/	work	עמודה	∂mwdh	/amuda/	column	מחברת	mxbrt	/maxberet/	notebook
פריחה	pryxh	/prixa/	blossom	פריסה	prySh	/prisa/	spread	מסלול	mSlwl	/maslul/	track
שתיקה	styqh	/Σtika/	silence	שתילה	stylh	/Σtila/	planting	מצפון	mcpwN	/mat͡spun/	conscience
שמירה	smyrh	/Σmira/	guarding	שבירה	sbyrh	/Σvira/	breaking	עצבות	θcbwt	/at͡svut/	sadness
רשימה	rsymh	/r≡Σima/	list	נשימה	nsymh	/n≡Σima/	breath	תפקד	tpqwd	/tafkid/	function
נביאה	nby?a	/n≡vi?a/	prophetess	נביחה	nbyxh	/n≡vixa/	bark	מקטרת	mqTrt	/mikteret/	smoking pipe
שריפה	sryph	/srefa/	fire	שטיפה	sTyph	/Σtifa/	washing	מקצוע	mqcwθ	/mikt͡so?a/	profession
בליטה	blyth	/blita/	bulge	בלימה	blymh	/blima/	braking	מקצפת	mqcpt	/mikt͡sefet/	meringue
שאיבה	s?ybh	/Σe?iva/	pumping	שכיבה	skybh	/Σxiva/	lying down	מרגוע	mrgwθ	/margu?a/	repose
זהירה	zhyrh	/z≡hira/	careful (f.)	נהירה	nhyrh	/n≡hira/	streaming	מקלדת	mqldt	/mikledet/	keyboard
כתיבה	ktybh	/ktiva/	writing	כתישה	ktysh	/ktiΣa/	crushing	חדשות	xdswt	/xadaΣot/	news
דילול	dylwl	/dilul/	dilution	דילוג	dylwg	/dilug/	skipping	הפגזה	hpgzh	/hafgaza/	bombing
ביגוד	bygwd	/bigud/	clothing	בידוד	bydwd	/bidud/	isolation	מטחנה	mTxnh	/matxena/	grinding-mill

Non-Productive Roots

Target				Form -Related				Control			
Word	*Orth. Trans.*	*Phon. Trans.*	*Meaning*	*Word*	*Orth. Trans.*	*Phon. Trans.*	*Meaning*	*Word*	*Orth. Trans.*	*Phon. Trans.*	*Meanin*
ארנב	?rnb	/arnav/	rabbit	ארנק	?rnk	/arnak/	wallet	חתול	xtwl	/xatul/	cat
אלון	?lwn	/alon/	oak	ארון	?rwN	/aron/	closet	תירס	tyrS	/tiras/	corn
חמאה	xm?h	/xem?a/	butter	חלאה	xl?h	/xala?a/	scum	ערסל	?rSl	/arsal/	hammock
פמוט	pmwT	/pamot/	candlestick	פעוט	pʕwT	/pa?ot/	infant	דלעת	dlʕt	/dla?at/	pumpkin
מזרון	mzrwM	/mizron/	mattress	מדרון	mdrwN	/midron/	slope	חצאית	xc?yt	/xatsait/	skirt
עיתון	ʕytwN	/iton/	newspaper	קיתון	kytwn	/kiton/	jug	ממחטה	mmxTh	/mimxata/	handkerchief
תמונה	tmwnh	/himnon/	picture	תאונה	t?wnh	/t≡?una/	accident	אבטיח	?btyx	/avatix/	watermelon
המנון	hmnwn	/kopta/	anthem	תמנון	tmnwN	/t≡manon/	octopus	צפרדע	cprdʕ	/tsfarde?a/	frog
כופתה	kwpth	/kufta/	dumpling	כומתה	kwmth	/kumta/	beret	נחשון	nxswN	/naxΣon/	brave
בהמה	bhmh	/b≡hema/	beast	בימה	bymh	/bima/	stage	פרדס	prdS	/pardes/	orchard
מומיה	mwmyh	/momia/	mummy	גומיה	gwmyh	/gumia/	elastic	אשראי	?sr?y	/aΣray/	credit
גרזן	grzN	/garzen/	ax	גרון	grwN	/garon/	throat	קסדה	qSdh	/kasda/	helmet
הברה	hbrh	/havara/	syllable	הבעה	hbʕh	/haba?a/	expression	מפתן	mptN	/miftan/	threshold
חזית	xzyt	/xazit/	front	חזיר	xzyr	/xazir/	pig	דרור	drwr	/dror/	liberty
חלזון	xlzwN	/xilazon/	snail	חלמון	xlmwN	/xelmon/	yolk	נרקיס	nrqyS	/narkis/	daffodil
תאנה	t?nh	/t≡?ena/	fig	תחנה	txnh	/taxana/	station	לולב	lwlb	/lulav/	Lulav
סולם	swlM	/sulam/	ladder	אולם	?wlM	/ulam/	hall	פטיש	pTys	/patiΣ/	hammer
שועל	swʕl	/su?al/	fox	שובל	swvl	/Σoval/	trail	צמרת	cmrt	/tsameret/	tree-top
אלומה	?lwnh	/aluma/	sheaf	פלומה	plwmh	/pluma/	feathers	עכביש	ʕkbys	/akaviΣ/	spider
נמיה	nmyh	/n≡miya/	ichneumon	נמלה	nmlh	/n≡mala/	ant	סולת	swlt	/solet/	semolina
סוכר	swkr	/sukar/	sugar	סוהר	swhr	/soher/	jailor	פדחת	pdxt	/padaxat/	forehead
סנדק	sndk	/sandak/	godfather	סנדל	sndl	/sandal/	sandal	חציל	xcyl	/xatsil/	eggplant
כרית	kryt	/karit/	pillow	כריש	krys	/kariΣ/	shark	תפוח	tpwx	/tapuax/	apple
סינר	synr	/sinar/	apron	סיגר	sygr	/sigar/	cigar	עדשה	ʕdsh	/adaΣa/	lens
קולר	kwlr	/kolar/	collar	קולב	kwlv	/kolav/	hanger	שחמט	sxmt	/Σaxmat/	chess
חלון	xlwN	/xalon/	window	בלון	blwN	/balon/	balloon	אגדה	?gdh	/agada/	legend
תמוז	tmwz	/tamuz/	Tammuz	תפוז	tpwz	/tapuz/	orange	קיסר	qysr	/keysar/	Caesar
ערפד	ʕrpd	/arpad/	vampire	ערפל	ʕrpl	/arafel/	fog	תלתן	tltN	/tiltan/	clover
ענבר	ʕnbr	/inbar/	amber	עכבר	ʕkbr	/axbar/	mouse	תנין	tnyN	/tanin/	crocodile
ברדס	brdS	/bardas/	hood	דרדס	drdS	/dardas/	smurf	שלכת	slkt	/Σalexet/	foliage
אריה	?ryh	/arye/	lion	ארבה	?rbh	/arbe/	locust	כחול	kxwl	/kaxol/	blue
יתום	ytwM	/yatom/	orphan	כתום	ktwN	/katom/	orange	מצדה	mcdh	/m≡tsada/	fort
ברוש	brws	/broΣ/	cypress	ברנש	brns	/barnaΣ/	fellow	שחפת	sxpt	/Σaxefet/	tuberculosis
שמיים	smyyM	/Σamayim/	sky	שתיים	styyM	/Σtayim/	two	קרטון	qrtwN	/karton/	cardboard
שביט	sbyT	/Σavit/	comet	שביל	sbyl	/Σvil/	path	אדמה	?dmh	/adama/	earth
ידית	ydyt	/yadit/	handle	ידיד	ydyd	/yadid/	friend	אצבע	?cbʕ	/etsba/	finger

(*Appendixes continue*)

