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**THE MORPHOLOGY-SEMANTICS INTERFACE IN THE MENTAL LEXICON:
THE CASE OF HEBREW**

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ABSTRACT

The overall goal of the study was to investigate the impact of the factors of root transparency, familiarity/frequency, and concreteness on form-meaning relations in the mental lexicon of Hebrew speaker-writers in a developmental perspective. The theoretical grounds underlying the study encompass a range of topics, including: definition and description of the mental lexicon as against conventional dictionaries, the role of morphology in the mental lexicon, models of semantic representation, the effect of ease of root extraction (hence, morphological transparency) and of semantic relatedness (hence, semantic transparency) on the morphology-semantics interface, and accounts of the factors of familiarity and/or frequency and of imageability and/or concreteness in the mental lexicon. This broad array of issues is considered in each case in terms of crosslinguistically shared properties followed by analysis of Hebrew-specific features – as delineated in relation to prior research in the introduction (Chapter I), tested by means of a complex multi-phased research design (Chapter 2), and reviewed and re-interpreted in light of the findings of the study (Chapter 3) in the concluding discussion (Chapter 4).

The theoretical concerns noted above were operationalized in the study in the form of a three-phased research-project, focusing on the category of Hebrew derived nouns. This class of items represents a rich, yet coherent and homogenous lexical category, one that displays a wide array of form-meaning reactions, in the shape of word-families related by shared consonantal elements (e.g., *migdal* ‘tower’, *gdila* ‘growing, growth’, *gidul* ‘growing, growth and also tumor’, *gdula* ‘greatness, importance’, *gódel* ‘size’ and *gdil* ‘tassel’ -- all derived from the triconsonantal root *g-d-l*).

The first and second phases of the study were devoted to establishing a data-base of Hebrew derived nouns with respect to the independent variables of the study: the structural variable of root transparency, the usage variable of familiarity/frequency, and the semantic variable of concreteness. The first phase of the study, aimed at preliminary selection of research items, took the form of **dictionary searches**. As its point of departure, the list of roots provided in the supplement of the *Even-Shoshan* (1993) dictionary was searched for roots, both three-consonantal (hence transparent) and bi-consonantal (hence opaque), which could be defined as “productive”, since they included

at least four derived nouns with varying degrees of semantic relatedness between them. The interim result of this initial search yielded 4,000 Hebrew derived nouns, arranged in small families with a shared root, typically including 4-8 derived nouns for each shared root. The next step of this phase of the study was a comparison of this initial data-base with three other dictionaries -- (1) *The Concise Sapphire -Dictionary* (Avneyon, 1997) (Henceforth, Sapphire); (2) the floppy-disc version of *Rav-Milim* ‘multi-word’ computerized dictionary (Choueka & Freidkin, 1997); and (3) the internet site of the Academy of the Hebrew Language – on the basis of which, only those nouns out of the 4,000 that occurred in at least two of these three dictionaries qualified for inclusion in the research data-base. The next step involved discarding families of nouns derived from the same root that were also all related by a shared meaning (hence semantically transparent). Three judges decided whether a given word family was semantically transparent or not, in order to restrict the final data-base to word families that were unanimously judged to include unrelated (hence, semantically opaque) derived nouns. For example, the derived nouns from the root *p-g-š* ‘meet’ (as in *pgiša* ‘meeting’, *mifgaš* ‘encounter’, *pagoš* ‘car bumper’) were excluded from the database since one of the judges considered them to all be semantically related; on the other hand, nouns derived from the root *g-d-l* ‘grow’ were retained, since they include both semantically transparent relations (e.g., *gódel*. ‘size’, *migdal* ‘tower’) and unrelated, hence opaque relations (e.g., *gdil* ‘tassel’). This set of different procedures eventually yielded a data-base of **2,400 Hebrew derived nouns** with differing degrees of semantic transparency, two-thirds of which were derived from full or canonically triconsonantal (hence, morphologically transparent) roots and the remaining one-third derived from weak or defective (hence morphologically opaque) roots.

In the second phase of the study this data-base was randomly subdivided into 9 groups of around 260 nouns each, for use in **questionnaires** each of which were administered to 30 native speakers of Hebrew. The purpose of these questionnaires was to compensate for lack of large-scale, established norms for such psycholinguistic variables as familiarity and imageability in Hebrew – by providing rankings of (1) subjective familiarity (a variable corresponding closely to frequency in the research literature) and (2) Imageability (the ease with which a mental image is evoked by a given noun). Both types of questionnaires, however, yielded unexpected outcomes that

required reconsideration of these factors as independent variables of the study for the following reasons. First, although the familiarity questionnaires deliberately included a sizeable proportion of derived nouns that the researcher and her associates had defined as infrequent, arcane, or virtually obsolete, in over 80% of the cases respondents rated them as “well-known” or “very familiar”. This finding was attributed to the effect of “pseudo-familiarity”, such that speaker-writers of Hebrew judge words to be familiar on the basis of their familiarity with extant Hebrew roots and morphological patterns, even when they in fact do not know their meanings. This unanticipated finding led to administration of a second questionnaire, aimed at ranking subjective frequency in terms of how often respondents had encountered the target items. The subjective frequency questionnaires showed more evenly distributed rankings, so proving more sensitive to the actual lexical status of the target items and giving a more realistic picture of respondents’ knowledge of what they meant. Eventually, a combined measure of both variables was specified in terms of was termed the **F-score**, a weighted mean of familiarity and frequency combined.

As for the second variable, of imageability, attempts to achieve valid or reliable rankings failed, because (1) respondents found it impossible to rank imageability to unfamiliar/infrequent nouns (that is, with low F-scores), (2) they found it hard to rank imageability for nouns lying somewhere in the middle of the imageability scale, and (3) their responses showed a very high level of individual variation. Consequently, it was decided to replace imageability by the variable of concreteness, defined for a subset of nearly 400 nouns which a group of 30 other respondents (some language or linguistic specialists, others not) had agreed on as being either very concrete or very abstract. In all, over 600 respondents participated in these two initial phases, either as consultants with expert knowledge of Hebrew language and linguistics or as naïve respondents to the questionnaires.

The third and final phase of the study included structured elicitations aimed at shedding light on varied facets of the mental lexicon of Hebrew. Elicitations took the form of off-line written tests and on-line computerized priming experiments – based on carefully selected subsets of nouns from the familiarity/frequency database (with high or low F-scores respectively) and nouns with plus or minus values for concreteness

(concrete or abstract respectively). A special battery of seven tests was designed and administered in writing to three groups of respondents -- 6th graders aged 11-12 years, 10th graders aged 15-16 years, and adults in their 20s and 30s. The seven tasks were organized around four main topics of varying degrees of difficulty, as follows: (1) Two tests concerned **relatedness** between words, in which the input nouns were presented to the respondents with four distractors, related to the input noun morphologically (the same root), morphologically plus semantically (the same root and semantic relatedness), semantically (semantic relatedness), and phonologically (a rhyming word) – with respondents in one test required to select the word out of the four that was most highly related to the input nouns and in the second to rank the degree of relatedness of each distracter to the input noun. (2) In a comprehension task of **interpretation in context**, respondents were required to give the meaning of unfamiliar/infrequent input nouns presented to them in sentential contexts providing vaguely general semantic-pragmatic clues to their meaning and use. (3) In two **free association** tasks, respondents were required to provide a single association or multiple associations respectively to the input nouns. (4) Two tasks of **sentential use and definitions** required respondents to construct a sentence with or give a definition for the input nouns. Instructions to the tasks were deliberately kept to a minimum, with no explicit directives or examples, so as to achieve unbiased results that genuinely reflect the mental lexicon of Hebrew speaker-writers. After extensive piloting, two parallel versions of the questionnaires were prepared, balanced for difficulty and the time required to fill them out. A total of 250 respondents participated in the written battery, subdivided by age so that the same number and types of test items were administered in each of the three age groups.

The on-line facet of the third phase of structured elicitations took the form of pilot priming experiments, designed as lexical decision tasks conducted with 120 students at Haifa University. The experimental stimuli were basically similar to the items in the relatedness written tasks, so as to provide complementary off-line and on-line perspectives on the mental lexicon. An identical number of non-words as of real words were presented to participants, who were required to decide as quickly and accurately as possible whether the string of letters they saw on the screen was a real Hebrew word.

Respondents were exposed to primes for the brief period of 50ms or 100ms, with items related to the target noun predicted to shorten the lexical decision time.

All the tasks in the structured elicitations yielded rich results and interactions, the most salient of which are noted in what follows. The two relatedness tasks differed in the preferred distractor in each case: The semantic distractor was preferred in the multiple-choice task and the morphological distractor in the ranking task, while the phonological distractor was markedly less preferred on both tasks. Results of the task of interpretation in context highlighted the importance of a supportive context, even when vague and general, as a clue for interpretation of unfamiliar/infrequent words. The association tasks yielded thousands of results, the most interesting of which were (i) the numerous semantic-pragmatic relations represented by the associations given to familiar/frequent nouns and (ii) the strategies employed by respondents in giving associations to unfamiliar/infrequent nouns, which were typically based on either their morphological/phonological properties or their resemblance to other, familiar/frequent nouns (for example, the association *pil* ‘elephant’ given to the input noun *gdil* ‘tassel’, based on the root *g-d-l* ‘grow’). Results of both the sentential tasks (sentence-construction and definitions) revealed a clear semantic-syntactic interdependency, expressed by the preference for relative clauses with concrete nouns and by the role of the concrete-abstract contrast in determining the syntactic position of the input noun.

Robust effects for each and every independent variable were revealed in this study, part predicted and part unpredicted. Root transparency was predicted to play a role in the mental lexicon mainly for isolated words, mainly unfamiliar/infrequent nouns, which were expected to be decomposed to their morphological constituents. However, root transparency played an unanticipated role in the sentential tasks and in familiar/frequent nouns as well. The most remarkably unanticipated effect of familiarity/frequency emerged in the form of the varied strategies, based mainly on structural cues, employed by Hebrew speaker-writers when encountering unfamiliar/infrequent nouns in the off-line written tasks and in the very high rate of errors that they demonstrated in the lexical decision tasks. The variable of concreteness was shown, as predicted, to facilitate psycholinguistic processing, but it also turned out to interact with all the other independent variables, demonstrating two differential

trajectories in the mental lexicon, one for concrete and another for abstract derived nouns -- developmentally and syntactically as well as semantically.

Developmental findings proved that consolidation of the mental lexicon of Hebrew speaker-writers is a long and protracted process that continues into adolescence and beyond. The youngest group of 6th graders differed markedly in many respects from 10th graders and adults, showing more reliance on structural cues and less proficient or well-established lexical knowledge than older respondents. Age also interacted strongly with all the other independent variables of the study, yielding two distinct curves, a moderate one with a high starting point to nouns derived from full roots, to familiar/frequent items, and to concrete nouns, as against a steep, often inconclusive developmental trajectory in the case of nouns derived from defective roots, as well as unfamiliar/infrequent items, and abstract nouns.

This multifaceted and complex design, based on several phases and sub-phases, yielded numerous unpredicted and interesting results, the implications of which are considered in detail in the concluding part of the study. The most salient such findings can be summed up as follows: (1) negative effects throughout the study of normative diacritical vowel pointing, especially of those that are less common, on Hebrew speaker-writers, who typically ignored and often misread them; (2) the distinct nature of the factors of familiarity and frequency, typically referred to as one entity in the research literature, in the mental lexicon of Hebrew; (3) the effects of typological factors such as type of verbal pattern and type of morphological derivation on the breakdown of familiarity/ frequency rankings; and (4) the various, sometimes very creative, types of associations given to unfamiliar/infrequent nouns, proving this task to be a very insightful tool for investigating the associative networks of the mental lexicon of Hebrew.

In sum, this study offers a “guided tour” into the mental lexicon of Hebrew, a tour whose outcomes and implications were in part anticipated and to a large extent unexpected. The large mass of data collected in the course of the study (more than 18,000 responses in the structured elicitations) and the high number of participants (over 1,000 in all) made it possible to obtain a comprehensive and multifaceted picture on the mental lexicon of Hebrew in development.

NOTATIONAL CONVENTIONS

Hebrew data are represented distinctly for roots – as abstract, unpronounceable elements – and for words as items in the Hebrew lexicon.

1. **Root elements** are entered by IPA symbols, reflecting their orthographic counterparts, and separated by hyphens, as illustrated further below.

2. **Words** are represented in broad phonemic transcription to reflect pronunciation of “General Israeli Hebrew” (Blanc, 1964; Ravid, 1995), with an *accent aigu* indicating the stressed syllable in words with non-final (penultimate or antepenultimate) stress, and followed by an English gloss in single quotes. For example, the letters *q-c-b* stand for the three root consonants of words like *kécev* ‘rhythm’ and *kicba* ‘allowance’, with the symbol *q* standing for the Hebrew letter ק, typically pronounced as a voiceless velar stop, the *c* standing for the voiceless alveolar affricate, צ and the letter *b* used for both the stop and fricative realizations of the letter ב. Similarly, the letters *p* and *k* are used for both the stop and fricative versions of the voiceless labial and velar consonants respectively. For example, the medial and final elements of the root *h-p-k* occur as fricatives in the word *hafixa* ‘uprising’ (cf. *mahapexa* ‘revolution’).

3. The **weak radical elements** represented by the letter א (the glottal stop) and ע (historically, the voiced pharyngeal fricative) are transcribed by ʔ and ʕ respectively. For example, the root ʔ-b-q occurs in nouns like *avak* ‘dust’ and the semantically unrelated noun *ma'avak* ‘struggle’ (the symbol ʔ is also used to represent separation between vowels in cases both of words spelled with *alef* (as here), or *ayin* (e.g., *ma'avar* ‘passage’, with a medial ע, derived from the root ʔ-b-r, as in *ma'avar*, *ibur* ‘conception’). The symbol ħ stands for the historically pharyngeal fricative *chet*, typically pronounced the same as the voiced velar fricative *x*.

PREFACE: OUTLINE OF STUDY

The study examines the interface between structure (morphology) and meaning (semantics) in the mental lexicon of Hebrew speaker-writers in relation to the impact of three psycholinguistic factors (root transparency, familiarity/frequency, and concreteness) on the developing lexicon of Hebrew from pre-adolescence to adulthood. The study thus concerns issues of typological structure (the Semitic root), of lexical usage (the factors of familiarity and frequency), of semantic content (the opposition between concrete and abstract terms), and of later language development. The domain selected for analysis is that of derived nouns in Hebrew, as structurally complex lexical items that are generally associated with families of words, typically from the same consonantal root and often having a shared meaning. After a protracted dictionary-based process of item selection, values for the three independent variables of the study were set by means of specially constructed questionnaires administered to large groups of native speakers of Israeli Hebrew. These procedures served as the input to a series of offline written tests given to respondents at three age-schooling levels -- pre-adolescent grade-school students, adolescent high-school students, and university-level adults – supplemented by a series of online priming experiments administered to different groups of adult speakers.

The study is organized as follows: Chapter I introduces the topic under study on the basis of background literature concerning its independent and dependent variables, in relation to the mental lexicon in general and to Hebrew-specific and developmental factors. Chapter II delineates the complex, multifaceted research design of the study, as carried out in three distinct but inter-related phases (selection of data-base, establishing values for the independent variables, and structured elicitations); explicit motivations, aims, and predictions are formulated for each facet of the three phases of the study, and findings of the first two phases – of item-selection and variable-setting – are detailed as input to the structured elicitations. Chapter III presents results and analyses of a battery of seven written tests and priming experiments in terms of the independent variables involved in each task, with detailed statistical distributions and interactions followed by brief summaries and interpretations of the findings. Chapter IV is devoted to discussion of the general conclusions and broader implications emerging from the findings of the study in relation to prior research on the mental lexicon in Hebrew and other languages.

CHAPTER I -- INTRODUCTION

This introductory chapter provides an overview of different models and approaches regarding the mental lexicon (Section 1), as background to discussion of the psycholinguistic variables of familiarity, frequency, imageability, and concreteness in the mental lexicon (Section 2). Relevant features of Hebrew typology – including orthography, morphology, and derived nouns – are then delineated (Section 3), followed by a review of the domain of later language development in general and in Hebrew specifically (Section 4). The rationale and overall goals of the study are presented in the concluding section (Section 5), with more specific aims and predictions detailed in the context of the Research Design described in Chapter II.

1. The Mental Lexicon

This section deals with the mental lexicon, as a sophisticated tool for organizing linguistic elements in the mind for efficient comprehension and retrieval of words. A general introduction to the topic (Section 1.1) is followed by descriptions of different facets of the mental lexicon in terms of form (morphology) -- Section 1.2, meaning (semantics) -- Section 1.3, and form-meaning relations -- Section 1.4. The overview provided here is deliberately descriptive in nature, with the author's own perspective on these issues presented in the discussion that concludes the study as a whole (Chapter IV).

1.1. The Mental Lexicon: An Introduction

The mental lexicon, as the mysterious "black box" in the human mind where linguistic data is stored and from which it is retrieved, has attracted the attention of scholars from various fields of research across different periods in history, including formal linguistics (Aronoff, 1976, 1994; DiSciullo & Williams, 1987; Jackendoff, 2002; Langacker, 1991), psycholinguistics (Aitchison, 2003; Bates & Goodman, 1997; Levelt, Roelofs & Meyer, 1999), and philosophy (Lyons, 1977; Wittgenstein, 1958). The mature mental lexicon of literate speaker-writers that is of concern in the present context, is described as including several dozen thousands of lexical entries, the bulk of which are words, mainly content words -- nouns, verbs and adjectives. This huge and variegated repository, in the shape

of a dense network of lexical items varying in size, in imageability and/or concreteness, and in familiarity and/or frequency, has been depicted as encyclopedic in nature and as closely related to general conceptual development and literacy achievements (Aitchison, 2003; Ravid, 2004).

The very term “mental lexicon” is by no means unequivocal, but is subject to various interpretations, so that it is important to specify how this term is applied in the context of the present study. For example, results of priming experiments conducted both in Israel and elsewhere are commonly reported under the quite general heading of “the mental lexicon” (e.g., Deutsch, Frost & Forster, 1998; Forster, 1981; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Schiff, Raveh, & Kahta, 2008). Yet this paradigm -- as further detailed in Chapter II, Part B, Section 2 below -- is typically confined to the early stages of lexical access. It follows that findings from priming experiments, which provide partial, mainly implicit and initial, insights on lexical processing, cannot provide a full picture of the mental lexicon, with all its multiple complexities and subsequent stages of processing beyond that of lexical access. Consequently, in attempting to encompass different facets of the mental lexicon as a multidimensional system, the present study deliberately relies on a variety of different measures, each aimed at investigating distinct stages and processes in the domain from distinct though overlapping perspectives.

The common metaphor of the mental lexicon as an “inner dictionary” calls for a comparison between the mental lexicon and **conventional dictionaries**, as entities differing in their principles of organization and the process of retrieving a lexical entry in each case. Whereas conventional dictionaries are organized by the single dimension of orthography, the mental lexicon is multi-dimensional, organized by numerous criteria that are constantly changing in response to pragmatic circumstances. For example, the ability to perform “cross-classification”, in the sense of retrieving lexical items by various different criteria (for example, by color, shape, function, and so on), is considered a hallmark of mature linguistic knowledge (Nguyen, 2003; Nguyen & Murphy, 2007). Further, criteria for organization of the lexicon are not confined to a single linguistic domain but rather move flexibly between domains: Lexical items may be retrieved by semantic criteria (e.g., animals), phonological/orthographic criteria (e.g., words that begin

with a certain letter), or by both in combination (an animal whose name begins with a certain letter). This ability to move from one criterion of organization to another under pressure of time is clearly characteristic of the human mental lexicon rather than of conventional dictionaries. As for ease of retrieval of a given lexical entry, access to the mental lexicon is far easier and more efficient even than in the case of the most advanced on-line computerized dictionaries, with the human lexicon representing the result of years of evolutionary adaptation to communicative and interactional constraints.

Another point relevant to distinguishing between the mental lexicon and conventional dictionaries lies in the more intuitive, more implicit, and less controlled nature of the former as against the more carefully planned, explicit, and monitored knowledge reflected in written or computer dictionaries. To illustrate, lexical entries in dictionaries are structured in the form of a definition, manifesting the highest level of linguistic knowledge (Benelli, Belacchi, Gini & Lucangeli, 2006; Johnson & Anglin, 1995; Marinellie & Johnson, 2003, 2004; Snow, 1990; Nippold, 1999; Watson, 1995); yet people's mental lexical entries do not necessarily display the same hierarchical and structured linguistic knowledge across the board as do dictionaries. For example, words that are low in familiarity and/or frequency obviously lack a clearly established definitional-type entry in the mental lexicon, yet conventional dictionaries treat them on a par with their highly familiar and very frequent counterparts. This intuitiveness, combined with the dynamically changing content of people's linguistic environment and communicative contexts, means that speakers will sometimes entertain some uncertainty with respect to the very existence of particular lexical items – a situation that they typically resolve by consulting dictionaries, regarded as an authoritative source of knowledge. A basic assumption of this study, however, is that these interrelations between the mental lexicon and conventional dictionaries are not in fact unilateral and hierarchical, but rather, bilateral and reciprocal, with potential for influence in both directions.

Another contrast between the mental lexicon and conventional dictionaries relates to the size of lexical entries. Despite differences between lexicographers in this respect, a lexical entry in a conventional dictionary typically takes the form of a single uninflected word. In consequence, dictionaries do not generally list as separate entities

either units larger than words, such as idioms, or smaller than words, such as bound morphemes or affixes. In contrast, the basic units of the mental lexicon quite typically include elements that are larger than words, in the case of multilexemic expressions such as compounds, idioms, collocations, and even quite long phrases (Aitchison, 2003; Arnon & Snider, 2010; Bannard & Matthews, 2008; DiSciullo & Williams, 1987; Jackendoff, 2002; Langacker, 1999; Lyons, 1977). The widely disputed issue of whether elements of less than a word (affixes, roots, stems, etc.) have an independent status in the mental lexicon is discussed at length later in the next section. Here, suffice it to say, in sum, that the mental lexicon and conventional dictionaries both constitute highly organized systems or repositories of linguistic knowledge, which overlap to some extent, but also differ in many important respects (Aitchison, 2003; Anshen & Aronoff, 1999; Bolozky, 1999).

Another issue of particular relevance to the mental lexicon as dealt with in this study is that of **ambiguity**, that is, violations of one-to-one mapping of form/meaning relations, as manifested in the two phenomena of **homonymy** and **polysemy** (Klein & Murphy, 2001; Klepousniotou, 2002; Klepousniotou & Baum, 2007; Lyons, 1977; Rodd, Gaskell & Marslen-Wilson, 2002). Homonymy refers to cases where there is more than a single lexical entry with the same surface form, as in the English word *bank* ‘the side of a river’ ~ ‘a place where one puts money’ ~ ‘rely (on)’; or Hebrew *ax* ‘brother’ ~ ‘male nurse’, ‘fireplace’. The other facet of ambiguity is polysemy, where a single lexical entry has more than one sense, as in the English word *heart*, which may be interpreted variously as *the bodily organ, a vital body part, as the seat of feeling, understanding, and thought, as something having a central position* or as *something in the shape of a heart* (Oxford English Dictionary Online, 1989). Polysemy is closely related to non-literal or figurative language, as in expressions like *learn by heart, the heart of the matter, heartbreaking*. Thus the Hebrew derived noun *sidur* from the root *s-d-r* ‘arrange’, for example, involves polysemy in a range of extended senses including ‘arrangement’, ‘setting’, ‘prayer book’, and the slang sense of ‘setting someone up’, while the derived action nominal *kabala* from *q-b-l* ‘receive, accept’ means, variously, ‘acceptance’, ‘mystical doctrine’, ‘(social) reception’, ‘receipt’ – represents homonymic ambiguity. Homonymy and polysemy play an important role in natural languages in general, and are critically important for characterizing the mental lexicon of a given language in

particular, as considered in some detail in relation to Hebrew typology further in this chapter (Section 3 below).

1.2. Morphology in the Mental Lexicon

As noted, the existence of morphemes or units smaller than words in the mental lexicon is a subject of controversy. Yet more controversial is the issue of the status of morphology as a linguistic domain whose very existence or autonomy has been challenged by scholars working in different theoretical paradigms (Anderson, 1982; Aronoff, 1976, 1994; Chomsky, 1970; Gonnerman, Seidenberg & Andersen, 2007; McCarthy, 1981; Plaut & Gonnerman, 2000; Raveh, 2002; Selkirk, 1982). There are twofold motivations for assigning an inferior status to morphology: On the one hand, syntacticians, phonologists, and even semanticists claim that morphology is a secondary sub-domain constituting a component of their respective domain of linguistic inquiry; on the other, morphemes such as affixes that are smaller than words are not recognized as independent lexical entries in theories claiming that words are the minimal building blocks of the mental lexicon.

From the point of view of the present study, aimed explicitly at investigating the role of derivational morphology as well as of semantics in the mental lexicon, the nature of the different morphological models reviewed below is of critical importance. The status of morphemes, as minimal units of grammatical analysis, in scope a word or less than a word, lies at the core of two ongoing debates (Anderson, 1982; Aronoff, 1976; 1994; Bybee, 1985, 1995; Chomsky, 1970; Frauenfelder & Schreuder, 1991; Lieber, 1982, 2006; Libben & Jarema, 2004; Lyons, 1997; Prunet, 2006; Selkirk, 1982). The first debate concerns the specification of a morpheme: Defined in traditional accounts of morphology as a minimal unit that carries meaning (Matthews, 1991, Spencer, 1991), other scholars (such as Aronoff in his seminal 1976 paper) question the very existence of core meanings in morphemes. Paradoxically, Aronoff's important claim, that the structure of a morpheme can be dealt with separately from meaning, gains support from contemporary computational accounts (e.g., De Jong, Schreuder & Baayen, 2000; Gonnerman et al., 2007; Longtin, Segui & Hallé, 2003) which, in a way, challenge Aronoff's (1994) notion of "Morphology by Itself" (1994), or the very existence of morphology as a distinct linguistic domain.

The second debate concerns morphological decomposition, that is, whether morphemes exist as independent units in the lexicon. Three types of accounts have been proposed in this respect: Full decomposition models or Item-and-Arrangement models, full listing, lexicalist or Word-and-Paradigm models, and hybrid or Item-and-Process models (Prunet, 2006; Schwarzwald, 2002). Full decomposition models (e.g., Taft, 1988; Taft & Forester, 1976) contend that words are analyzed into their morphological constituents. In contrast, full listing, lexicalist models (e.g., Butterworth, 1983) claim that words are stored as whole units, with no morphological decomposition. Between these two extremes are hybrid models, which attempt to accommodate both alternatives by assuming either a “horse-race”, that is, parallel existence in the mental lexicon of both decomposed words and whole words (Schreuder & Baayen, 1995), or serial access to whole words with consecutive decomposition if necessary (Chiliant & Caramazza, 1995).

The above models are all binary, in the sense that, for them, the morpheme either does or does not exist, whereas whole words, in contrast, are either retained as wholes or decomposed into their parts. Another view of morphological decomposition, as a distributed rather than a discrete process, is proposed by Parallel Distributed Processing (PDP) models, based on connectionist accounts (Feldman, Soltano, Pastizzo & Francis, 2004; Gonnerman et al, 2007; Hay & Baayen, 2005; Plaut & Gonnerman, 2000; Raveh, 2002; Seidenberg & Gonnerman, 2000). Such distributed accounts claim that the best way to describe morphemes is not as binary entities but as deriving from the overlap of meaning (semantics) and form (phonology/orthography). For example, Gonnerman et al claim that traditional accounts of morphology fail to explain words like *grocer* in contrast to *writer* and *baker*: The latter can be described as *someone who writes* and *someone who bakes* respectively, with a high level of form-meaning consistency through addition of the agentive suffix *-er* to the stem (verb) form, hence retaining the same meaning of the verbal action and the noun agent, but the word *grocer* cannot be interpreted as *someone who *groces*. The lack of independent meaning of the stem *groc* in the word *grocer* thus poses a problem for decomposition accounts, which are much more easier to apply in the case of *writer* and *baker*. Gonnerman et al suggest an alternative account, to the effect that “morphological structure is a graded, interlevel representation that reflects the systematic though probabilistic relationships among phonological, orthographic, and

semantic codes. These codes typically converge, giving rise to morphological subunits. The units are not the discrete morphemes proposed in previous theories; they encode regularities that vary in type and degree” (2007, pp. 327-328). The present study aims to provide supporting evidence for these latter proposals, by demonstrating the role of the Semitic root and its psychological reality in the mental lexicon of Hebrew speaker-writers.

1.3. Meaning (Semantics) in the Mental Lexicon

As for meaning in the mental lexicon, most scholars who argue for or against the involvement of meaning in morphology typically fail to refer to the nature of meaning relations, confining themselves to general statements about the presence or absence of semantic relatedness – in terms of semantic transparency and/or opacity respectively. But meaning or semantic connections represent a rich array of relations, each of which has distinct outcomes and each of which requires further clarification and specification, as highly controversial notions. To this end, follows a brief consideration of issues such as semantic categorization, semantic versus associative relations in the mental lexicon, and models of semantic processing.

With respect to categorization, the first question that arises is the relative proportion of semantic (or word) knowledge, typically focused on in classical semantic theories, as against pragmatic (or world) knowledge, as reflected in contemporary theories (Lyons, 1977; Nerlich & Clarke, 2000). Traditional field semantics, inspired by scholars such as von Humboldt, de Saussure, and Trier (cited in Nerlich & Clarke), was based mainly on relations between words within in a given semantic field, driven by the notion that semantic fields are closed sets, in which each item defines and is defined by the other items in the set, so yielding top-down and bottom-up dynamics of semantic shifts. This bidirectional analysis is further developed in contemporary lexical semantics, with the adherents of top-down processes seeking semantic universals (e.g., Wierzbicka, 1992) and those arguing for bottom-up processes adopting a more localist point of departure (e.g., Fillmore, 1975, 1982; Fillmore & Atkins, 1992). Contemporary models emphasize the effect of subjective word knowledge in describing relations between words, of a kind not likely to be accounted for in terms of a hermetically sealed or

encapsulated system that is indifferent to external effects (Allan, 1992). Hybrid theories such as “frame semantics” (Barsalou, 1992; Fillmore & Atkins, 1992) attempt to incorporate both relations within words (bottom-up) and between words and the external world in creating frames. In contrast, essentially top-down “script” theories (Allain, Le Gall, Foucher, Etcharry-Bouyxs, Barré, Dubas, & Berrut, 2008; Schank & Abelson, 1977) like “schema” based models (Rumelhart, 1975), contend that conceptual organization is driven solely by world experience from which are derived scriptal categories (for example, a hospital, a restaurant) or schemas (for example, narrative action structure).

With respect to types of relations between words, two distinct classes of connections are identified in the literature: semantic and associative. Classic **semantic relations** include: synonymy (e.g., *state-situation*), antonymy (e.g., *strength-weakness*), meronymy or part-whole relations (e.g., *computer-screen*), and hierarchic relations of category-exemplar (*clothing-skirt*) or co-hyponymy (*skirt-dress*) (Aitchison, 2003; Chaffin, 1992; Cruse, 1986; Miller & Fellbaum, 1991). Relations of the kind generally termed **associative**, typically those provided in free-association tasks, derive from contiguity or co-occurrence (see Prior, 2004, for a detailed review). It has been suggested that semantic relations differ from associative relations in being based on the overlap of semantic features; for example, *skirt* and *dress* share numerous features (*made of cloth, generally worn by women, round shape, etc.*) in contrast to *skirt* and *woman*, which are related by contiguity or co-occurrence rather than by shared features (Neely & Kahan, 2001). It is hard, however, to draw the line between associative and semantic relations, since many types of associates, such as *skirt* and *dress*, can be interpreted as sharing both semantic (co-hyponymic) and associative relations, reflected by spatial contiguity, as in the case, say, of *wardrobe* (and see, further, Prior, 2004). Psycholinguistic evidence for the semantic /associative distinction is inconclusive, since some priming experiments report semantic priming only to semantically related pairs (e.g., Lucas, 2000) whereas others detect priming effects for both types of relations (Anaki & Henik, 2003; Bueno & Frenck-Mestre, 2008; Jones, Kintsch, & Mewhort, 2006; Nelson & Goodman, 2002; Perea & Gotor, 1997; Spellman, Holyoak & Morrison, 2001).

Many different **semantic models** have been proposed to account for semantic representation in the mind, based on observations and demonstrations deriving from a variety of sources. The foremost of these are briefly reviewed below, beginning with the division of semantic models into localist versus distributed models of word meaning proposed by Jones et al (2006). Localist models such as spreading activation theories (Collins & Loftus, 1975) posit that the meaning of each lexical item (e.g., *dog*) is condensed in a single node in the semantic network. Distributed accounts -- further subdivided between feature/category models (Chaffin, 1992; Fillmore, 1975, Forster, 2004 ; Grondin, Lupker, & McRae, 2009; Lucas, 2000; Rosch, 1975) and connectionist models (Elman, 2004; Plaut & Booth, 2000; Plaut & Shallice, 1993) -- posit that the meaning of a lexical item is not expressed in a single node but is spread according to its perceptual features (*fur, tail, barking, bone, etc.*). Semantic space models, a third approach to word meaning described by Jones et al, are based on statistical measures of co-occurrences in texts without human intervention (Buchanan & Westbury, 2001; Bueno & Frenck-Mestre, 2008): These include the Bound Encoding of the Aggregate Language Environment (BEAGLE) model (Jones et al, 2006), Hyperspace Analogue to Language (HAL) model (Lund & Burges, 1996), Wordnet (Maki, McKinley, & Thompson, 2004; Miller & Fellbaum, 1991), and Latent Semantic Analysis (LSA) (Landauer & Dumais, 1997). In general, high correlations are reported between measures elicited by human respondents and by computational measures such as these (Spence & Owens, 1990; but see also Prior, 2004), so serving to validate computer analyses.

Another controversial question is whether semantic representation is abstract and modality-independent (as claimed, for example, by Fodor, 1983; Jackendoff, 2002) or, rather, **modality-dependent** in terms of particular perceptual senses such as vision or hearing, as recently claimed in a range of studies (Desail, Binder, Conant, & Seidenberg, 2010; Grondin et al, 2009; Vigliocco, Meteyard, Andrews, & Kousta, 2009; Vinson, Vigliocco, Cappa, & Siri, 2003; Wise, Howard, Mummery, Fletcher, Leff, Büchel, & Scott, 2000). Most of these current models report evidence for modality-dependency, mainly visual, in semantic organization. For example, Desail et al (2010), employing an fMRI paradigm in presenting participants with three semantic classes of verbs -- motor,

visual, and abstract -- found differential activation patterns in the brain related to each of the three types of verbs.

The last question concerning semantic processing addressed in this section concerns the degree of **automaticity** of semantic/associative processing. Spreading activation theories are described as more automatic and less conscious (Lucas, 2000; Neely, 1991), whereas other mechanisms underlying semantic priming are described as strategic/expectancy-based and more conscious (Perea & Gotor, 1997). A point relevant to the developmental facet of the present study is raised by Plaut and Booth's (2000) claim that distributed models account best for automatization processes, which they note as being subject to individual learning strategies and to developmental change.

The present study aims to shed light on the semantic facet of the mental lexicon of Hebrew from several distinct yet complementary perspectives. To this end, closed, limited-choice tasks based on *a priori* specified semantic relations as well as more open-ended tests requiring interpretation and production of words both in and out of context were designed to provide detailed insights into the organization of the semantic lexicon of Hebrew speaker-writers.

1.4. Morphology-Meaning in the Mental Lexicon

Almost all morphological models, except for lexicalist approaches, assume a certain degree of morphological decomposition. The controversy lies mainly in demarcating the boundary between items that are processed as wholes versus those that are decomposed into their constituent morphemes. Two factors that are critical to this decision are morphological and semantic **transparency**. Morphological transparency depends on ease of analysis: Verbs like *restart* and *redial*, for example, are considered morphologically transparent and easily analyzable into their constituent morphemes, *re- start* and *re- dial* –on the basis of the shared prefixal morpheme *re-* and the verbs *start*, *dial*. Semantic transparency is determined by the relatedness of meaning between lexical items. Thus English *restart* and *redial* are semantically as well as morphologically transparent, since their meanings denote repetition of the action encoded by the stem verb: *dial again*, *start over*. In contrast, a verb like verb *recover*, in the sense of ‘get well’ or ‘gain back’, is semantically opaque since its meaning is not composed of the separate meanings of the

bound morpheme *re-* and the stem *cover*. And a verb like *reduce* represents even greater morphological opacity, because of the dubious status of the stem *-duce* as an independent morpheme.¹ In fully decomposition models, the verbs *redial*, *restart*, *recover* (and maybe even *reduce*) would be analyzed in the mental lexicon into their component morphemes as *re + start*, *re + dial* and *re + cover*. In contrast, lexicalist models would claim that all the above verbs be stored as whole units. Hybrid models would probably propose that the more transparent cases, where the prefix *re-* denotes repetition, be analyzed into their morphemes, while the more opaque verb *recover* would remain unanalyzed and stored as a whole word.

Analogous instances of a full range of possibilities, from complete transparency to total opacity, are identifiable in the class of derived nouns in Hebrew. Thus, for example, the Hebrew derived nouns *maxbet* '(tennis) racket' and *masrek* '(hair) comb' both share the nominal pattern *maCCeC*, which usually denotes instruments, and are easily analyzable into their constituent morphemes, the pattern *maCCeC* and the verb roots *x-v-t* 'hit' and *s-r-k* 'comb' respectively. These two nouns are also semantically transparent, since their meanings are close to the meaning of their corresponding verb and to the core meaning of their root. In contrast, the derived noun *maxšev* 'computer' is morphologically transparent, but semantically less transparent, since the root *x-š-b* stands for both 'think' and 'compute'. And the derived noun *magev* '(windshield) wiper' in the same nominal pattern is morphologically opaque because it is formed from a defective root *n-g-v*, with the initial radical omitted, which makes morphological analysis harder. The noun *mazleg* 'fork' in the same pattern represents yet another type of morphological opacity (similar to English *reduce*), since the consonants *z-l-g* do not constitute an active root (Berman, 1987, 1993). As these examples show, derived nouns in Hebrew display varying degrees of morphological and/or semantic transparency, and so offer a promising site for examining the morphology-semantic interface.

The literature on the issue of semantic and/or morphological transparency, reviewed here primarily for English, with discussion of Hebrew left for later, yields several lines of evidence. Numerous studies find strong correlations between the

¹ Note that this opacity is typical of Latinate compared with Germanic stems in English, yielding large groups of semantically opaque even though possibly morphologically divisible words like: *reduce*, *produce*, *transduce*; *remit*, *transmit*, *commi*, *submit*, etc.

decomposition process and semantic transparency, to the effect that semantically transparent words are more likely to be decomposed into their shared morphemes (Baayen, Lieber, & Schreuder, 1997; Bertram, Baayen, & Schreuder, 2000; Chateau, Knudsen, & Jared, 2002; De Jong et al, 2000; Feldman, O'Connor, & Moscoso del Prado Martín, 2009; Feldman et al, 2004; Frost, Deutsch, Gilboa, Tannenbaum & Marslen-Wilson, 2000; Gonnerman et al, 2007; Marslen-Wilson et al, 1994; Plaut & Gonnerman, 2000; Raveh, 2002; Schirmeier, Derwing, & Libben, 2004); others report that decomposition is dependent on the time course of lexical processing (Diependaele, Sandra, & Grainger, 2009; Feldman & Prostko, 2002; Feldman & Soltano, 1999); while the remaining studies report morphological decomposition as appearing in the very early stages of lexical processing, irrespective of semantic transparency, as predicted by full-decomposition models (Dohmes, Zwitserlood, & Bölte, 2004; Longtin & Meunier, 2005; Marslen-Wilson, Bozic, & Randall, 2008; Meunier & Longtin, 2007; Roelofs & Baayen, 2002; Sánchez-Casas, Igoa, & García-Albea, 2003; Solomyak & Marantz, 2010). Implications of the studies reviewed here need, however, to take into account the fact that the results they report were all obtained in on-line priming experiments: As noted earlier, these are typically confined to the initial stages of lexical access, while the results they yield may vary according to the specific priming paradigm employed. The present study is not confined to lexical access or to initial stages of lexical processing, but instead provides two complementary perspectives, based on on-line and off-line tasks respectively.

In sum, morphological decomposition or “parsing” is best viewed as ranged along a continuum rather than as an all-or-nothing process (Bybee, 1985). Degree of parsability depends not only on semantic transparency along the time course of lexical processing, but on psycholinguistic factors such as familiarity and frequency (as considered in the next section) as well as on factors of linguistic structure and typology of the kind noted later in this chapter for Hebrew (Section 4).

2. Psycholinguistic Variables in the Mental Lexicon

This section describes two pairs of variables that are hypothesized to affect form-meaning relations in the mental lexicon: familiarity-frequency and concreteness-imageability, as reviewed in Sections 2.1 and 2.2 respectively.

2.1. Familiarity-Frequency in the Mental Lexicon.

Frequency, in the sense of how often a word is used in a given corpus or in the language in general, is recognized as a crucial factor in language processing. Its importance is acknowledged in models of language comprehension (Gaskell & Marslen-Wilson, 1997) and production (Levelt et al., 1999) deriving from various disciplines and theoretical orientations (Aitchison, 2003). Frequency can be measured either objectively, by occurrences in corpora (Baayen, Piepenbrock, & van Rijn, 1993; Content, Mousty & Radeau, 1990) or subjectively, by estimates of number of encounters with words (Balota, Cortese, Sergent-Marshall, Spieler, & Yap, 2004; Balota, Piloti, & Cortese, 2001; Balota, Yap, & Cortese, 2006; Gordon, 1985). The current study endorsed the latter method since Hebrew lacks satisfactory objective frequency counts, as discussed further in Section 3.1.

Theoretical grounds for the robust frequency effect are reviewed first, beginning with the locus of frequency, or the stage of lexical processing where frequency applies. From the point of view of the accepted division of lexical processing into three levels -- sub-lexical (phonology-orthography and morphology), lexical, and post-lexical (semantics) -- some studies assign frequency to the lexical level (e.g., Balota et al, 2006), while others assign it to the post-lexical, semantic level, taking the fact that high frequency words tend to score higher on indices of semantic richness as indicative of the semantic nature of frequency (Baayen, Feldman, & Schreuder, 2006; Forster, 2004; Nelson & McEvoy, 2000a).

Three types of theoretical models account for frequency from the perspective of the time-axis of on-line stages of lexical processing (Balota et al, 2006; Forster, 1981; Neely, 1991): Activation models, which posit that frequent words have lower activation levels than infrequent words; frequency-ordered search models, which posit that high frequency words are searched earlier than infrequent words; and hybrid models, of activation and search, which combine these two approaches. Connectionist accounts (e.g.,

Monsell, 1991) are fundamentally different with respect to the locus of frequency from these other approaches, since in connectionism, frequency is an inherent property of the system, and one which determines its learning mechanisms. In fact, connectionist accounts alone refer to frequency as a dynamic entity that changes the system over time.

Another question raised in the research literature with respect to frequency is whether the frequency effect is bound to a specific modality (vision, hearing, etc.) or is amodal and abstract in nature – as claimed, for example, by Bates, Burani, D’Amico and Barca (2001) and Forster (1976). Interestingly in this respect, Gaygen and Luce (1998) found differential effects of modality-dependence for low versus high frequency words, with the former more independent, the latter more dependent on the visual modality. A possible explanation for the discrepancy found by Gaygen and Luce is that low-frequency words are encountered more in the visual modality (reading), an observation that supports Gernsbacher’s (1984) assumptions about the higher modality-dependency of infrequent as against high frequency words in general.

As noted, the theoretical status of frequency is a matter of controversy, but the robust effect of frequency on just about every linguistic and psycholinguistic measure is widely acknowledged. Frequency has been found to be highly correlated with key semantic variables such as concreteness and imageability (Auer & Bernstein, 2008; Balota et al, 2004; Gilhooly & Logie, 1980; McDonald & Shillcock, 2001), as well as with performance on a host of psycholinguistic processes including: lexical decision making (Caza & Moscovitch, 2005; Colombo & Burani, 2002; Rajaram & Neely, 1992), naming (Masterson, Druks & Gallienne, 2008), reading (Bonin, Barry, Méot & Chalard, 2004; Juhasz & Rayner, 2003; O’Malley, Reynolds & Besner, 2007), and word associations (De Deyne & Storms, 2008a, 2008b; Nelson & McEvoy, 2000a; Spence & Owens, 1990)..

Familiarity, defined as an index of personal acquaintance with words, is a term that is employed in conjunction, and often confounded, with frequency (Gernsbacher, 1984; Williams & Morris, 2004). However, these two variables, although sharing a great deal of overlap, tap different types of knowledge in the mental lexicon. Gernsbacher (1984), who argues against objective measures of frequency as a psycholinguistic measure, exemplifies this discrepancy by the words *boxer*, *joker*, *gnome*, and *assay*, all

taken from the same frequency range in Kučera and Francis (1967) but yielding totally different scores on familiarity ratings. Other studies support Gernsbacher's insights, suggesting that the meaning component is more salient in infrequent words (Cordier & Le Ny, 2005; Gordon, 1985; Lovelace, 1988; Peerman, Content & Bonin, 1998) and that familiarity is a more sensitive measure for words of very low frequency due to the decreased accuracy of frequency estimates for such words. Finally, compelling support for Gernsbacher's proposal was provided by Williams and Morris (2004), who deliberately selected words with the same range of frequency but different familiarity ratings (e.g., *dagger* of low frequency and high familiarity and *lance*, of low frequency and low familiarity) to reveal differential processing times between the two classes of items, indicating that familiarity is a more sensitive psycholinguistic index than frequency.

2.2. Concreteness-Imageability in the Mental Lexicon

The two semantic factors of concreteness and imageability, also highly correlated with one another, are likewise pervasively referred to in the research literature, often used to denote a single phenomenon. This section starts by comparing how the two notions are defined in the literature, followed by a review of relevant theoretical models and empirical findings concerning each of them

Differentiating between the notions of imageability and concreteness is not a straightforward matter. One distinction is provided by scholars who define imageability as the ease with which a word gives rise to a sensory mental image, whereas concreteness refers to other senses like touch and feel (Paivio, Yuille, & Madigan, 1968; Reilly & Keah, 2007). A theoretically interesting distinction is provided by Vigliocco et al (2009), who state that imageability is a measure of the relevance of primarily visual sensory properties of entities whereas concreteness is a measure of the distinction between entities and events that exist in the physical world and entities and events that exist in the human mind. Other researchers suggest that the difference between the two notions lie in their relative degree of operationalization, such that concreteness is a more theoretical term, related to lexical organization, whereas imageability typically serves as an index or an operationalized scale of concreteness (Balota et al, 2006; Barry & Gerhand, 2003).

Empirically, several studies reveal differential effects of concreteness and imageability respectively (Bird, Franklin & Howard, 2001; Clark & Paivio, 2004; Paivio et al, 1968; Vigliocco et al, 2009) -- illustrated, for example, by emotive terms that are, on the one hand, abstract but, on the other, quite imageable. The rest of this section refers to both concreteness and imageability, since there is such a high degree of overlap between them in the literature that it is almost impossible to refer to one apart from the other.

The research literature generally describes an advantage of concrete/imageable over abstract/non-imageable words in a range of tasks including, among others, lexical decision (Balota et al, 2006), naming (Balota et al, 2004; Bates et al, 2001; Masterson et al, 2008), and free associations (De Deyne & Storms, 2008a, 2008b; De Groot, 1989). Further, concreteness/imageability has been shown to be related to frequency (Balota et al 2006; Bates et al, 2001; Juhasz & Rayner, 2003; Reilly & Keah, 2007) as well as to lexical development, which relies heavily, at least in the initial acquisition of the lexicon, on visual clues (Auer & Bernstein, 2008; Bloom, 2000; Gentner, 1982; Mestres-Missé, Münte, & Rodriguez-Fornells, 2009; Rinaldi, Barca, & Burani, 2004). Various sets of norms have been established for imageability/concreteness, making it a useful tool in psycholinguistic research that has proved to be a powerful variable in psycholinguistic processing (Cortese & Fugett, 2004; Flieller & Tournois, 1994; Gilhooly & Logie, 1980; Paivio et al, 1968).

Two main models have been proposed to account for the concreteness/abstractness differentiation: dual-coding (Paivio, 1991, 2006; Sadoski, Kealy, Goetz, & Paivio, 1997) and context-availability (Schwanenflugel, Harnishfeger, & Stowe, 1988; Schwanenflugel & Noyes, 1996). The dual-coding theory, which claims that the concreteness effect arises from the superiority of the dual (visual and verbal) representation of concrete words as against the single (only verbal) representation of abstract words has been supported by a range of studies (Binder, Westbury, McKiernan, Possing, & Medler, 2005; Goetz, Sadosky, Stricker, White, & Wang, 2007; Kellog, Olive, & Piolat, 2007; Sadosky et al, 1997; Sadosky, Goetz, & Rodriguez, 2000; Sadosky, Goetz, Stricker, & Burdinski, 2003). The context-availability theory, which explains the concreteness effect by a denser network of contextual knowledge in the case of concrete words, is also acknowledged, but there are fewer studies that report results

that can be explained by this model (Colombo & Burani, 2002). Three other, rather innovative, explanations for the concreteness effect are provided by contemporary models inspired by PDP connectionist networks: One explains the advantage of concrete items in distributional properties of semantic features, as sharing more common features with each other and thus yielding higher activation levels (Grondin et al, 2009; Pexman, Hargreaves, Edwards, Henry & Goodyear, 2007); another posits that the concrete/abstract differentiation lies in the distributional properties of the two types of words, with concrete words clustering with sensory-motor experience and abstract words with affective and linguistic information (McDonald & Shillcock, 2001; Vigliocco et al, 2009). A third and, to this writer, the most interesting, approach suggests that the conceptual features of concrete words are more consistent and specific whereas the conceptual features of abstract words are more general and flexible (Tolentino & Tokowicz, 2009).

As for the neural mechanisms underlying this concreteness effect, various innovative techniques such as fMRI, ERP and PET have been employed in the last two decades to ascertain the neural basis of the concreteness/abstractness contrast: Several found neuroanatomical distinctions, while most found neurophysiological distinctions between the two (Chiarello, Liu & Shears, 2001; Crutch & Warrington, 2004; Desai, Binder, Conant & Seidenberg, 2010; Giesbrecht, Camblin, & Swaab, 2004; Holcomb, Kounios, Anderson & West, 1999; Jessen, Heun, Erb, Granath, Klose, Papassotiropoulos, & Grodd, 2000; Kellenbach, Wijers, Hovius, Mulder, & Mulder, 2002; Martin-Loeches, Hinojosa, Fernandez-Frias & Rubia, 2001; Mestres-Missé et al, 2009; Nitto, Suehiro & Hori, 2002; Perani, Cappa, Schnur, Tettamanti, Collina, Rosa & Fazio, 1999; Swaab, Baynes & Knight, 2002; West & Holcomb, 2000; Wise, Howard, Mummery, Fletcher, Leff, Büchel & Scott, 2000).

The complex psycholinguistic notions of familiarity, frequency, imageability, and concreteness are each considered in detail in this study, as a major portion of its independent variables. To this end, specially designed questionnaires were constructed to

meet the careful criteria applied in this study for item selection and variable identification, as detailed in the next chapter (Chapter II, Section 1.3).²

3. Background on Hebrew

This section surveys relevant properties of Modern Israeli Hebrew, the language on which this study was carried out (3.1), followed by an overview of Hebrew derivational morphology (3.2), and a detailed description of Hebrew derived nouns as the subject-matter of the study (3.3).

3.1. An Introduction to Hebrew

Hebrew, a Semitic language with unique historical circumstances, goes back at least 4,000 years, with a hiatus of nearly 2,000 years during which it was not used as an everyday spoken language or as the first language of any generation of speakers, until its revival in the late 19th century as part of Jewish re-settlement in what was then Palestine (Berman, 1978, 1987, 1997; Harshav, 1993; Nir, 1993; Ravid, 1995; Shimron, 2003). The lexicon of Modern Hebrew consists of items from three major historical layers: Biblical, Mishnaic/ Medieval, and Modern, accounting for 22%, 38% and 40% of the lexicon respectively (Ravid, 2005). Since the revival of Hebrew, numerous words have entered the language, so closing historical gaps between a language that formerly served mainly for reading and study of the scriptures to the ongoing needs of a living language functioning in a full range of secular as well as sacred context.

The accelerated pace and heightened rate of constant lexical change has important psycholinguistic implications, with a twofold impact on speaker-writers of Modern Hebrew -- yielding openness and readiness to accept innovation, on the one hand, and lack of confidence or uncertainty, on the other. Thus, Hebrew speakers are generally open to lexical innovation, particularly if they are constructed by accepted processes of Hebrew word-formation (typically by interdigitation of an extant consonantal root with

² The study by Henik, Rubinstein, and Anaki (2005), of Ben Gurion University, provides Hebrew norms for familiarity, imageability, and other psycholinguistic variables for 800 words. However, for reasons detailed further below (in Chapter II, Section 1.3), their data-base did not meet the requirements stipulated here for item selection and specification of independent variables.

accepted prosodic templates or morphological patterns); yet they are often uncertain as to the exact meaning of such coinages (Nir, 1982). Of particular relevance to the present study is the question of how Hebrew speakers react to words that are infrequent or unfamiliar words, such as were carefully selected and deliberately included as stimulus items for the study, to serve as a test-case for the claims made here for the two possibly contradictory tendencies to openness and uncertainty respectively.

Another by-product of the special socio-historical circumstances of Modern Hebrew is the lack of validated norms for such dimensions as frequency, familiarity, concreteness, and imageability in the language. Several attempts have been made to fill these lacunae and to establish Hebrew-specific norms (Henik et al, 2005) and frequency counts (Frost & Plaut, 2001), but the situation is still far from satisfactory. The present study hopes to contribute to Hebrew research in this respect, too, by establishing Hebrew norms for subjective familiarity, frequency and concreteness for a large, carefully selected set of Hebrew derived nouns.

The study was conducted in the written modality, indicating need for a brief description of Hebrew orthography, along the following lines. Modern Hebrew employs two versions of the same script (Ravid & Schiff, 2004). The first, so-called *menukad* ‘(vowel) pointed’ version represents both consonants and vowels – with all 22 consonants represented by letters, and the five vowels occurring in current pronunciation -- *a*, *e*, *i*, *o*, *u* -- represented by no fewer than 13 diacritic signs termed *nikud* ‘pointing’, so that each vowel has at least two, in some cases three, corresponding written signs, with varying degrees of frequency. For example, the vowel *e* is represented by the diacritics termed *cerey*, *segol*, and *hataf-segol* appearing under the letters, as in examples *s’fer* ‘book’ spelled סֵפֶר, and *emet* ‘truth’ spelled אֱמֶת. This pointed version, which is used in teaching reading and writing in the early school years, in children’s books, in materials for new immigrants, and in Biblical and poetic texts, is thus a transparent and orthographically shallow representation that provides precise phonological information about the written Hebrew word. A second version of Hebrew writing, *non-pointed* orthography, which represents all consonants by letters, with vowels only partially and ambiguously represented, is the default version of current written Hebrew, used across the board for

most purposes, including newspapers, prose literature, as well as school texts and teaching materials from 4th grade on.³

All of the stimuli in this study were presented to the participants in the normative, fully pointed version, in order to resolve the problem of non-pointed or so-called unvocalized Hebrew, in which misinterpretations are endemic, due to a high degree of homography that is typically resolved by means of contextual clues (Bar-On, 2010 and see further Chapter IV, Section 3.2. for a detailed discussion). Since the vast bulk of the stimuli in the present study were presented in the form of isolated words, for which contextual clues were not available, it was decided to present to the participants with words accompanied by a full range of normative diacritic markings, as is customary in conventional as well as computerized dictionaries of Hebrew to this day.

3.2. Hebrew Derivational Morphology

There are two main means of word-formation in Hebrew: (1) nonlinear interdigitation by means of a consonantal root combined with a prosodic template or affixal pattern (e.g., *n-h-g* ‘lead, drive’ in the nouns *nehag* ‘driver’, *nehiga* ‘driving’, *minhag* ‘custom’, *manhig* ‘leader’ and many more) and (2) linear concatenation, where stems and affixes are overtly concatenated, primarily by suffixation (e.g., *manhig-ut-iy-ut*, ‘leader-ness-ishness = leaderliness’). Linear affixation, which has increased considerably in Modern Hebrew compared with earlier stages of the language (Schwarzwald, 2001; Ravid, 2006a) is more transparent than interdigitation in terms of one-to-one form/meaning relations, and so seems easier to acquire and to perceive (Ravid & Malenky, 2001). Nonetheless, the preferred option for new-word formation of both young children and adult speakers of Hebrew is nonlinear, in the form of combining a consonantal root with an affixal pattern (Berman, 1993, 2000, 2003; Clark & Berman, 1984; Ravid, 1990, 2003; Schwarzwald, 1975, 2000, 2001, 2002).

The root, a basic unit in Hebrew morphology, is an abstract entity of three to four consonants which are interdigitated with a fixed set of word patterns to create words. For

³ A third type of script, so-called *plene* ‘full’ is employed in most written materials including newspapers and academic texts as well as schoolbooks. This makes use of *matres lectiones* in the form of the semi-vowels *waw*, *yod*, and partially resolves some of the ambiguities inherent in a consonantal orthography. It was decided not to use this version, however, since not only is it applied inconsistently by even highly literate users, it fails to resolve many of the homographic ambiguities of unpointed script.

example, the root *g-d-l* yields verbs like *li-gdol* ‘to grow, Intr.’, *le-gadel* ‘to-grow, raise’, *le-hagdil* ‘to-enlarge’; adjectives like *gdol* ‘big’, *megudal* ‘(over)grown’; and nouns like *gdila* ‘growing’, *gidul* ‘growth, tumor’, *gadlut* ‘greatness’, *hagdala* ‘enlargement’, as well as *migdal* ‘tower, large building’. Roots are essentially abstract entities: They are not separate words nor independent phonological entities since they are not pronounceable. However, even though they are not taught explicitly before second grade, they play an important role in mediating between words in the mental lexicon of Hebrew speakers from early on, even at preschool age (Bentin & Frost, 1994; Berman, 1987, 2003; Berman & Sagi, 1981; Frost et al, 1997; Ravid & Bar-On, 2005; Shimron, 2003). A special sub-category of roots, which include semi-vowels or glides as well as weak back consonants like historical *ayin*, *alef*, *heh* rather than obstruents as one or more of their radical elements, have only two or even one consonants since not all of their elements show up in the same way in all words that are constituted out of them, and they involve numerous rather opaque morphophonological alternations (Berman, 1978, 1981, Schwarzwald, 2002). As a result, some of their radicals are omitted, some appear with a vowel change, and some are reduplicated. Scholars employ distinct terms for this special category of roots, such as weak roots (Gesenius, 1910), opaque roots (Schwarzwald, 2003), or defective roots, others further differentiate between various subtypes of such roots (Velan et al, 2005). The present study employs the term “defective roots” to generalize across all different types of so-called “weak” or “partial” roots.

Compare, for example, words derived from the full, nondefective, or “strong” root *g-d-l* noted earlier with the following words from the defective root *r-?-y*: the verbs *ra’a* ‘saw’, *her’a* ‘showed’, *hitra’u* ‘saw each other’ and the nouns *re’iya* ‘seeing, sight’, *mar’a* ‘mirror’, *mar’e* ‘view’, *re’ut* ‘visibility’, *re’ayon* ‘interview’.⁴ The opaqueness of those roots makes them harder to identify and less accessible to perception of connections between words constructed out of them. For example, certain priming experiments in Hebrew give evidence of priming between words related by full roots such as *gidul*

⁴ Hebrew words are transcribed here in broad phonemic transcription meant to represent the pronunciation of speaker-writers of “standard Hebrew” (Berman, 1987; Ravid, 1995) including the subjects of the present study -- rather than abstract theoretical underlying or historical forms -- including distinctions made in the orthography between homophonous consonants. In indicating roots, a question mark ? is used for alef and an apostrophe ’ for ayin. Note, further, that verbs are generally represented in the morphologically unmarked form of past tense, masculine singular -- unless otherwise indicated as infinitives. Word-stress is final unless indicated as penultimate or antepenultimate by an accent aigu on the stressed vowel.

'growth, tumor' and *migdal* 'tower, large building' as against lack of priming between words related by non-full roots such as *mar'a* 'mirror' and *re'aya* 'evidence' (Frost, Deutsch, & Forster, 2000).

The consonantal root plays a major role in traditional Hebrew scholarship (e.g., Blau, 1971; Gesenius, 1910), but its status is by no means unequivocal in contemporary studies (Berman, 1999, 2003; Lieber, 2006; Prunet, 2006; Ravid, 1990, 2003; Shimron, 2003). Some scholars have challenged its status as an independent entity on either syntactic or phonological grounds (Bat-El, 1989; McCarthy, 1981; Ussishkin, 2005), while the autonomy of the root is also queried by adherents of word-based derivation (e.g., Aronoff, 2007; Bolozky, 1999) rather than sub-word derivation. However, whereas the linguistic grounds arguing for the existence of a Semitic root may be a matter of controversy, psycholinguistic research provides unquestionable evidence for the psychological reality of the consonantal skeleton in the mental lexicon of Hebrew speakers from as early as age three years and on to adulthood (Avivi Ben-Zvi, 2010; Berman, 1988, 2000, 2003; Bick, Frost & Goelman, 2010; Bick, Goelman & Frost, 2008; Deutsch et al., 1998; Clark & Berman, 1984; Deutsch, Frost, Pollatsek, & Rayner, 2000; Deutsch, Frost, Pollatsek & Rayner, 2005; Frost et al, 1997; Ravid, 1990, 2003; Ravid & Bar-On, 2005; Ravid & Malenky, 2001; Seroussi, 2002). The present study recognizes the root as having definite weight in the mental lexicon of Hebrew, and employs it as an important variable across the different phases and facets of the research design.

3.3. Hebrew Derived Nouns

Hebrew derived nouns, the focus of the study, are formed nonlinearly, with consonantal roots and affixal patterns. In this analysis, the term "derived noun" is used in a general sense to refer not only to abstract nouns derived from verbs and adjectives by a process of nominalization, analogously to English *acquire/acquisition*, *warn/warning*, *black/blackness* (Chomsky, 1970), but also to other verb-related Hebrew nouns with varying degrees of abstractness. In fact, the term "nominalization" is usually reserved for abstract nouns, although some linguists extend it to other derived nouns such as agentive, locative, or reason nouns (Comrie & Thompson, 1985). In general, whatever the analysis, nominalizations do not constitute a homogeneous category. Studies of English usually

distinguish between gerundive *-ing* nominals like *amusing*, *giving* and derived nominals like *amusement*, *gift* (Asher, 1993; Zucchi, 1993), with gerundives characterized as generally more verb-like and derived nouns as more noun-like. In addition to their uniquely intermediate verbal-nominal status, derived nouns are a category bridging lexicon and syntax, derivation and inflection (Zucchi, 1993). In Hebrew, too, nominalizations have a dual verbal-nominal nature and so fail to constitute a homogeneous class (Berman, 1973, 1978). Semantically, the process of nominalization entails a conceptual as well as a lexico-syntactic permutation, since it results in terms that denote actions (typically expressed by verbs) in a nominal way, yielding a high level of abstractness (Langacker, 1991; Lyons, 1977). The degree of abstractness of derived nouns is not uniform, but graded, and depends on factors like frequency and imageability as well as degree of lexicalization (DiSciullo & Williams, 1987) and the count/non-count distinction (Langacker, 1991). In terms of language acquisition, this complexity of derived nouns locates them in the domain of later language development, and mastering them is a protracted process, not fully complete even among adults (Avivi Ben-Zvi, 2010; Levie, Avivi Ben-Zvi, & Ravid, 2008; Ravid & Avidor, 1998; Ravid & Cahana-Amity, 2005; Seroussi, 2002, 2004).

In the present context, as noted, the term "derived nouns" is used to refer not only to nominalized forms that derive from verbs in the class of so-called canonic *šmot pe'ula* 'action nominals' (e.g., from verbs constructed out of the root *k-t-b*, in four different verb-patterns, the nouns *ktiva* 'writing', *haxtava* 'dictation', *hitkatvut* 'correspondence', *kituv* 'captioning'). Here, the term also applies to the entire range of nouns that are systematically related to verbs with which they share a common root in Hebrew, including verb-related, but morphologically less predictable derived nouns, analogous to English *deliver / delivering / delivery / deliverance*. For example, other nouns related to the Hebrew verb *katav* 'write' are *mixtav* 'letter', *któvet* 'address', *ktav* 'handwriting', *ktiv* 'spelling', *ktuba* 'marriage contract', *maxteva* '(writing) desk'. The lexicon of Modern Hebrew includes numerous instances of word-families, such as illustrated earlier for the roots *g-d-l*, *r-?-y*, as well as *k-t-b*. For example, the monumental Even-Shoshan (1993) dictionary includes a supplement of roots, accompanied by listings of members of families of words derived from the same root.

In psycholinguistic terms, the existence of a “Family Size Effect” in Hebrew (Moscoso del Prado Martin et al, 2005) provides strong evidence for the root as a mediator between Hebrew words (Ravid, 1990, 2003). Recall that the phenomena of polysemy and homonymy are prevalent in Hebrew derived nouns as well (see Section 1.1), typically in the form of a derived noun like *sidur* that can be interpreted in various, basically related, senses (‘arrangement’, ‘setting’, ‘prayer book’, ‘setting someone up’), or the derived noun *kabala* whose various senses (‘acceptance’, ‘mystical doctrine’, ‘(social) reception’, ‘(sales) receipt’) appear unrelated to one another

Hebrew derived nouns constitute an excellent category for performing the investigation at issue here for two main reasons. First, it was important both in principle as well as methodologically to maintain homogeneity in terms of lexical category. It is well established that processing of nouns differ from processing of verbs in early acquisition (e.g., Berman, 1993, 2000; Colombo & Burani, 2002; Gentner, 1982; Johnson & Anglin, 1995; Marinellie & Chan, 2006; Snedeker & Gleitman, 2004) as well as in the adult population (Frost et al, 2000; Frost et al, 2000; Kellenbach et al, 2002; Kellog et al, 2007; and see a detailed review in Masterson et al, 2008) -- even though the sources of the distinction between these two major open-class categories in the lexicon are under debate (see Langacker, 1991; Vinson & Viglicco, 2002 for a semantic account). Since this study was carefully designed with respect to variables, it was important to exclude verbs, which might, accordingly, have been a potentially interfering factor biasing its findings.

A second consideration for restricting the study to derived nouns was the internal heterogeneity of the category in both form and in meaning. From the point of view of morphological productivity, word formation rules provide native speakers of Hebrew with numerous options for coining new words, many of them in the form of non-occurrent but well-formed Hebrew derived nouns – for example, **kétev* and **kitavon* are formed by combining a root (*k-t-b*) with common noun patterns in which it does not happen to occur (*CéCeC*, *CiCaCon*) (Ornan, 1983). Semantically, derived nouns cover an extremely large group of open-class items representing a broad array of semantic relations including sub-ordination, super-ordination, and synonymy (Maasterson et al, 2008), covering various degrees of concreteness (Avivi Ben-Zvi, 2010; Comrie & Thompson, 1985; Lyons, 1977; Ravid, 2006b; Seroussi, 2002, 2004), and involving a good deal of both polysemy and

homonymy (Seroussi, 2004). This class of items thus formed an ideal point of departure for my study.

4. Later Language Development

This study lies in the field of what has come to be known as “later language development”, a period that begins in school age and ends in adulthood (Nippold, 1998), one that is characterized by significant linguistic and meta-linguistic changes (Avivi Ben-Zvi, 2010; Bar-On, 2010; Berman, 2004, 2005, 2007, 2008; Karmiloff-Smith, 1986; Nippold, 2000; Ravid, 2004; Ravid & Tolchinsky, 2002) and concomitant social and cognitive changes (e.g., Case, 1988; Paus, 2005; Piaget, 1972; Steinberg, 2005). This section briefly reviews domains of later language development that are relevant to the present study, proceeding from the more general issue of meta-linguistic development, followed by linguistic development, (morpho)lexical development, to the more specific topic of acquisition of Hebrew derived nouns.

Meta-linguistic awareness, defined as the ability of language users to monitor their language, to reflect upon it, and to employ explicit linguistic terms referring to it, relies heavily on both cognitive and linguistic skills (Bialystok, 1986; Gombert, 1992; Karmiloff-Smith, 1986, 1992). The acquisition of meta-linguistic awareness is not all-or-none but rather gradual and differential, dependent on the particular linguistic domain and interacting with acquisition of literacy (Berman, 2007; Menyuk & Chesnick, 1997; Pratt & Grieve, 1984; Ravid & Tolchinsky, 2002). For example, emergent signs of meta-linguistic awareness start to appear at kindergarten, especially in phonological awareness tasks (Goodman, Libenson & Wade-Woolley, 2010), but the ability to provide a well-structured definition, a hallmark of meta-linguistic awareness, consolidates only in adolescence and adulthood (Benelli et al, 2006). This study is conducted in writing, a modality that in itself places the tasks it involves at a high starting point with respect to meta-language. Further, the study includes tasks that display a variety of meta-linguistic demands, from “easiest” (for example, selecting one distractor out of four) to “hardest” (for example, providing a definition).