Appendix D

Stimuli used in Experiment 3

Hebrew Stimuli

Target				*Form-Related*				*Control*			
Word	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***
תחמושת	txmwst	/txmoΣet/	ammunition	תחפושת	txpwst	/taxposet/	costume	מרכזיה	mrkzyh	/merkazia/	operator
שילוט	sylwT	/Σilut/	signposts	שילוב	sylwb	/Σiluv/	combination	התקנה	htqnh	/hatkana/	installation
נימוק	nymwq	/nimuk/	argument	צימוק	cymwq	/tsimuk/	shriveling	הגדרה	hgdrh	/hagdara/	definition
קפיצה	qpych	/kfitsa/	jump	קריצה	qrych	/kritsa/	wink	מושלג	mwslg	/muΣlag/	snowy
כיבוש	kybws	/kibuΣ/	occupation	כיבוד	kybwd	/kibud/	refreshment	הלחמה	hlxmh	/halxama/	soldering
הצדקה	hcdqh	/htsdaka/	justification	הצדעה	hcdϑh	/hatsda?a/	salute	כיפור	kypwr	/kipur/	atonement
סלידה	Slydh	/slida/	repulsion	גלידה	glydh	/glida/	ice-cream	שארית	s?ryt	/sh≡?erit/	remainder
הערכה	Hϑrkh	/ha?araxa/	evaluation	הדרכה	hdrkh	/hadraxa/	guidance	פילוג	pylwg	/pilug/	division
קינוח	qynwx	/kinuax/	dessert	קידוח	qydwx	/kidux/	drilling	הרתעה	hrtϑh	/harta?a/	deterrence
פליאה	ply?h	/pli?a/	astonishment	פלישה	plysh	/pliΣa/	invasion	תרבות	trbwt	/tarbut/	culture
הגשמה	hgsmh	/hagΣama/	fulfillment	הגזמה	hgzmh	/hagzama/	exaggeration	ברבור	brbwr	/barbur/	swan
תבליט	tblyT	/tavlit/	relief	תקליט	tqlyT	/taklit/	record	ארוחה	?rwxh	/aruxa/	meal
מחסור	mxSwr	/maxsor/	shortage	מחזור	mxzwr	/maxzor/	cycle	נגיעה	ngyϑh	/n≡gi?a/	touch
תחבורה	txbwrh	/taxbura/	transportation	תחבולה	txbwlh	/taxbula/	trick	אסימון	?SymwN	/asimon/	token
שיקול	syqwl	/Σikul/	consideration	שיקום	syqwM	/Σikum/	rehabilitation	הפתעה	hptϑh	/hafta?a/	surprise
הפעלה	hpϑlh	/haf?ala/	activation	הרעלה	hrϑlh	/har?ala/	poisoning	צינור	cynwr	/tsinor/	pipe
מרפסת	mrpSt	/mirpeset/	balcony	מדפסת	mdpSt	/madpeset/	printer	גניזה	gnyzh	/gniza/	archive
כתיבה	ktybh	/ktiva/	writing	כתישה	ktysh	/ktiΣa/	crushing	ארמון	?rmwN	/armon/	palace
שאיבה	s?ybh	/Σ≡?iva/	pumping	שכיבה	skybh	/Σxiva/	lying down	פותחן	pwtxN	/potxan/	can opener
גלישה	glysh	/gliΣa/	surfing	תלישה	tlysh	/tliΣa/	plucking	ערבון	ϑrbwN	/eravon/	collateral
פיצוץ	pycwC	/pitsuts/	explosion	פיצול	pycwl	/pitsul/	splitting	מעברה	mϑbrh	/ma?abara/	transit camp
מיקוד	myqwd	/mikud/	focus	ריקוד	ryqwd	/rikud/	dance	הלחנה	hlxnh	/halxana/	composition
ישיבה	ysyϑh	/yeΣiva/	meeting	יציבה	ycybh	/yetsiva/	posture	תרגום	trgwM	/tirgum/	translation
הפגנה	hpgnh	/hafgaza/	demonstration	הפגזה	hpgzh	/hafgaza/	bombing	קיבוץ	qybwC	/kibuts/	Kibbutz
תזכורת	tzkwrt	/tizkoret/	reminder	תזמורת	tzmwrt	/tizmoret/	orchestra	עגבניה	ϑgwnyh	/agvanya/	tomato
הסברה	hsbrh	/hasbara/	publicity	הדברה	hdbrh	/hadbara/	disinfection	מקלחת	mqlxt	/miklaxat/	shower
בדיקה	bdyqh	/bdika/	examination	בדיחה	bdyxh	/bdixa/	joke	מחתרת	mxtrt	/maxteret/	underground
דירוג	dyrwg	/derug/	ranking	דילוג	dylwg	/dilug/	skipping	צנצנת	cncnt	/tsintsenet/	jar
שכירות	skyrwt	/sxirut/	rent	שכיחות	skyxwt	/sxixut/	frequency	מנגינה	mngynh	/mangina/	tune
משטרה	msTrh	/miΣtara/	police	ממטרה	mmTrh	/mamtera/	sprinkler	איפול	?ypwl	/ipul/	blackout
המצאה	hmc?h	/hamtsa?a/	invention	הרצאה	hrc?h	/hartsa?a/	lecture	שולחן	swlxN	/Σulxan/	table
משיכה	msykh	/m≡Σixa/	attraction	נשיכה	nsykh	/n≡Σixa/	bite	קורבן	qwrbN	/korban/	victim
התקפה	htqfh	/hatkafa/	attack	השקפה	hsqph	/haΣkafa/	outlook	עיגול	ϑygwl	/igul/	circle
תצלום	tclwm	/tatslum/	photograph	תשלום	tslwM	/taΣlum/	payment	הפרטה	hprTh	/hafrata/	privatization
הנהגה	hnhgh	/hanhaga/	leadership	הנהלה	hnhlh	/hanhala/	management	בקבוק	bqbwq	/bakbuk/	bottle
היפוך	hypwk	/hipux/	reversal	הילוך	hylwK	/hilux/	gear	מברשת	mbrst	/mivreΣet/	brush

English Stimuli

Target	*Related*	*Control*
river	rider	knock
chest	crest	moral
chair	chain	slope
power	tower	habit
belly	jelly	watch
nation	notion	member
carrot	parrot	simple
alone	clone	spark
master	matter	colony
flower	blower	banana
trace	truce	skunk
recent	regent	whisky
tutor	tumor	level
phase	chase	group
space	spice	glory
father	rather	signal
goose	moose	panic
horse	house	bunch
prize	price	gloom
angel	anger	truck
vocal	local	dream
stage	stake	broom
brave	brace	study
freak	creak	point
giant	grant	cover
clean	clear	sword
value	valve	north
danger	dagger	police
settle	kettle	paving
nibble	dibble	carbon
blush	brush	frame
cheap	cheat	world
nudge	judge	crown
mixer	miser	glass
tribe	bribe	clock
motel	model	crack

(*Appendixes continue*)

Appendix E

Stimuli used in Experiment 4

Target				*Form – Related*			
Word	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***
מגרעת	**mgrθt**	/migra?at/	disadvantage	מגבעת	mgbθt	/migba?at/	top hat
שילוט	**sylwT**	/Σilut/	signposts	שיטוט	syTwT	/Σitut/	wandering
תצלום	**tclwM**	/tat̲slum/	photograph	תשלום	tslwM	/taΣlum/	payment
פיצוץ	**pycwC**	/pit̲sut̲s/	explosion	ניצוץ	nycwC	/nit̲sot̲s/	spark
שיעור	**syθwr**	/ΣI?ur/	lesson	שידור	sydwr	/Σidur/	broadcast
מותחן	**mwtxN**	/motxan/	thriller	פותחן	pwtxN	/potxan/	can opener
מחלבה	**mxlbh**	/max.leva/	dairy	מחלקה	mxlqh	/maxlaka/	division
חריטה	**xryTh**	/xarita/	carving	חריגה	xrygh	/xariga/	divergence
נעילה	**nθylh**	/ne?ila/	locking	נפילה	npylh	/n≡fila/	fall
אכילה	**?kylh**	/ʌxial/	eating	אכיפה	?kyph	/axifa/	enforcement
משלחת	**mslxt**	/miΣlaxat/	delegation	מקלחת	mqlxt	/miklaxat/	shower
שיבוץ	**sybwC**	/Σibut̲s/	placement	קיבוץ	qybwC	/kibut̲s/	Kibbutz
פעימה	**pθymh**	/pe?ima/	throbbing	נעימה	nθymh	/n≡?ima/	melody
קידוש	**qydws**	/kiduΣ/	Kiddush	קידום	qydwM	/kidum/	promotion
השפעה	**hspθh**	/haΣpa?a/	influence	השקעה	hsqθh	/haΣka?a/	investment
ריכוז	**rykwz**	/rikuz/	concentration	ריכוך	rykwK	/rikux/	softening
ריקוד	**ryqwd**	/rikud/	dance	ריפוד	rypwd	/ripud/	upholstery
קפיצה	**qpych**	/kfit̲sa/	jump	קריצה	qrych	/krit̲sa/	wink
סינון	**SynwN**	/sinun/	filtering	סימון	SymwN	/simun/	notation
כיבוד	**kybwd**	/kibud/	refreshment	כיבוש	kybws	/kibuΣ/	occupation
הדרכה	**hdrkh**	/hadraxa/	guidance	הערכה	hθrkh	/ha?araxa/	evaluation
פירוט	**pyrwt**	/perut/	itemization	פירוש	pyrws	/peruΣ/	meaning
בידוד	**bydwd**	/bidud/	isolation	ביגוד	bygwd	/bigud/	clothing
נימוק	**nymwk**	/nimuk/	argument	נימוס	nymwS	/nimus/	politeness
החלטה	**hxlTh**	/haxkata/	decision	החלפה	hxlph	/haxlafa/	exchange
ביטול	**byswl**	/biΣul/	cooking	ביטול	bytwl	/bitul/	cancellation
תפילה	**tpylh**	/tfila/	prayer	תהילה	thylh	/t≡hila/	glory
שיקוף	**syqwP**	/Σikuf/	mirroring	שיקול	syqwl	/Σikul/	consideration
עבודה	**θbwdh**	/avoda/	work	עמודה	θmwdh	/amuda/	column
פריחה	**pryxh**	/prixa/	blossom	פריסה	prysh	/prisa/	spread
שתיקה	**styqh**	/Σtika/	silence	שתילה	stylh	/Σtila/	planting
אחיזה	**?xyzh**	/axiza/	grip	אריזה	?ryzh	/ariza/	package
שמירה	**smyrh**	/Σmira/	guarding	שבירה	sbyrh	/Σvira/	breaking
קיפוח	**qypwx**	/kipux/	deprivation	קינוח	qynwx	/kinuax/	dessert
רשימה	**rsymh**	/r≡Σima/	list	נשימה	nsymh	/n≡Σima/	breath
זכרון	**zkrwN**	/zikaron/	memory	שכרון	skrwN	/Σikaron/	drunkenness
כתיבה	**ktybh**	/ktiva/	writing	כתישה	ktysh	/ktiΣa/	crushing
עשירה	**θsyrh**	/aΣira/	rich (f.)	נשירה	nsyrh	/n≡Σira/	shedding
זהירה	**zhyrh**	/z≡hira/	careful (f.)	נהירה	nhyrh	/n≡hira/	streaming
נביאה	**Nby?h**	/n≡vi?a/	prophetess	נביחה	nbyxh	/n≡vixa/	bark
פליאה	**ply?h**	/pli?a/	astonishment	פליטה	plyth	/plita/	discharge
יישוב	**yyswb**	/yiΣuv/	settlement	יישון	yyswn	/yiΣun/	aging
פיזור	**pyzwr**	/pizur/	dispersal	פיגור	pygwr	/pigur/	retardation
חיזור	**xyzwr**	/xizur/	courtship	חיסור	xyswr	/xisur/	subtraction
שריפה	**sryph**	/sr≡fa/	fire	שטיפה	sTyph	/Σtifa/	washing
בליטה	**blyTh**	/blita/	bulge	בלימה	blymh	/blima/	braking
דילול	**dylwl**	/dilul/	dilution	דילוג	dylwg	/dilug/	skipping
שאיבה	**s?ybh**	/Σ≡?iva/	pumping	שכיבה	skybh	/Σxiva/	lying down

Morphology – Related				*Control*			
Word	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***
גרעון	grϑwn	/gera?on/	deficit	יהלום	yhlwM	/yahalom/	diamond
שליטה	slyTh	/Σlita/	control	הפסקה	hpSqh	/hafsaka/	intermission
מצלמה	mclmh	/matslema/	camera	משענת	msϑnt	/mis?enet/	back rest
הפצצה	hpcch	/haftsatsa/	bombing	מבחנה	mbxnh	/mavxena/	test tube
השערה	hsϑrh	/haΣ?ara/	hypothesis	ממלכה	mmlkh	/mamlaxa/	kingdom
מתיחה	mtyxh	/m≡tixa/	prank	קליפה	qlyph	/klipa/	peel
חלבון	xlbwn	/xelbon/	protein	תצפית	tcpyt	/tatspit/	observation
תחריט	txryT	/taxrit/	engraving	מקלעת	mqlϑt	/mikla?t /	slingshot
מנעול	mnϑwl	/man?ul/	lock	מסגרת	mSgrt	/misgeret/	frame
האכלה	h?klh	/ha?axala/	feeding	חשבון	xsbwN	/xeΣbon/	arithmetic
שלוחה	slwxh	/Σluxa/	extension	סיפון	sypwN	/sipun/	ship deck
משבצת	msbct	/miΣbetset/	square	מקדחה	mqdxh	/makdexa/	drill
פעמון	pϑmwn	/pa?amon/	bell	חסרון	xSrwN	/xisaron/	disadvantage
הקדשה	hqdsh	/hakdaΣa/	inscription	מלכוד	mlkwd	/milkud/	trapping
שיפוע	sypwϑ	/shipu?a/	inclination	מטמון	mTmwN	/matmon/	treasure
תרכיז	trkyz	/tarkiz/	concentrate (juice)	מסעדה	mSϑdh	/mis?ada/	restaurant
הרקדה	hrqdh	/harkada/	dance	מחמאה	mxm?h	/maxma?a/	compliment
מקפצה	mqpch	/makpetsa/	spring-board	תעלול	tϑlwl	/ta?alul/	prank
מסננת	msnnt	/mesanenet/	strainer	מדבקה	mdbqh	/madbeka/	sticker
מכובד	mkwbd	/mexubad/	respectable	מספרה	msprh	/mispara/	barber shop
מדריך	mdryK	/madrix/	guide	תחמיץ	txmyC	/taxmits/	silage
תפריט	tpryT	/tafrit/	menu	מכשלה	mkslh	/maxΣela/	obstacle
מבודד	mbwdd	/mevudad/	secluded	מטחנה	mTxnh	/matxena/	grinding-mill
הנמקה	hnmqh	/hanmaka/	argumentation	הפתעה	hptϑh	/hafta?a/	surprise
מוחלט	mwxlT	/muxlat/	absolute	מעצור	mϑcwr	/ma?atsor/	block
תבשיל	tbsyl	/tavΣil/	cooked dish	חטיפה	xTyph	/xatifa/	abduction
התפלה	htplh	/hatpala/	desalination	קורבן	qwrbN	/korban/	victim
משקפת	msqpt	/miΣkepet/	binoculars	מאפרה	m?prh	/ma?afera/	ashtray
מעביד	mϑbyd	/ma?avid/	employer	מחברת	mxbrt	/maxberet/	notebook
תפרחת	tprxt	/tifraxat/	inflorescence	מסלול	mSlwl	/maslul/	track
משתיק	mstyq	/mashtik/	silencer	מצפון	mcpwN	/matspun/	conscience
אחוזה	?xwzh	/axuza/	estate	בצורת	bcwrt	/batsoret/	drought
משמרת	msmrt	/miΣmeret/	shift	עצבות	ϑcbwt	/atsvut/	sadness
מקופח	mqwpx	/m≡kupax/	deprived	הרעלה	hrϑlh	/har?ala/	poisoning
רישום	ryswm	/risum/	registration	תפקוד	tpqwd	/tipkud/	function
מזכרת	mzkrt	/mzkeret/	souvenir	חטיבה	xTybh	/xativa/	subdivision
כתובת	ktwbt	/ktovet/	address	חדשות	xdswt	/xadashot/	news
מועשר	mwϑsr	/mu?aΣar/	enriched	מכפלת	mkplt	/maxpelet/	hem
זוהרת	zwhrt	/zoheret/	glamorous (f.)	מקלדת	mqldt	/mikledet/	keyboard
נבואה	nbw?h	/n≡vu?a/	prophecy	מקטרת	mqtrt	/mikteret/	smoking pipe
מופלא	mwpl?	/mufla/	magnificent	רגשות	rgswt	/r≡gaΣot/	emotions
מושבה	mwsbh	/moΣava/	village	הפרעה	hprϑh	/hafra?a/	disturbance
מפוזר	mpwzr	/m≡fuzar/	disorganized	אבטלה	?bTlh	/avtala/	unemployment
מחוזר	mxwzr	/m≡xuzar/	courted	מעטפה	mϑTph	/ma?atafa/	envelope
משרפה	msrph	/misrafa/	crematorium	מקצוע	mqcwϑ	/miktso?a/	profession
מובלט	mwblT	/muvlat/	conspicuous	מקצפת	mqxpt	/miktsefet/	meringue
מדולל	mdwll	/m≡dulal/	diluted	הפגזה	hpgzh	/hafgaza/	bombing
משאבה	ms?bh	/maΣ?eva/	pump	מרגוע	mrgwϑ	/margo?a/	repose