As for linguistic proficiency, later language development is typified by an increase of mastery and sophistication in almost every linguistic domain with concomitant more sophisticated discursive skills (Berman, 2005, 2008; Berman & Katzenberger, 2004; Berman & Nir-Sagiv, 2007, 2009; Ravid & Berman, 2009, 2010). These advances in different facets of linguistic knowledge and language use reflect three properties that are particularly relevant to the study at issue here. The first concerns the ability to employ proficiently divergent linguistic tools and other metalinguistic, cognitive, and social resources for the expression of different linguistic functions (Berman, 2004, 2007) -- suggesting that the responses of the adult population should be richer and more divergent than those of the younger groups of respondents in the study. The second, defined by Tolchinsky (2004) in terms of decontextualization, is the ability to produce decontextualized language, of the kind that does not need recourse to external scaffolding, as in the case of definitions, which represent highly decontextualized linguistic expression. Besides, degree of contextualization was varied in this study, from isolated words to sentences, with the goal of examining the effect of context on the mental lexicon and the developmental course of the decontextualization process. A third relevant property of later language development involves greater exposure to and familiarity with conventionalized and formal language use, hence a more literate, high-level or elevated linguistic register together with greater awareness of non-literal language and non-conventional meanings (Clark, 1993; Ravid & Berman, 2009). In relation to the present study, these developments led me to predict that with age, participants would reveal more comprehension and production of formal conventional language and a concomitant growing awareness of polysemy and homonymy and of the range of secondary meanings associated with polysemous and homonyms terms.

Later lexical development is known to reveal enormous vocabulary growth, both quantitatively and qualitatively (Dockrell & Messer, 2004). In quantity, the vocabulary in later language development increases exponentially from approximately 10,000 words in the 1st grade, via approximately 40,000 words in the 5th grade to several dozen thousands of words in adulthood (Anglin, 1993; Nagy & Herman, 1987; Zechmeister, D'Anna, Hall, Paus, & Smith, 1993). In quality, the literate lexicon includes a high ratio of derivationally complex words (Anglin, 1993; Bar-Ilan & Berman, 2007; Nir-Sagiv, Bar-

Ilan & Berman, 2008), abstract non-imageable words (Avivi Ben-Avi, 2010; Ravid, 2004, 2006b), highly specific words (Seroussi, 2002), polysemous and homonymous words (Seroussi, 2004), and unfamiliar/infrequent words (Nagy & Anderson, 1984), all of which constitute an integral part of the present study.

As for the morphological facet of lexical acquisition, control of derivational morphology of English is considered a late acquisition (e.g., Anglin, 1993; Carlisle, 1995; 2000; Deacon & Bryant, 2005; Feldman, Rueckl, DiLiberto, Pastizzo & Vellutino, 2002; Freyd & Baron, 1982; Larsen & Nippold, 2007; Leong, 2000; Lewis & Windsor, 1996; Mahony, Singson & Mann, 2000). Studies cited above generally revealed age-related increases in mastery of derivational morphology, affected by semantic and phonological factors, and highly correlated with literacy achievements and meta-linguistic competence. The role of derivational morphology in acquisition of English is considered at further length in the concluding discussion (Chapter IV, Section 2.4).

Several studies conducted in Hebrew have documented the developmental route of Hebrew derivational morphology, demonstrating that it belongs solidly in the domain of later language acquisition (Avivi Ben-Zvi, 2010; Berman, 2004; Levie et al, 2008; Ravid, 2004; Ravid & Avidor, 1998; Seroussi, 2002, 2004). Consistent findings emerged from different studies on action nominals in Hebrew: Ravid and Avidor, who examined oral production of action nominals from kindergarten to adulthood, Seroussi (2002), who administered the same test in writing to 6th graders, 8th graders, 11th graders, young and mature adults, and Avivi Ben-Zvi (2010), who conducted the same task orally to a wider range of age-groups from 1st graders to adults -- all found an age-related increase affected both by morphological regularity and by various semantic factors. (Further details comparing results on these tests to findings of the present study are detailed in the concluding discussion, Chapter IV, Section 2.4). Another consistent developmental trend across the board was a discrepancy between the relatively early acquisition of morphological knowledge, manifested by control of word-formation rules, and the later consolidation of lexical knowledge in the form of in-depth familiarity with a literate lexicon, in all its nuances and specificities – a discrepancy compatible with Aronoff's (1976) distinction between (morphologically) possible and (lexically) actual words.

5. Rationale and Overall Goals of Study

The overall goal of this study was to examine how factors of morphological structure and semantic content affect the organization of the mental lexicon of Hebrew in later language development, with respect to the psycholinguistic factors of familiarity/frequency and concreteness/imageability, on the one hand, and to various task demands, on the other. To this end, a three-phased research design was established, as detailed in the next chapter, which formulates the motivations for and delineates the procedures applied at each phase in turn..

The major trigger for conceptualization of this study was a prior study of the author (Seroussi, 2002), which yielded interesting results with respect to command of the “literate lexicon” (Ravid, 2004) in later, school-age language development, reflected by both quantitative and qualitative analyses. In the 2002 study, participants were asked to provide regular and irregular action nominals, to select the lexically correct out of two to four morphologically related distractors, to judge the correctness of a derived noun in a sentential context, to correct it if necessary, and to write sentences with pairs of derived nouns sharing the same roots (Seroussi, 2004). As predicted, comprehension preceded production, degree of difficulty of the tasks had an effect on the results and morphologically regular items preceded irregular items. Most importantly, this study yielded numerous not entirely expected insights with regard to the nature of the mental lexicon in later language development, in relation to variables such as familiarity/frequency and imageability/concreteness that had not been anticipated or predicted in advance as playing a role in respondents’ handling of the tasks. The need to validate these intuition-based findings by adopting these as *a priori* independent variables for independent, in-depth study was a direct consequence of the 2002 study, further supported by the vast research on familiarity/frequency and imageability/concreteness and their pervasive effect in the domain of psycholinguistics.

The rationale for the battery of tests was likewise inspired by my earlier (2002) study as well as by the evidence provided by Anglin (1993) for graded acquisition of lexical knowledge, dependent largely on the nature of the task itself and correlating with meta-linguistic awareness. The addition of on-line priming experiments derived from the desire to add examination of the initial, implicit stages of lexical access, so excluding the impact of meta-linguistic awareness, so as to test the effect of two different experimental settings, one more monitored and conscious and the second less monitored and unconscious, in relation to the same input items as stimuli. At

the other extreme, addition of a definitions test to the written battery aimed at investigating the highest level of explicit meta-linguistic knowledge. The sentence-construction task used in the 2002 study yielded such interesting insights, written up separately in Seroussi (2004), that it was decided to employ a similar version of this task in the present study, one that is more controlled and carefully designed with respect to the input items. Finally, an innovative idea was to examine associations, both in comprehension (selection of distractors) and in production (free associations), as reflecting various networks of the mental lexicon, including structural (morphological and phonological) relations. To date, most studies of free associations (as detailed further in the next chapter) fail to go any further than providing norms, while studies on selection of distractors in word-relatedness tests are generally confined to various types of semantic/associative relations without specifying which precisely is involved or why.

In concluding this background introduction, it is important to underline that the study documented below was undertaken with the overall goal aim of providing an unbiased window, as close to natural as possible, on the mental lexicon of Hebrew speaker-writers. To achieve these aims, people's personal judgments and evaluations were involved at each and every phase of the study, coming to a total of over one thousand native speakers of Hebrew who took part in this study, either as judges and consultants, or as respondents in extensive pilot studies as well as in the final questionnaires and structured elicitations (battery of written tests and priming experiments). Further, in the interests of impartiality, instructions to tests were worded in very general, neutral terms, and categories for coding responses were not hierarchically ranked *a priori*, but instead were evaluated by the results they yielded in relation to each of the variables constituting the design of the research.

CHAPTER II -- RESEARCH DESIGN

As explained in the introduction, the study aims to investigate the interrelation between morphological form and semantic content (its dependent variables) in relation to the factors of familiarity, frequency, and concreteness as its independent variables. The investigation was carried out in the following four distinct but interrelated phases, as detailed in the two parts of this chapter. **Part A** describes the two initial stages as follows: Phase I -- Construction of Data-Base included selection of a list of over 2,000 derived nouns that constituted the research materials; Phase II – Questionnaires included construction and administration of specially devised questionnaires testing this entire data-base for the three independent variables of (subjective) familiarity, (subjective) frequency, and concreteness; **Part B** describes Phase III – Structured Elicitations that included construction, administration, and coding of sets of written tests and on-line pilot priming experiments – based on items selected on the basis of findings from the Phase II questionnaires. Below motivations and procedures are detailed for each phase in turn.

Note that, for reasons motivated in detail in the preceding chapter (Chapter I, Section 3.1), in order to circumvent the problem of homography of words in isolation, in all the phases of the study, test items were rendered in fully **vocalized orthography** with normative diacritics. Instructions to participants were written in conventional “plene” Hebrew orthography using *matres lectionis* but no diacritic vowel-pointing, as accepted in regular Hebrew reading materials -- newspapers, encyclopedias, short stories, novels, etc. (Bentin, 1989; Frost, Kugler, Deutsch & Forster, 2005).

A. BACKGROUND TO TESTS: PHASES I AND II

This part of the chapter describes the dictionary searches and fieldwork conducted in order to establish the input materials for the tests administered in Phase III. These took the form of Phase I initial construction of an overall pool of around 4,000 Hebrew derived nouns, followed by selection of 2,400 of these nouns (Section 1 below) for use in the Phase II questionnaires that served to establish the independent variables of the study (Section 2 below).

1. Phase I – Data-Base Preparation

The goal of this phase was to construct a foundational data-base of research items for the subsequent phases of the study. In the present study, this refers specifically to nouns derived from a consonantal root shared by other items in the lexicon of Hebrew, in so-called “word families” (Bertram et al, 2000; De Jong et al, 2000; Moscoso del Prado Marti´n et al, 2005), as in the following group of words from the shared root *h-b-r*: *xovéret* ‘booklet’, *maxbéret* ‘notebook’, *xibur* ‘addition, composition’, *taxbura* ‘transportation’). To this end, the following procedures were undertaken: initial screening of possible items, comparisons of items in different dictionaries, and semantic transparency judgments (Sections 1.1 to 1.3 respectively).

1.1. Initial Screening

The first step was to decide on an initial source for establishing a list of derived nouns. This was done by consulting the 1993 edition of the monumental four-volume Even-Shoshan dictionary, to this day the most reputable dictionary of the Hebrew language and, importantly, one with a supplement that provides a listing of all Hebrew roots in alphabetical order of their initial radical. This made it possible to adopt the following criteria for selecting a set of research items out of all the nouns listed: root structure, root productivity, and root semantics.

- (1) *Root transparency*: Roots were divided between “full” triconsonantal roots and “defective” biconsonantal roots – alternating for the value of plus and minus transparent respectively.
- (2) *Root productivity*: Only productive roots were selected. In the present context, a root was defined as “productive” (Anshen & Aronoff, 1999; Baayen & Renouf, 1996) if (i) it occurs in current Hebrew usage with at least one verb, so that research items consisted of only deverbal and not de-adjectival nouns; and (ii) the same root is the basis for deriving at least four different nouns. This meant, for example, that the triconsonantal string *d-r-m* was not selected, since it has only two associated nouns: *darom* ‘south’ and *hadrama* ‘moving southwards’.
- (3) *Meaning variation*: Only roots that involved more than a single meaning were selected, where semantic variation was specified as involving polysemy and/or

homonymy. For example, the root *s-p-r* conveys the meanings of both ‘tell, recount’ (as in *sipur* ‘story’) and ‘cut(hair)’ as in (*tispóret* ‘haircut’); and the root *`-b-q* has the sense both of ‘dust, powder’ as in the nouns *avak* ‘dust’, *avka* ‘powder’, *ibuk* ‘dusting, pulverization’ and also of ‘endeavor’ as in the nouns *ma’avak* ‘struggle’, *he’avkut* ‘wrestling’.⁵ A rather different type of meaning variation is represented by a word like *mavxena* ‘test-tube’ from the root *b-ḥ-n* ‘test, examine’, which shares the same root as the semantically closely similar nouns *mivxan* ‘test’, *bexina* ‘examination’. Polysemy is also represented by a noun like *tikróvet* ‘refreshments’ (a literary term of low frequency in current usage) from the root *q-r-b*, which has the basic sense of ‘be-near’ as in the nouns *kirva* ‘closeness’, *hitkarvut* ‘approaching’. The criterion of meaning variation meant, for example, that the root *b-r-g* was excluded from the study: Although several different nouns are derived from it (e.g., *bóreg* ‘(a) screw’, *mavreg* ‘screwdriver’, *mavrega* ‘electric screwdriver’, *havraga* ‘screwing in’, *tavrig* ‘threadscrew’, *tavrog* ‘screw-stock’), all are closely and clearly semantically related, with the same basic sense of ‘screw’. And the root *`-s-p* was excluded for the same reason, since the many nouns derived from it all share the same basic sense of ‘collect, gather’ as in *isuf* ‘gathering’, *asefa* ‘meeting’, *ósef* ‘collection’. The criterion of variety of meaning was necessary to establish a pool of test items that display two distinct types of relationship: nouns with both a morphological and a semantic relation, on the one hand, and nouns that are morphologically related but semantically distinct, on the other.

1.2. Selection of Research Items

The list of nouns in the supplement to the Even-Shoshan (1993) dictionary -- numbering around five thousand in all -- proved too unconstrained for purposes of the present study, since it was composed out of the entire word-stock of Hebrew, from different periods in the history of the language, regardless of whether they are part of contemporary Hebrew usage. Besides, various items in the list are possible but not actual words in Hebrew (Aronoff, 1976). For example, the list includes numerous verb-based action nominals that

⁵ As noted in the introductory notational conventions, **consonantal roots** are represented as they occur in Hebrew orthography, irrespective of current pronunciation or possible historical levelings. On the other hand, **words** (here, mainly derived nouns) are represented in broad phonemic transcription that mirrors “General Israeli Hebrew” pronunciation (Blanc, 1964; Ravid 1995) except where given in Hebrew script.

are theoretically well-formed but non-occurrent in Hebrew usage, such as the action nominal **hibargut* from the verb **nivrag* 'be-screwed' in the passive *nif'al* verb pattern (Berman, 1976; Ravid & Avidor, 1998).

These observations highlight the problem of the discrepancies between conventional dictionaries and the mental lexicon (Aitchison, 2003; Anshen & Aronoff, 1999), as described in the previous chapter, and led to the decision to rely on more than a single dictionary in establishing the data-base for the present study. To this end, the nouns listed in the Even-Shoshan supplement were checked against three other sources: the computerized floppy-disk version of the dictionary *Rav-Milim* 'Multi-Words' (Choueka & Freidkin, 1997), which is explicitly oriented to contemporary as well as traditional Hebrew usage; the popular, relatively non-academic one-volume Concise Sapphire Dictionary edited by Avenyon (1997); and the website of the Academy of the Hebrew Language, an official body of the Hebrew language establishment (Ravid, 1995) that prescribes norms for language usage and, importantly for present purposes, specifies all the coinages recommended by the Academy for innovating new vocabulary items. This search reduced the original list based on Even-Shoshan to a set of **4,000 derived nouns**, which (a) excluded any items judged to be non-existent (e.g. *hibargut* as noted earlier) and (b) included only nouns that appeared in at least one other dictionary in addition to Even-Shoshan.

1.3. Inter-Personal Judgments of Semantic Transparency

The procedures described in the preceding section yielded a data-base of some 4000 derived nouns grouped in small root-based "families", each consisting of at least four derived nouns with a potential meaning variation between them as noted above. The next step involved decisions regarding the degree of semantic transparency or proximity between the nouns constituting the members of each family. To this end, the author worked in consultation with two other native speakers of Hebrew with formal background in language studies, since (a) evaluation of semantic proximity depends on subjective individual intuitions, so suggesting a need for inter-judge agreement and (b) the impact of morphology in the Hebrew lexicon may bias native speakers to assume that words that share the same consonantal root are semantically related, even when in fact no

such connection exists. For example, native speakers of Hebrew tend to believe that the nouns *migraš* ‘plot, field’ and *geruš* ‘deportation’, from the root *g-r-š* or the words *géver* ‘man’ and *gibor* ‘hero’, from the root *g-b-r*, are semantically related (Bar-On, 2001). Extra precautions were thus required to neutralize a possible “morpho-semantic bias”.

Decisions as to the relative proximity or distance in semantic relatedness of nouns with a shared root were made as follows. The three researchers (the author and her collaborators) working in conjunction went over the list of roots and the nouns derived from them. We discarded any root all of whose associated nouns appeared to us to be clearly semantically related and retained those roots regarding which all three agreed as having only a morphological but no semantic relation. Any items where there was no unanimity of judgment were likewise discarded. For example, the root *p-g-š* was discarded because one of the three judges considered the noun *pagosh* ‘(car) bumper’ to be semantically related to *pegisha* ‘meeting, encounter’. This was a long and tedious process, since – as demonstrated by Bar-On (2001) -- well-educated, highly literate Hebrew speakers tend to find quite out-of-the-way connections between the senses of words that are in fact related only in surface morphology. After much careful consideration and further inter-judge discussions of problematic cases, a final list of some **2,400 nouns** was constructed, constituting the **data-base** for the entire study. Of these, approximately two-thirds were morphologically transparent in the sense that they had full or non-defective roots (1,700 nouns based on 180 roots) and the rest were morphologically more opaque (700 nouns from 80 defective roots), by criteria described in Section 1.1 above.

2. Phase II - Questionnaires

The original research plan was to obtain rankings for the two independent variables of subjective familiarity and imageability for all 2400 derived nouns in the data-base, on the assumption that the combination of these two independent measures would be the best basis for deriving a complete and accurate picture of how Hebrew words (as represented by the test nouns) are represented in the mental lexicon. For this purpose, original questionnaires were designed and administered to several hundred native speakers of

Hebrew, aged between 20 and 60 years, with at least high school and usually some further level of formal education. As administration of these questionnaires proceeded, unexpected problems arose of a kind not acknowledged, as far as I know, in the research literature on Hebrew (Drori & Henik, 2005) let alone of other languages. These unanticipated difficulties led us to revise the initial research program in several ways, as detailed and motivated below for the variables of subjective familiarity (Section 2.1), subjective frequency (2.2), the two combined (2.3), and concreteness (2.4).

2.1. Subjective Familiarity

The first independent variable tested was ranking of items for what is termed “subjective familiarity”, by asking participants to indicate how familiar or well-known they consider a certain word to be, the commonest method cited in the literature for estimating frequency of use (see Chapter I, Section 2.1). The present study started out by applying the same procedures as those adopted by prior research in this domain, as follows. The entire data-base of 2,400 Hebrew derived nouns was randomly ordered by computerized means and then sub-divided into nine parallel questionnaires, each containing some 260 nouns listed in random order ($9 \times 260 = 2,340$). Each questionnaire was administered in writing to 30 native Hebrew-speaking adults, yielding a total of 270 participants (30 times each of 9 parallel questionnaires) with the aim of providing rankings for the variable of subjective familiarity. Participants were required to rank each of these nouns on a five-point scale from “not at all familiar” to “more or less familiar” and up to “very familiar indeed”, based on the following written instructions (in free translation from Hebrew): “The aim of the following questionnaire is to rank familiarity of Hebrew words to native Hebrew speakers. All the words you are going to see are nouns. If there is more than one interpretation to a word, a partial context is given in parenthesis. You are asked to please rank the degree of your personal familiarity with each word. This questionnaire deliberately contains many words that are unfamiliar. Do not hesitate to mark them as such.”

The most striking result yielded by the subjective familiarity questionnaire was that the vast bulk (over 80%!) of all nouns were given a rank of 4 or 5 on the 5-point scale (implications of this finding are discussed in Chapter IV, Section 3.2). That is,

respondents rated the vast majority of the nouns presented to them as being highly familiar, even though the questionnaire deliberately included numerous items that seemed intuitively quite archaic and arcane or else represented highly esoteric stipulated coinages -- nouns that were rated as unknown to a group of around 10 native-speaking undergraduate students of linguistics, who were asked in an informal setting to say what these words meant. One possible explanation for this finding is a perhaps Hebrew-specific phenomenon of **pseudo-familiarity**, leading to a kind of “over-familiarization” owing to the powerful impact exerted on speakers of the language by consonantal roots that they know, or think they know. This finding points to the weight of morphology rather than phonology in processing the Hebrew lexicon, an issue discussed at length in the concluding chapter (Chapter IV, Section 1.1). And it makes good sense typologically, since for a word to be morphologically “well-formed” in Hebrew, it typically consists of an occurrent consonantal root combined with an established *miškal* morphological pattern. For example, the noun *tikróvet* ‘refreshments’, noted earlier as a literary term of low frequency in current usage, shares the same affixal pattern tiCCóCet as familiar nouns like *tispóret* ‘haircut’, *tisbóxet* ‘complication’; and the high-register, semantically specialized noun *laktanut* ‘eclecticism’ shares the pattern CaCCanut with more everyday words like *paršanut* ‘commentary’, *aclanut* ‘laziness’. Once a Hebrew speaker sees a word made up out of these two elements -- as were all the words in the data-base for the present study -- he or she will regard it as a “possible” word in the language (Aronoff, 1976; Halle, 1973) and hence as “legitimate”, however arcane or esoteric it may be in fact. Sociolinguistic and historical factors conspire with this structural bias to make Hebrew speakers treat words that they may not know at all as “familiar”, since the language is in a highly dynamic state of flux and new words are constantly entering it, while “old” words still form an integral part of the mental lexicon (e.g., Nir, 1982, 1993; Ravid, 2005; Yannai, 1974 – and see, too, Chapter I, Section 3.1)

Since the familiarity questionnaire proved an insufficiently sensitive instrument for determining the actual frequency of Hebrew nouns, an additional questionnaire was constructed, aimed directly at the factor of “subjective frequency”, as defined below.

2.2. Subjective Frequency

A further set of questionnaires was constructed, following the procedure used by Balota, Piloti and Cortese (2001) for English. Respondents were asked to rate the extent to which they themselves had encountered the word, on a five-point scale from very often indeed via sometimes, down to never at all. The same nine randomized questionnaires, each containing approximately 260 derived nouns, were administered in writing to **another**, but similar group of 270 native Hebrew-speaking adults (30 respondents to each of 9 questionnaires). In order to evaluate subjective frequency, they were instructed as follows: “The aim of the following questionnaire is to rank the degree of frequency of Hebrew words. Frequent words appear more often while infrequent words appear less often. You are asked to please evaluate the frequency with which you yourself have personally encountered each word on the list. This questionnaire deliberately contains many infrequent words. If you see words that you have never encountered, do not hesitate to mark them in the column headed ‘never’”.

Unlike the familiarity questionnaire, the frequency questionnaire turned out to be highly diagnostic. It took respondents much longer to fill out this latter questionnaire (averaging some 15 to 20 minutes for 250 items as compared with 10 minutes or less for the same number of items on the familiarity questionnaire), suggesting that their responses were less more thoughtful and less mechanical. More importantly, responses to the frequency questionnaire yielded a far wider distribution across the five-point scale, with a mean of 3.34 (SD=1.92) as against 4.47 (SD=0.78) in the familiarity scale.

2.3. The F-Score

Recall that the scores on the familiarity questionnaires clustered around the top end of the 5-point scale. In contrast, responses on frequency were not nearly so high, tending to cluster more in the middle of the scale. In spite of this difference in absolute ratings, there was a relatively very high correlation (.834) between responses to the same nouns on the two variables of familiarity and frequency respectively which, recall, were provided by different groups of respondents. Responses on both questionnaires showed a strong effect of the same three major **intervening variables**: (i) morphological *binyan* conjugation pattern of the base-verb -- in the case of verb-related Action Nominals; (ii) type of

derivation – root-based or linear; and (iii) historical origin – whether Modern, following the revival of Hebrew as a medium of spoken communication in the late 19th century, or coming from earlier stages of the language. The role of these factors is discussed later in the study (Chapter IV, Section 3.2).

Taken together, the questionnaires of subjective familiarity and frequency yielded the following picture. On the one hand, these two variables share common properties with respect to such factors as verb morphology, type of noun-structure, and historical origin. On the other hand, each elicited strikingly different responses from native speakers, with nearly all items clustering high on the scale of familiarity but diverging far more on frequency. We concluded that these variables reflect two complementary facets of the same complex phenomenon, with each playing a distinct, but related role in the mental lexicon of Hebrew (nouns). Procedurally, this meant that both factors needed to be taken into account in planning the subsequent phases of the study. The solution we arrived at, in consultation with statistical and other experts on research methodology, was to calculate a novel variable, labeled an “**F-Score**”, as a weighted mean of the scores for subjective familiarity and subjective frequency taken together. This F-Score, constituting an integrated measure of the factors of lexical familiarity/frequency, served as the basis for selection of stimuli for the subsequent phases of the study – the test batteries and priming experiments.⁶

2.4. Evaluation of Concreteness

The initial plan was to obtain imageability rankings for each noun in the data-base by means of imageability questionnaires, along the same lines as the familiarity and frequency questionnaires (nine of each, each administered to 30 different subjects). This proved unfeasible for various unexpected reasons. After several lengthy, time-consuming, and very tedious trials, we ended up eventually with a small-scale corpus of around **400 nouns** (that is, some 15% of the total data-base), divided equally between clearly concrete and clearly abstract items. This section details the sequence of steps by means of

⁶ A full data-sheet of all the variables is available on request from the author batia.seroussi@gmail.com.

which this subset of items was established, in order to measure the variable of concreteness / imageability.

To start, **imageability** questionnaires were initially constructed along the same lines as the familiarity and frequency questionnaires. Participants were asked to rank each of 260 nouns presented to them in writing on a 5-point scale from 1 (very imageable) to 5 (not at all imageable). The instructions were worded as follows, bearing in mind that there is no established word in the conventional Hebrew lexicon for “imageable” let alone for “imageability”, and a group of native speakers majoring in linguistics were unable to agree on a term that would be sufficiently transparent to convey the sense of this notion. “The aim of the following questionnaire is to rank the mental imagery of Hebrew words. Concrete nouns are considered to have high imageability while abstract nouns are considered low in imageability. Please rank the degree of imageability – that is the ease of evoking a mental image -- for each word. This questionnaire deliberately contains many infrequent words. If the word is not frequent enough to determine the degree of imageability, please, mark it in the column headed “cannot decide”.

The imageability questionnaires were administered by parallel procedures to those for familiarity and frequency; again, 9 questionnaires of approximately 260 items were distributed to yet other groups of native Hebrew-speaking adults. However, a remarkable procedural (presumably psycholinguistically significant) difference emerged between responses to the familiarity and imageability questionnaires right from the start and across the board. Respondents filled out the familiarity questionnaire without any evident difficulty, in a matter of minutes, with high inter-subject agreement. In contrast, it took respondents a long time to fill out the imageability questionnaire, they complained that it was too hard, too long, and very tedious, and their responses were more variable, possibly due to individual differences in visualization skills. Besides, respondents often accompanied the questionnaire with comments on the difficulty of specifying imageability, especially in relation to unfamiliar/infrequent words (that is, ones that had rated a low F-score). These differences can be interpreted as due to different levels of activation of word meanings: In the familiarity questionnaire, respondents could relate to the stimulus nouns as familiar on the basis of their repertoire of more or less well-known vocabulary items, with additional cues provided by their familiarity with the

morphological constructs of well-established consonantal roots and conventional affixal patterns in the stimulus items -- so that they did not have to concern themselves with a full range of possible semantic interpretations for each word. This option was not possible in the case of the imageability questionnaire, where respondents had to take into account the meaning of each word out of a possible range of meanings in order to perform the task. After administering the full imageability questionnaires to several dozen respondents, only a small part of whom answered them in full, it was decided that the task in its present format was not feasible on practical grounds. We attempted to solve this problem by dividing each of the original questionnaires into half the number of items, so reducing the time it would take to fill them out, but this did not help, since it was still hard for people to complete the task. Again, several dozen (different) respondents participated in this procedure until it, too, was abandoned. We concluded that, in principle, both the full and the shorter questionnaires failed to provide a valid measure of the variable of imageability for Hebrew nouns.

In an attempt to solve the problem of measuring the imageability of Hebrew nouns, relevant background research led us to adopt the variable of **concreteness**, as very closely related to and yet less controversial than imageability (see Chapter I, Section 2.2). Not only do the terms “concrete(ness)” and “abstract(ness)” have clear, well-established counterparts in Hebrew, the idea of concreteness is more widely accepted in everyday usage and is less dependent on the visual sense than imageability. This time, (yet another group of) respondents were asked to rank the same set of 260 derived nouns in each questionnaire on a 5-point scale from 1 (very concrete) to 5 (not at all concrete, very abstract). Instructions were as follows: “The aim of the following questionnaire is to rank the degree of concreteness of Hebrew words. Concrete nouns can be experienced by the senses (sight, hearing, taste, smell, touch) while abstract words cannot be experienced by the senses. You are requested to rank the degree of concreteness of each word. This questionnaire deliberately contains many infrequent words. If the word is not common enough to determine its degree of concreteness, please mark it in the column headed “not measurable”. Regrettably, replacement of imageability by concreteness was not successful, either. Again, several dozen respondents were given the concreteness questionnaire, but here, too, there were complaints about the difficulty of determining the

degree of concreteness, mainly in relation to two classes of input items: for unfamiliar/infrequent words – as independently established by their F-score; and for words with a not unequivocal degree of concreteness, lying somewhere between the two poles of concreteness / abstractness – in cases like collective nouns, nouns denoting places, etc. (See, in this respect, the 10-point scale of concreteness/specificity to abstractness/generality devised and tested by Ravid, 2006, for Hebrew -- subsequently adapted to large-scale English-language corpora in Berman & Nir-Sagiv, 2009; Nir-Sagiv, Bar-Ilan, & Berman, 2008).

At this point, after several months of attempts to obtain scores for imageability/concreteness, on the basis of questionnaires to hundreds of frustrated participants, it was decided to seek a different format for measuring this variable. As noted, a major difficulty manifested by participants in the preceding stages of this investigation had been to provide a ranking for items whose degree of concreteness / abstractness was not unanimous or clear-cut, but lay somewhere between the two poles of this variable. On the other hand, relatively greater agreement had been attained in cases at the two extremes of the continuum, that is, very abstract or very concrete respectively. In consultation with the research group in Ruth Berman's lab (Hebrew-speaking graduate students majoring in linguistics), it was decided to make do with a smaller sample of items, including only nouns at the two ends of the scale, either clearly concrete or clearly abstract. This goal was achieved in several steps, as follows. First, the full data-base was divided into two, each of 1,200 derived nouns, and presented to 20 volunteers, mainly graduate students majoring in linguistics, or members of their families and friends. These twenty respondents were asked to scan one of the two lists of 1,200 derived nouns, marking what they regarded as the most concrete and the most abstract of the lot. Nouns that rated a high level of agreement, marked by 70% or more of the 20 volunteers as clearly either plus or minus concrete, were included in the final sample. The task of going through these long lists of over one thousand words proved very demanding in terms of visual attention, and there were numerous cases in which nouns that appeared intuitively either very concrete or very abstract were not marked by a sufficient proportion of the participants, apparently because they had simply slipped their attention. All such nouns were presented to another group of 10 Hebrew speakers majoring in linguistics, who were

asked to mark whether they agreed with the judgments given them previously as very concrete / very abstract. Again, nouns that reached 70% or more agreement on this round of responses were added to the final sample of items specified for concreteness / abstractness. Taken together, the two rounds of judgments yielded a data-base of **370 nouns**, half judged highly concrete, half highly abstract, by at least 70% of the 30 respondents. Interestingly, the mean F-score of the nouns in this sub-sample of items was significantly higher than the mean F-score of all 2,400 nouns in the full data-base, meaning that mainly nouns ranking high on familiarity/frequency were included in the concreteness variable.

A common debate in the literature on concreteness and familiarity/frequency in the lexicon concerns the question of whether these two variables are inter-dependent or not (e.g., Baayen et al, 2006; Balota et al, 2004; McDonald & Shillcock, 2001). The findings of the present study, as detailed here, demonstrate an unequivocal inter-dependency between the two. Across the board, respondents had a hard time deciding on the relatively concreteness or abstractness of infrequent/unfamiliar nouns. These were evidently words for which they had no clear semantic representation, and the reason why mainly nouns with high F-scores were included in the sample of items judged independently as plus or minus abstract.

The subset of 370 nouns, as noted, was now available for use in tests of nouns with a high F-score. However, one of the tests planned for a subsequent phase of the study involved nouns with a low F-score that were judged as either plus or minus concrete, that is, that had a high or a low score on concreteness. The following procedure was adopted in order to obtain concreteness judgments for unfamiliar/infrequent derived nouns: Several dozen derived nouns with low F-scores were assessed by the investigator as having either high or low scores for concreteness. The dictionary meanings of these nouns were then conveyed to a team of five research assistants in the Berman lab, who were asked to confirm or refute the investigator's judgments of concreteness for these items. Where all five participants agreed unanimously on whether the (to them formerly unfamiliar word) was concrete or abstract, the word was included as a research item. This yielded a set of **20 nouns** with low F-scores that had been judged unambiguously for

concreteness, half as concrete and half as abstract. By means of these procedures, values for plus or minus concrete were available for a total of nearly 400 nouns.

B. TESTS: PHASE III

Once Phase II was completed, the entire data-base of 2,400 items with F-scores and a subset of nearly 400 nouns with values for concreteness were ready for use in the two final phases of fieldwork conducted for this study. Below are detailed the test-battery of seven written tasks (Section 1) and the on-line pilot priming experiments (Section 2).

1. Written Test Battery

Construction and administration of the battery of seven written tasks starts with a review of the independent variables tested in the battery and predictions related to each of them (Sections 1.1 and 1.2), followed by the rationale (1.3) and procedures (1.4) of the test battery, breakdown of each of the 7 tasks (1.5), summary tables (1.6), and test-administration procedures (1.7), concluding with details of coding categories and methods of analysis (1.8).

All tests administered in this phase were “untutored” in the following sense: Participants were not given sample responses or any other kind of illustrative examples, nor were they explicitly instructed on preferred methods of carrying out the tasks presented to them. Moreover, the written (off-line) component was conducted under conditions that were as open-ended as possible, in order to meet the overall goal of gaining insights into the mental lexicon of Hebrew speaker-writers by ensuring that responses would reflect participants’ genuine, unbiased grasp of the tasks at hand. For similar reasons, no *a priori* evaluative scales were applied in analyzing responses, and only general predictions were formulated. Further grounds for these decisions are that two of the independent variables (the F-score and concreteness) as well as the bulk of the tasks administered (except for definitions) are almost totally novel, certainly in psycholinguistic research and certainly in Hebrew, so that their outcomes were not readily predictable.

1.1. Word-Internal Independent Variables and Predictions

The first step was to specify the values of each test item in the entire battery for type of root (full / defective) and F-score value (high / low), and a subset of items for concreteness (concrete / abstract) – as three item-based variables -- with participants' age as a fourth independent variable (Section 1.2). All four variables except for concreteness were manipulated across the entire test battery, as detailed further below (Section 1.5). This section specifies the breakdown into the three item-based independent variables (type of root, F-scores, and concreteness) along with general predictions relating to each one separately.

Type of Root: The nature of the consonantal roots on which the research items were based constitutes a structurally motivated variable, dividing the data-base into two classes of items: “full” or “defective” respectively. Roots defined as “full” consist of three consonants, all of which appear overtly in all nouns constructed out of them, while “defective” roots may be only bi-consonantal in some if not all of the nouns based on them. This division meant that about two-thirds of the original data-base of 2,400 derived nouns were comprised of full roots, while the remaining third were based on defective roots. This ratio of two-thirds to one-third full to defective roots was kept for the structured tests as well, in order to enable the team that designed the tests to carefully select the appropriate items for the tests with control over all the independent variables. Stipulation of a half-half ratio between full and defective roots, for example, would have inhibited the overall research design, since because this would not have yielded a sufficient number of appropriate nouns derived from defective roots that meet the aims of the tests in terms of F-score and concreteness.