(*Appendixes continue*)

Appendix F

The Arabic Alphabet

Letter	*Orth. Trans.*	*Phon. Trans.*
ا / ء	?	?
ـا	a	a / aa
ب	b	b
ت	t	t
ث	T	T
ج	g	Z
ح	X	
خ	x	x
د	d	d
ذ	D	Δ
ر	r	r
ز	z	z
س	s	s
ش	S	Σ
ص	×	×
ض		
ط	∝	∝
ظ	ℵ	ℵ
ع	∂	∂
غ	G	Γ
ف	f	f
ق	q	q
ك	k	k
ل	l	l
م	m	m
ن	n	n
ه	h	h
و	w	w / uu
ي	y	y / ii
ـُ	u	u
ـِ	e	e

Stimuli used in Experiment 5

Target				*Related – F*			
Word	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***
شريف	Sryf	/Sariif/	noble	عريف	∂ryf	/∂ariif/	corporal
حنين	Xnyn	/ aniin/	longing	حزين	Xzyn	/ aziin/	sad
كمان	kman	/kamaan/	violin	كمال	kmal	/kamaal/	perfection
سائل	sa?l	/saa?el/	questioning	قائل	qa?l	/qaa?el/	saying
جمال	gmal	/Zamaal/	beauty	كمال	kmal	/kamaal/	perfection
عنيد	∂nyd	/∂aniid/	stubborn	عميد	∂myd	/∂amiid/	dean
مجروح	mgrwX	/maZruu /	wounded	مجروم	mgrwm	/maZruum/	criminal
اخرج	?xrg	/?axraZa/	to get out	اعرج	?∂rg	/?a∂raZ/	lame
موجود	mwgwd	/mawZuud/	existing	موعود	mw∂wd	/mau∂uud/	was promised
سلام	slam	/salaam/	peace	كلام	klam	/kalaam/	speech
قائل	qael	/qa?el/	saying	قائد	qa?d	/qaa?ed/	leader
مرعوب	mr∂wb	/mar∂uub/	afraid	مركوب	mrkwb	/markuub/	is ridden
صريح	ṣryX	/xarii /	frank	جريح	gryX	/Zarii /	wounded
مقاله	mqalh	/maqaalah/	article	عماله	∂malh	/∂amaalah/	agency
صادق	sadq	/xaadeq/	honest	صادر	xadr	/xaader/	confiscate
اعتدى	?∂tda	/?i∂tadaa/	impinge	ارتدى	?rtda	/?ertadaa/	get dressed
سماح	smaX	/samaa /	forgiveness	سلاح	slaX	/silaa /	weapon
حقوق	Xqwq	/ uquuq/	rights	حقول	Xqwl	/ uquul/	fields
معلم	m∂lm	/mu∂allem/	teacher	مسلم	mslm	/muslem/	muslim
مسرور	msrwr	/masruur/	happy	مجرور	mgrwr	/maZruur/	towed
مرمى	mrma	/marma/	goal	مسمى	msma	/musammaa/	named
مردود	mrdwd	/marduud/	output	معدود	m∂dwd	/ma∂duud/	counted
رنين	rnyn	/raniin/	ring	رزين	rzyń	/raziin/	staid
ادان	?dan	/?adaan/	condemn	ابان	?ban	/?abaana/	clear up
ارعب	?r∂b	/?ar∂aba/	frighten	اركب	?rkb	/?arkaba/	ride
اجبر	?gbr	/?aZbara/	to force	ادبر	?dbr	/?adbara/	die
متروك	mtrwq	/matruuk/	abandoned	مبروك	mbrwk	/mabruuk/	congratulations
اسلم	?slm	/?aslama/	make peace	اعلم	?∂lm	/?a∂lama/	inform
رجوع	rgw∂	/ruZuu∂/	returning	ركوع	rkw∂	/rukuu∂/	kneeling
صدور	sdwr	/xuduur/	publishing	صبور	xbwr	/xabuur/	patient
رمايه	rmayh	/rimayah/	archery	روايه	rwayh	/riwayah/	novel
كتاب	ktab	/kitaab/	book	كلاب	klab	/kilaab/	dogs
مدرسه	mdrsh	/madrasah/	school	مدراه	mdrah	/mudraah/	pitchfork
معلق	m∂lq	/mu∂allaq/	hang	معتق	m∂tq	/mu∂taq/	vintage
تاجيل	t?gyl	/ta?Ziil/	postponement	تاجير	t?gyr	/ta?Ziir/	hiring
مرور	mrwr	/muruur/	passage	غرور	Grwr	/Γuruur/	vanity
خروج	Xrwg	/xuruuZ/	exit	مروج	mrwg	/muruuZ/	meadows
محروس	mXrws	/ma ruus/	guarded	مدروس	mdrws	/madruus/	studied
الغام	?lGam	/alΓaam/	mines	الفاء	?lGa?	/?ilΓaa∂/	abolition
محرك	mXrk	/mu arrek/	engine	محرر	mXrr	/mu arrer/	editor
اجرام	?gram	/?iZraam/	conviction	اجراء	?gra?	/?iZraa?/	procedure
مقصود	mqxwd	/maqxuud/	intended	موصود	mwxwd	/mauxuud /	closed
مقال	mqal	/maqaal/	write up	مقام	mqam	/maqaam/	position
مقلوب	mqlwb	/maqluub/	reversed	مجلوب	mglwb	/maZlub/	brought
احسان	?Xsan	/?i saan/	charity	انسان	?nsan	/?insaan/	human being
زياره	zyarh	/ziyarah/	visit	زواده	zwadh	/zuwadah/	viaticum
جميل	gmyl	/Zamiil/	beautiful	زميل	zmyl	/zamiil/	mate
جنون	gnwn	/Zunuun/	madness	جنود	gnwd	/Zunuud/	soldiers
جهاد	ghad	/Zihaad/	"jihad"	جهاز	ghaz	/Zihaaz/	devise
جواب	gwab	/Zawaab/	reply	جواد	gwad	/Zawaad/	horse
دروس	drws	/duruus/	lessons	دروب	drwb	/duruub/	ways
دفينه	dfe?h	/dafii?ah/	hothouse	دفينه	dfynh	/dafiinah/	buried
ممنوع	mmnw∂	/mamnuu∂/	forbidden	ممنون	mmnwn	/mamnuun/	thankful
عباده	∂badh	/∂ibaadah/	worship	عباره	∂barh	/∂ibaarah/	phrase
عداله	∂dalh	/∂adaalah/	justice	عداوه	∂dawh	/∂adaawah/	enmity
اجرام	?gram	/?iZraam/	conviction	اجراء	?gra?	/?iZraa?/	procedure
موصود	mwxwd	/mauxuud/	closed	مقصود	mqxwd	/maqxuud/	intended
زراعه	zra∂h	/ziraa∂ah/	agriculture	زرافه	zrafh	/zaraafah/	giraffe
سريع	sry∂	/sarii∂/	fast	سرير	sryr	/sariir/	bed
مصرع	mxr∂	/maxra∂/	death	مسرع	msr∂	/musre∂/	accelerated
تنظيم	tnʁym	/tanʁiim/	organizing	تنظيف	tnʁyf	/tanʁiif/	cleaning
مكلوم	mklwm	/makluum/	wounded	مظلوم	mʁlwm	/maʁluum/	maltreated
ولاده	wladh	/wilaadah/	birth	ولايه	wlayh	/wilaayah/	state
محرك	mXrk	/mu arrek/	engine	محرر	mXrr	/mu arrer/	editor