Predictions were that (1) full, triconsonantal roots would be easier to identify and to manipulate than defective biconsonantal roots on all subtests, since the latter are less transparent and less identifiable than full roots; and (2) root transparency/opacity would interact with age, with younger participants finding it harder to cope with defective roots.

Familiarity/Frequency (F-score): The F-scores derived by calculating the standardized mean of frequency and familiarity served as a basis for selection of test items. Items that scored more than one standard deviation below the mean group score were defined as having a low F-Score (N = 507 derived nouns), while items scoring more than one

standard deviation above the mean were defined as high F-Scores (N= 464). This set of nearly one thousand (971) derived nouns served as the data-base for item-selection with respect to the variable of familiarity/frequency.

Predictions were that (1) words with a low F-Score would elicit more morphologically-based responses in terms of consonantal root or skeleton than words with a high F-score (Hay & Baayen, 2001); (2) as a corollary, words with high F-scores, for which participants have an established semantic representation, would elicit more responses based on factors of content or meaning, compared to words with low F-scores; and (3) developmentally, the factor of familiarity/frequency would have a stronger effect among younger participants, reflecting the fact that they have a less extensive lexicon than older students and adults.

Concreteness: The subset of 374 items for this variable (see Part A, Section 2.4 above) divided up as follows: The bulk were concrete nouns (214) -- 153 with full roots and 61 with defective roots – while the rest were nouns judged to be abstract (160) -- 96 with full roots and 64 with defective roots. Recall that the mean F-score of the 374 nouns in the Concrete / Abstract subset of items was significantly higher than for the data-base as a whole, with the result that several nouns relatively low-frequency nouns in this subset in fact had F-scores that were above the cut-off point for the variable of familiarity /frequency. Recall, too, that this subset of 374 items was supplemented by an additional 20 nouns rated as unfamiliar/infrequent by a separate selection procedure (Section 2.4 above).

Predictions were that (1) the variable of concreteness would have a differential effect on different tasks on the test-battery; for example, in the sentence-construction task, concrete nouns were predicted to appear more in post-verbal and abstract nouns more in pre-verbal (subject) position (Seroussi, 2004; Ravid & Berman, 2010; Ravid & Cahana-Amitay, 2005); and (2) an interaction with age would emerge such that concreteness would have a greater effect among younger participations and would in general correlate highly with the factor of age (Bates et al, 2001; Colombo & Burani, 2002; Johnson & Anglin, 1995; Marinellie & Chan, 2006; Masterson et al, 2008; Nippold, Hegel, Sohlberg & Schwartz, 1999; Nippold & Haq, 1996).

1.2. Population – Rationale and Predictions

An important goal of the study was to shed light on the mental lexicon in relation to (later) language development. Research on later language development in Hebrew and other languages has shown the period from grade-school middle childhood across high school adolescence and into adulthood to reveal significant age- and literacy-related changes in linguistic knowledge in general and in mastery of the lexicon in particular (Berman, 2004, 2007, 2008; Nir & Berman, in press; Nir-Sagiv, Bar-Ilan, & Berman, 2008; Ravid, 2004, 2006; Ravid & Berman, 2009; Ravid & Levie, 2010; Ravid & Zilberbuch, 2003). The Hebrew-specific design and findings of Segal (2008) on use of lexical and other devices for narrative evaluation provide further support for the three age-schooling levels that were selected for the present study: grade-school -- 6th grade pre-adolescents aged 11 to 12 years; high school – 10th grade adolescents aged 15 to 16; and university student adults aged 21 to 30 (as detailed in Table 4). It was thus assumed that these age groups would yield reliable, in-depth insights into development of the mental lexicon across the school years en route to mature linguistic proficiency. Criteria for selection of participants were that they include only monolingual or first-language speakers of Hebrew, from middle to high socio-economic backgrounds, with the two younger age-groups taken from well-established urban schools in central Israel. Children reported by school authorities as having language impairments or as being treated for learning disabilities were excluded from the sample.

Predictions were that (1) there would be age-related changes across the board, on all tasks; (2) age would interact with the other independent variables of root, familiarity/frequency, and concreteness; and (3) high school adolescents would reflect an intermediate stage between younger children and adult participants with respect to the developing mental lexicon.

1.3. Rationale for Written Test Battery

The design of this study was inspired largely by insights deriving from research conducted in the framework of my masters' thesis (Seroussi, 2002, 2004) and heavily supported by Anglin's (1993) large-scale developmental study and Durso and Shore's (1991) study of levels of lexical knowledge in adults. The point of departure was that

word knowledge is not binary but rather gradient, describable as a continuum (Dockrell & Messer, 2004), in which “full knowledge” is found at one end, no knowledge at the other, with partial knowledge lying between the two. In the studies of Anglin and of Durso and Shore, words with various degrees of frequency were selected from established English-language dictionaries, and lexical abilities were defined along the following quite similar hierarchical scale: **Definitions** were taken to represent the highest level of lexical and meta-linguistic knowledge, since full and explicit knowledge of a word is required in order to define it properly; the ability to **generate sentences** with a given word was ranked slightly below the ability to define; and the ability to identify a word out of a set of **multiple-choice distractors** was ranked at a still lower point since it requires identification but not any independently generated lexical operation. Anglin used this hierarchy in his three-staged examination of vocabulary growth among school-children from 1st to 5th grade: Participants were asked first to define words, then to construct sentences with words they could not define and, third, in cases where they could not construct a sentence, to identify the correct interpretation of the word out of a closed set of distractors. In their investigation of English-speaking adults, Durso and Shore adopted both the tasks of definition and sentence-construction as representing fully established lexical knowledge; in addition, they probed partial knowledge (which they termed “frontier knowledge”) by means of sentence-embedded distractors rather than by isolated words; and they also had participants provide **associations** to the partially known words.

The present study, too, includes various tasks such as providing definitions, constructing sentences, giving word associations, selecting the correct response out of several distractors, and interpreting unknown or partially known words presented in sentential contexts. The major difference between this study and those of Anglin and of Durso and Shore is that it was deliberately not executed in consecutive stages: Given that its goal was not to tap individual lexical knowledge, but rather to gain insights into the collective mental lexicon of Hebrew, the study reported here relied on a more “horizontal” mapping of degrees of lexical knowledge. To this end, all words used in the present study, from the shared category of derived nouns, were selected *a priori* as representing different variables: Form (morphological structure), usage

(familiarity/frequency), and semantic content (concreteness) – each in interaction with development (three levels of age-schooling).

To this end, a battery of seven tasks, aimed at tapping both morphological and semantic facets of the lexicon, was devised in consultation with a team of graduate students majoring in linguistics associated with Ruth Berman's laboratory (The full set of tasks and task-items are provided in their original Hebrew form in Appendices 1, 2 and 3). The tasks were designed to probe varying levels and types of lexical knowledge by means of a carefully controlled range of tasks varying in (i) type of processing demands they involved, (ii) the linguistic knowledge required, and (iii) presumed level of difficulty.

With regard to processing demands, the battery included both tasks that required multiple-choice as well as single-word responses, construction of sentences, and definitions. With respect to types of linguistic knowledge, several of the tasks involved both lexico-semantic and structural (syntactic and/or morphological); for example, **interpretation of (unfamiliar) words in context** requires attention to both the syntactic structure, hence knowledge of the lexical category of the input item, and also the pragmatic implications of the sentential context. An important consideration in designing the test battery in relation to both type of processing and level of difficulty was the comprehension / production distinction, taking into account the well-established observation that comprehension precedes and outstrips production in early acquisition as in subsequent linguistic knowledge of the lexicon and other domains (e.g., Ben-David, 2002; Clark & Berman, 1987; Seroussi, 2002).

Table 1 summarizes the test battery in terms of task demands made on respondents and the independent variables involved in each of the seven tasks.

Topic	Type of Task	Independent Variables
Relatedness between Words	(1) Multiple Choice	Root
	(2) Ranking	Familiarity/Frequency Age
Interpretation in Context	(3) Interpretation in Context	Root Concreteness Age
Free Association	(4) Single	Root Familiarity/Frequency
	(5) Multiple	Concreteness Age
Sentential Use and Definition	(6) Sentence Construction	Root Familiarity/Frequency Concreteness Age
	(7) Definitions	Root Concreteness Age

Table 1: Breakdown of Tasks in the Test-Battery by Topic, Type of Task, and Independent Variables

As shown in Table 1, the seven tasks fall into four clusters by topic -- relatedness between words, interpretation in context, free associations, sentential use and definition. The considerations motivating each type of task are delineated below.

Relatedness between Words: The tasks dealing with relatedness between words were devised specifically for the present study, for both typological and methodological reasons. Typologically, Hebrew words are traditionally treated as falling into “word families”, and presented as such from early on in children’s language studies, grouped around the language-specific morphological factor of having a shared consonantal root. Accordingly, on these two tasks, respondents were presented with nouns representing different types of linguistic relations to the input items, in order to evaluate the relative

salience of structure compared with meaning in this connection. A similar task was employed in the studies of Anglin and of Durso and Shore specifically in cases where participants were not able to construct a sentence or provide a definition and all the distractors were semantically related. Unlike these studies, the relatedness task used here deliberately includes known words and structurally related distractors, precisely in order to shed light on the variable of familiarity/frequency in performing this task. A further reason for including tasks on this topic was as a means for comparing results on these conscious off-line tasks with those of on-line priming tasks using the same stimuli.

Interpretation in Context: The importance of a supportive context for extracting word meaning is widely acknowledged in reading comprehension studies in general and in the case of unknown words in particular (Bolger, Balass, Landen & Perfetti, 2008; Chaffin, Morris & Seely, 2001; Fukkink, Blok & De Glopper, 2001; Lockett & Shore, 2003; Prior, 2004; Prior & Bentin, 2008; Shore & Kempe, 1999). The relative contribution of context as compared with word-internal features for successfully deriving word meaning remains unresolved, however. In the present study, this task was designed specifically to address this issue, by carefully controlling for both sentential and word-internal properties. To meet this goal, the sentences in this task all (i) used unfamiliar/infrequent words (with low F-scores); (ii) were constructed so as to provide clear syntactic cues to the lexical category of nouns; (iii) gave only general pragmatic, scriptal orientation to possible meanings; so (iv) providing very general semantic cues, without specifying further suggestive details (Kittay, 1992; Nerlich & Clarke, 2000; Shore & Kempe, 1999).

The variable of concreteness was also taken into account in constructing this task, since concrete and abstract words are known to differ in their semantic representation (see Chapter I, section 2.2), with an effect on how they are interpreted in context as well (Fukkink et al., 2001; Goetz et al, 2007; McDonald & Shillcock, 2001). Finally, in typological perspective, the variable of root type was also controlled for, as in all other tasks in the battery, so as to examine whether and how this factor figures when Hebrew speakers encounter unfamiliar/infrequent words in context.

Free Association: Two words are said to be associated if the presentation of one brings the second to the awareness of the perceiver (Deese, 1965; Tulving, 1972). This type of association is most readily tested by free association tasks (De Groot, 1990), which

require participants to produce the first word that comes to mind on presentation of the cue word (Nelson & McEvoy, 2000b; Nelson, McEvoy & Denis, 2000) (A clear and detailed review of the history of associations and of recent studies incorporating association tasks in psycholinguistic research is given by Prior, 2004). Association norms typically serve as a valuable tool in psycholinguistic research (De Deyne & Storms, 2008a, 2008b; Deese, 1965; De Groot, 1989; Henik, Rubinstein, & Anaki, 2005; Prior, 2004; Nelson, McEvoy & Schreiber, 2004; Spence & Owens, 1990) as well as in psychiatric assessment (Baskak, Tugba Ozel, Cem Atbasoglu & Baskak, 2008; Bleuler, 1911; Ceccherini-Nelli & Crow, 2003; Chen, Lam & Kan, 1996; Freud, 1900). Associations to unfamiliar/infrequent words, an important constituent of the current study, have, however, been explored in relatively few studies (Chaffin, 1997, Durso & Shore, 1991; Nelson et al., 2000; Shore & Kempe, 1999; Spence & Owens, 1990). The goal in the present study was not to establish norms in order to identify psychiatric problems or to explore people's subconscious, but rather to examine the association themselves as a function of the study's different independent variables -- root type, familiarity/frequency, concreteness, and age -- in order to shed light on the mental lexicon of Hebrew in a form-meaning perspective. As far as I know, the study by Henik et al (2005) is the only one conducted in Hebrew which aimed at obtaining norms for 800 familiar/frequent Hebrew words, irrespective of type of root structure. These norms were further analyzed by Prior (2004) as detailed in Chapter IV, Section 1.3.

Note, further, that the task of associations constructed for present purposes constitutes by way of a "mirror image" of the relatedness tasks, which also involved associations between words. The difference between the two tasks is that in the relatedness tasks, the associations were provided to respondents in a closed set, while the free associations task provided them with a more open-ended and less restricted design, allowing for individual choices and hence variation in responses.

Two types of association tasks are described in the literature: single or discrete associations (De Groot, 1989; Nelson, McEvoy & Schreiber, 2004), on the one hand, and multiple or continuous associations, on the other (De Deyne & Storms, 2008b). Single association tasks generally elicit one salient association, while the task of multiple associations reflects various networks that may exist in the mental lexicon by allowing

participants to provide more than one association to the same word. Both types of association tasks were included in the present battery of tests, on the assumption that this would provide an optimally comprehensive view of both strong and weak association networks (Anaki & Henik, 2003).

Sentential Use and Definition: The fourth and last topic specified here concerns two tasks in which participants were asked to construct responses of more than a single word, so requiring them to refer to the input nouns syntactically as well as semantically and/or morphologically.

The task of sentence construction is deeply entrenched in language curricula as a common school-based vocabulary assignment (Myhill, 2008). In psycholinguistic terms, production of a sentence containing or explaining a given word represents a high level of lexical knowledge (Anglin, 1993; Durso & Shore, 1991; Seroussi, 2004). This task was thus expected to reveal developmentally different levels of word knowledge, while clearly demonstrating the effects of the word-internal independent variables. In terms of the comprehension / production distinction, the sentence-construction task can be viewed as a mirror image of interpretation-in-context. Both tasks involve a sentential context, but in the present design, interpretation-in-context hones in on comprehension of unfamiliar/infrequent words, while the sentence-construction task focuses on the ability to produce sentences with relatively familiar/frequent items.

The last task in the battery, providing definitions, at the highest level of lexical skill, involves three types of knowledge: semantic -- use of a superordinate term, syntactic -- use of a relative clause, and structural -- avoiding repetition (Benelli et al, 2006). The most common and conventionally accepted form of definition is the Aristotelian format: 'An X is a Y that Z', where 'X' is a given object or concept, 'Y' represents the super-ordinate category and Z is the information that allows the specific object or concept to be identified. Definitions also correlate highly with metalinguistic awareness and school achievements (Anglin, 1993; Benelli et al, 2006; Nippold, 1999; Nippold et al, 1999; Snow, 1990; Watson, 1985).

In view of the relative difficulty of providing a definition and how much this ability depends on fully-established knowledge of vocabulary, only familiar/frequent nouns were selected for this task. The variable of concreteness was also taken into

account here, since it has been found to affect both the semantics and the syntax of definitions (Benelli et al., 2006; Goetz et al, 2007; Nippold, 1999; Nippold et al, 1999).

1.4. Construction and Administration of Tests

The original plan was to administer the full battery of tests in a single session (one class meeting for schoolchildren). Since initial piloting demonstrated that all seven tasks could not be completed in 30 to 40 minutes, however, two parallel tests (versions A and B) were constructed, balanced for level of difficulty of tasks and amount of time needed to complete them – with three different tasks in each of the two versions and the seventh task divided equally between the two versions.

The following decisions were adopted in designing both Versions A and B of the test battery:

- 1) **Number of task items** was adjusted to correspond to the degree of task difficulty – for example, the definition task included only 10 items, as against 60 items in the association task.
- 2) The **7 tasks were each sub-divided** into two or three parts, with varied orders of presentation, to minimize the effects of boredom and perseveration in responses.
- 3) Only **one noun with a given root** was used in any one task and, as far as possible, nouns with the same root appeared only once in each version A and B, so as to avoid a root-priming effect.
- 4) The **labels** heading and the **instructions** preceding each task were minimal and deliberately neutral in wording so as to leave room for respondent interpretations of the participants, to meet the overall goal of exploring the mental lexicon of Hebrew speakers without guidance or prior directions that might bias them towards a preferred response.
- 5) As in the previous phase of the questionnaires, instructions to participants were written in conventional “plene” **Hebrew orthography** using *matres lectionis* but no diacritic vowel-pointing, as accepted in regular Hebrew reading materials (newspapers, encyclopedias, short stories, novels, etc.) (see Chapter I, Section 3.1).
- 6) Test items were rendered in fully **vocalized orthography** with normative diacritics – in the same way as they were represented in the questionnaires probing the independent variables of Phase II of the study.

7) The items in each task were presented in **randomized order**.

1.5. Breakdown of Tasks

This section describes each task in the battery according to the serial numbers they were assigned by presumed order of difficulty, starting from the two tasks of Relatedness between Words (No. 1 and 2), followed by the task of Interpretation in Context (No. 3), the tasks of Associations (No. 4 and 5), the Sentence Construction task (No. 6), concluding with the task of the Definitions (No. 7).

Task (1): Degree of Relatedness – Multiple Choice (in Version B)

The two tests relatedness tasks explored participants' perception of the relatedness between sets of four nouns in relation to the three independent variables of type of root, F-score and age.

This task is a relatively easy multiple-choice task, where participants were required to select the one word out of four that they considered most closely related to the stimulus item. Graphically, the forty stimulus items were presented in bold in the middle of circle, surrounded by the four distractors, with the spatial arrangement of distractors randomized by type of distractor (as detailed below). Instructions in free translation were: "In the next section you will see some test items in bold, with four other related words arrayed around them. Choose and circle the word that in your opinion is mostly related to the test item."

Selection of distractors was performed as follows: Four types of relations were represented by the distractors for each test item in these two tasks -- morphological, morphological plus semantic, semantic, phonological. These are illustrated here for the test noun *xovéret* 'booklet' from the triconsonantal root *ḥ-b-r*. (a) **Morphological** -- related by the same root but without a shared meaning -- e.g., *xaverut* 'friendship'; (b) **Morphological plus Semantic** -- a shared root and a related meaning -- e.g., *maxbéret* 'copybook' -- typically in a relationship of co-hyponymy, that is, a noun in the same category as the stimulus item; (c) **Semantic** -- a different co-hyponym of the test item, related to it by meaning, but unrelated by root -- e.g., *pinkas* 'notebook'; (d)

Phonological -- a noun that rhymes with the test item but is unrelated to it morphologically or semantically -- e.g., *gevéret* ‘Madam, lady’.⁷

The F-score data-base was searched for roots used in at least one noun with a high F-score (e.g. *xovéret* ‘booklet’) and one with a low F-Score (e.g., *maxbar* ‘connector, joint’) – both from the root *ḥ-b-r*. Since the data-base had been *a priori* constructed out of “families” of nouns from the same root sub-divided by the semantic relations between them (see Phase I above), morphological and morpho-semantic distractors were already available. However, semantic and phonological distractors needed to be devised from scratch; this was done by team-work requiring unanimous agreement between at least three people, since perceptions of semantic and phonological degrees of relatedness and the nature of semantic relations tend to be quite individual, varying from one person to another. (For example, each member of the team tended to have rather different ideas about the “goodness” of rhymes). Eventually, a set of **60** test items were selected in this way -- 30 derived nouns with high F-scores (e.g., *xovéret*) and 30 from the same root with a low F-score (e.g., *maxbar*) -- 40 constructed of full roots and 20 from defective roots. Each of the 60 items was assigned four distractors, related to it in the four different relations (a) to (d). For example, for the low-F-score item *maxbar* ‘connector, joint’, the distractors were *maxbéret* ‘notebook’ (morphological), *hitxabrut* ‘joining, connecting’ (morpho-semantic), *blita* ‘protrusion’ (semantic); and *axbar* ‘mouse’ (phonological). These 60 stimulus nouns were divided up between the two relatedness tests, one with 40 and the other with 20 items.

Predictions were that participants would use more morphological distractors for words with low F-score and that this tendency would interact with age, for example, that reliance on morphological distractors would decrease with age.

Task (2): Degree of Relatedness – Ranking (in Version A)

This task had identical independent variables and types of stimuli as in the Multiple-Choice task, but it was cognitively more demanding, because participants were required to rank the degree of relatedness of each distractor to the stimulus item, coming to a total

⁷ Note that conventions for what counts as rhymes in Hebrew differ quite considerably from canonically rhyming words in English. See, for example, Ravid & Hanauer (1998). Here, too, in the present context, native-speaking graduate students of linguistics had to agree on what words could be said to “rhyme” with the input items.

of 80 values to be assigned (20 items x 4 ranks each). Graphically, the four distractors were written below each stimulus item, with a short line next to each distractor – again, randomized by type -- to be filled in by ranking of 1, 2, 3, and/or 4. Instructions were: “In the next section, you will see the test items in bold and four words, related to them in different types of relations, written below them. Rank how each word is related to the test item by the numbers 0-4, reflecting your opinion on how closely the word is related to the test item: 0 would signify no relation at all and 4 would signify a very strong relation. You may use the same number more than once.”

The process of selection of distractors and the predictions were the same as for the Multiple-Choice Relatedness task, with the additional prediction that Ranking would be more difficult, and that task difficulty would have an effect on the results.

Task (3): Interpretation in Context (in Versions A and B)

This task investigated participants’ ability to interpret and then provide an explanation for derived nouns with a low F-score, presented in a supportive context, taking into account the independent variables of: type of root, concreteness, and age.

This was the only one of the seven tasks in which test items were presented in the context of a sentence, rather than in isolation. Twenty unfamiliar / infrequent (i.e., low F-score) derived nouns served as stimuli, half concrete and half abstract. Each item was presented in a specially constructed sentence providing a relevant, but quite general semantic-pragmatic context for the test word, without specific details as clues to its meaning. For example, the unfamiliar noun *tasmix*, a novel coinage of the Academy of the Hebrew Language to translate the English word ‘association’ (cf. *smixut* ‘adjacency’ from the same root *s-m-k*) was presented in the following sentence: “The sounds of music that I could hear from far away evoked an **association** of a dark rainy evening.” Participants were instructed as follows: “Following are sentences, each with a bolded word. What is the meaning of the word, in your opinion? Please write it down in the space below the sentence.”

The predictions for this task were that the supportive sentential context would affect participants’ responses so that they would rely less on morphologically structural cues and more on semantic-pragmatic contextual cues, and that this tendency would be age-sensitive, such that younger children would be less proficient in deriving contextual

cues than older counterparts. The concreteness / abstractness variable was also predicted to affect the responses, as detailed in the rationale for this task (Section 1.3).

Task (4): Free Associations - Single (in Version A)

The tasks of association are the only ones in the battery that included stimulus items taken both from the full F-score data-base (60 nouns) and from the subset of concreteness (30 nouns), yielding 90 derived nouns, that were divided between the two tasks of associations. The Single-Associations task of 60 derived nouns required participants to write down the first association that came to mind for them on encountering the input items. The independent variables employed in this task were type of root, F-Score, concreteness, and Age. Instructions to participants were as follows: “In the next section you will see a list of words, some of which are familiar and some unfamiliar. Please write down next to each test item the first word that comes into your mind. Try to give associations even for unfamiliar words.”

Predictions were that words with a low F-score would elicit more structural associations while words with a high F-score would get more semantic-pragmatic associations, and that this trend would interact with age, given that the mental lexicon of young speaker-writers is more febrile and less well- established than that of older students and adults.

Task (5): Free Associations - Multiple (in version B)

Thirty derived nouns were used in this task, with independent variables the same as those of the Single Associations Task. Instructions for participants were: “In the next section you will see a list of words, some of which are familiar and some unfamiliar. Please write down next to each test item all the words that in your opinion are connected to it.”

Predictions were also the same as for the Single-Associations task, plus the prediction that this task would yield more associations to words with a high F-score than with a low F-score, and that number of associations would increase as a function of Age.

Task (6): Sentence construction (in version A)

This task, which included 20 items, aimed at ascertaining how well respondents are able to explain derived nouns by using them in appropriate sentential contexts, taking into account the independent variables of type of root, F-score, concreteness, and age.

Instructions were as follows: “In the next section you will see a list of words, some of

which are more familiar and others less familiar. Please write a sentence using each word in the list.”

Since this task was the only one in the battery based on a similar task from a former study of the author (Seroussi, 2004) and on relevant finding from discourse analyses (Ravid & Berman, 2010; Ravid & Chana-Amitay, 2005), predictions were more detailed and elaborated as follows. The first prediction was that respondents would show an increase with age in the overall understanding of the input nouns and that this tendency would interact with the word-internal independent variables. The second prediction was that there would be an impact of the independent variables of familiarity/frequency, concreteness and root transparency as follows. It was predicted that (1) the variable of root transparency would affect the results by providing morphological clues to unfamiliar/infrequent words; (2) the F-score would have an effect such that relatively unfamiliar/infrequent nouns would elicit fewer sentences overall, the sentences using them would be more general and less specific in content, and either grammatically more incorrect or semantically inappropriate; and (3) the variable of concreteness would affect the syntactic position of the stimulus items, such that concrete nouns would be used more in post-verbal and abstract more in pre-verbal syntactic positions.

Task (7): Definitions (in version B)

The aim of this task was to probe the highest, most meta-linguistic level of lexical knowledge by means of an Aristotelian definition, a task that requires both syntactic well-formedness and extensive semantic knowledge, in relation to the independent variables of type of root, concreteness and age. Instructions were: “You are requested to write a definition for each of the following words. Please try to explain exactly what each word means, as is done in a dictionary.”

Predictions were that concrete nouns would be easier to define than abstract nouns, so that definitions given to concrete nouns would be better-structured and would observe the Aristotelian stipulated form of conventional definitions. It was also predicted that more, and better, definitions would be provided with age.

1.6. Summary Tables

In sum, a battery of 7 tasks was designed, consisting of a total of 200 items in two corresponding versions (110 items in Version A, 90 in B), as detailed in Appendix 3. The test items were selected from three sources: (1) The Familiarity/Frequency data-base of 2,400 derived nouns, (2) The Concreteness subset of 370 derived nouns; and (3) an additional 20 unfamiliar/infrequent derived nouns selected especially for Task (3) Interpretation-in-Context. The tests were administered to 250 participants in three age-groups (6th Grade, 10th Grade, Adults). The breakdown of the test battery is presented in Tables 2 and 3 below, the first summarizing the entire battery and the second detailing the distribution of items in each task.

Topic	Type of Task	Version	No. of Items	Independent Variables
Degree of Relatedness	(1) Multiple choice	B	40	Root
	(2) Ranking	A	20	Familiarity/Frequency Age
Interpretation in Context	(3) Interpretation in Context	A B	20	Root Concreteness Age
Free Association	(4) Single	A	60	Root Familiarity/Frequency
	(5) Multiple	B	30	Concreteness Age
Explaining and Defining	(6) Sentence Construction	A	20	Root Familiarity/Frequency Concreteness Age
	(7) Definition	B	10	Root Concreteness Age

Table 2: Breakdown of Seven Tasks in the Test Battery by Topic, Type and Version of Task, Number of Items and Independent Variables

Table 3 represents the breakdown of 200 items on the full battery of 7 tasks in versions A and B, specifying the number of test items representing each combination of within-word independent variables, labeled as followed: High-F=Familiar/Frequent; Low-F=Unfamiliar/Infrequent; Full=Full Root; Def=Defective Root; Con=Concrete; Abs=Abstract.

Items Test and version	Familiarity/Frequency				Concreteness				Total
	Full High-F	Full Low-F	Def High-F	Def Low-F	Con High-F	Con Low-F	Abs High-F	Abs Low-F	
(1) B	12	12	8	8					40
(2) A	6	6	4	4					20
(3) AB						5A 5B		5A 5B	20
(4) A	12	12	8	8	5	5	5	5	60
(5) B	6	6	4	4	5		5		30
(6) A					5	5	5	5	20
(7) B					5		5		10

Table 3: Breakdown of Items on Two Versions of the Seven Tasks by Independent Variables [N=200 items]

The procedures for administering the full set of 7 tasks as summarized in Tables 2 and 3 are detailed in the next section.

1.7. Piloting and Data-Collection

It was necessary to recruit at least 30 respondents for each of the two versions (A and B) of the test battery in order to ensure statistically reliable and valid calculations of results. This decision also suited the nature of a group-test administered in writing to two groups of school students, since Israeli grade- and high- schools typically average classes of around 40 students each, some of whom might not have qualified as participants in the

study since they did not meet its criteria of having no language or learning disabilities (see Section 1.2), they failed to complete the test, or were not at school when the test was administered.

The two final versions of the tests, A and B, were developed following extensive piloting and numerous “dry-runs” in smaller groups as well as in classroom settings. Both versions were originally designed to take around one half-hour to complete, hence doable in the space of a single school-class session of 40 to 45 minutes. This assessment of test-duration turned out to fit the 10th graders and adults, but not the younger group of 11- to 12-year-old 6th grade students – evidently due to the impact of the high proportion of unfamiliar/ infrequent words on the test on children with relatively smaller lexical repertoires, and lack of experience in dealing with such items. To counter the likelihood that a large proportion of the children in the youngest age-group might not succeed in completing the full battery in either Version A or B, it was decided to divide each of the two complete versions of the test into two balanced shorter versions (Aa and Ab, Bc and Bd respectively), each containing half of the stimuli of the original version, for administration to children in 6th-grade. This meant that the number of participants in the youngest age-group had to be doubled so as to ensure that all three groups responded to the same number of items in total: 30 adults, 30 10th-graders, and 30 + 30 6th-graders.

Ministry of Education stipulations required that the tests be administered anonymously, which meant we were unable to *a priori* identify students with learning difficulties or who were non-native speakers of Hebrew. Accordingly, a short personal questionnaire was added before each test battery, with participants required to provide details such as date of birth, sex, first language. [See the complete test forms in Appendices 1 and 2]. Another short questionnaire was added at the end of the tests, asking participants to respond to a few questions regarding their school achievements, particularly in Hebrew studies, English, and math, as subjects that might be related to the topic of the present study, as a means of screening out students with language-learning difficulties.

The study was dependent on official permission from the Chief Scientist, the Israel Ministry of Education, for administering the tests in grade- and high-schools. Once official authorization was obtained, schools needed to be located that met the criterion of

being well-established, attended by students of mid to high socioeconomic status, whose teachers and principals would cooperate with us in administering the tests. Eventually, three grade-schools and one high school in the greater Tel Aviv area participated in the study, while the adult population of undergraduate and graduate-level university students (with 13.9 years of schooling on average) were recruited on a voluntary basis. Table 4 shows the breakdown of the test population into three age-groups by number of completed test forms, total number of respondents, and the age-range and mean age of respondents in each group.

	Completed Forms for Each Version	Total No. of Respondents	Age Range	Mean Age
Sixth Grade	Ga = 35 Gb = 29 Gc = 31 Gd = 31	126	11;00-12;00	11.42
Tenth Grade	Ha = 30 Hb = 30	60	15;00-16;00	15.25
Adults	Aa = 31 Ab = 33	64	21;00-30;00	24.48

Table 4: Distribution of Three Age Groups on Test-Battery by Age-Schooling level and by Mean Age [N=250 respondents]

Students from five grade-school classes in three different schools and from two classes of a single high school participated in the experiments. Tests were administered by the author of this study in the course of a single lesson-hour, who distributed the two or four versions of the battery to all students present in class that day, answered questions if there were any, and collected the completed questionnaires at the end of the hour. The time needed to complete the tests and the two short questionnaires that preceded and followed them took between 30 to 50 minutes. The bulk of the students were able to complete the full set of tests in the time-frame of a single lesson, and ones who needed extra time were allowed to do so after the lesson ended, in a quiet room nearby, so as not to disturb the class.

As noted earlier, the adult participants were selected on a voluntary basis, most of them currently enrolled as graduate or undergraduate students at Tel Aviv University, at other universities or in Colleges of Education. Tests were administered to students in small groups or in class, with each being paid 25 NIS (equivalent to around \$6 or \$7) for their participation, and they, too, typically managed to complete the test in 30 to 40 minutes. The investigator asked adult volunteers who had been diagnosed in the past as having language-learning difficulties not to participate in the study.

1.8. Data Entry and Coding

A special program was devised in the framework of this study to establish a computerized data-base, as a basis for coding and analysis of the entire set of responses to all items on the different tasks on the different versions of the test battery as administered by the procedures described above. The following materials were disqualified for purposes of analysis in the study: Cases where (a) respondents stated that they were not native speakers of Hebrew (in response to the pre-test questionnaire); (b) respondents explicitly declared that they had difficulties in their school studies (in response to the post-test queries); (c) over 10% of the test items were left blank; and (d) a high proportion of responses seemed *a priori* unreasonable, for example, where all the relations to all the nouns on a multiple-choice task were consistently ranked by the numbers 1-2-3-4, irrespective of the stimulus items. The research assistants who entered material on the computerized data-base were instructed to enter all responses and all data in exactly the form given by the participants, without any changes or corrections.

Once a sufficient body of data had been entered on computer, coding categories were established for each item on each task in all 7 tasks in the battery. This was done in concert, by a team of five, including the investigator, the supervisor of her study (Ruth Berman), and three graduate-level linguistics majors employed as research assistants on the project for this study. Coding categories for each open-ended task were established *post hoc*, as listed in the relevant section of the next chapter. (Responses to the multiple-choice and ranking tasks were scored by a pre-established set of four categories -- Morphological, Morphological + Semantic, Semantic, Phonological -- as described in

Section 1.5 above). The following procedures were adopted in deciding on how responses to each of the other five tasks would be classified.

First, responses on the spread-sheet for each task were examined separately, without any identifying details of the respondents such as age or sex. Following intensive and lengthy brain-storming sessions, coding categories for each task were agreed on by the entire team. Next, the full set of responses on each task was allocated to two research assistants for coding, supervised by the senior investigator (the author of this study). Queries and problems that arose at this stage of the process were discussed by the entire team in another series of meetings and coding categories were modified accordingly. The codes were deliberately neutral with respect to “quality” of response; that is, the categories were not classified hierarchically from best to poorest. The only exception was in the definitions task, as a task for which levels of adequacy have already been established by considerable prior research (Benelli et al., 2006). The number of response categories differed for each task, depending on the nature of the task, ranging from 3 to 5 major categories, each subdivided into several subcategories. The breakdown of categories of coding and analysis are detailed prior to presentation of findings (see Chapter III).