(*Appendixes continue*)

Stimuli used in Experiment 5

Related - M				Control			
Word	Orth. Trans.	Phon. Trans.	Meaning	Word	Orth. Trans.	Phon. Trans.	Meaning
اشرف	?Srf	/əaΣraf/	nobler	قالب	qalb	/qaaleb/	pattern
حنان	Xnan	/ anaan/	tenderness	سراب	srab	/saraab/	mirage
كمين	kmyn	/kamiin/	ambush	رابع	rabə	/raabeə/	forth
سؤال	sual	/su?aal/	question	نائم	naem	/naaəim/	sleeping
مجمل	mgml	/muZmal/	beautified	قريب	qryb	/qariib/	near
عناد	ənad	/ənaad/	stubbornness	سمين	smyn	/samiin/	fat
جريحه	gryXh	/Zarii ah/	wounded	مشؤوم	mSum	/maΣ?uum/	pessimist
خروج	xrwg	/xuruuZ/	exit	مساله	ms?lh	/mas?alah/	problem
ايجاد	?ygad	/?iZaad/	finding	مجروح	mgrwX	/maZruu /	wounded
اسلم	?slm	/?aslama/	make peace	علوم	əlwm	/əuluum/	sciences
يقول	yqwl	/yaquul/	say	مراد	mrad	/muraad/	desirable
مرعبه	mrəbh	/murəibah/	frightful	عصفور	ə×fwr	/ə×fuur/	bird
صارح	×arX	/×aara a/	spoke frankly	معرض	mər	/maəra /	exhibition
يقولون	yqwlwn	/yaquuluun/	are saying	عصافير	ə×afyr	/ə×aafiir/	birds
صدقه	×dqh	/×adaqah/	bounty	جمله	gmlh	/Zumlah/	sentence
عداوه	ədawh	/ədaawah/	enmity	حقيبه	Xqybh	/ aqiibah/	bag
سامح	samX	/saama a/	forgive	قاتل	qatl	/qaatala/	fought
تحقيق	tXqyq	/ta qiiq/	investigation	عادل	ədl	/əadil/	fair
عالم	əalm	/əaalim/	scientist	سائل	sael	/saa?il/	questioning
اسرار	?srar	/?asraar/	secrets	اجمال	?gmal	/?iZmaal/	summation
رمايه	rmayh	/rimaayah/	archery	اسلم	?slm	/?aslama/	make peace
مردد	mrdd	/muraddad/	repeated	اعتدى	?ətda	/?iətadaa/	impinge
رنان	rnan	/rannaan/	resonant	سماح	smaX	/samaa /	forgiveness
مدين	mdyn	/madiin/	owe	صالح	xalX	/×aale /	valid
مرعب	mrəb	/murəib/	frightful	ساعد	saəd	/saaəada/	helped
مجبر	mgbr	/muZbar/	forced	جبان	gban	/Zabaan/	coward
تركه	trkh	/tirkah/	heritage	اخراج	?Xrag	/?ixraaZ/	direction
سالم	salm	/saalem/	unscathed	راجع	ragə	/raajiə/	coming back
ارجع	?rgə	/?arZaəa/	give back	سلام	slam	/salaam/	peace
اصدر	?×dr	/?asdara/	publish	راحل	raXl	/raa il/	leaving
راميه	ramyh	/raamiyah/	archer	ارسال	?rsal	/?irsaal/	sending
كاتب	katb	/kaateb/	writer	عالم	əalm	/əaalem/	scientist
تدريس	tdrys	/tadriis/	teaching	مكتبه	mktbh	/maktabah/	library
تعلق	təlq	/taəalloq/	attachment	مدرع	mdrə	/mudarraə/	armored
تاجلت	t?glt	/ta?aZZalat/	postponed	تاخير	t?Xyr	/ta?xiir/	delay
مرار	mrar	/maraar/	bitterness	دروس	drws	/duruus/	lessons
اخرج	?xrg	/?axraZa/	get out	ولوج	wlwg	/wuluuZ/	entrance
احترس	?Xtrs	/?i tarasa/	beware	مجروح	mgrwX	/maZruu /	wounded
ملغوم	mlGwm	/malГuum/	mined	افناء	?fna?	/?ifnaa?/	extermination
تحرك	tXrk	/ta arraka/	move	مجرد	mgrd	/mujarrad/	demilitarized
مجرمه	mgrmh	/muZrimah/	criminal	املاء	?mla?	/?imlaa?/	dictation
مقتصد	mqt×d	/muqta×ed/	frugal	محروق	mXrwq	/ma ruuq/	burnt
يقال	yqal	/yuqaal/	get the sack	مراد	mrad	/muraad/	desirable
تقليب	tqlyb	/taqliib/	thumbing	مجذوب	mgDwb	/maZΔuub/	crazy
تحسين	tXsyn	/ta siin/	improvement	ادراك	?drak	/?idraak/	recognition
تزاور	tzawr	/tazaawara/	visiting	عماره	əmarh	/əamaarah/	building
جمال	gmal	/Zamaal/	beauty	جرئ	gre	/Zarii?/	daredevil
جنان	gnan	/Zanaan/	gardens	حنان	Xnan	/ anaan/	kindness
مجهد	mghd	/muZhad/	tired	خلود	xlwd	/xuluud/	eternity
مجاب	mgab	/muZaab/	done	مقام	mqam	/maqaam/	position
دارس	dars	/daares/	educated	علوم	əlwm	/əuluum/	sciences
مدفاه	mdf?h	/madfa?ah/	fireplace	جرينه	gry?h	/Zarii?ah/	daredevil
موانع	mwanə	/mawaaniə/	preventatives	مدارس	mdars	/madaaris/	schools
معابد	məabd	/maəaabed/	chapels	معارض	məer	/maəaari /	exhibitions
عادله	ədlh	/əadilah/	fair	دروس	drws	/duruus/	lessons
مجرمه	mgrmh	/muZrimah/	criminal	احسان	?Xsan	/?i saan/	charity
اوصاد	?w×ad	/?aw×aad/	locks	عباره	əbarh	/əibaarah/	phrase
مزرعه	mzrəh	/mazraəah/	farm	غزاله	Gzalh	/Γazaalah/	deer
مسرع	msrə	/musreə/	accelerated	شعور	Səwr	/Σuəuur/	feeling
يصرع	y×rə	/ya×raə/	die	نجمه	ngmh	/niZmah/	star
منظمه	mnNmh	/munaNamah/	organization	مقصله	mq×lh	/miq×alah/	guillotine
كلمات	klmat	/kalimaat/	words	مدرسه	mdrsh	/madrasah/	school
اولاد	?wlad	/?awlaad/	children	معادله	məadlh	/muəaadalah/	equation
تحرك	tXrk	/ta arraka/	move	محول	mXwl	/mu awwil/	transformer

Appendix G

Stimuli used in Experiment 6

Low Density Words

Target				*Form-Related*				*Control*			
Word	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***
שפיפות	spypwt	/sfifut/	stooping	צפיפות	cpypwt	/tsfiput/	density	מסגריה	mSgryh	/masgeriya/	framing workshop
בידור	bydwr	/bidur/	entertainment	ביאור	by?wr	/bi?ur/	interpretation	הצמחה	hcmxh	/hatmaxa/	growing
שיעור	syðwr	/ΣI?ur/	lesson	שיעול	syðwl	/ΣI?ul/	cough	הקפדה	hqpdh	/haqpada/	strictness
התפלה	htplh	/hatpala/	desalination	התחלה	htxlh	/hatxala/	beginning	צינור	cynwr	/tsinor/	pipe
תמונה	tmwnh	/tmuna/	picture	תבונה	tbwnh	/tvuna/	sense	גילוף	gylwP	/giluf/	carving
פירוק	pyrwq	/peruk/	disassembly	מירוק	myrwq	/meruk/	polishing	הלשנה	hlsnh	/halΣana/	informing
שיפור	sypwr	/Σipur/	improvement	שידור	sydwr	/Σidur/	broadcast	הכחדה	hkxdh	/haxada/	extinction
סינון	SynwN	/sinun/	filtering	מינון	mynwN	/minun/	dosage	הדבקה	hdbqh	/hadbaka/	gluing
פליטה	plyTh	/plita/	discharge	פשיטה	psyTh	/pΣita/	raid	מאוחד	m?wxd	/m≡?uxad/	united
חריגה	xrygh	/xariga/	divergence	אריגה	?rygh	/ariga/	weaving	כשלון	kslwN	/kiΣalun/	failure
הברקה	hbrqh	/havraka/	shining	הבזקה	hbzqh	/havzaka/	flash	מחצלת	mxclt	/maxtselet/	mat
רגיעה	rgyðh	/r≡gi?a/	tranquility	פגיעה	pgyðh	/pgi?a/	hit	מצנפת	mxnpt	/mitsnefet/	headdress
קליעה	qlyðh	/kli?a/	shooting	קטיעה	qTyðh	/kti?a/	amputation	תמרון	tmrwN	/timrun/	maneuver
מהירות	mhyrwt	/m≡hirut/	speed	בהירות	bhyrwt	/b≡hirut/	brightness	אספסוף	?SpSwP	/asafsuf/	mob
פריסה	prySh	/prisa/	spread	פריצה	prych	/pritsa/	burglary	נצחון	ncxwN	/nitsaxon/	victory
מרידה	mrydh	/m≡rida/	revolt	מריחה	mryxh	/m≡rixa/	spreading	חיבוק	xybwq	/xibuk/	hug
ספירה	Spyrh	/sfira/	counting	ספינה	Spynh	/sfina/	ship	שגעון	sgðwN	/Σiga?on/	madness
צביעות	cbyðwt	/tsvi?ut/	hypocrisy	צניעות	cnyðwt	/tsni?ut/	modesty	מלפפון	mlppwN	/m≡lafefon/	cucumber
חלוקה	xlwqh	/xaluka/	division	עלוקה	ðlwqh	/aluka/	leech	פעמון	pðmwN	/pa?mon/	bell
מימון	mymwN	/mimun/	funding	מימוש	mymws	/mimuΣ/	realization	הצלבה	hclbh	/hatslava/	hybridization
שמורה	smwrh	/Σmura/	reservation	קמורה	qmwrh	/kmura/	arched (f.)	תפנית	tpnyt	/tafnit/	turn
תנופה	tnwph	/tnufa/	momentum	תנוחה	tnwxh	/tnuxa/	position	קרטון	qrTwN	/karton/	cardboard
מלוכה	mlwkh	/m≡luxa/	kingdom	מלונה	mlwnh	/m≡luna/	kennel	תפקיד	tpqyd	/tafkid/	role
מעונן	mðwnN	/m≡?unan/	cloudy	מעוגן	mðwgN	/m≡?ugan/	anchored	השאלה	hs?lh	/haΣ?ala/	loaning
חטיבה	xTybh	/xativa/	subdivision	חשיבה	xsybh	/xaΣiva/	thinking	תוספת	twSpt	/tosefet/	supplement
השקעה	hsqðh	/haska?a/	investment	השפעה	hspðh	/haΣpa?a/	influence	תחרות	txrwt	/taxarut/	competition
הפרדה	hprdh	/hafrada/	separation	הפחדה	hpxdh	/hafxada/	frightening	גישוש	gysws	/giΣuΣ/	groping
הפרשה	hprsh	/hafraΣa/	allocation	הפרעה	hprðh	/hafra?a/	disturbance	טיגון	TygwN	/tigun/	frying
נחישות	nxyswt	/n≡xiΣut/	determination	נחיתות	nxytwt	/n≡xitut/	inferiority	מהלומה	mhlwmh	/mahaluma/	blow
הצלחה	hclxh	/hatslaxa/	success	המלחה	hmlxh	/hamlaxa/	salting	פירוז	pyrwz	/piruz/	demilitarization
קידוד	qydwd	/kidud/	coding	קידוש	qydws	/kiduΣ/	Kiddush	מחרשה	mxrsh	/mxreΣa/	plough
החלטה	hxlTh	/haxlata/	decision	החלשה	hxlsh	/haxlaΣa/	weakening	צימוד	cymwd	/tsimud/	coupling
סימון	SymwN	/simun/	notation	אימון	?ymwn	/imun/	training	השתקה	hstqh	/haΣtaka/	silencing
עליבות	ðlybwt	/alibut/	wretchedness	עליצות	ðlycwt	/alitsut/	gaiety	צרכניה	crknyh	/tsrxaniya/	grocery
נעילה	nðylh	/n≡?ila/	locking	מעילה	mðylh	/m≡?ila/	embezzlement	חורבן	xwrbN	/xurban/	ruin
חטיפה	xTyph	/xatifa/	abduction	לטיפה	lTyph	/l≡tifa/	petting	תעלול	tðlwl	/ta?alul/	prank

(*Appendixes continue*)