2. Pilot Priming Experiments

One of the goals of the study was to compare the mental lexicon of Hebrew speaker-writers as reflected in off-line and on-line experiments respectively (see Chapter I, Section 5). A varied array of priming tests were conducted towards the end of this multi-phased doctoral study in a complex experimental design. The eventual number of 130 participants who participated in these priming experiments did not, however, suffice to ensure statistical validity of the analyses when taking into account all its different variables, so that many of the results of the priming experiments reported below are best regarded as an extended pilot study, and the basis for further research.

For on-line testing, two priming experiments were designed, using the same stimuli as in the two tasks testing relatedness between words (Section 1.5) with slight changes as specified below. The background rationale of the priming tests (Section 2.1) is

followed by a description of piloting prior to establishing the final research design (2.2) and details of the research experiments, including stimuli, apparatus, population, and procedures (Section 2.3).

2.1. Background to Priming Study

The rationale of these experiments as a tool for shedding light on another, subliminal facet, of the Hebrew mental lexicon, is detailed in the introduction (Chapter I, Section 5). The priming technique employed in these tests was that of the Masked Priming paradigm (Forster & Davis, 1984), as adapted to Hebrew by Frost et al (1997). This research paradigm was selected since it allows direct access to the automatic and unconscious level of structural sensitivity in the mental lexicon, thus complementing the more conscious level of processing reflected by the written relatedness tasks.

One accepted way of applying this paradigm is by means of a lexical-decision task, in which participants are required -- as rapidly as possible -- to identify classify each Target item presented on the computer screen either as a word or not as a word in their language. The target is primed by a forward-pattern mask presented before the prime for a very brief space of time, though usually inaccessible to report by participants, influences the speed of lexical decision in cases where it is related by form to the target item. A number of non-words equal to the number of target items are inserted, serving the role of fillers and aiding participants in carrying out the lexical- decision task. Robust priming effects have been reported for primes that are identical to the target, termed “Identity Priming”, and also for primes that differ from the target in only a single letter, termed “Form priming” (Forster, 1987). The time duration of the Prime, termed “Stimulus Onset Asynchrony” (henceforth SOA), has differential effects on the results in this paradigm. At a short SOA, the technique is highly sensitive to overlap at the level of form rather than meaning (Forster, Davis, Schoknecht, & Carter, 1987; Forster & Taft, 1994). However, longer SOA’s allow more conscious awareness of meaning relations than is manifested at shorter intervals (Bueno & Frenck-Mestre, 2008).

As noted, Frost et al (1997) adapted the Masked Priming paradigm to Hebrew, on the assumption that Hebrew morphology, most particularly the consonantal root, would be sensitive to “form priming”. In a series of experiments, Frost and his associates

revealed a morphological priming effect, especially by means of root priming in Hebrew nouns, irrespective of the semantic proximity between prime and target (see Frost et al, 2000, for a review). That is, a target noun such as *avka* ‘powder’ could be primed either by an item that is both semantically plus morphologically related, such as *avak* ‘dust’, or by one that relates only morphologically to the target, sharing the same root but not the same meaning, such as *ma’avak* ‘struggle’ (with the three nouns *avka*, *avak*, *ma’avak* based on the same consonantal root elements ʔ-b-q). The research reported on here is largely along the lines of Frost et al, with certain changes, as detailed below.

First, half of the targets items were nouns that had been independently rated as unfamiliar/unfrequent (that is, as having a low F score). Research in English has documented an interaction between familiarity/frequency and priming, with a stronger effect found for Low-F words (Forster & Davis, 1984; Rajaram & Neely, 1992). The current study is the first, to the best of my knowledge, that includes the variable of familiarity/frequency in a priming experiment in Hebrew. Second, two separate priming experiments were designed, one with a shorter SOA (50 ms) and one with a longer SOA (100ms), in order to pinpoint the dynamic facet of form-meaning interfacing as a function of time. The prediction was that morphology would exert a greater effect in the short-time condition, while the longer time-interval would be more sensitive to semantic relations, which take slightly longer to be consciously activated or accessed than morphological relations (Feldman et al, 2004; Feldman & Prostko, 2002; Feldman & Raveh, 2003; Neely, 1991; Raveh, 2002). Third, different software was employed than in the Frost et al studies, and statistical procedures were somewhat adapted to suit the needs of the present study.

Predictions of the priming experiments were that (1) for familiar/frequent words, there would be morphological priming in the short SOA and semantic priming in the long SOA, (2) there would be no consistent priming effect for the unfamiliar/infrequent words, since they lack a well-established lexical status, and (3) there would be a differential effect of the type of root, such that targets derived from full roots would show a greater effect of priming than targets derived from defective roots.

2.2. Initial Piloting and Design of Research

The stimuli selected for these experiments were much the same as the input nouns in the two tasks of relatedness between nouns. For example, the input item (e.g. *avka* ‘powder’) served as a target, while three of the four distractors served as primes on this test, for example: *avak* ‘dust’ for a morpho-semantic relation, *ma’avak* ‘struggle’ for a purely morphological (structural) relation, and *púdra* ‘powder’ for a semantic (conceptual) relation. The fourth distractor from the relatedness task – based on phonology (e.g. *erka* ‘kit’) -- was replaced by an unrelated prime (e.g., *mazlef* ‘watering can’ that has no apparent connection to the target item). This unrelated prime served as a basis for measuring the priming effect, by reducing the Reaction Time of the unrelated Prime compared with the related Prime.

The final design of the experiments was decided on after extensive piloting, which turned out to be protracted and challenging, fraught with unexpected difficulties and snags. After pilot studies conducted with some 20 participants, the following decisions were taken.

- 1) The short SOA would be 50 ms and the long one 100 ms. In longer SOA’s, the prime was totally overt and caused interference.
- 2) The same mask, the same relative difference in font size between target and prime items, and the same sequence of experimental steps were adopted -- as in the study conducted by Frost et al (1997).

The first round of piloting yielded no priming effects, accounted for by two possible lines of explanation, and leading to the following decisions:

- 3) Lack of priming effect could have been due to difficulty of Hebrew speakers when encountering (normative) diacritic vowel marking (see Chapter I, Section 3.1 and Section 3.2 of the discussion, Chapter IV). Unlike the studies of Frost and his associates, the stimuli in all phases of the current research were presented with full diacritic marking of vowels, which were found to be largely ignored and quite often misinterpreted by participants, especially in the case of unfamiliar/unfrequent items. We assumed that the diacritic marks might interfere with the priming process because of the extra visual load they entail, hence possibly distracting participants’ attention. Accordingly, it was decided to remove full, normative diacritic marks, leaving only those essential for an

unambiguously correct reading of the stimuli items – both targets and primes (see Appendix No. 4 for a detailed list of the stimuli).

4) Another possible explanation for the lack of priming effect in the first round related to psychological factors. In a study composed of familiar/frequent items, there is an equal division of “yes” and “no” responses. Not so in the present study, which included unfamiliar/infrequent words that could have biased participants towards pressing the “no” button far more than “yes”. The excessive reliance on “no” responses might have affected participants’ judgments negatively, indirectly related to the lack of priming. Accordingly, it was decided to insert an additional 36 High-F words into the design so as to encourage more “yes” responses. Four random “primes” were assigned to each of these dummy filler words as well, so that they appeared to be an integral part of the experiment.

2.3. Apparatus and Procedures

After numerous prior attempts undertaken in a general research site at Tel Aviv University, the final set of priming experiments were conducted at the specially designed laboratory in Haifa University under the supervision of Bracha Nir, a faculty member of the Department of Communication Disorders. A doctoral student employed by the Haifa University Institute of Information Processing, where such experiments are routine, and skilled in the E-Prime priming software and in the SPSS statistical software, was hired to program and analyze the experiments, and a research assistant at Haifa University was hired to recruit participants and to conduct the experiments.

The experimental stimuli included 72 real-word Targets and 72 non-word Targets. Half (36) of the Targets were of High-F and the other half of Low-F values. Half the Target items were derived from full roots and half from defective roots. The length of the Targets ranged from 3 to 6 letters, with a mean length of 4.65. The non-words were constructed in the same morphological patterns as the real words but with non-existing roots, and matched in initial letter and in length in letters to their corresponding word Targets. In addition, 36 “pseudo-targets” (familiar/frequent “dummy” nouns) were inserted among the test stimuli. Each Target had four possible Primes. For the target word *avka* ‘powder’, for example, the four Primes were: a) *avak* ‘dust’ -- morphologically plus semantically related, b) *ma’avak* ‘struggle’ -- morphologically related, c) *púdra* ‘powder’

-- semantically related, and d) *mazolef* ‘watering can’ -- in the unrelated condition (see Appendix 4 for the complete list of stimuli in the priming experiments).

The prime selection for each target was balanced by participant identity, so that all possible Prime-Target combinations were used in a group of 4 participants numbered consecutively. This design ensured that each participant would encounter an equal number of the four possible primes ordered randomly, combined with two possible targets (High- and Low-F), so yielding 8 possible combinations of prime and target.

Recall that the stimuli for this test were largely based on the stimuli for the relatedness tasks, constructed of pairs of nouns from the same root, one of High familiarity/frequency and one of low familiarity/frequency. This situation, of pairs of nouns of the same root in the same experimental list, was liable to cause undesirable Repetition Priming, that is, priming caused by the same root being repeated in a given list of items (Bentin & Feldman, 1990). To avoid this noise, the list was divided into two blocs, with the pairs of nouns divided between them, such that one noun of a given root would be in one bloc and the other in the second bloc. As an extra precaution against Repetition Priming, liable to interfere with the Masked Priming of these experiments, a time interval of 30 seconds was designed between the blocs.

The participants were 130 university students (75 women and 55 men), aged 20 to 52 (mean age = 25 years), all native Hebrew speakers with normal or corrected-to-normal vision. Participants were randomly assigned to one of two experiments, one with a short SOA (50 ms) and one with a long SOA (100 ms). Each such group consisted of 65 subjects, with data from five participants removed from the final analyses due to an error rate higher than 20%.

The apparatus used for the priming experiment was a computer program using PST’s E-Prime software version 1.2 on a PC. Stimuli were displayed on a 17-inch CRT monitor with a 60 Hz refresh rate. Responses were collected by means of a PST’s serial response box. Font size was 24 pt. David (Hebrew) for the Target items and 20 pt. David for the Primes.

The experimental steps were as follows: Each trial began with a mask consisting of 7 white double-bar (#) characters shown at the center of the screen on a black background for 500 milliseconds. The mask was then replaced by a Prime word,

presented in italics, displayed for a preset interval of 50 or 100 ms, depending on the priming-duration condition. After presentation of the Prime, a dark screen appeared for a 33 millisecond ISI. And, finally, the Target word was displayed at the center of the screen until the participant pressed the key.

The procedure was as follows: Upon arrival, participants were seated in front of a computer monitor and a response box, and each was assigned to a prime duration of either 50 or 100 milliseconds. Participants were then shown an instruction screen and instructed by the experimenter to pay constant attention to the center of the screen and to respond as quickly and accurately as possible to the target word by pressing one key if they considered the target to be a word and another if they considered it to be a non-word. The session began with 20 practice trials, followed by the experimental stimuli divided into two blocs with a fixed break between them. After the experimental session, usually lasting 10 to 15 minutes, participants were paid and dismissed.

CHAPTER III -- RESULTS AND ANALYSES

This chapter first presents and analyses results on the seven tasks on the battery, based on the motivations and procedures detailed in Chapter II (Part B, Section 1.6), summed up in there in Table 2. Taken together, these tasks yielded over 18,000 responses to the 200 test items, given by at least 30 respondents in each of three age-groups. Results of each of the tasks are presented below as numbered in the following order: Relatedness –Multiple Choice (1) and Ranking (2); Interpretation in Context (3); Free Associations -- Single (4) and Multiple (5); Sentence Construction (6) and Definitions (7). The chapter concludes with findings of the Priming experiments (8). Results for each task are presented in three sub-sections: Coding Categories, Findings, Interim Summary and Discussion.

With respect to coding categories, recall that coding decisions for all tasks were based on intensive group discussion and all codings for open-ended tasks were conducted on the same spreadsheet by at least two investigators working in conjunction. Spelling errors were disregarded in analyzing responses.

The description of findings for each task starts with an overall distribution of the responses in the form of a pie-chart, followed by breakdowns of responses in the form of histograms by the independent variables of Root, Familiarity/Frequency, Concreteness, and Age -- in that order. Interactions between Age and the other independent variables are detailed in tables.

The bulk of statistical analyses employed in the study were Chi-square tests, since both dependent and independent variables were nominal. Parametric tests were conducted in cases where the independent variables could be specified as consecutive on a hierarchical numerical scale. Where significant effects emerged, further tests were performed to identify sources of interactions.

1. Degree of Relatedness -- Multiple Choice

This task required respondents to choose the one noun out of four most closely related, in their opinion, to the input item, as explained in Chapter II (Part B, Section 1.3). This task had 40 items, selected from the Familiarity/Frequency database, half with High-F and half with Low-F scores, 24 from Full Roots and the other 16 with Defective Roots. The

two tasks of Relatedness were the only ones in the entire test battery for which coding categories were specified in advance, by four types of responses: Morphological, Morpho-semantic, Semantic, Phonological. The summary and interim discussion of both tasks of Degree of Relatedness are provided together (in Section 2.2), following a breakdown of results on each of the two tasks separately.

1.1. Findings

Figure 1 shows the overall distribution of over three thousand responses [N=3,547] to 40 nouns on the Degree of Relatedness Multiple Choice task, by four different response categories.

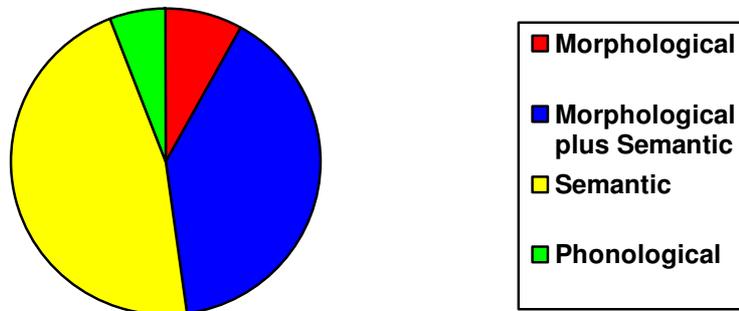


Figure 1: Overall Distribution of Degree of Relatedness -- Multiple Choice, by Four Types of Responses [N= 3,547]

A chi-square test for independent samples revealed significant effects for Type of Response ($\chi^2(6, N= 3,547)= 109.714, p<.001$) as follows: The Semantic choice was the favored response type nearly half the time (46.3%), followed by the Morpho-semantic distractor (39.8%). A Morphological distractor was chosen in less than 10% of the cases (8.1%) and the Phonological even less (5.8%).

All of the independent variables -- Root Transparency, Familiarity/Frequency, and Age -- had significant effects on the results on this task, described in Figures 2, 3, and 4 below, with response-types throughout labeled as follows: Mor=Morphological; MorSem=Morpho-semantic; Sem=Semantic; Phon=Phonological.

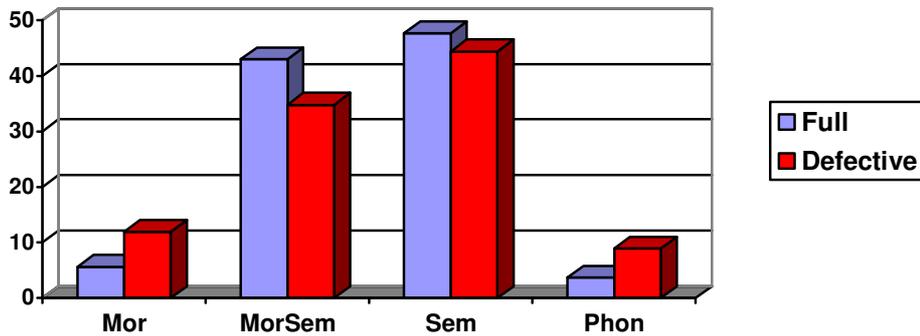


Figure 2: Effects of Root Transparency on Degree of Relatedness, Multiple Choice

A chi-square test for independent samples revealed significant effects for Root Transparency ($\chi^2(3, N= 3,547)= 97.388, p<.001$) as follows: More Semantic and Morpho-semantic distractors were selected for nouns derived from Full Roots while more Morphological and Phonological distractors were selected in response to nouns derived from Defective Roots.

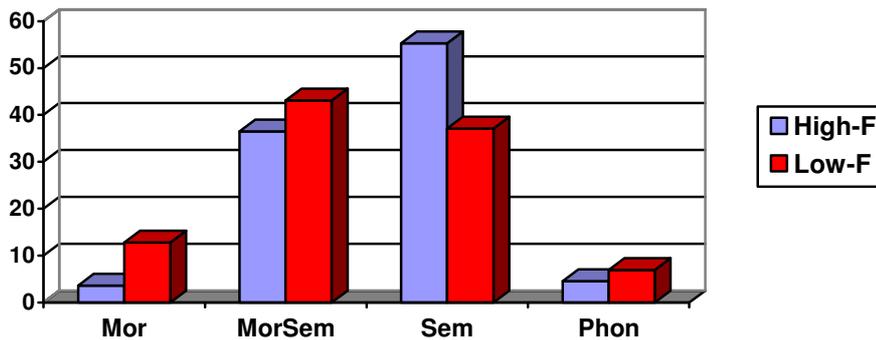


Figure 3: Effects of Familiarity/Frequency on Degree of Relatedness --Multiple Choice

A chi-square test for independent samples revealed significant affects for Familiarity/Frequency ($\chi^2(3, N= 3,547)= 174.298, p<.001$) as follows: More Semantic distractors were selected for High-F nouns while more Morphological, Morpho-semantic and Phonological were selected for Low-F nouns.

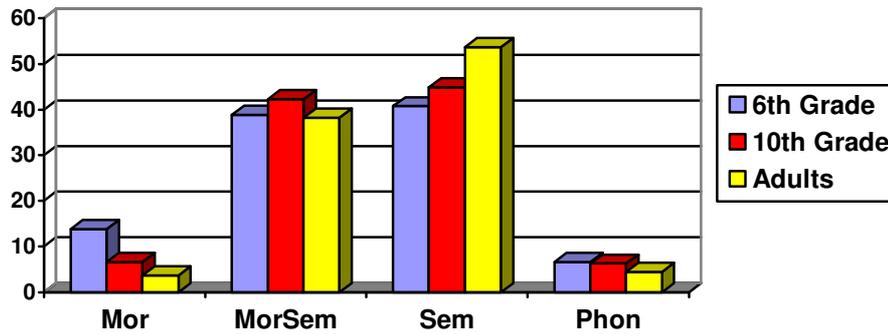


Figure 4: Effects of Age on Degree of Relatedness -- Multiple Choice

A chi-square test for independent samples revealed significant affects for Age ($\chi^2(6, N= 3,547)= 109.714, p<.001$) as follows: There was a gradual increase in the preference for the Semantic distractor with Age and a concomitant gradual decrease in the preference for the Morphological distractor with Age.

As for interactions between the independent variables, chi-square tests revealed interactions between all the three independent variables of Root, Familiarity/ Frequency and Age, as shown in tables 5, 6, and 7 -- with response-types again labeled as follows: Mor=Morphological; MorSem=Morpho-semantic; Sem=Semantic; Phon=Phonological.

Table 5 shows the interaction in percentage of responses between Age and Root Transparency (Full Roots, $\chi^2(6, N= 3,547)= 95.922, p<.001$, Defective Roots, $\chi^2(6, N= 3,547)= 34.944, p<.001$).

Type of Response	Full Roots				Defective Roots			
	Mor	MorSem	Sem	Phon	Mor	MorSem	Sem	Phon
6 th Grade	11.1	44.7	39.6	4.7	18	30.1	42.4	9.5
10 th Grade	3.7	44.9	46.9	4.6	11.2	38.3	41.7	8.8
Adults	1.8	39.6	56.6	2	6.6	36.2	48.9	8.3

Table 5: Interaction Root Type X Age, Degree of Relatedness -- Multiple Choice

Table 5 shows that Full Roots reveal an Age-related gradual increase in Semantic distractors and a concomitant gradual decrease in Morphological distractors. Defective Roots, in contrast, reveal the following patterns: (1) there is a more moderate Age-related decrease in Morphological responses, (2) the proportion of Morphological distractors is

higher in absolute numbers than those of Full Roots, and (3) there is a less marked increase in proportion of Semantic distractors, mainly between 10th Graders and Adults.

Table 6 shows the interaction in percentage of responses between Familiarity/Frequency and Root (High-F, $\chi^2(6, N= 3,547)=97.243, p<.001$, Low-F, $\chi^2(6, N= 3,547)= 49.128, p<.001$).

Type of Response	High-F				Low-F			
	Mor	MorSem	Sem	Phon	Mor	MorSem	Sem	Phon
Full	1.9	43	53.2	1.9	9.3	43.1	42	5.7
Defective	6	26.8	58.4	8.8	18.1	43.2	29.7	9

Table 6: Interaction Familiarity/Frequency X Root Type, Degree of Relatedness Multiple Choice

Table 6 shows that High-F nouns yielded a marked difference in preference for Morpho-semantic distractors to words derived from Full Roots as against Defective Roots and more Phonological distractors for words derived from Defective Roots; Low-F nouns revealed a marked difference between Full and Defective Roots mainly in the proportion of Semantic distractors and in greater use of Morphological distractors in response to nouns derived from Defective Roots.

Table 7 shows the interaction in percentage of responses between Familiarity/Frequency and Age (High-F, $\chi^2(6, N= 3,547)= 23.083 p<.001$, Low-F, $\chi^2(6, N= 3,547)= 100.306, p<.001$).

Type of Response	High-F				Low-F			
	Mor	MorSem	Sem	Phon	Mor	MorSem	Sem	Phon
6 th Grade	5.9	37.4	51.9	4.9	22.2	40.5	28.8	8.4
10 th Grade	3.2	38.5	53.7	4.6	10.2	46	35.8	8.0
Adults	1.5	33.7	60.5	4.4	5.9	42.9	46.6	4.6

Table 7: Interaction Familiarity/Frequency X Age, Degree of Relatedness Multiple Choice

Table 7 shows that for High-F nouns, the two preferred distractors were the Morpho-semantic and Semantic, with a gradual increase in the latter with Age; for Low-F nouns, the selection of distractors was more scattered, with a gradual increase in Semantic preferences and a sharp decrease in choice of Morphological distractors with Age.

2. Degree of Relatedness -- Ranking

This task required respondents to rank the noun distractors by their proximity to the input item, as explained in Chapter II (Part B, Section 1.3). The task had 20 items, selected from the Familiarity/Frequency database, half with High-F and half with Low-F scores, twelve derived from Full Roots and the other eight derived from Defective Roots. Coding categories were the same as for the Degree of Relatedness Multiple-Choice task presented in the preceding section.

2.1. Findings

Figure 5 shows the mean ranking obtained for over seven thousand responses [N=7,046] to 40 nouns on Degree of Relatedness – Ranking, by four different response categories.

A repeated-measures ANOVA with age as a between-subject factor revealed main effects of Type of Response, of Familiarity/Frequency and a marginal effects of Root as follows.

A main effect of Type of Response ($F(3, 345) = 124.489, p < .001$) appeared, as detailed in Figure 5 with response-types labeled as follows: Mor=Morphological; MorSem= Morpho-semantic; Sem= Semantic; Phon=Phonological.

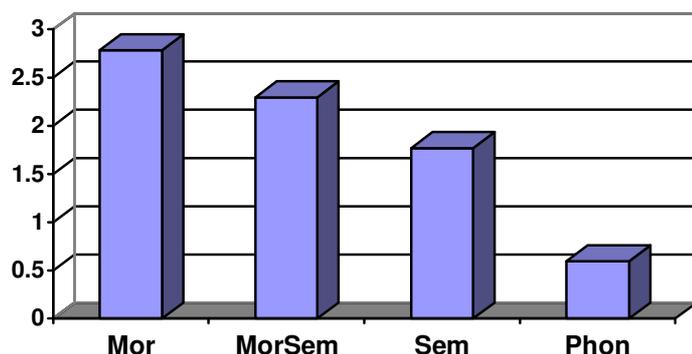


Figure 5: Overall Mean Ranking, Degree of Relatedness -- Ranking, by Four Types of Responses [N= 7,046]

Morphological distractors scored the highest ($M=2.785$, $SD=0.057$), followed by Morpho-semantic distractors ($M=2.298$, $SD=0.067$), Semantic distractors ($M=1.772$, $SD=0.092$), while the Phonological distractors were ranked lowest ($M=0.595$, $SD=0.103$). A post-hoc test revealed significant differences between all the four types of responses.

A main effect of Familiarity/Frequency ($F(1, 115) = 30.492$, $p < .001$) was also found. High-F nouns received significantly higher scores ($M=1.949$, $SD=0.037$) than Low-F nouns ($M=1.775$, $SD=0.043$). A marginal main effect Root ($F(1, 115) = 3.540$, $p = .062$) was also revealed so that input items derived from Full Roots received higher scores ($M=1.892$, $SD=0.040$) than input items derived from Defective Roots ($M=1.833$, $SD=0.040$).

Pairwise interactions were found between (1) Familiarity/Frequency X Type of Response ($F(3, 345) = 4.158$, $p < .01$), (2) Age X Familiarity/Frequency and ($F(2, 115) = 4.515$, $p < .05$) and (3) Age X Type of Response ($F(6, 345) = 2.252$, $p < .05$). The effects are detailed in Tables 8 to 13 with the response-types again labeled as follows:

Mor=Morphological; MorSem= Morpho-semantic; Sem=Semantic; Phon=Phonological.

Table 8 describes the interaction between Familiarity/Frequency X Type of Response.

Type of Response	Mor	MorSem	Sem	Phon
High-F	2.937 (0.066)	2.341 (0.074)	1.916 (0.104)	0.603 (0.107)
Low-F	2.632 (0.067)	2.254 (0.072)	1.627 (0.098)	0.587 (0.108)

Table 8: Effects of Familiarity/Frequency on Mean Ranking of Degree of Relatedness, Means and Standard Deviations

Post-hoc tests revealed the sources of the differences Types of Response, detailed in Table 9.

Type of Response	Significant differences High-F – Low-F
Mor	Yes
MorSem	No
Sem	Yes
Phon	No

Table 9: Familiarity/Frequency X Type of Response, Sources of Interaction, Degree of Relatedness – Ranking

Table 10 describes the interaction Age X Familiarity/Frequency.

Familiarity/Frequency	High-F	Low-F
6 th Grade	1.915 (0.050)	1.860 (0.059)
10 th Grade	1.934 (0.069)	1.71 (0.082)
Adults	1.999 (0.069)	1.747 (0.082)

Table 10: Effects of Age X Familiarity/Frequency on Age, Degree of Relatedness, Means and Standard Deviations

Post-hoc tests revealed the sources of interactions as detailed in Table 11.

Age Group	Significant differences High-F – Low-F
6 th Grade	No
10 th Grade	Yes
Adults	Yes

Table 11: Age X Familiarity/Frequency, Sources of Interaction, Degree of Relatedness -- Ranking

Table 12 describes the interaction Age X Type of Response.

Type of Response	Mor	MorSem	Sem	Phon
6 th Grade	2.807 (0.077)	2.287 (0.091)	1.721 (0.125)	0.733 (0.141)
10 th Grade	2.528 (0.108)	2.178 (0.126)	2.073 (0.174)	0.526 (0.195)
Adults	3.020 (0.108)	2.427 (0.126)	1.521 (0.174)	0.525 (0.195)

Table 12: Effects of Age X Type of Response on Mean Ranking of Degree of Relatedness, Means and Standard Deviations

Post-hoc tests revealed the sources of interactions as detailed in Table 13.

Type of Response	Significant Differences
Mor	Adults > 6 th Grade > 10 th Grade
MorSem	No
Sem	10 th Grade > 6 th Grade, Adults
Phon	No

Table 13: Age X Type of Response, Sources of Interaction, Degree of Relatedness -- Ranking

2.2. Summary and Interim discussion: Relatedness tasks

The main results are first summarized for each of the two relatedness tasks separately and then compared. The two tasks, although using the same types of stimuli and distractors, yielded different results, evidently due to their different task demands. While in the Multiple Choice task, respondents were required to provide a total of 40 responses (one out of four possible options for each of 40 input items), the design of the Ranking task required them to provide double the number of responses (20 input items X 4 rankings), with each distractor being given an independent ranking between 1 and 4.

The Multiple Choice task yielded the following hierarchy of distractors: semantic > morpho-semantic > morphological > phonological, with the phonological distractors being markedly lower than the others. All the independent variables had relatively similar effects, as follows: Semantic distractors were preferred in the case of (1) words derived from full roots, (2) familiar/frequent nouns, and (3) more mature respondents. The proportion of structural (morphological and phonological) distractors increased in the case of (1) nouns derived from defective roots, (2) unfamiliar/infrequent nouns and (3) younger respondents. Interactions between the independent variables, revealed two

distinct developmental profiles, one for full roots and familiar nouns and another, more scattered pattern, for defective roots and unfamiliar/infrequent nouns.

The Ranking task yielded a different, somewhat surprising, hierarchy of distracters: morphological > morpho-semantic > semantic > phonological. Of the independent variables, only familiarity/frequency had an effect, yielding higher rankings for nouns with high F-scores, whereas the effect of root was marginal and there was no effect for age. Interactions between variables on this task revealed (1) a differentiation between low-F and high-F words that consolidated with age and (2) an interplay between semantic and morphological distracters, interacting with both age and familiarity/frequency in rather inconsistent, if not inconclusive, patterns.

The two tasks of Relatedness yielded two shared trends in both distributional percentages and hierarchical scale of ranking: Preference for familiar/frequent items over unfamiliar/infrequent items, and avoidance of phonological distractors. Factors that were dissimilar on the two tasks were, first, a different hierarchy of distractors, with morphology taking over in the Ranking task and, second, differential effects of the independent variables, some of which played no role in the Ranking task. The developmental pattern of the latter was unexpected, since all three age groups adopted the same patterns of responses. This might be due to the difficulties experienced by participants in coping with the demands of a ranking task, which might have led them to respond in a relatively automatic or mechanical fashion. The second unexpected finding of the Ranking task, the significantly less favoring of morpho-semantic options, could be attributed to the complexity of this task. Ranking four degrees of relatedness between input and response items, participants tended to avoid responses that required them to take into account concurrently two distinct sources of information, both form and content.

The most striking finding of these tasks is the discrepancy in their hierarchies of distractors, specifically the advantage of morphological distractors in the Ranking task. This morphological advantage is unusual, compared with the results of the Multiple Choice task of relatedness as well as of all the other tasks in the battery, as discussed in Chapter IV (Section 1.1). The favoring of morphological factors in the Ranking task, even in the case of highly familiar/frequent items, was unexpected, since morphology is expected to operate mainly when semantic cues are not available. One possible

explanation relates to the demands imposed by this specific task, which burdened respondents by requiring them to perform 80 independent rankings, providing an individual score to each of four options on each input item. Evidence of this difficulty could be found in the fact that several of the forms in this task were not filled out in full, while others appeared to be filled out quite randomly, possibly due to fatigue or tedium. This suggests that respondents encountering difficulties when confronted with the demanding task of ranking adopted a more mechanical “cop-out” strategy, by resorting to more easily identified structural relations between words. In Hebrew, this means relying on morphological rather than on phonological cues, an issue considered further in the concluding discussion in Chapter IV.

3. Interpretation in Context

This task required respondents to interpret an Unfamiliar/Infrequent noun presented in the context of a sentence, as explained in Chapter II (Part B, Section 1.3). This task had 20 Low-F items, half Concrete and the other half Abstract.

3.1. Coding Categories

Responses on this task were coded in four major categories – Structural (either morphological or morphophonological), Semantic, Semantic plus Structural, and Miscellaneous -- each further divided into sub-categories, based on the relation of the answer to the input item. The examples given below, unless otherwise specified, are responses to the (Low-F) input item *egron* ‘thesaurus’ (cf. the root `-g-r ‘amass’).

Structurally Related: Responses that related to the input item structurally by the following criteria:

- (1) Morphological – shared consonantal root (e.g., *igéret* ‘missive’ -- a high-register term for ‘letter’), derived from the same root as the input item, `-g-r.
- (2) Morphophonological – either a shared morphological pattern or prosodic template (e.g., *ikaron* ‘principle’) or phonological relation of rhyming or suffix (e.g., *patron* ‘patron’).

Semantically Related: Responses related to the input item by meaning, as follows:

- (1) Closely related, a near synonym or an expression defining the input item (e.g., *ósef munaxim* ‘a collection-of terms’).
- (2) Partially related to the input item (e.g., *adam ha-bodek et ha-safa u-metaken ota* ‘a person who checks and corrects the language’).
- (3) Vaguely related to the input item (e.g., *otiyot* ‘letters’).
- (4) Contextual – a response clearly indicating that the respondent related only to the sentential context rather than to the input item itself (e.g., *šóni* ‘difference’ for the input item *dmiyut* ‘resemblance, similarity between items’ – on the basis of the sentence: *ramat ha-dmiyut ben axim shona mi-mišpaxa le-mišpaxa* ‘the level of resemblance between siblings differs from one familiar to the next’).

Semantically plus Structurally Related – responses that related both semantically and structurally to the input item as follows:

- (1) Closely related semantically to the input item (e.g., *ma`agar šel milim* ‘a pool of words’), and also structurally related, since the word *ma`agar* is derived from the root *`-g-r* of the input item.
- (2) Distantly related semantically to the input item (e.g., *iš šemexalec anašim bemikre xerum* ‘someone who rescues people in case of emergency’ to the input item *xalécet* ‘rescue boat’).

Miscellaneous – this category included the following responses:

- (1) No response.
- (2) Irrelevant response (e.g., *xalukat de’ot, de’ot šonot* ‘division-of opinions, different opinions’ – both given by the same respondent).
- (3) Semantically mediated responses -- in the sense detailed in Section 4.1 below, e.g., *mixtav* ‘(a) letter’, a synonym of the noun *igéret* ‘missive’, derived from the same root as the input item.

Coding of this task was performed by two persons working together, the author and a graduate student majoring in linguistics. The degree of semantic relatedness of the responses had to be agreed on by both coders, and in case of discrepancies, a third person, another research assistant, was called in to resolve the disagreement.

3.2. Findings

Figure 6 shows the overall distribution of a total of over two thousand responses [N=2,648] to 20 nouns in the Interpretation-in-Context Task, in terms of the four different response categories specified in the preceding section.

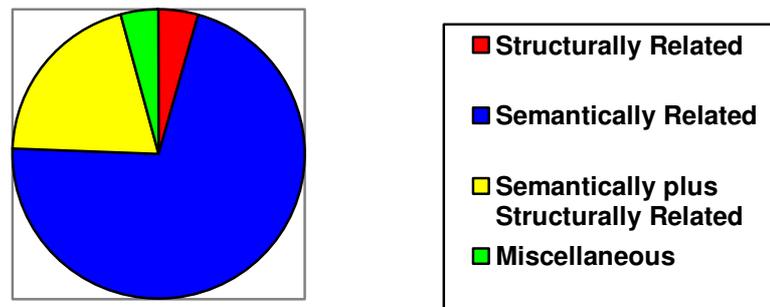


Figure 6: Overall Distribution of Responses on Interpretation in Context across the Population [N= 2,648]

As Figure 6 shows, the overwhelming majority of the responses, almost three-quarters (71.3%) were Semantically Related, followed by one-fifth Semantically plus Structurally Related responses (20.1%), with other types of responses taken together accounting for under 10%, including Structurally Related (4.4%) and Miscellaneous (4.3%).