Stimuli used in Experiment 6

High Density Words

Target				Form-Related				Control			
Word	*Orth. Trans.*	*Phon. Trans.*	*Meaning*	*Word*	*Orth. Trans.*	*Phon. Trans.*	*Meaning*	*Word*	*Orth. Trans.*	*Phon. Trans.*	*Meaning*
תחמושת	txmest	/taxmoΣet/	ammunition	תחפושת	txpwst	/taxposet/	costume	מרכזיה	mrkzyh	/merkaziya/	telephone exchange
שילוט	sylwT	/Σilut/	signposts	שילוב	sylwb	/Σiluv/	combination	התקנה	htqnh	/hatkana/	installation
צימוק	nymwq	/nimuk/	argument	צימוק	cymwq	/tsimuk/	shriveling	הגדרה	hgdrh	/hagdara/	definition
קפיצה	qpych	/kfitsa/	jump	קריצה	qrych	/kritsa/	wink	מושלג	mwslg	/muΣlag/	snowy
כיבוש	kybws	/kibuΣ/	occupation	כיבוד	kybwd	/kibud/	refreshment	הלחמה	hlxmh	/halxamh/	soldering
הצדקה	hcdqh	/hatsdaka/	justification	הצדעה	hcdϑh	/hatsda?a/	salute	כיפור	kypwr	/kipur/	atonement
סלידה	Slydh	/slida/	repulsion	גלידה	glydh	/glida/	ice-cream	שארית	s?ryt	/Σ≡?erit/	remainder
הערכה	hϑrkh	/ha?araxa/	evaluation	הדרכה	hdrxh	/hadraxa/	guidance	פילוג	pylwg	/pilug/	division
קינוח	qynwx	/kinuax/	dessert	קידוח	qydwx	/kiduax/	drilling	הרתעה	hrtϑh	/hartaϑh/	deterrence
פליאה	ply?h	/pli?a/	astonishment	פלישה	plysh	/pliΣa/	invasion	תרבות	trbwt	/trbut/	culture
הגשמה	hgsmh	/hagΣama/	fulfillment	הגזמה	hgzmh	/hagzama/	exaggeration	ברבור	brbwr	/barbur/	swan
תבליט	tblyT	/tavlit/	relief	תקליט	tqlyT	/taklit/	record	ארוחה	?rwxh	/aruxa/	meal
מחסור	mxswr	/maxsor/	shortage	מחזור	mxzwr	/maxzor/	cycle	נגיעה	ngyϑh	/n≡gi?a/	touch
תחבורה	txbwrh	/taxbura/	transportation	תחבולה	txbwlh	/taxbula/	trick	אסימון	?symwN	/asimon/	token
שיקול	syqwl	/Σikul/	consideration	שיקום	syqwM	/Σikum/	rehabilitation	הפתעה	hptϑh	/hafta?a/	surprise
הפעלה	hpϑlh	/haf?ala/	activation	הרעלה	hrϑlh	/har?ala/	poisoning	צינור	cynwr	/tsinor/	pipe
מרפסת	mrpSt	/mirpeset/	balcony	מדפסת	mdpSt	/madpeset/	printer	גניזה	gnyzh	/gniza/	archive
כתיבה	ktybh	/ktiva/	writing	כתישה	ktysh	/ktiΣa/	crushing	ארמון	?rmwN	/armon/	palace
שאיבה	s?ybh	/Σ≡?iva/	pumping	שכיבה	skybh	/Σxiva/	lying down	פותחן	pwtxN	/potxan/	can opener
גלישה	glysh	/gliΣa/	surfing	תלישה	tlysh	/tliΣa/	plucking	ערבון	ϑrbwN	/eravon/	collateral
פיצוץ	pycwC	/pitsuts/	explosion	פיצול	pycwl	/pitsul/	splitting	מעברה	nϑbrh	/mϑbrh/	transit camp
מיקוד	myqwd	/mikud/	focus	ריקוד	ryqwd	/rikud/	dance	הלחנה	hlxnh	/hlxnh/	composition
ישיבה	ysybh	/yeΣiva/	meeting	יציבה	ycybh	/yetsiva/	posture	תרגום	trgwM	/tirgum/	translation
הפגנה	hpgnh	/hafgana/	demonstration	הפגזה	hpgzh	/hafgaza/	bombing	קיבוץ	qybwC	/kibuts/	Kibbutz
תזכורת	tzkwrt	/tizkoret/	reminder	תזמורת	tzmwrt	/tizmoret/	orchestra	עגבניה	ϑgbnyh	/agvanya/	tomato
הסברה	hsbrh	/hasbara/	publicity	הדברה	hdbrh	/hadbara/	disinfection	מקלחת	mqlxt	/miqlaxat/	shower
בדיקה	bdyqh	/bdika/	examination	בדיחה	bdyxh	/bdixa/	joke	מחתרת	mxtrt	/maxteret/	underground
דירוג	dyrwg	/derug/	ranking	דילוג	dylwg	/dilug/	skipping	צנצנת	cncnt	/tsintsenet/	jar
שכירות	skyrwt	/sxirut/	rent	שכיחות	skyxwt	/Σxixut/	frequency	מנגינה	mngynh	/mangina/	tune
משטרה	msTrh	/miΣtara/	police	ממטרה	mmTrh	/mamtera/	sprinkler	איפול	?ypwl	/ipwl/	blackout
המצאה	hmc?h	/hamtsa?a/	invention	הרצאה	hrc?h	/hartsa?a/	lecture	שולחן	swlxN	/Σulxan/	table
משיכה	msykh	/m≡Σixa/	attraction	נשיכה	nsykh	/n≡Σixa/	bite	קורבן	qwrbN	/korban/	victim
התקפה	htqph	/hatkafa/	attack	השקפה	hsqph	/haΣkafa/	outlook	עיגול	ϑygwl	/igul/	circle
תצלום	tclwM	/tatslum/	photograph	תשלום	tslwM	/taΣlum/	payment	הפרטה	hfrTh	/hafrata/	privatization
הנהגה	hnhgh	/hanhaga/	leadership	הנהלה	hnhlh	/hanhala/	management	בקבוק	bqbwq	/bakbuk/	bottle
היפוך	hypwK	/hipux/	reversal	הילוך	hylwK	/hilux/	gear	מברשת	mbrst	/mivreΣet/	brush