The independent variables of Root, Concreteness and Age had significant effects on the results, depicted in Figures 7, 8, and 9 respectively, with response-types labeled as follows: Str=Structurally Related; Sem=Semantically Related; Semstr=Semantically plus Structurally Related; Mis=Miscellaneous.

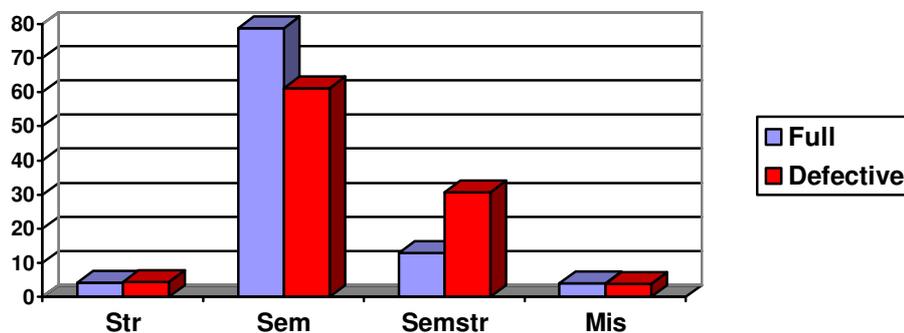


Figure 7: Effect of Root on Overall Responses to Interpretation in Context

A chi-square test for independent samples revealed significant effects for

Root ($\chi^2(4, N= 2648)= 129.527, p<.001$) as follows: Nouns derived from Full Roots yielded relatively more Semantically Related responses while nouns derived from Defective Roots yielded relatively more responses that were both Semantically and Structurally related.

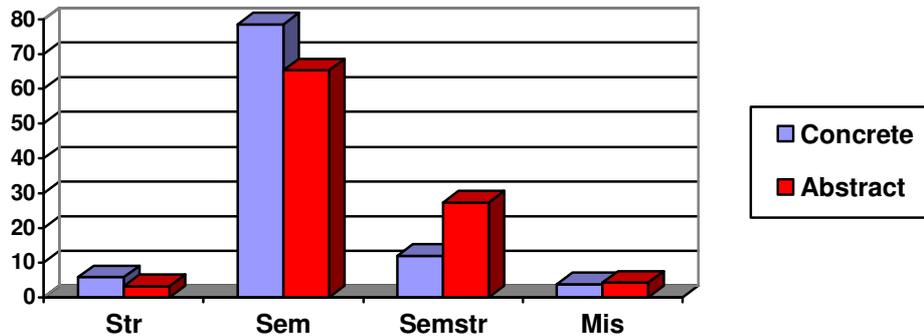


Figure 8: Effect of Concreteness on Overall Responses to Interpretation in Context

A chi-square test for independent samples revealed significant effects for Concreteness ($\chi^2(4, N= 2648)= 111.03, p<.001$) as follows: Concrete nouns yielded more Semantically Related responses than Abstract nouns while the latter yielded relatively more responses that were both Semantically and Structurally related.

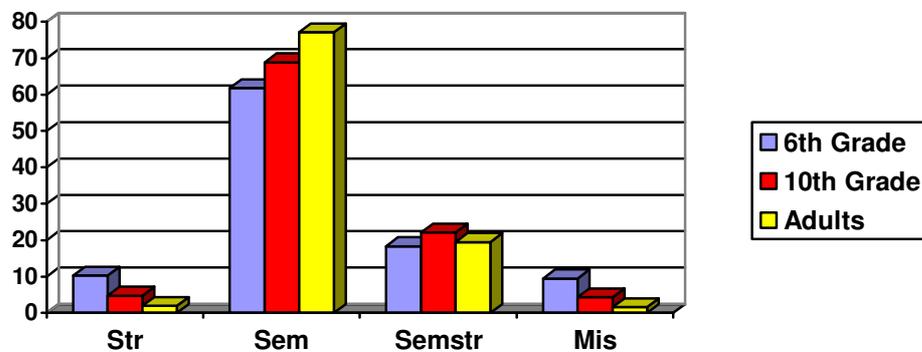


Figure 9: Effect of Age on Overall Responses to Interpretation in Context

A chi-square test for independent samples revealed significant effects for Age ($\chi^2(8, N= 2648)= 141.478, p<.001$) as follows: The proportion of Semantically Related responses increased gradually with Age, while the proportion of Structurally Related and inadequate, Miscellaneous responses decreased gradually with Age.

As for interactions between the independent variables, chi-square tests revealed interactions between Age and Root and Age and Concreteness as shown in tables 14 and

15 -- with responses labeled as follows: Str=Structurally Related; Sem=Semantically Related; Semstr=Semantically and Structurally Related; Mis=Miscellaneous.

Table 14 shows the interaction in percentage of responses between Age and Root Transparency (6th Grade, no significance, 10th Grade, χ^2 (3, N= 2648)= 72.547, $p<.001$, Adults, χ^2 (3, N= 2648)= 61.102, $p<.001$).

Type of Response	Full Roots				Defective Roots			
	Str	Sem	Semstr	Mis	Str	Sem	Semstr	Mis
6 th Grade	10.4	66.8	15.4	7.4	10.8	58.1	23.6	7.4
10 th Grade	4.6	79.2	12.7	3.6	4.9	53.7	37.3	4.0
Adults	1.9	84.4	12.2	1.5	1.9	67.0	29.6	1.5

Table 14: Interaction Age X Root Type, Interpretation in Context

This table shows that 6th Graders do not differentiate markedly between Full and Defective Roots in their responses, a picture that changes among 10th Graders and Adults, who prefer Semantically Related response for Full Roots and Semantically plus Structurally related responses for Defective Roots.

Table 15 shows the interaction in percentage of responses between Age and Concreteness (6th Grade, χ^2 (4, N= 2648)=17.223, $p<.01$, 10th Grade, χ^2 (4, N= 2648)= 68.086, $p<.001$, Adults, χ^2 (4, N= 2648)=36.817, $df=4$, $p<.001$).

Type of Response	Concrete				Abstract			
	Str	Sem	Semstr	Mis	Str	Sem	Semstr	Mis
6 th Grade	12.6	66.4	11.8	9.3	8.4	57.8	24.0	9.9
10 th Grade	7.7	77.3	10.7	4.4	2.0	61.3	32.4	4.3
Adults	1.8	84.3	12.7	1.2	1.9	70.9	25.4	1.9

Table 15: Interaction Age X Concreteness, Interpretation in Context

Table 15 shows that both types of input nouns yielded a gradual Age-related increase in proportion of Semantically Related responses, and a concomitant decrease in the Structurally Related response, more markedly for Abstract nouns. Semantically Related responses yielded a higher proportion and a sharper Age-related rise for Concrete than for Abstract nouns.

The two major categories of responses, Semantically Related and Semantically plus Structurally Related, were further analyzed. Figure 10 shows the overall distribution of the Semantically Related responses.

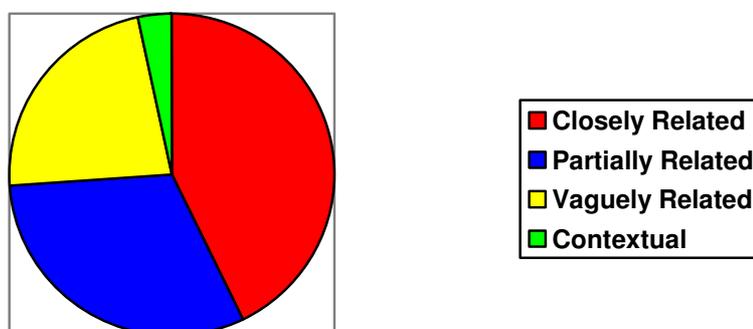


Figure 10: Overall Distribution of Semantically Related Responses on Interpretation in Context [N=1888]

The subcategory of “Closely Related” accounted for the majority of Semantically Related responses (42.9%), followed by Partially, and Vaguely Related responses (30.9% and 22.8% respectively), and Contextual (3.4%) responses.

The independent variable of Age had an effect on the distribution of the semantically related responses. Figure 11 describes the effect of Age with response-types labeled as follows: Close=Closely Related; Part=Partially Related; Vague=Vaguely Related; Cont=Contextual.

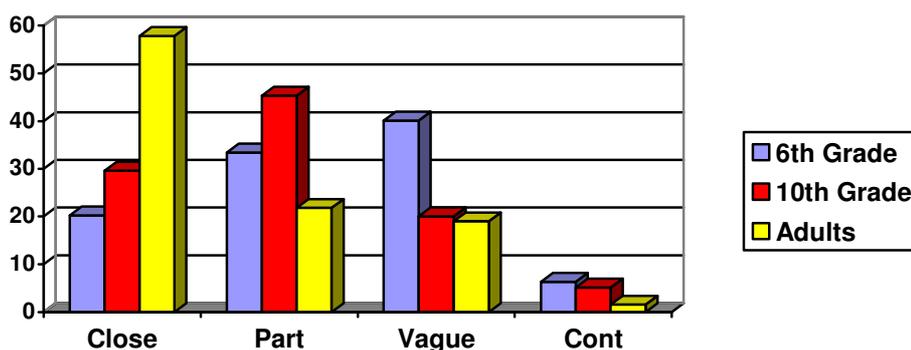


Figure 11: Effect of Age on Semantically related Responses to Interpretation in Context

A chi-square test for independent samples revealed significant effects for

Age ($\chi^2(6, N= 1888)=252.111, p<.001$) as follows: The proportion of Closely Related responses increased with Age while the proportion of Vaguely Related and Contextual responses decreased with Age.

As for interactions, chi-square tests revealed interactions between Age and Root and between Age and Concreteness for the semantically related responses, as shown in tables 16 and 17 – with response-types labeled as follows: Close=Closely Related; Part=Partially Related; Vague=Vaguely Related; Cont=Contextual.

Table 16 shows the interaction in percentage of responses between Age and Root Transparency (6th Grade, $\chi^2(3, N= 1888)= 33.656, p<.001$, 10th Grade, $\chi^2(3, N= 1888)= 105.163, p<0.001$, Adults, $\chi^2(3, N= 1888)= 71.155 p<0.001$).

Type of Response	Full Roots				Defective Roots			
	Close	Part	Vague	Cont	Close	Part	Vague	Cont
6 th Grade	10.6	36.7	47.2	5.5	36.4	28.0	28.0	7.6
10 th Grade	21.3	58.8	17.5	2.5	48.9	14.4	25.9	10.9
Adults	48.5	26.9	23.6	0.9	74.0	12.7	10.8	2.5

Table 16: Interaction Age X Root Type in the Semantically Related Responses, Interpretation in Context

The main observation emerging from Table 16 is that Full Roots allowed participants to employ a variety of response strategies, both Semantically Related and unrelated, while Defective Roots caused them to prefer highly Semantically Related response. This trend for differentiation between Full and Defective roots with relatively more semantic freedom manifested in the interpretation of Full Roots consolidates with Age.

Table 17 shows the interaction in percentage of responses between Age and Concreteness (6th Grade, $\chi^2(3, N= 1888) = 76.659, p<.001$, 10th Grade, $\chi^2(3, N= 1888)= 53.540, p<.001$, Adults, $\chi^2(3, N= 1888)= 45.931, p<.001$).

Type of Response	Concrete				Abstract			
	Close	Part	Vague	Cont	Close	Part	Vague	Cont
6 th Grade	37.3	33.5	20.9	8.2	3.1	33.3	59.1	4.4
10 th Grade	38.0	35.3	17.5	9.2	20.3	56.5	22.9	0.4
Adults	55.6	16.6	24.8	3.0	60.0	27.0	13.0	0.0

Table 17: Interaction Age X Concreteness in the Semantically Related Responses, Interpretation in Context

Table 17 shows the following interactions: For Concrete nouns there is (1) a marked increase in the amount of Closely Related responses between 6th and 10th Grade, (2) a decrease in the use of Contextual responses between 10th Grade and Adults, and (3) a relatively wide distribution of the other responses. For Abstract nouns, the picture is different, with (1) a marked increase in the Closely Related responses with Age, (2) little reliance on Contextual clues, used only by the youngest Age group, and (3) a preference for more Semantically Related responses, mainly in the two older Age groups.

The next analyses describe the effects of the independent variables on the Semantically plus Structurally Related responses. Figure 12 describes Age effects on the distribution of the Semantically plus Structurally Related responses [N=537] with response- types labeled as follows: Close=Closely Related; Dist=Distantly Related.

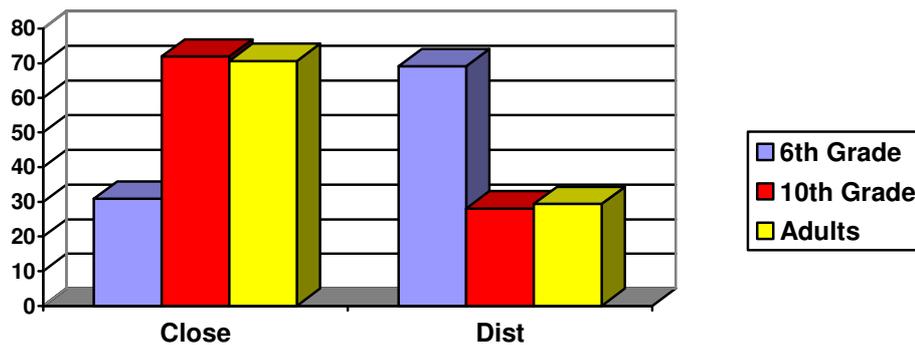


Figure 12: Effect of Age on Semantically plus Structurally Related Responses to Interpretation in Context

A chi-square test for independent samples revealed significant effects for Age ($\chi^2(2, N=537)=54.667, p<.001$) as follows: There is a marked increase in the proportion of Closely Related responses and a concomitant marked decrease in the

proportion of Distantly Related responses between 6th and 10th Grade.

As for interactions, chi-square tests revealed interactions between Age and Root and Age and Concreteness for the Semantically plus Structurally Related responses, as shown in tables 18 and 19 – with response-types labeled as follows: Close=Closely Related; Distant=Distantly Related.

Table 18 shows the interaction in percentage of responses between Age and Root Transparency (6th Grade, $\chi^2(1, N= 537)= 20.728$, $p<.001$, 10th Grade, $\chi^2(1, N= 537)= 62.59$, $p<.001$, Adults, $\chi^2(1, N= 537)= 138.635$, $p<.001$).

Relatedness	Full Roots		Defective Roots	
	Close	Distant	Close	Distant
6 th Grade	8.7	91.3	52.1	47.9
10 th Grade	35.9	64.1	90.9	9.1
Adults	26.1	73.9	96.3	3.8

Table 18: Interaction Age X Root Type in the Semantically plus Structurally Related Responses, Interpretation in Context

Table 18 shows similar effects to those in Table 16 above for Age X Root interactions in the Semantically plus Structurally related responses: (1) clear differentiation between Full and Defective Roots, (2) heavy reliance on semantic proximity for Defective Roots, and (3) relatively more semantic variability for Full Roots, a trend that intensifies with Age.

Table 19 shows the interaction in percentage of responses between Age and Concreteness (6th Grade, no significance, 10th Grade, $\chi^2(1, N= 537)= 15.842$, $p<.001$, Adults, $\chi^2(1, N= 537)= 42.702$, $p<.001$).

Relatedness	Concrete		Abstract	
	Close	Distant	Close	Distant
6 th Grade	25.0	75.0	33.3	66.7
10 th Grade	47.6	52.4	79.0	21.0
Adults	42.1	57.9	83.0	17.0

Table 19: Interaction Age X Concreteness in the Semantically plus Structurally Related Responses, Interpretation in Context

Table 19 shows that the Age related differentiation between Concrete and Abstract nouns is also apparent in the Semantically plus Structurally Related responses, but it is more marked in the 10th Grade and Adult groups, both of whom gave relatively far more Semantically Related responses to Abstract than to Concrete nouns.

These analyses of the results yielded a picture that could be defined as a hierarchical scale, as follows: (0) No response, (1) Irrelevant response, (2) Structurally but not Semantically Related response, (3) Semantically less related responses, with or without structural relatedness, and (4) Semantically more Related response, with or without structural relatedness. A two-way ANOVA was performed, with Age as a between-subjects factor and Concreteness as a within-subject factor. Main effects of Age were found ($F(2, 2634)=125.986, p<.001$) as follows: Adults scored the highest ($M=3.695, SD=0.594$) followed by 10th Graders ($M=3.531, SD=0.798$), and 6th graders scored the lowest ($M=3.076, SD=0.993$). A Scheffe post-hoc test revealed that the Adult group was significantly different from the other two groups. No main effects for Concreteness were found, but there was an interaction Age X Concreteness ($F(2, 2634)=9.480, p<.001$) as follows: 6th Graders scored higher on Concrete ($M=3.155, SD=1.069$) than on Abstract items ($M=2.996, SD=0.918$), while the other two Age groups showed the opposite trends: 10th Graders scored higher on Abstract ($M=3.617, SD=0.741$) than on Concrete items ($M=3.443, SD=0.850$) and so did Adults -- Abstract ($M=3.770, SD=0.571$) versus Concrete ($M=3.619, SD=0.808$). This result explains the lack of main effects of Concreteness, which were neutralized by the inverse results of 6th Graders as against the two other Age groups.

3.3. Summary and Interim Discussion

This task was the only one in the battery that presented the input nouns in a sentential context. The first observation is that the presence of a context, however vague and unspecified, causes participants to favor semantic responses even to largely unfamiliar lexical items. This trend is in marked contrast to responses to items presented in isolation, as shown by results on the other tasks in the battery. Moreover, the age-related increase in preference for semantically based responses revealed by the interpretation-in-context task suggests that use of semantic cues for lexical interpretation constitutes a

more maturely appropriate strategy for Hebrew speaker-writers when encountering unfamiliar words in context.

The first independent variable – root transparency -- had two major impacts: (1) markedly less reliance on roots when there is context to rely on, and (2) a differential attitude towards unknown words from full and defective roots. Full roots promote a more venturesome attitude to interpreting an unfamiliar word, in the form of attempts to guess its meaning on the basis of its consonantal root elements, without concern for semantic relatedness. Defective roots, in contrast, elicit a more conservative attitude, with stricter adherence to the closest semantic interpretation of each specific root. This differential strategy, of using the full root as an anchor for further searches and of limiting the scope of the search in the case of defective roots, interacts with age, since these differences are more marked in the older age-groups.

The second independent variable -- concreteness -- had widespread effects on the results of the interpretation-in-context task, including an interaction with age. Overall, the “concreteness effect” -- traditionally interpreted as representing an advantage of concrete over abstract nouns – did not emerge in the task of interpreting unfamiliar nouns in context, but instead yielded rather differential strategies in approaching concrete and abstract nouns respectively. Thus, respondents throughout preferred more purely semantic interpretations for concrete nouns and relied more on structural in addition to semantic clues in interpreting abstract nouns. The expected advantage of concrete items was evident only in the semantically related responses of the youngest group of participants, the 6th graders, who provided more near synonyms to concrete than to abstract nouns.

Finally, the variable of age affected the results significantly, interacting with all the other independent variable. There was an age-related increase in the semantic and near synonymous responses, with a concomitant age-related decrease in structurally related and in semantically less related responses. Another developmental finding was a growing differentiation between full and defective roots and between concrete and abstract words with age.

In sum, the requirement of interpreting unfamiliar lexical items in pragmatically, semantically, and syntactically appropriate but non-definitional sentential contexts yields

striking results in terms of all the variables of this study. As such, this task contributes to our understanding of the special challenge posed to speaker-writers when encountering unfamiliar words in general, and in the Hebrew lexicon in particular, by complementing findings from other tasks on this battery where words were presented in isolation.

4. Free Associations -- Single

This task required respondents to provide a single free association to each noun in a given set of nouns. The task had 60 items, divided as follows: 40 items selected from the Familiarity/Frequency database, 24 nouns with Full Roots and 16 with Defective Roots, half of the 40 with High-F and the other half with Low-F scores; and the remaining 20 items were selected from the Concreteness subset -- 10 Concrete and 10 Abstract, half of each High-F and half Low-F.

The statistical analyses employed in this task were χ^2 tests, since both the dependent and independent variables were nominal. In case of significant results, further χ^2 tests were performed in order to identify sources of interactions.

4.1. Coding Categories

Responses on the tasks of associations were coded in five major categories, each further divided into sub-categories. The following types of relations were identified, as detailed below: Semantic-Pragmatic, Morphological, Morpho-phonological, Syntagmatic and Other/ Miscellaneous.

Semantic-Pragmatic Associations

This heading refers to associations at the level of both word (semantics) and world (pragmatics) (see Chapter I, Section 1.3), subdivided as follows.

(1) **Categorially Related** associations were specified when a clear intensional relation in terms of canonic semantic categories like synonymy, antonymy, or hyponymy could be identified. For example, as synonyms -- the loan-word association *situ'acya* for the test-item noun *macav* 'position, state, situation', *meheymanut* 'reliability' for *aminut* 'credibility'; as an antonym -- *néfeš* 'soul, spirit' for the test-item *xomer* 'matter, substance, material'; and as a co-hyponym -- *adšot maga* 'contact lenses' for the test-

item *miškafáyim* ‘spectacles’. As these examples indicate, categorially related associations were most typically words in a single lexical sub-class (for example, abstract nouns or instruments).

(2) **Hierarchically Related** associations were typically in the form of a definition-like sentence, often introduced by a super-ordinate term (e.g., *mekom diyur betox binyan* ‘(a) place-of residence inside a building’ for the test-item *dira* ‘apartment’, *mašehu še-samim al ha-ecba* ‘something (you) put on your-finger’ was given in response to *ecba’on* ‘thimble’).

(3) **Semantic-Pragmatic-Frame Related** associations were ones based on contexts of use and world experience (e.g., *maškanta* ‘mortgage’ or *šeyna* ‘sleep’ (noun) for the test-item *dira* ‘apartment’).

(4) **Semantically Mediated** associations related only indirectly to the input noun; for example, the infrequent noun *ómen* ‘fidelity’ yielded such disparate associations as *cayar* ‘painter (artist)’ (cf. *oman, omanut* ‘artist, art’), *kiduš* ‘sabbath grace’ (cf. *emuna* ‘faith’), and also *yéled* ‘child’ (cf. *oménet* ‘nanny’). As these examples show, mediation in this case arose from the multiple homography of the shared root ‘-m-n. Morphophonological mediation is illustrated by a word like *histaklut* ‘looking, observation’ in response to *bonenut* ‘insight’ via the familiar word *hitbonenut* ‘meditation’, while phonological mediation occurs in the response *šéker* ‘lie, falsehood’ in association to the noun *blaya* ‘weathering, erosion’ mediated by the word *bdaya* ‘fiction, falsehood’ in the same morphophonological pattern.

Morphological Associations

Morphological associations were specified by words that **share a root** with the input noun; for example, in response to the noun *bicúa* ‘performance, execution’ – the related verb *levacéa* ‘to perform, execute’ from the root *b-c-‘* and also the semantically unrelated noun *béca* ‘greed’; in response to the noun *hesek* ‘inference’ – the related noun *maskana* ‘conclusion’ from the same root *n-s-q* and also the unrelated noun *masok* ‘helicopter’.

Morpho-phonological Associations

Three types of responses were classified as Morpho-phonological:

- (1) Responses that shared a partial or skeletal root with the input noun (e.g., *beyca* ‘egg’ to the noun *bicú’a* ‘performance, execution’).
- (2) Responses that shared the same pattern or prosodic template as the input noun (e.g., *kfic* ‘spring, coil’ to the noun *gdil* ‘tassel’).
- (3) Responses that rhymed with the input noun (e.g., *šablul* ‘snail’ to *xivlul* ‘rope barrier’).

Syntagmatic Associations

Responses were assigned to this category in cases where their relation to the input item was combinatory or collocational, as follows:

- (1) Productive, open-ended collocations, such as the adjective *tov* ‘good’ to the noun *bicúa* ‘performance, execution’ or the adjective *meruváxat* ‘spacious’ to the noun ‘*dira*’ ‘flat, apartment’ (with which it shows gender agreement, since both the noun and adjective are masculine in the first example, feminine in the second).
- (2) Formulaic, rote-learned collocations, for example, *lehaskir* ‘to let, for rent’ to the noun ‘*dira*’ ‘flat, apartment’, *haškafat olam* ‘world view, *Weltanschauung*’ from the noun *haškafa* ‘view, outlook’.

Miscellaneous

This residual category of associations was very mixed, consisting of inappropriate responses that could not be attributed to any of the other coding categories, as follows:

- (1) Idiosyncratic relations – associations that seemed unrelated in any conventional or obvious manner to the input noun, such as *rocéax* ‘killer, murderer’ to the input noun *bicúa* ‘performance, execution’, *réša* ‘evil’ in response to *xómeç* ‘vinegar’.
- (2) Misreading – this category consisted of associations based on another, usually a more familiar or common way of reading the string of symbols constituting the input noun. Misreadings occasionally involved ellipsis or metathesis of consonants, but were primarily due to inattention to the conventional vowel-pointing provided in the task. This kind of response demonstrates lack of familiarity on the part of native Hebrew speakers with normative vowel-pointing as discussed at some length in Chapter IV (Section 3.1), leading them to rely mainly on the consonants, and hence to misread the word. For example, the unfamiliar/infrequent, normatively derived noun *malkétet* ‘tweezers’ – an official coinage of the Academy of the Hebrew Language referred to in general usage by the loan-word *pinçéta* -- was read as the verb *melakétet* ‘collects’, hence yielding the

association *mazon* ‘food’, while the noun *góva* ‘height’ was misread as *gove* ‘(tax) collector’ to yield the word *misim* ‘taxes’ as an association.

(3) Sentential responses – some of the younger participants wrote sentences instead of giving an association, evidence for how difficult they found the task.

The coding process, as noted in the previous chapter, was long, multi-phased and typically prone to disagreements due to subjective variability among the judges. Interpretation of the results of this task was even harder with respect to individual inter-judge variation. Below are summarized the solutions eventually decided on to these differences.

- 1) As across the battery, spelling errors were ignored.
- 2) It was sometimes hard to distinguish, especially for abstract items with a high familiarity/frequency rating, between semantic-pragmatic frames, co-hyponymic responses, syntagmatic relations, and definitions (e.g., *yexólet* ‘ability’ for *bicúa* ‘performance’ could be either a synonym, a superordinate, or a syntagmatic response -- the latter as head of a compound noun). We therefore decided that associations would be coded as based on a semantic-pragmatic frame only when no other code could be assigned.

4.2. Findings

Responses on the Single Associations tasks are analyzed below, proceeding from an overall distribution of responses to effects of the independent variables and interactions, major types of responses, concluding with analysis by grammatical category. An integrative summary and interim discussion of these results is provided in Section 5.2, following results for the Multiple Associations task in Section 5.1.

Figure 13 shows the overall distribution of a total of over five thousand responses [N=5,266] to 60 nouns in the single-association task, in terms of the five different response categories specified in the preceding section.

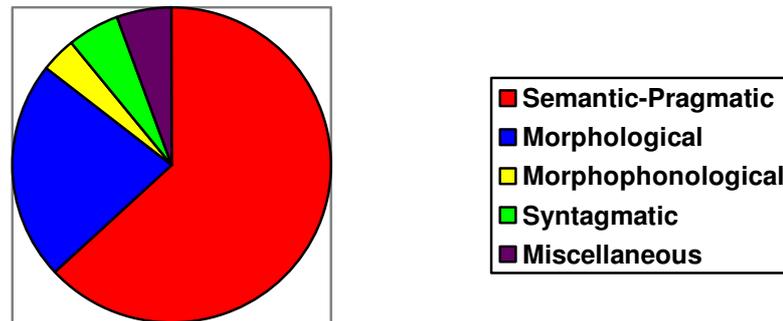


Figure 13: Overall Distribution of Responses on Single Associations across the Population [N= 5,266]

As Figure 13 shows, the majority of the overall responses, around two-thirds in all (63.3%) were Semantic-Pragmatic, followed by nearly one-quarter Morphological responses (22.7%), with other types of responses taken together accounting for under 10%, including Syntagmatic (5.4%) and Morphophonological (3.4%).

All of the independent variables – Root Transparency, Familiarity/Frequency, Concreteness, and Age -- had significant affects on the results on the Single-Associations task, described in Figures 14 to 17 respectively, with response-types labeled as follows: Sem=Semantic-Pragmatic; Mor=Morphological; Mph=Morphophonological; Syn=Syntagmatic; Mis=Miscellaneous.

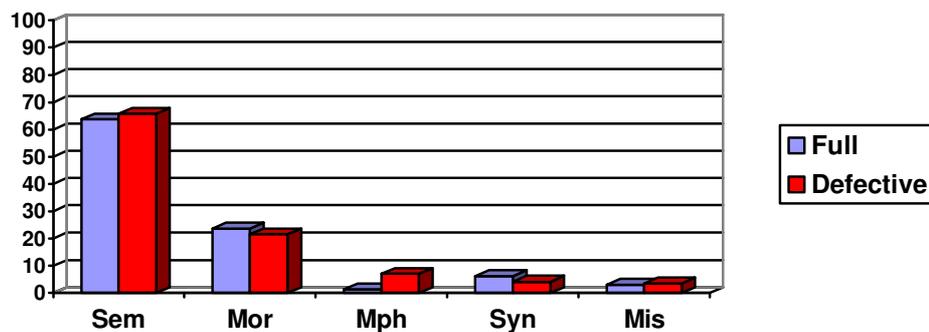


Figure 14: Effects of Root Transparency on Overall Responses to Single Associations

A chi-square test for independent samples revealed significant affects for Root Transparency ($\chi^2(4, N= 5,266)= 130.33, p<.001$) as follows: Nouns derived from Full Roots were given far more Morphological and Syntagmatic associations than nouns derived from Defective Roots, and the latter were given more Semantic-Pragmatic and Morphophonological associations than nouns derived from Full Roots.

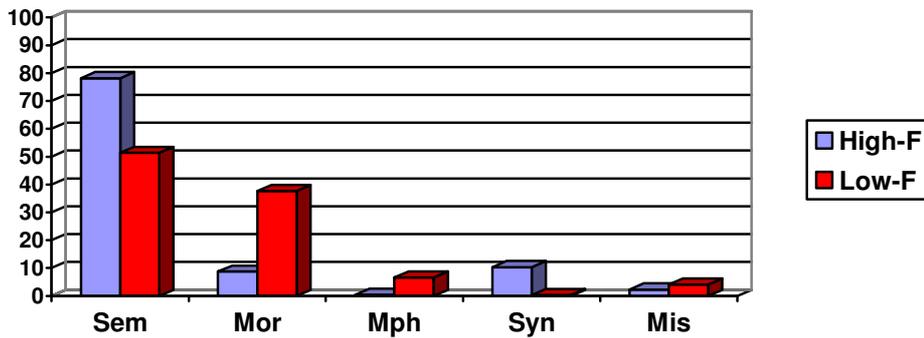


Figure 15: Effects of Familiarity/Frequency on Overall Responses to Single Associations

A chi-square test for independent samples revealed significant effects for Familiarity/Frequency ($\chi^2(4, N= 5,266)=1019.92, p<.001$), as follows: High-F input nouns received significantly more Semantic-Pragmatic and Syntagmatic associations than Low-F nouns and Low-F nouns received significantly more Morphological and Morphophonological associations than High-F nouns.

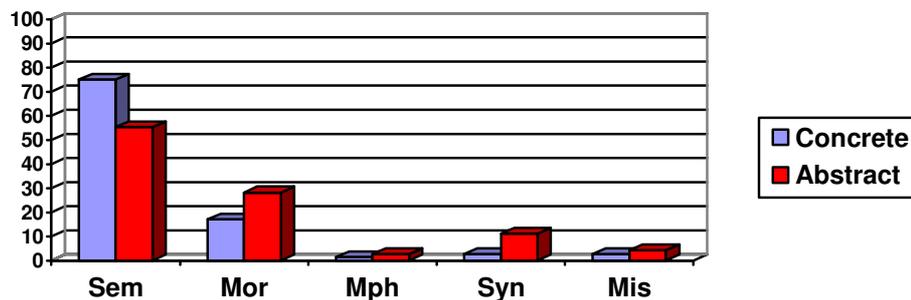


Figure 16: Effect of Concreteness on Overall Responses to Single Associations

A chi-square test for independent samples revealed significant effects for Concreteness ($\chi^2(4, N= 5,266)=104.464, p <.001$) as follows: Concrete nouns received clearly more Semantic-Pragmatic associations than Abstract nouns, while Abstract nouns received far more Morphological and Syntagmatic associations than Concrete nouns.

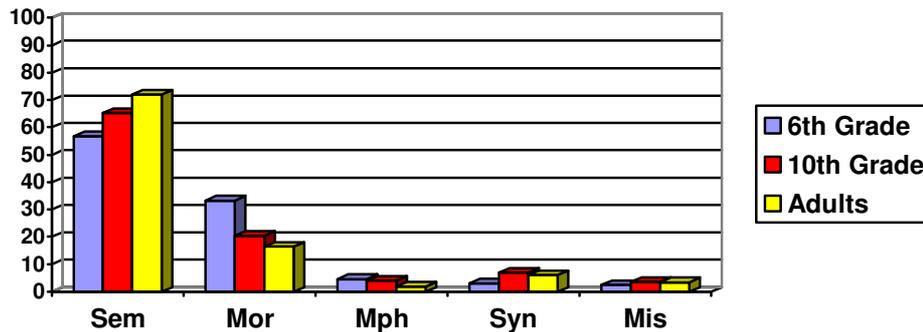


Figure 17: Effect of Age on Overall Responses to Single Associations

A chi-square test for independent samples revealed significant effects for Age ($\chi^2(8, N= 5,266) =93.217, p <.001$) as follows: There was a marked increase in Semantic-Pragmatic and Syntagmatic associations with age, accompanied by an Age-related decrease in Morphological and Morphophonological associations.

As for interactions between the independent variables, χ^2 tests revealed interactions between Age and all three independent variables of Root, Familiarity/Frequency, and Concreteness, as shown in tables 20, 21, and 22 – with response-types labeled as follows: Sem=Semantic-Pragmatic; Mor=Morphological, Mph=Morphophonological, Syn=Syntagmatic, Mis=Miscellaneous

Table 20 shows the interaction in percentage of responses between Age and Root Transparency (6th Grade, $\chi^2(4, N= 5,266) =59.009, p<.001$, 10th Grade, $\chi^2(4, N= 5,266) =51.967, p<.001$, Adults, $\chi^2(4, N= 5,266) =32.693, p<.001$).

Type of Response	Full Roots					Defective Roots				
	Sem	Mor	Mph	Syn	Mis	Sem	Mor	Mph	Syn	Mis
6 th Grade	59.5	34.3	1.6	2.8	1.8	52.1	31.7	9.7	3.3	3.4
10 th Grade	66.4	20.7	1.5	7.9	3.5	63.1	20.0	8.0	5.2	3.7
Adults	70.7	17.6	0.7	7.4	3.6	74.1	14.6	3.8	4.1	3.5

Table 20: Interaction Age X Root Type, Free Associations -- Single

The effect of Root Transparency as depicted in Table 20 shows an interaction with Age as follows. **Full roots** yielded more Semantic-pragmatic associations in the two younger populations and more Morphological associations across the population. And there were more Syntagmatic associations in the two older age groups, showing a

gradual increase with Age. **Defective roots** yielded more Morphophonological associations than Full roots, with a gradual decrease with Age.

Table 21 shows the interaction in percentage of responses between Age and Familiarity/Frequency (6th Grade, $\chi^2(4, N= 5,266)=439.611, p<.001$, 10th Grade, $\chi^2(4, N= 5,266)=388.911, p<.001$, Adults, $\chi^2(4, N= 5,266)=314.172, p<.001$).

Type of Response	High-F					Low-F				
	Sem	Mor	Mph	Syn	Mis	Sem	Mor	Mph	Syn	Mis
6 th Grade	76.8	15.7	0.8	5.1	1.7	30.3	56.6	9.7	0.1	3.3
10 th Grade	76.8	6.2	0.4	13.6	3.0	53.9	34.2	7.4	0.3	4.2
Adults	81.0	4.3	0.0	12.3	2.3	63.8	27.5	3.6	0.4	4.7

Table 21: Interaction Age X Familiarity/Frequency, Free Associations -- Single

Table 21 shows that High F nouns yielded a gradual increase in proportion of Semantic-Pragmatic associations with Age and a concomitant gradual Age-related decrease in Morphological associations. For Low-F nouns, the difference between the Age groups was much more dramatic, with the youngest group of 6th Graders showing the lowest proportion of Semantic-Pragmatic associations and the highest proportion of Morphological associations.

Table 22 shows the interaction in percentage of responses between Age and Concreteness (6th grade, $\chi^2(4, N= 5,266)=20.525, p<.001$, 10th grade, $\chi^2(4, N= 5,266)=43.063, p<.001$, Adults, $\chi^2(4, N= 5,266)=59.648, p<.001$).

Type of Response	Concrete					Abstract				
	Sem	Mor	Mph	Syn	Mis	Sem	Mor	Mph	Syn	Mis
6 th Grade	63.1	30.0	3.5	0.3	3.1	51.7	37.1	2.5	6.3	2.5
10 th Grade	76.8	14.4	3.5	3.2	2.1	56.4	22.9	1.8	13.9	5.0
Adults	83.6	8.5	0.9	3.9	3.0	57.1	25.8	0.0	12.4	4.7

Table 22: Interaction Age X Concreteness, Free Associations -- Single

Table 22 shows that Concrete items revealed the following interaction with Age: There was a high proportion of Semantic-Pragmatic responses across the population, with a sharper rise with Age in this type of response to Concrete compared with Abstract

nouns. In contrast, Abstract nouns yielded far more Syntagmatic responses in the two older than in the youngest Age-group.

The two major categories of responses, Semantic-Pragmatic and Morphological, which taken together accounted for the bulk of the responses, were further analyzed.

Figure 18 describes the overall distribution of the **Semantic-Pragmatic responses**.

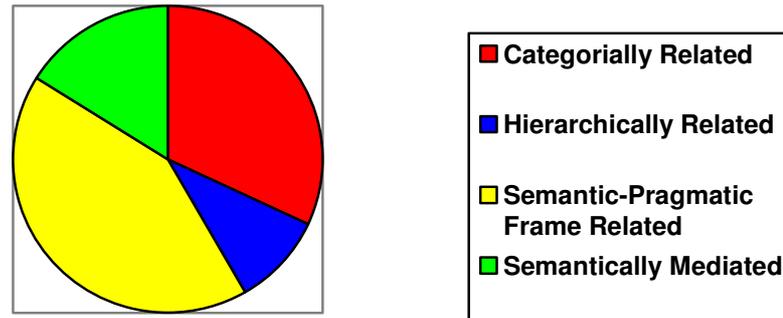


Figure 18: Overall Distribution of Semantic-Pragmatic Responses on Single Associations [N=3, 335]

The highest proportion of Semantic-Pragmatic responses (42.2%) were Semantic-pragmatic Frame-related, followed by Categorially Related (31.9%), Semantically Mediated (16.2%), and Hierarchically Related responses (9.7%). Moreover, all four independent variables – Root Transparency, Familiarity/Frequency, Concreteness, and Age -- had significant effects on the results on the semantic- pragmatic responses, as described below in Figures 19 to 22 respectively, with response-type labeled as follows: Cat=Categorially Related; Hie=Hierarchically Related; Fra=Semantic-Pragmatic Frame Related, Med=Semantically Mediated.

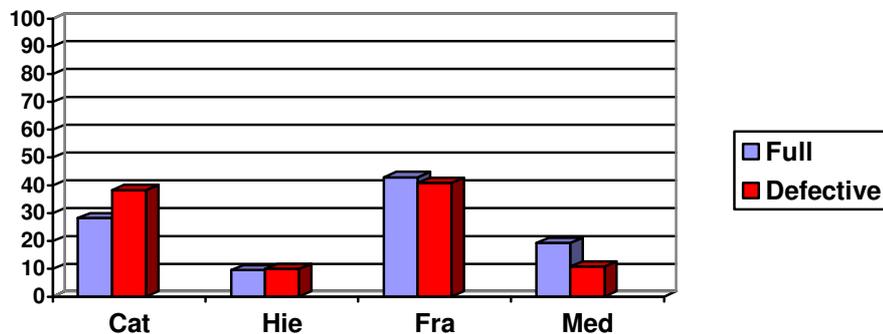


Figure 19: Effects of Root Transparency on Semantic-Pragmatic Responses to Single Associations

A chi-square test for independent samples revealed significant effects of Root ($\chi^2(3, N=3,335)=58.980, p <.001$) as follows: The main differences between Full and Defective roots were in two categories: Categorical Related and Semantically Mediated response. Defective Roots yielded more Categorical responses while Full Roots yielded more Mediated responses.

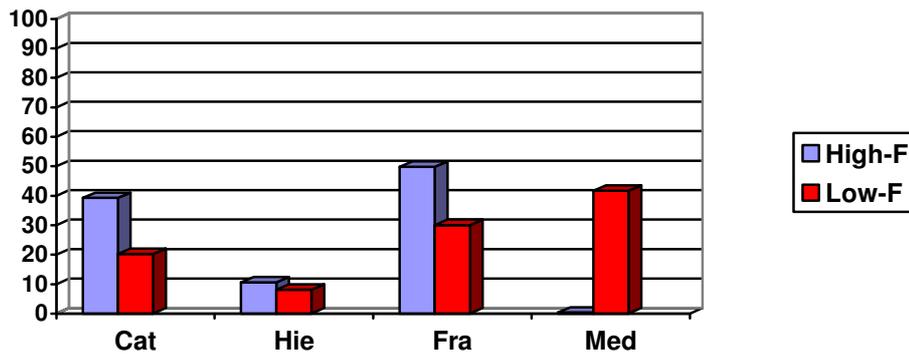


Figure 20: Effects of Familiarity/Frequency on Semantic-Pragmatic Responses to Single Associations

A chi-square test for independent samples also revealed significant effects of Familiarity/Frequency ($\chi^2(3, N=3,335)=980.659, p <.001$) as follows: High-F nouns yielded more Categorical and Semantic-pragmatic Frame Related responses, while Low-F nouns yielded mainly Semantically Mediated responses and fewer other types of responses compared to High-F nouns.

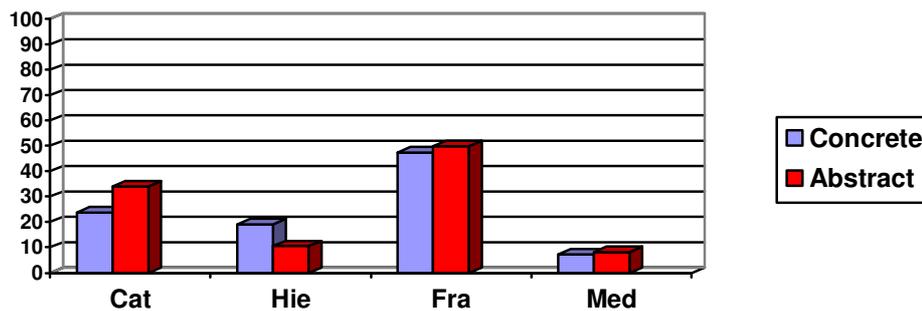


Figure 21: Effects of Concreteness on Semantic-Pragmatic Responses to Single Associations

A chi-square test for independent samples revealed significant effects of Concreteness ($\chi^2(3, N=3,335)=22.749, p <.001$) as follows: Concrete nouns yielded

more Hierarchically Related responses while Abstract nouns yielded more Categorically Related responses.

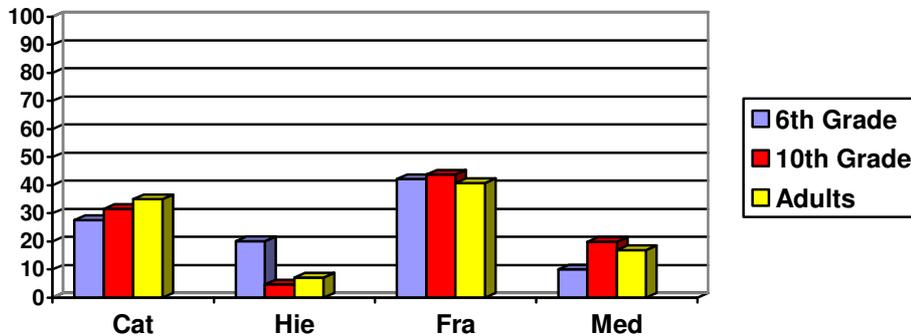


Figure 22: Effects of Age on Semantic-Pragmatic Responses to Single Associations

A chi-square test for independent samples likewise revealed significant effects of the fourth independent variable, Age ($\chi^2(6, N= 3, 335)= 173.512, p <.001$) as follows: The major differences between the Age groups in Semantic-Pragmatic associations are: (1) a gradual increase in Categorically Related responses with Age, (2) a sharp decrease in Hierarchically Related responses, accompanied by (3) an increase in Semantically Mediated responses between 6th and 10th Grade.

As for interactions between the independent variables, chi-square tests revealed interactions between Age and two of the independent variables: Root and Familiarity/Frequency. Tables 23 and 24 illustrate the interactions which emerged with response-type labeled as follows: Cat=Categorically Related; Hie=Hierarchically Related; Fra=Semantic-Pragmatic Frame Related; Med=Semantically Mediated.

Table 23 shows the interaction in percentage of responses between Age and Root Transparency (6th grade, $\chi^2(3, N= 3, 335)= 16.119, p<.005$, 10th grade, $\chi^2(3, N= 3, 335)= 25.064, p<.001$, Adults, $\chi^2(3, N= 3, 335)= 32.111, p<.001$).

Type of Response	Full Roots				Defective Roots			
	Cat	Hie	Fra	Med	Cat	Hie	Fra	Med
6 th Grade	23.6	19.9	45.2	11.3	35.7	20.5	36.0	7.8
10 th Grade	26.9	4.8	45.1	23.1	39.7	4.5	41.6	14.3
Adults	32.9	6.2	39.3	21.6	38.6	8.6	43.2	9.6

Table 23: Interaction Age X Root type in Semantic-Pragmatic Responses, Free Associations -- Single

Two major trends emerge from this table: (1) a sharp decrease in the use of Hierarchically Related responses with Age and (2) an interaction between Semantically Mediated responses and the two variables of Root and Age, with a higher proportion of such responses to words derived from Full Roots and a marked difference between the 6th Graders and the two older groups in reliance on this type of response.

Table 24 shows the interaction in percentage of responses between Age and Familiarity/Frequency (6th Grade, $\chi^2(3, N= 3, 335)= 325.828, p<.001$, 10th Grade, $\chi^2(3, N= 3, 335)= 381.97, p<.001$, Adults, $\chi^2(3, N= 3, 335)= 309.814, p<.001$).

Type of Response	High-F				Low-F			
	Cat	Hie	Fra	Med	Cat	Hie	Fra	Med
6 th Grade	31.4	20.2	48.1	0.3	14.4	19.7	21.3	44.7
10 th Grade	40.9	5.8	52.7	0.6	18.4	3.1	31.4	47.1
Adults	45.0	6.1	48.6	0.3	23.5	8.4	31.6	36.4

Table 24: Interaction Age X Familiarity/Frequency in Semantic-Pragmatic responses, Free Associations -- Single

Table 24 shows a gradual increase of Categorically Related response with Age and a marked difference between 6th Graders and the two other age groups in two respects: the youngest of the three Age groups revealed (1) a higher proportion of Hierarchically Related responses (as found before) and (2) for Low-F nouns, a relatively low proportion of Semantic-pragmatic Frame related responses.

Nearly one-third of the Semantic-pragmatic responses were characterized as “**Categorially Related**”. Figure 23 shows the internal composition of more than one thousand [N=1,045] Categorially Related responses to the Single Associations task.

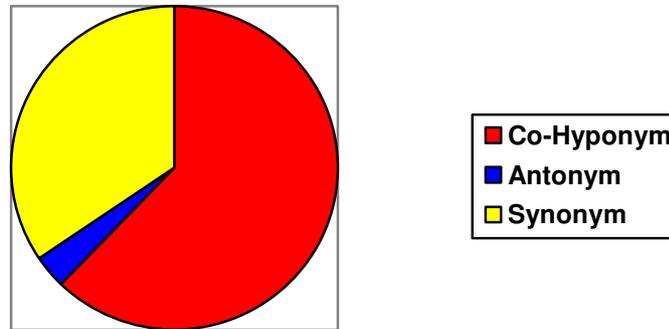


Figure 23: Overall Distribution of Categorially Related Responses on Single Associations [N=1045]

Co-hyponymic responses accounted for the majority of the categorially related responses (62.3%), followed by Synonyms (34.4%) and the residual category of Antonyms (3.3%).

To test the effect of the independent variables on the internal distribution of the Categorially Related responses, further analyses were conducted, which yielded the following results: Significant effects were found for the variables of Familiarity/Frequency, Concreteness, and Age, as depicted in Figures 24 to 26 respectively. Antonyms were not included in these analyses, since they were a very marginal category.

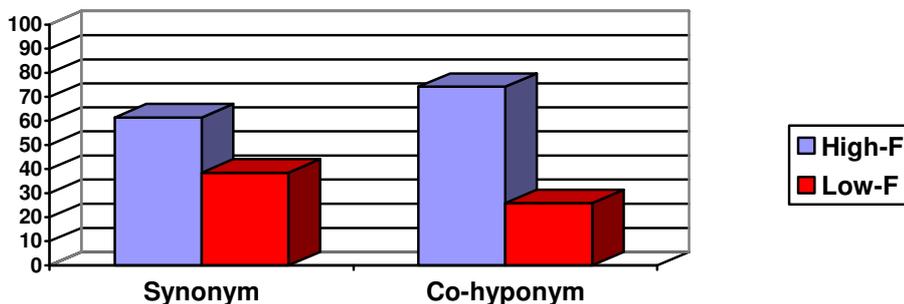


Figure 24: Effects of Familiarity/Frequency on Categorially Related Responses to Single Associations

A chi-square test for independent samples revealed significant effects of Familiarity/Frequency ($\chi^2(1, N= 1045)= 12.640, p <.001$) as follows: In the Categorially related responses, both High-F and Low-F nouns yielded more Synonyms than Co-hyponyms, but the difference was greater in the Low-F nouns.

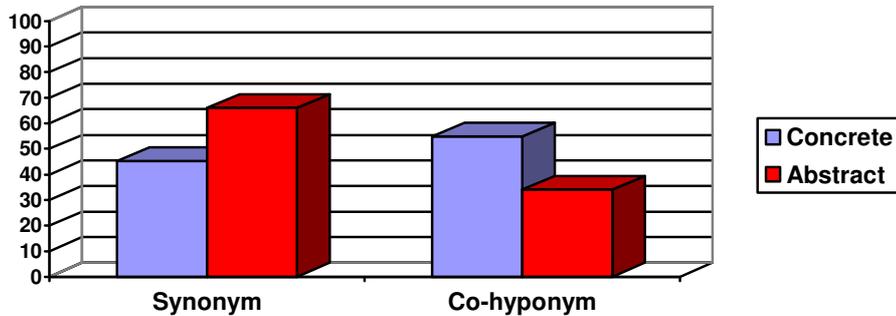


Figure 25: Effects of Concreteness on Categorially Related Responses to Single Associations

A chi-square test for independent samples revealed significant effects of Concreteness ($\chi^2(1, N= 1045)= 13.281, p <.001$) as follows: There was a marked difference between Abstract nouns, which yielded markedly more Synonyms and fewer Co-hyponyms, and Concrete nouns, which yielded more Co-hyponyms.

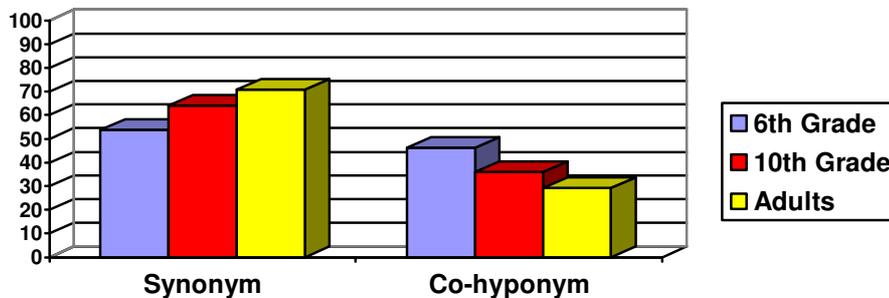


Figure 26: Effects of Age on Categorially Related Responses to Single Associations

A chi-square test for independent samples revealed significant effects of Age ($\chi^2(4, N= 1045)= 24.382, p <.001$) as follows: Figure 26 shows a gradual increase in Synonyms with a concomitant gradual decrease in Co-hyponyms with Age.

Moving to **Morphological responses**, which came to well over one thousand [N=1,196], Figure 27 describes their overall distribution.

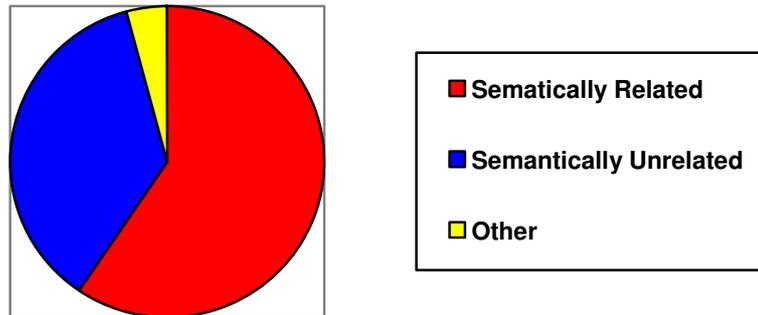


Figure 27: Overall Distribution of Morphological Responses on Single Associations [N=1,196]

Figure 27 shows that Semantically Related responses accounted for well over half (59.4%) of the Morphological, Root-related responses, followed by one-third (36.3%) responses with a shared Root but Semantically Unrelated. The other residual category, which accounted for less than 5% of the responses, included inflectional responses or responses with non-existent items or errors in root identification.

Examination of the effect of the independent variables on the Morphologically Related responses revealed significant effects for the independent variables of Root and Familiarity/Frequency, as detailed in Figures 28 and 29 respectively, with response-types labeled as follows: Rel=Semantically Related; Unrel=Semantically Unrelated

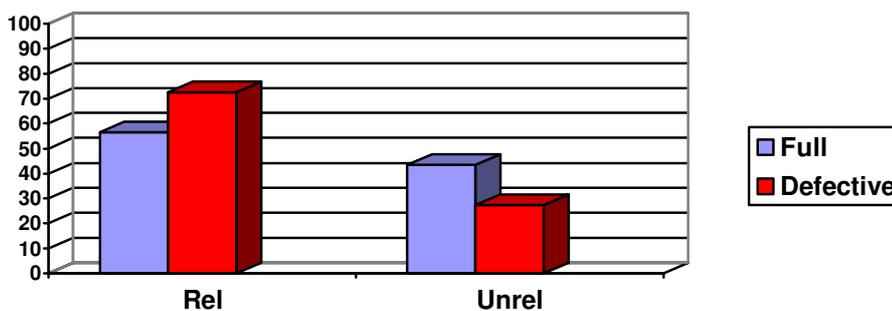


Figure 28: Effects of Root Transparency on Morphological Responses to Single Associations

A chi-square test for independent samples revealed significant effects of Root ($\chi^2(1, N= 1196)= 28.280, p <.001$) as follows: Full roots yielded a more balanced distribution of responses, while Defective roots yielded more Semantically Related than Semantically Unrelated responses.

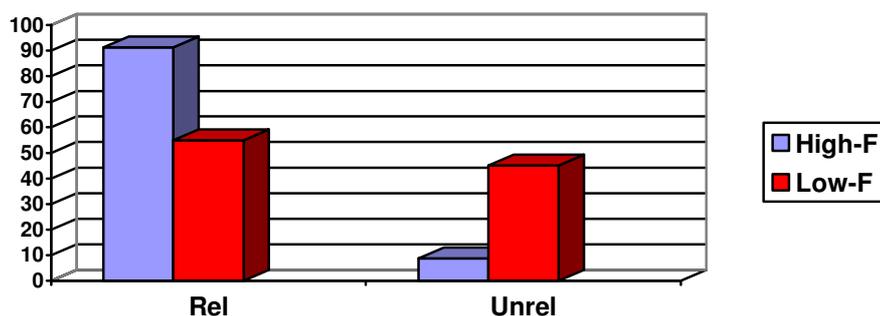


Figure 29: Effects of Familiarity/Frequency on Morphological Responses to Single Associations

A chi-square test for independent samples revealed significant effects of Familiarity/Frequency ($\chi^2(1, N= 1196)= 102.038, p <.001$) as follows: High-F nouns yielded more Morphologically and Semantically related responses, while Low-F nouns yielded more Morphologically Related but Semantically Unrelated responses.

As for the variable of Age, there was an interaction of Age with Familiarity/Frequency. Table 25 illustrates the interactions which emerged between Age and Familiarity/Frequency (6th Grade, $\chi^2(1, N= 1196)= 66.311, p<.001$, 10th Grade, $\chi^2(1, N= 1196)= 23.568, p<.001$, Adults, $\chi^2(1, N= 1196)= 20.491, p<.001$) as reflected in morphological responses on the Single-Associations task.

Type of Response	High-F		Low-F	
	Semantically Related	Semantically Unrelated	Semantically Related	Semantically Unrelated
6 th Grade	88.9	11.1	48.4	51.6
10 th Grade	92.6	7.4	58.0	42.0
Adults	97.4	2.6	59.8	40.2

Table 25: Interaction Age X Familiarity/Frequency in Morphological Responses, Free Associations -- Single

Table 25 shows: (1) a gradual increase in Semantically Related and a gradual decrease in Semantically Unrelated responses to Familiar/Frequent nouns with Age, and (2) a marked difference between the 6th Graders and the two older age groups in use of these two types of responses to Low-F nouns.

The last analysis conducted on the Single Associations task relates to the distribution of responses by Lexico-Grammatical Category. Figure 30 depicts the overall breakdown of responses analyzed on the Single Associations task into the categories of Nouns, Noun Phrases (including compound nouns), Verbs, and Adjectives.

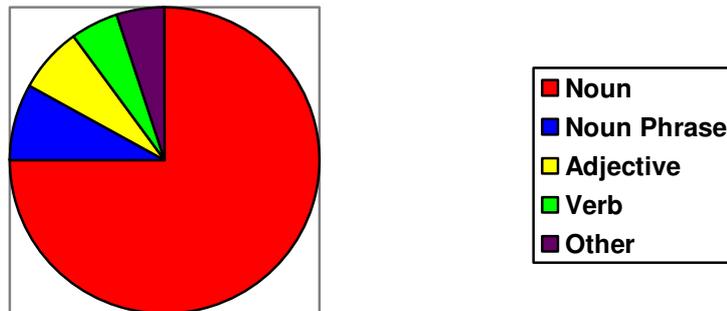


Figure 30: Overall Distribution of Responses on Single Associations by Lexico-Grammatical Category [N=5,266]

Figure 30 shows that the overwhelming bulk of Single Association responses were nominal in form, three-quarters (74.9%) in the form of single Nouns and another 8.1% as Noun Phrases or compounds nouns, with 7% Adjectives, and less than 5% (4.8%) in the form of Verbs.

Figure 31 shows the effect of Age on the distribution of responses to Single Associations by Lexico-Grammatical Category, with Noun Phrase response-type labeled NP.

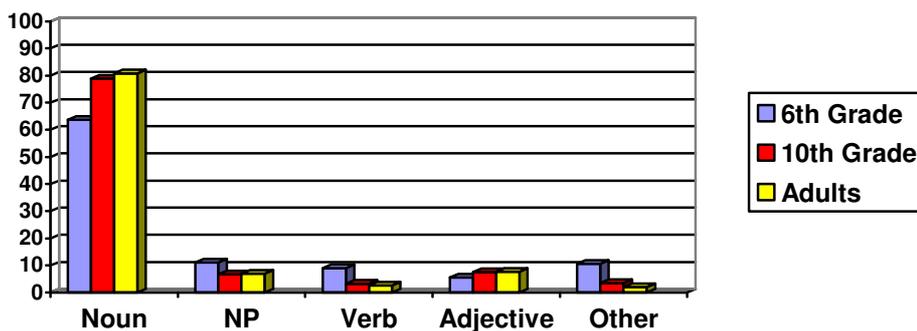


Figure 31: Effects of Age on Lexico-grammatical Category of Overall responses to Single Associations

A chi-square test for independent samples revealed significant effects of Age in relation to Lexico-grammatical Category ($\chi^2(10, N= 5,266)= 327.270, p<.001$) as follows:

Figure 31 shows a sharp Age-related increase in proportion of nominal responses from 6th to 10th Grade, with the youngest children giving relatively more verbal and idiosyncratic “other” type responses.

5. Free Associations -- Multiple

The Multiple Associations task required respondents to provide as many associations as they could to each of a given set of nouns. This task had 30 items, 20 from the familiarity/frequency database and 10 from the Concreteness subset. 20 items were selected from the familiarity/frequency database by the following criteria: 12 nouns were derived from Full Roots and the other 8 from Defective Roots; half of these nouns had High-F scores and the other half had Low-F scores. The other 10 items of the Concreteness subset were selected by the following criteria: five nouns were Concrete and the other five were Abstract; half of the items in this subset were High-F and half of them were Low-F. Responses on this task were analyzed by the independent variables of Type of Response and Lexico-Grammatical Category of responses, as for the Single Associations task and, in addition, by Number and Serial Order of responses.

Coding categories and procedures were identical to the ones applied in the Single Association task, as detailed in Section 4.1 above. Results (Section 5.1) are followed by an integrative summary and interim discussion of the findings of both the Single and Multiples Associations tasks (Section 5.2).

5.1. Findings

Responses on the Multiple Association tasks are analyzed below in two parts: Results are presented first for analyses similar to those performed on the Single Association based on all responses taken together, regardless of their serial order, followed by analysis of the innovative facet of this task compared with the Single Associations task -- Number and Order of associations.

Overall Findings

By and large, results on this task are highly consistent with findings for the Single Association task as described in the previous section. Accordingly, below are presented

only (1) major trends in the distributions and effects of responses on the Multiple Associations task and (2) results that differed markedly from those on the Single Associations task.

Figure 32 shows the overall distribution of more than 5,000 responses to 30 items [N=5,285] on the Multiple Association task, in terms of the five major types of responses specified in the preceding section.

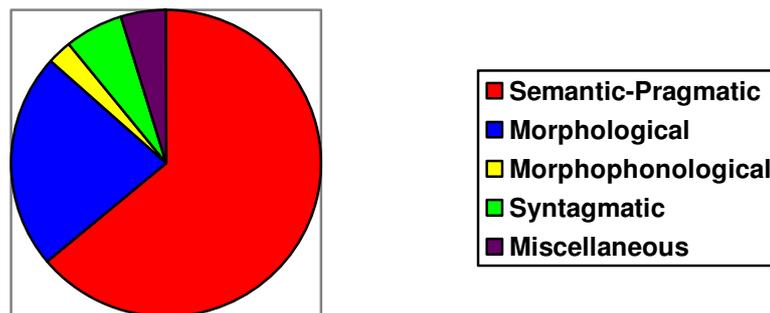


Figure 32: Overall Distribution of Responses on Multiple Associations across the Population [N=5,285]

As Figure 32 shows, the bulk of the overall responses, around two-thirds in all (64%) were Semantic-Pragmatic, followed by nearly one-quarter Morphological responses (22.6%), with other types of responses together accounting for under 10%, including Syntagmatic (6.2%) and Morphophonological (2.6%). Taken together, this yields a very similar picture to the one depicted in Figure 13 for the Single Associations.

As opposed to the Single Association task, not all of the independent variables had significant effects on the overall distribution of the results. Significant effects emerged for Root and Familiarity/Frequency but not for Concreteness and Age. The effect of Familiarity/Frequency, as the most salient effect, is considered further below. Figure 33 shows the effect of Familiarity/Frequency on overall responses on the Multiple Associations task, excluding the residual category of “Miscellaneous” with response-types labeled as follows: Sem=Semantic-Pragmatic; Mor=Morphological; Mph=Morphophonological; Syn=Syntagmatic.

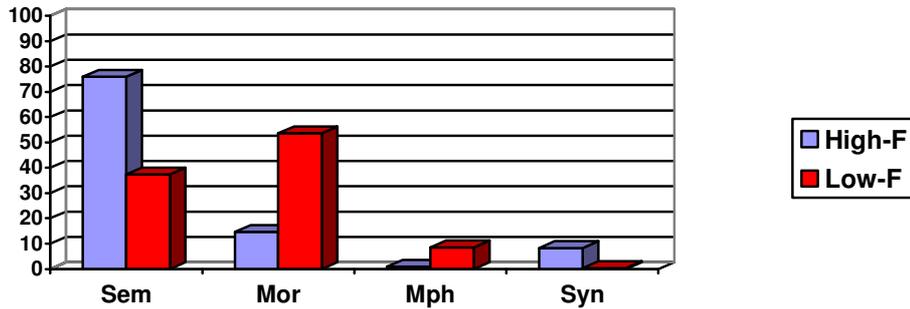


Figure 33: Effects of Familiarity/Frequency on Overall Responses to Multiple Associations

A chi-square test for independent samples revealed significant effects for Familiarity/Frequency ($\chi^2(3, N= 5,285)= 1055.413, p<.001$), as follows: High-F nouns received significantly more Semantic-Pragmatic and Syntagmatic associations than Low-F nouns, while Low-F nouns received significantly more Morphological and Morphophonological associations than High-F nouns.

As for interactions between Age and the other independent variables, χ^2 tests revealed an interaction between Age and the independent variables of Root and Familiarity/ Frequency and no interaction between Age and Concreteness. The interaction of Age and Familiarity/Frequency is shown in Table 26, with response-types labeled as follows: Sem=Semantic-Pragmatic; Mor=Morphological; Mph=Morphophonological; Syn=Syntagmatic.

Table 26 shows the interaction in percentage of responses between Age and Familiarity/Frequency (6th Grade, $\chi^2(3, N= 5,285)= 228.829, p<.001$, 10th Grade, $\chi^2(3, N= 5,285)= 397.004, p<.001$, Adults, $\chi^2(3, N= 5,285)= 462.134, p<.001$).

Type of Response	High-F				Low-F			
	Sem	Mor	Mph	Syn	Sem	Mor	Mph	Syn
6 th Grade	73.2	17.5	0.7	8.6	30.3	60	9.7	0.0
10 th Grade	76.9	15.2	0.5	7.4	30.9	58.8	10.1	0.3
Adults	76.8	13.0	1.3	8.9	43.1	49.1	7.3	0.5

Table 26: Interaction Age X Familiarity/Frequency, Free Associations -- Multiple

Table 26 shows that high-F nouns fail to reveal marked differences between the Age groups. On the other hand, low-F nouns showed a sharp increase in the use of Semantic-Pragmatic responses, accompanied by a sharp decrease in Morphological responses between the 6th and 10th Grade.

Moving to the Semantic-Pragmatic responses, which accounted for over three thousand responses [N=3,335], about two-thirds of the responses overall, their internal distribution is described in Figure 34.

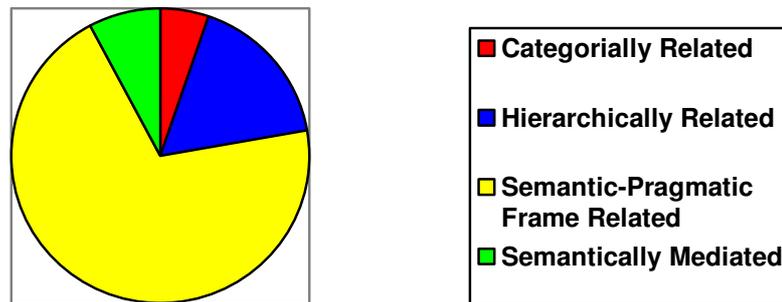


Figure 34: Overall distribution of Semantic-Pragmatic Responses on Multiple Associations [N=3,335]

As in the Single Associations task, the highest proportion of Semantic-Pragmatic responses (47.6%) were Frame Related, followed by Categorially Related (35.5%) responses. Unlike the Single Association task, however, Hierarchically Related responses (11.7%) followed, with Semantically Mediated responses yielding the lowest percentage of responses (5.3%).

All four independent variables – Root Transparency, Familiarity/Frequency, Concreteness, and Age -- had significant effects on the type of Semantic-Pragmatic responses, as was the case in the Single Associations task. The most salient effects, for Familiarity/Frequency and Concreteness, are detailed in Figures 35 and 36, with response-type labeled as follows: Cat= Categorially Related; Hie=Hierarchically Related; Fra=Semantic-Pragmatic Frame Related; Med=Semantically Mediated;

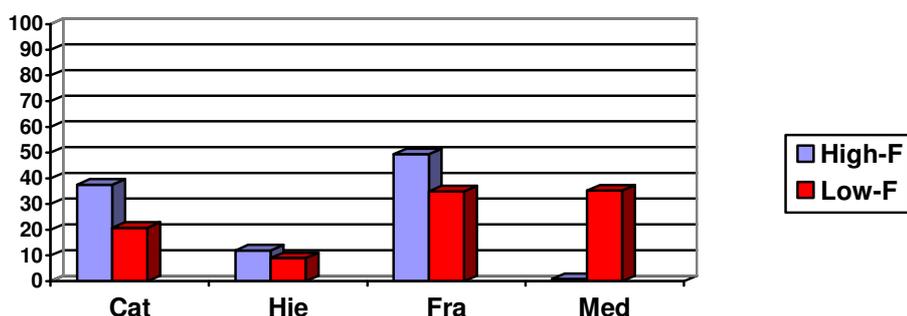


Figure 35: Effects of Familiarity/Frequency on Semantic-Pragmatic Responses to Multiple Associations

A chi-square test for independent samples revealed significant effects of Familiarity/Frequency ($\chi^2(3, N= 3,335 = 890.075, p <.001)$) as follows: High-F nouns yielded more Categorically and Frame Related Semantic Pragmatic responses, while Low-F nouns yielded mainly Semantically Mediated responses and fewer other types of responses compared to those with a high F score.