Appendix H

Stimuli used in Experiment 7

Target				*Form Related*				*Control*			
Word	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***	***Word***	***Orth. Trans.***	***Phon. Trans.***	***Meaning***
תורה	twrh	/tora/	Torah	מורה	mwrh	/mora/	teacher	אננס	?nnS	/ananas/	pineapple
פנים	pnyM	/panim/	face	שנים	snyM	/Σanim/	years	אהבה	?hbh	/ahava/	love
זעיר	z∂yr	/za?ir/	minor	זמיר	zmyr	/zamir/	nightingale	שמחה	smxh	/simxa/	happiness
עולם	∂wlM	/olam/	world	סולם	SwlM	/sulam/	ladder	קנאה	qn?h	/kin?a/	jealousy
אויר	?wyr	/avir/	air	אסיר	?Syr	/asir/	prisoner	מחלה	mxlh	/maxala/	illness
יקום	yqwM	/y≡kum/	universe	מקום	mkwM	/makom/	place	שחפת	sxpt	/Σaxefet/	tuberculosis
חזיר	xzyr	/xazir/	pig	חזיה	xzyh	/xaziya/	bra	שטות	sTwt	/Σtut/	folly
הצעה	hc∂h	/htsa?a/	suggestion	הגעה	hg∂h	/haga?a/	arrival	בושם	bwsm	/bosem/	perfume
עמוק	∂mwq	/amok/	deep	עמוד	∂mwd	/amud/	page	סנדל	Sndl	/sandal/	sandal
מרחק	mrxq	/merxak/	distance	מרחב	mrxb	/merxav/	space	לשון	lswN	/laΣon/	tongue
מטבח	mTbx	/mitbax/	kitchen	מזבח	mzbx	/mizbeax/	altar	צפוף	cpwP	/tsafuf/	crowded
נחמה	nxmh	/nexama/	solace	נקמה	nqmh	/n≡kama/	revenge	אצבע	?cb∂	/etsba/	finger
סבון	SbwN	/sabon/	soap	סלון	SlwN	/salon/	living room	הקפה	hqph	/hakapa/	encircling
נזיר	nzyr	/nazir/	monk	נזיל	nzyl	/nazil/	liquid	טעות	T∂wt	/ta?ut/	mistake
מקלט	mqlT	/miklat/	shelter	מפלט	mplT	/miflat/	escape	כוכב	kwkb	/kokav/	star
טוהר	Twhr	/tohar/	purity	זוהר	zwhr	/zohar/	radiance	נזלת	nzlt	/nazelet/	common cold
משחה	msxh	/miΣxa/	cream	משגה	msgh	/miΣge/	error	כדור	kdwr	/kadur/	ball
אורך	?wrK	/orex/	length	צורך	cwrK	/tsorex/	need	מעגל	m∂gl	/ma?agal/	circle
קוטב	qwTb	/kotev/	pole	רוטב	rwTb	/rotev/	sauce	חליל	xlyl	/xalil/	flute
סיבה	Sybh	/siba/	reason	ריבה	rybh	/riba/	jam	משחק	msxq	/misxak/	game
העברה	h∂brh	/ha?avara/	transfer	הסברה	hSbrh	/hasbara/	publicity	מסלול	mSlwl	/maslul/	track
תפירה	tpyrh	/tfira/	sewing	ספירה	Spyrh	/sfira/	counting	בקבוק	bqbwq	/bakbuk/	bottle
חשיפה	xsyph	/xasifa/	exposure	חליפה	xlyph	/xalifa/	suit	תרבות	trbwt	/tarbut/	culture
מטריה	mTryh	/mitriya/	umbrella	פטריה	pTryh	/pitriya/	mushroom	שגשוג	sgswg	/sigsug/	prosperity
תבוסה	tbwsh	/tvusa/	defeat	תבונה	tbwnh	/tvona/	sense	מדריך	mdryK	/madrix/	guide
תמונה	tmwnh	/tmuna/	picture	תמותה	tmwth	/tmuta/	mortality	שיזוף	syzwP	/Σizuf/	suntan
מגרעת	mgr∂t	/migra?at/	disadvantage	מגבעת	mgb∂t	/migba?at/	top hat	בדיקה	bdykh	/b≡dika/	examination
מפואר	mpw?r	/m≡fu?ar/	fancy	מפחר	mpwzr	/m≡puzar/	disorganized	צביטה	cbyth	/tsvita/	pinch
נפילה	npylh	/n≡fila/	fall	תפילה	tpylh	/tpila/	prayer	זמזום	zmzwm	/zimzum/	humming
הלבשה	hlbsh	/halbaΣa/	clothing	הלבנה	hlbnh	/halbana/	whitening	מסתור	mStwr	/mistor/	hiding-place
שידור	sydwr	/Σidur/	broadcast	בידור	bydwr	/bidur/	entertainment	מפלצת	mplct	/mifletset/	monster
סיפור	Sypwr	/sipur/	story	כיפור	kypwr	/kipur/	atonement	מקלדת	mqldt	/mikledet/	keyboard
ספינה	Spynh	/sfina/	ship	ספיגה	Spygh	/sfiga/	absorption	זלזול	zlzwl	/zilzul/	contempt
הזמנה	hzmnh	/hazmana/	invitation	הטמנה	hTmnh	/hatmana/	concealing	מברשת	mbrst	/mivreΣet/	brush
שמירה	smyrh	/Σmira/	guarding	שמיכה	smykh	/smixa/	blanket	תקציב	tqcyb	/taktsiv/	budget
צריבה	crybh	/tsriva/	burn	צרימה	crymh	/tsrima/	disharmony	משלחת	mslxt	/miΣlaxat/	delegation
שבירה	sbyrh	/Σvira/	breaking	שביתה	sbyth	/Σvita/	strike	סכסוך	SkSwK	/sixsux/	conflict
שיפור	sypwr	/Σipur/	improvement	שיעור	syd∂wr	/Σi?ur/	lesson	הפגזה	hpgzh	/hafgaza/	bombing
תרופה	trwph	/trufa/	medication	תגופה	tnwph	/tnufa/	momentum	מגעיל	mg∂yl	/mag?il/	repulsive
תצלום	tclwM	/ttslum/	photograph	תשלום	tslwM	/taΣlum/	payment	סביבה	Sbybh	/sviva/	surroundings
תזכורת	tzkwrt	/tizkuret/	reminder	תזמורת	tzmwrt	/tizmoret/	orchestra	עגבניה	∂gbnyh	/agvanya/	tomato
שריטה	sryTh	/srita/	scratch	שריפה	sryph	/srefa/	fire	תחכום	txkwM	/tixkum/	sophistication
קמצן	qmcN	/kamtsan/	miser	קבצן	qbcN	/kabtsan/	beggar	עליה	∂lyh	/aliya/	uphill
שוטר	swTr	/Σoter/	policeman	זוטר	zwtr	/zutar/	junior	נחלה	nxlh	/naxala/	estate
מעידה	m∂ydh	/m≡?ida/	stumble	צעידה	c∂ydh	/ts≡?ida/	march	שלטון	sltwn	/Σilton/	reign
מריבה	mrydh	/m≡rida/	revolt	מריבה	mrybh	/m≡riva/	quarrel	קשקוש	qsqws	/kiΣkuΣ/	nonsense
עמיד	∂myd	/amid/	durable	צמיד	cmyd	/tsamid/	bracelet	ארון	?rwN	/aron/	closet
שמורה	smwrh	/Σmura/	reserve	תמורה	tmwrh	/tmura/	return	תחליף	txlyP	/taxlif/	substitute

(*Appendixes continue*)

Stimuli used in Experiment 7

Form nonwords		***Control Nonwords***	
Word	***Orth. Trans.***	***Word***	***Orth. Trans.***
רורה	rwrh	גפשך	gpsK
טנים	TnyM	צשקל	csql
זליר	zlyr	דקלב	dklb
טולם	TwlM	גצטר	gcTr
אליר	?lyr	דטפש	tTps
[illegible]	[illegible]	[illegible]	[illegible]
נזיש	nzys	חלטק	xlTq
מצלט	mclT	געבד	g∂bd
כוהר	kwhr	שמפק	smpq
משמה	msmh	גרלח	grlx
גורך	gwrK	מסטב	mSTb
סוטב	Swtb	משצק	mscq
פיבה	pybh	קלזש	qlzs
הלברה	hlbrh	מצפשת	mcpst
גפירה	gpyrh	סקצוש	Sqcws
חמיפה	xmiph	גבסוק	gbSwq
שטריה	sTryh	ספלקת	Splqt
תבורה	tbwrh	קלשצג	klscg
תמושה	tmwsh	צקריל	cqryl
מגסעת	mgS∂t	שדפיץ	sdpyC
מפובר	mpwbr	צלקרת	clqrt
זפילה	zpylh	מצשקת	ncsqt
הלבחה	hlxbh	תקמיר	tqmyr
צידור	cydwr	הקצסה	hqcSh
זיפור	zypwr	מלנגה	mlngh
ספימה	Spymh	שקדוב	sqdwb
הקמנה	hqmnh	תפגיט	tpgyt
שמיצה	smych	סלקוט	SlkwT
צרילה	crylh	קלעשת	ql∂st
שביגה	sbygh	צפמדת	cpmdt
שיסור	sySwr	צלגיז	clgyz
תהופה	thwph	שקחין	sqxyN
תדלום	tdlwM	שדגיז	sdgyz
תזלורת	tzlwrt	אפציגל	?pcygl
שרילה	srylh	צלמגג	clmgg
קשצן	qscN	סגלר	Sglr
צוטר	cwTr	סתכף	StkP
קעידה	q∂ydh	כלסור	klSwr
מרישה	mrysh	קצלות	qclwt
פמיד	pmyd	גלקט	glqT
דמורה	dmwrh	טלגדץ	TlgdC

Received July 27, 2004
Revision received June 7, 2005
Accepted June 11, 2005 ■