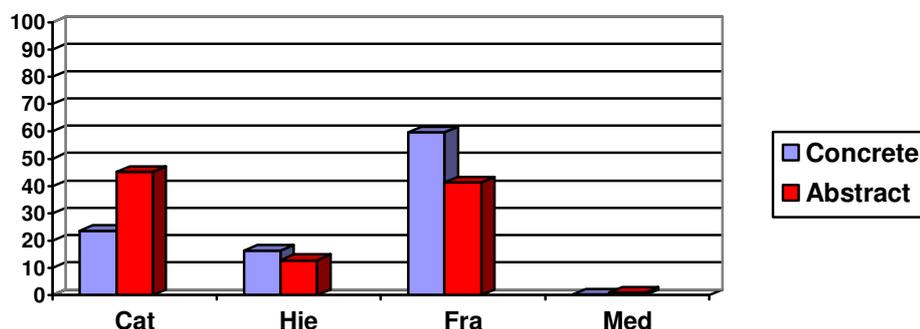


Figure 36: Effects of Concreteness on Semantic-Pragmatic Responses to Multiple Associations

A chi-square test for independent samples revealed significant effects of Concreteness ($\chi^2(3, N= 3,335)= 88.204, p <.001)$) as follows: Concrete nouns yielded mostly Frame Related responses, while Abstract nouns yielded more Categorically Related responses and fewer Frame Related responses.

As for **the internal composition** of Categorically related responses, their overall distribution was almost identical to those on the Single Associations task, thus: Synonyms accounted for almost two-thirds (60.6%), Co-hyponyms accounted for more

than one-third (38%), and the rest were Antonyms. Unlike the Single Associations task, there were not significant effects of Root, Familiarity/Frequency and Age on the internal distribution of the Categorially Related responses. A significant effect of Concreteness was found, as described bellow.

Figure 37 shows the effect of Concreteness on the distribution of Categorially Related responses on the Multiple Associations task. Antonyms were not included in this analysis, since here, too, they were few and far between.

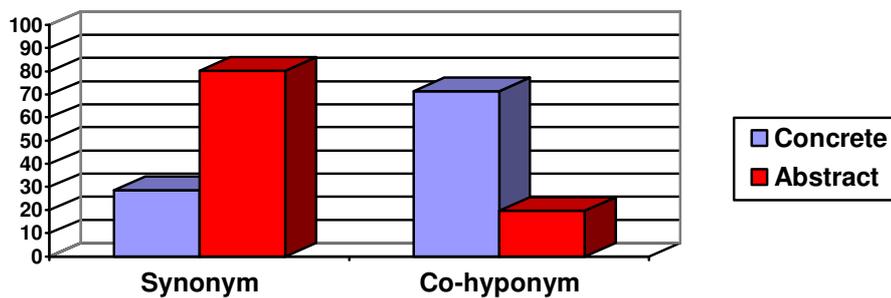


Figure 37: Effects of Concreteness on Categorially Related Responses to Multiple Associations

A chi-square test for independent samples revealed significant effects of Concreteness ($\chi^2(1, N= 1,199)= 141.339, p <.001$) as follows: As in the Single Associations task, there was a difference between Abstract nouns, which yielded markedly more Synonyms and fewer Co-hyponyms, and Concrete nouns, which yielded relatively far more Co-hyponyms. This contrast was far more marked, however, than in the Single Associations task.

Moving to **Morphological responses**, Figure 38 describes the overall distribution of over one thousand morphologically Root-based responses [N=1,192]

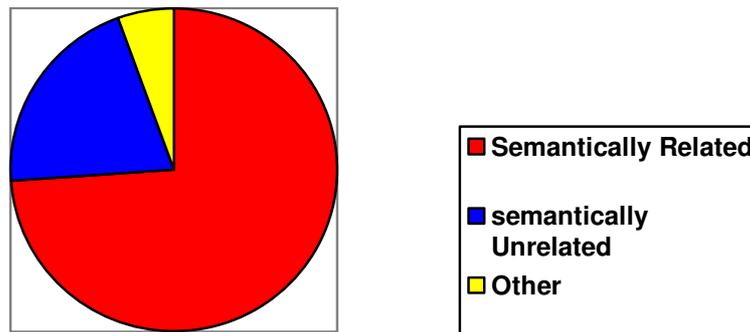


Figure 38: Overall Distribution of Morphological Responses on Multiple Associations [N=1,192]

Figure 38 shows that Semantically Related responses accounted for three-quarters (74%) of the Morphological, Root-related responses, followed by one-fifth (20.5%) responses that had a shared Root but were Semantically Unrelated. The other residual category, which accounted for less than 5% of the responses, included inflectional responses or responses with non-existent items or errors in root identification. These trends are similar to those found on the Single Associations task, but the proportion of Semantically Related morphological responses is higher by 20%, while the difference between Related and Unrelated responses is far more marked.

As for the effect of the independent variables on Morphologically related responses, unlike the Single Associations task, there were no effects for Familiarity/Frequency, but as in the Single Associations, there were significant effects of Root, again much more dramatic.

Figure 39 shows the effect of Root Transparency on the Morphological responses on the Multiple Associations task with response-types labeled as follows:

Rel=Semantically Related; Unrel=Semantically Unrelated

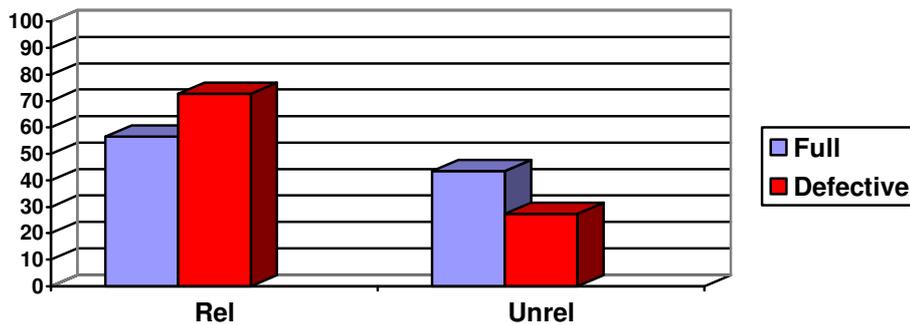


Figure 39: Effects of Root Transparency on Morphological Responses to Multiple Associations

A chi-square test for independent samples revealed significant effects of Root ($\chi^2(1, N= 1,192)= 61.097, p <.001$) as follows: Full Roots yielded a more balanced distribution of responses, while Defective Roots yielded more Semantically Related than Semantically Unrelated responses.

The distribution of responses on the Multiple Associations task by Lexico-grammatical Category was nearly identical to that of the Single Associations task and so will not be detailed here. The effect of Age on the overall distribution of Lexico-Grammatical Categories was also almost identical ($\chi^2(10, N= 5,285)=239.179, p<.001$), with a sharp Age-related increase in proportion of nominal responses from 6th to 10th grade, with the youngest children giving relatively more verbal and idiosyncratic “other” type responses.

Analyses by Number and Order of Responses

Number of responses on the Multiple Associations task ranged from 1 to 8, with a mean of 2.23 (SD=1.399), as shown in Figure 40.

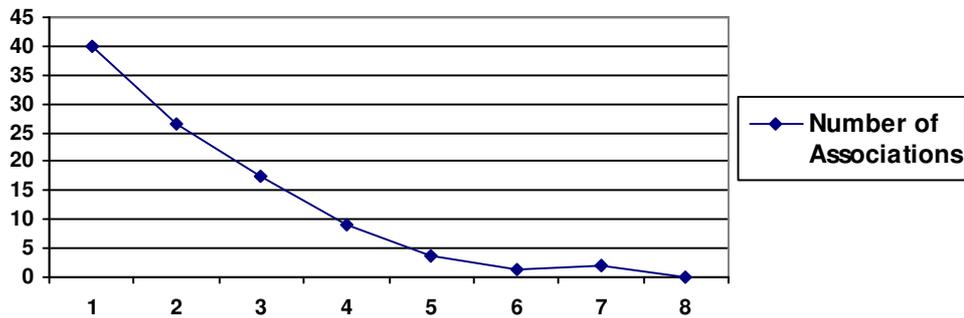


Figure 40: Distribution of Responses by Number on the Multiple Associations

Nearly 40% (39.8%) of the items on the task were given a single response, slightly more than a quarter (26.5%) were given two associations, while less than 20% yielded three associations (17.5%), and only around 15% of participants giving over 3 responses, with a proportional decrease in number of respondents giving 4 or more responses, such that the fewest participants gave the maximal number of 8 associations.

A T-test for independent samples revealed a significant effect of Frequency ($t(2347) = 5.39, p < .001$) as follows: High-F nouns received significantly more associations ($M = 2.33, SD = 1.477$) than Low-F nouns ($M = 1.95, SD = 1.133$).

A one-way ANOVA revealed a significant effect of Age ($F(2, 2346) = 217.139, p < .001$) as follows: Adults gave more associations ($M = 2.92, SD = 1.534$), 10th Graders gave fewer associations ($M = 1.98, SD = 1.179$), and 6th Graders gave the fewest ($M = 1.63, SD = 1.032$). Scheffe's post-hoc test revealed significant differences between all the Age groups. No significant effects were found for Root or Concreteness.

In order to avoid detailing all response types out of the total pool of over 5,000 associations, it was decided to confine analysis to the first three responses given by the adults. These accounted for as high as over two thousand (2,033) of the adults' responses, and so can be taken as representative of the range and type of associations in the well-established mental lexicon of mature Hebrew speakers. Figures 41, 42, and 43 show the overall distribution of results on the First, Second, and Third association of the adult population with response-types labeled as follows: Four semantically related response type as follows: Cat= Categorially Related; Hie=Hierarchically Related; Fra=Semantic-Pragmatic Frame Related; Med=Semantically Mediated; and the other

types of responses labeled as follows: Mor=Morphologically Related, Morsem=Morphologically plus Semantically Related; Mph=Morphophonological, Syn=Syntagmatic.

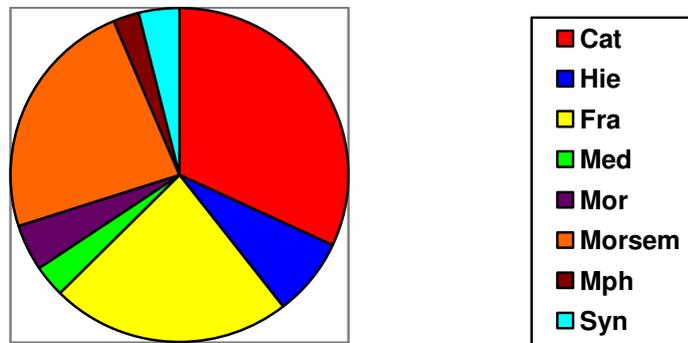


Figure 41: Distribution of First Associations Given by Adults by Response Types, Free Associations -- Multiple [N=857]

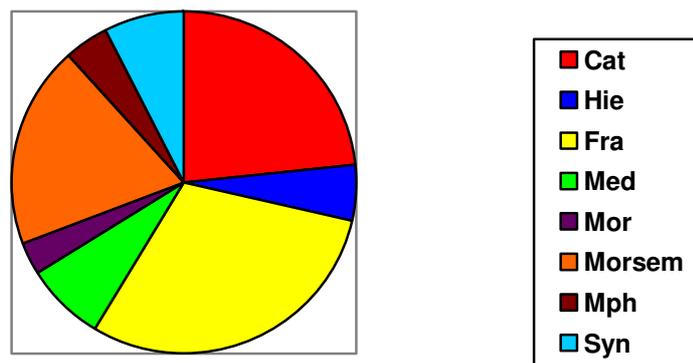


Figure 42: Distribution of Second Associations Given by Adults by Response Types, Free Associations -- Multiple [N=714]

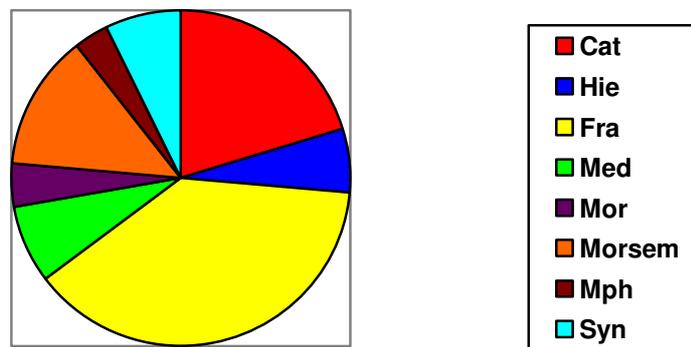


Figure 43: Distribution of Third Associations given by Adults by Response Types, Free Associations -- Multiple [N=462]

In sum, the responses to the Multiple Associations given by adults show two main changes in the internal distribution of associations between their first, second and third associations: (1) an increase in the proportion of Frame Related associations followed by a concomitant decrease in Categorially Related associations, and (2) a decrease in Morphologically plus Semantically related associations.

5.2. Summary and Interim Discussion – Association Tasks

This section provides an integrative summary and discussion of the results on the two associations tasks, Single and Multiple, taken together. Major trends are first reviewed, followed by consideration of the impact of the independent variables of Root, Familiarity/Frequency, Concreteness, and Age.

Summary of Main Findings - Association Tasks

- (1) Responses on the Single Association Task and on the Multiple Associations Task were largely congruent, demonstrating the high **internal reliability** of the experimental design applied here. However, analysis of the first, second, and third associations of the adult population revealed shifts in the relative weight of categories of responses as a function of the serial number of the association.
- (2) As in the tasks of Relatedness between words, two-thirds of the overall responses on both tasks were semantic-pragmatic, followed by almost a quarter of morphological responses, while morphophonological and syntagmatic responses accounted for less than 10% of the responses overall.
- (3) A closer inspection of the semantic-pragmatic category yields the following distribution: Almost half were frame-related, followed by categorially related, semantically mediated, and then hierarchically related responses. The categorially related responses manifested the following internal distribution: co-hyponymic responses accounted for the majority, followed by synonyms, and then by antonyms as a residual category.
- (4) All of the independent variables (Root, Familiarity/Frequency, and Concreteness and Age) had significant effects on the results, as follows.

Root Effects

Root transparency turned out to play an important role in the mental lexicon of Hebrew, as reflected by the tasks of Associations. First, nouns derived from full roots were given far more morphological and syntagmatic associations than nouns derived from defective roots, while the latter were given more semantic-pragmatic and morphophonological associations than nouns derived from full roots. This trend interacted with age in the following ways: (1) The difference was more marked in the two younger age groups; (2) there was a gradual increase with age in syntagmatic responses to full roots; and (3) there was a gradual decrease with age in morphophonological responses to defective roots.

Root transparency also had an effect in other respects as well, thus: (1) semantically mediated responses were commoner with nouns derived from full than defective roots; (2) categorially related responses were given to more nouns from full roots and mediated responses more to defective roots; (3) morphological responses showed particularly strong root effects in both the Single and Multiple Associations tasks, as follows: Full roots yielded a more balanced distribution between semantically related and unrelated responses, while defective roots yielded more semantically related than unrelated responses.

In sum, this complex picture of effects of interactions points to the **differential role** of full as against defective roots in the mental lexicon of Hebrew. Hebrew speaker-writers appear to treat full roots as an anchor or as solid ground for further psycholinguistic processes, such as root extraction, seeking other root-related words, or even providing a categorical or syntagmatic response more easily. Participants' morphologically related but semantically unrelated responses on the tasks of Associations reveals a "full root bias" that may lead Hebrew speakers to erroneous interpretations, based only on a shared skeletal root, as further discussed in Chapter IV (Section 2.1). Defective roots display a very different picture. First, Hebrew speakers are not sure about the three radical elements constituting the abstract historical root, and so shift to morphophonological responses, based on a distinct but superficially similar root and/or on a shared morphological pattern or prosodic template. Second, defective roots have a uniquely problematic status in the mental lexicon of Hebrew: On the one hand, words comprised of defective roots are recognized by Hebrew speakers-writers as

Hebrew words (unlike loan or foreign words) but, on the other hand, their root is phonologically opaque, hence ambiguous, so weakening the status of the word as a starting point for further psycholinguistic processing. This relative “weakness” or equivocal nature of the defective root restricts of Hebrew speaker-writers’ tendency to freely apply structural operations. In consequence, they prefer to adhere to semantically related words, unlike the strategies that they employ with full roots. Third, and importantly, this differential impact of root transparency/opacity is far more salient among the younger children, who rely more heavily than older participants on the scaffolding provided by the canonical three-consonantal root in order to proceed with further psycholinguistic processes.

Familiarity/Frequency Effects

As predicted, familiarity/frequency likewise exerted major effects on the associations tasks, both quantitatively and qualitatively, and this variable, too, yielded strong interactions with the other independent variables. In fact, the F-score variable had a strong effect across the board, on responses to both the Single and Multiple Associations tasks, which was not invariably the case for the other independent variables.

High-F nouns displayed the following patterns when compared with Low-F items: significantly higher proportions of (1) semantic-pragmatic and syntagmatic associations and (2) categorially and semantic-pragmatic frame-related responses; (3) responses that were not only morphologically but also semantically related to the input nouns; and (4) a greater number of associations on the Multiple Associations task. In contrast, Low-F nouns received significantly more (1) morphological and morphophonological associations, (2) semantically mediated responses, and (3) morphologically related but semantically unrelated responses.

Further, there was a strong interaction with development, with a gradual age-related increase for High-F nouns in proportion of semantic-pragmatic associations and a concomitant decrease in morphological associations with age. Moreover, the youngest group of 6th-graders differed most markedly from the two other groups in the impact of familiarity/frequency.

In sum, the factor of familiarity/frequency had a very strong impact on form-meaning mapping in the mental lexicon as reflected in the associations tasks, with a shift towards meaning relations for familiar/frequent items and in the opposite direction towards structural relations in the case of unfamiliar/infrequent items. The innovative facet of this study lies in demonstrating the role of Hebrew morphology as a “tool-kit”, a part of the readily accessible structural inventory of Hebrew speaker-writers from a young age when confronted with unfamiliar/infrequent lexical items. On the other hand, these findings suggest that morphology plays a less salient role in reading familiar/frequent words in Hebrew. This tendency to parse Low-F words and to refer to High-F words as wholes corroborates the findings of Hay & Baayen (2001), who found similar trends in English.

The strong interactions found with age are in line with correlations found between the factor of Frequency and the factor of Age of Acquisition in the literature (Bird et al, 2001; Bonin et al, 2004; Colombo & Burani, 2002; Morrison, Chappell & Ellis, 1997; Reily, Chrysikou & Ramey, 2007). Not only are Familiar/Frequent words acquired earlier in life, but their acquisition is a lengthy and protracted process, in which unfamiliar/infrequent items gradually become more established and thus more Familiar/Frequent in the mental lexicon during development.

Concreteness Effects

The variable of concreteness had an impact on the results as follows: (1) Concrete nouns received more semantic-pragmatic associations; (2) within semantic-pragmatic responses, concrete nouns yielded more semantic-pragmatic frame-related responses; and (3) within categorically related responses, concrete nouns yielded more co-hyponyms. Abstract nouns, in contrast, received far more morphological and syntagmatic associations, more categorically related responses, and markedly more synonyms and fewer co-hyponyms.

Interaction of this factor with Age also emerged, so that (1) the youngest population gave fewer syntagmatic associations to abstract nouns than their adult counterparts and (2) these different paths in processing concrete compared with abstract nouns seem to consolidate during adolescence, with an age-related increased distinctiveness between the two types of nouns towards adulthood.

In sum, these results challenge the accepted notion of a simple “concreteness effect” as defined by various psycholinguistic measures (see Chapter I, Section 2.2), generally interpreted as a straightforward advantage of concrete over abstract words. The findings of this study suggest that what is at play here is, rather, a “differential concreteness effect”, not necessarily just in the form of an advantage of concrete over abstract words, but rather as shaping two distinct trajectories in the mental lexicon – one for concrete and another for abstract nouns -- a differentiation that, moreover, consolidates with Age.

Age / Developmental Effects

The factor of age had a powerful impact on the associations given in this study, revealing strong interactions with all the other word-internal independent variables. This is revealed by age-related increases not only in number of associations but also, qualitatively, in the proportion of (1) meaning associations, (2) categorial associations out of meaning associations, and (3) synonyms out of categorial relations, as well as (4) semantically mediated responses, (5) syntagmatic responses, (6) semantically related morphological responses, and (7) lexico-grammatically nominal responses. These trends were accompanied by a concomitant decrease with age in (1) structural associations, (2) hierarchical responses out of the meaning associations, (3) co-hyponymic responses out of the categorial associations, (4) semantically unrelated morphological responses, and (5) verb-based and idiosyncratic responses in terms of grammatical category.

The interaction of age and the three other independent variables manifested heavy reliance overall on: (1) full as against defective roots, (2) familiar/frequent as against unfamiliar/infrequent items and (3) concrete as against abstract nouns. These trends in turn had a marked effect on types of responses and internal distributions of sub-types of responses, such that differences were far more dramatic in the younger populations in terms of breakdowns of the independent variables by age.

Thus, the youngest age group, the 6th graders, differed markedly from the older participants in the following ways. Members of this group (1) gave significantly fewer associations on the Multiple Associations task, (2) revealed the strongest interactions with all the other independent variables, (3) gave fewer semantically mediated responses,

fewer semantic-pragmatic frame-related responses, and fewer syntagmatic responses to abstract nouns, and (4) gave more hierarchically related responses, more mediated responses to words derived from full roots, more morphological responses to Low-F items, more semantically unrelated morphological responses, and more verb-like and idiosyncratic responses in terms of grammatical category.

Overall, all three groups revealed age-related changes in nearly every facet of these analyses, confirming the prediction for changes in and consolidation of the mental lexicon across adolescence. These radical changes in quantity and quality of associations go well beyond the *a priori* assumptions underlying the study, leading to a reconsideration of the important role of psycholinguistic factors in shaping the developmental trajectory of later language acquisition. The high dependency on root completeness, for example, is in no way obvious, since pre-adolescent 6th graders are typically considered quite maturely proficient native speakers, at least in their command of morphological structure. Yet far from demonstrating schoolchildren's mature mastery of their native-language structural "tool-kit", results of the current analyses indicate that, while clearly native-like in their dependence on Hebrew morphology as an important component of this assembly of appliances, they are unable to cope proficiently with a lack of canonicity, and so are at a loss when the "tool-kit" fails to work as expected (Berman, 2004)

6. Sentence Construction

This task required participants to compose sentences containing the test stimuli, as explained in Chapter II (Part B, Section 1.3). The task had 20 items, selected from the Concreteness subset, 10 Concrete and 10 Abstract, 12 from Full Roots and 8 from Defective Roots. Ten of the stimuli were High-F nouns and the other 10 were relatively Unfamiliar/Infrequent, having the lowest F scores on the Concreteness subset.

The statistical analyses employed in this test were χ^2 tests, since both the dependent and independent variables were nominal. In case of significant results, further χ^2 tests were performed in order to identify the sources of interactions. Coding categories are described in Section 6.1 below, followed by a description of results (6.2), and then

summarized and briefly discussed (6.3).

6.1. Coding Categories

Three independent analyses were employed in this task, as detailed below: Level of Understanding revealed by the sentences, types of Modifiers used with the input noun, and the syntactic Position of the input noun.

Level of Understanding: This analysis specified whether and to what extent the sentence showed that the respondent knew the meaning of the input item on a four-point scale, as follows.

(1) Full Understanding – The sentence respondent clearly understood what the input item meant (e.g., *ha-emuna xašuva u-meafšeret optimiyut* ‘belief is important and (it) enables optimism’ for the input item *emuna* ‘belief, faith’).

(2) Vague – It was not clear whether the respondent knew the meaning of the input item or not (e.g., *hayinu bemacav šel ba’arut* ‘We were in a state of ignorance’ for the input item *ba’arut* ‘ignorance’).

(3) No Understanding – The response sentence indicated that the respondent did not understand what the input item meant (e.g., *la-gafrur yešna ba’arut gdola* ‘A match [for igniting] has great ignorance’ to the input item *ba’arut*. The respondent clearly interpreted the word *ba’arut* as *be’era* ‘fire’ from the same root *b-* ‘-r as the input item.

(4) Miscellaneous – For responses that either were not in the form of a sentence or did not contain the input item.

Modifier: This analysis focused on the noun phrase of the input item, in terms of whether and how it was modified, as follows:

(1) No Modifier (e.g., *emuna* ‘belief, faith’)

(2) Grammatical Modifier – determiners, quantifiers, and possessives (e.g., *ha-emuna šeli* ‘the-belief of-me=my belief’, *kcat emuna* ‘little [=not much] faith’).

(3) Lexical Modifier – nouns, adjectives, prepositional phrases, and/or relative clauses following the input noun (e.g., *emuna ba-el* ‘faith in-God’, *emuna xazaka* ‘belief strong=a strong belief’, *emuna še-acliax be-veit ha-séfer* ‘(a) belief that I’ll-do-well at school’).

Noun Position: This examined the position of the input noun in the sentence, as follows:

(1) Pre-verbal position – e.g., *emuna be'emunot tfelet hi tipšit* 'belief in superstitions is foolish'.

(2) Post-verbal position – e.g., *yeš lo emuna xazaka ba-yahadut* 'he has (a) strong belief in Judaism'.

6.2. Findings

The first part of the results describes the level of understanding revealed by the sentences that were constructed. Figure 44 describes the overall distribution of responses.

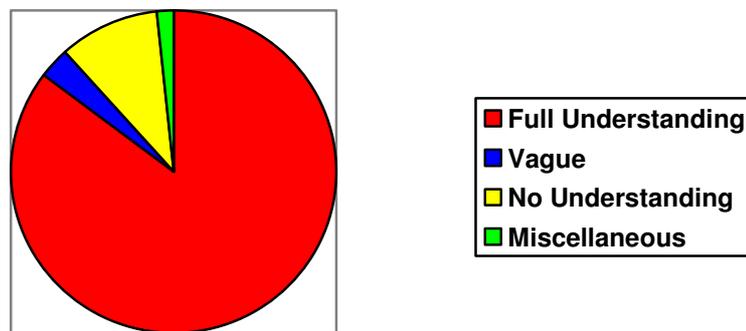


Figure 44: Overall Distribution of Responses in Terms of Level of Understanding on Sentence Construction across the Population [N=1,599]

Figure 44 shows that the overwhelming majority of the sentences (85.4%) revealed Full Understanding of the input noun, relatively few (9.9%) manifested No Understanding, and the rest were residual categories, accounting for less than 5% of the responses.

Examination of the effect of the independent variables on level of understanding revealed significant effects for all four factors -- Root, Familiarity/Frequency, Concreteness and Age -- as detailed in Figures 45-48 respectively, with response-types labeled as follows: Full=Full Understanding; Vague=Vague; No=No Understanding; Misc=Miscellaneous.

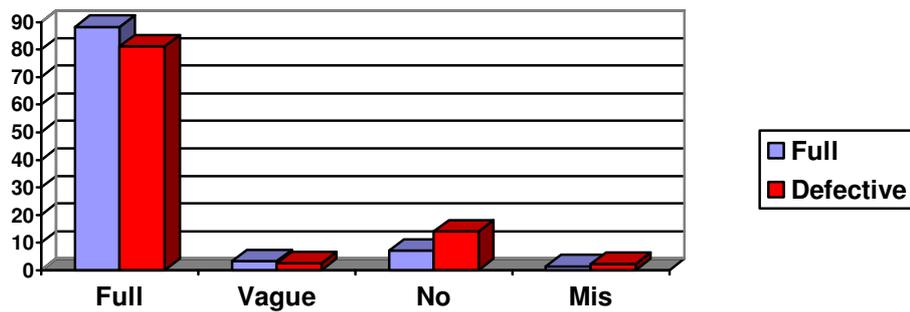


Figure 45: Effects of Root Transparency on Level of Understanding on Sentence Construction

A chi-square test for independent samples revealed a significant effect for Root ($\chi^2(3, N= 1,599)= 23.632, p<.001$), as follows: Nouns derived from Full Roots were more fully understood than nouns derived from Defective Roots.

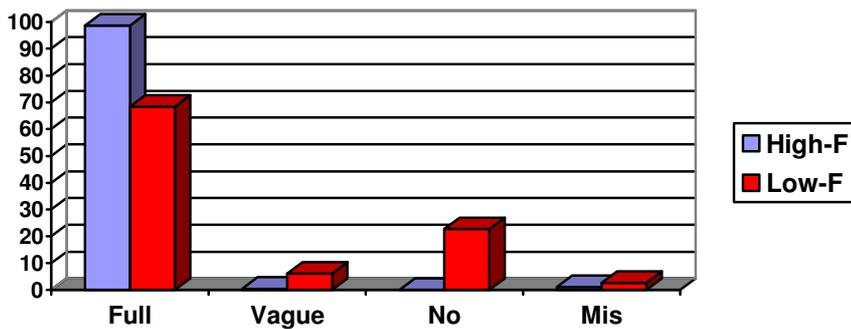


Figure 46: Effects of Familiarity/Frequency on Level of understanding on Sentence Construction

A chi-square test for independent samples revealed a significant effect for Familiarity/Frequency ($\chi^2(3, N= 1,599)= 296.108, p<.001$) as follows: High-F nouns were far better understood than Low-F nouns.

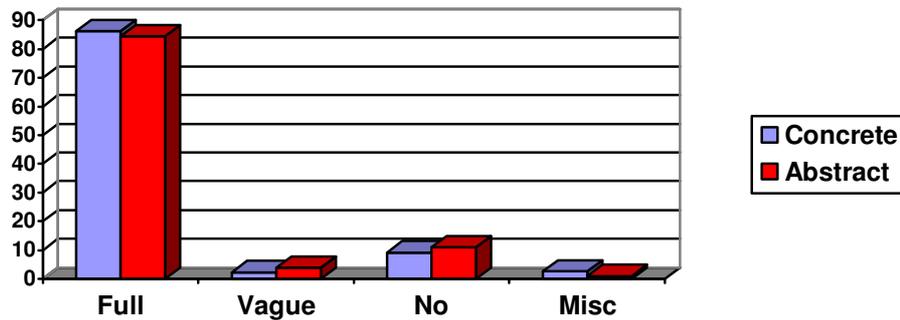


Figure 47: Effects of Concreteness on Level of Understanding on Sentence Construction

A chi-square test for independent samples revealed a significant effect for Concreteness ($\chi^2(3, N= 1,599)=10.974, p<0.05$), showing very slight differences between nouns that were plus or minus Concrete.

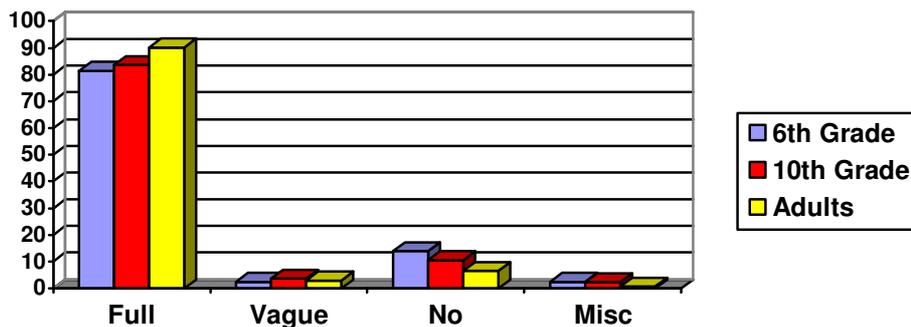


Figure 48: Effects of Age on Level of Understanding on Sentence Construction

A chi-square test for independent samples revealed a significant effects for Age ($\chi^2(6, N= 1,599)= 24.534, p<.001$) as follows: The proportion of fully understood items increased with Age, with a concomitant decrease in the proportion of items that were not understood.

As for interactions between Age and the other independent variables, χ^2 tests revealed an interaction between Age and all the other independent variables of Root, Familiarity/Frequency and Concreteness. The interactions are shown in Tables 27, 28 and 29, with response-types labeled as follows: Full=full Understanding; Vague=Vague; No=No Understanding; Mis=Miscellaneous.

Table 27 shows the interaction, in percentage of responses, between Age and Root (6th Grade, no significance, 10th Grade, $\chi^2(3, N= 1,599)= 14.997, p<.01$, Adults, $\chi^2(3, N= 1,599)= 16.027, p<.01$).

Level of Understanding	Full Roots				Defective Roots			
	Full	Vague	No	Mis	Full	Vague	No	Mis
6 th Grade	81.6	3.3	12.9	2.2	81.2	1.0	15.2	2.6
10 th Grade	88.1	3.7	6.7	1.5	77.1	3.5	15.9	3.5
Adults	93.5	2.8	3.1	0.6	85.2	2.6	11.4	0.9

Table 27: Interaction Age X Root in Level of Understanding, Sentence Construction

Table 27 shows a distinction between Full and Defective Roots that increases with Age. 10th Graders and Adults show a better understanding of nouns derived from Full Roots and a poorer understanding of nouns derived from Defective Roots.

Table 28 shows the interaction in percentage of responses between Age and Familiarity/Frequency (6th Grade, $\chi^2(3, N= 1,599)=156.113, p<.001$, 10th Grade, ($\chi^2(3, N= 1,599)= 100.487, p<.001$, Adults, $\chi^2(3, N= 1,599)= 68.884, p<.001$).

Level of Understanding	High-F				Low-F			
	Full	Vague	No	Mis	Full	Vague	No	Mis
6 th Grade	97.7	0.7	0.0	1.7	51.8	5.5	39.0	3.7
10 th Grade	98.0	0.7	0.0	1.3	67.1	7.0	22.5	3.5
Adults	100.0	0.0	0.0	0.0	79.5	5.8	13.3	1.4

Table 28: Interaction Age X Familiarity/ Frequency in Level of Understanding, Sentence Construction

Table 28 shows that there are no Age-related changes for High-F nouns, but Low-F nouns reveal a marked increase in Level of Understanding with Age and a concomitant decrease in “No understanding” responses.

Table 29 shows the interaction in percentage of responses between Age and Concreteness (6th Grade, $\chi^2(3, N= 1,599)= 9.195, df=3, p<0.05$, 10th Grade, $\chi^2(3, N= 1,599)= 10.994, p<0.05$, Adults, no significance).

Level of Understanding	Concrete				Abstract			
	Full	Vague	No	Mis	Full	Vague	No	Mis
6 th Grade	82.5	1.6	11.8	4.1	80.2	3.2	16.1	0.5
10 th Grade	87.6	1.4	8.5	2.5	79.4	5.9	12.5	2.2
Adults	88.0	3.3	7.4	1.3	92.6	2.1	5.3	0.0

Table 29: Interaction Age X Concreteness in Level of Understanding, Sentence Construction

Table 29 shows different trajectories for the two types of nouns: Concrete nouns have a relatively marked increase between 6th and 10th Grade, while Abstract nouns show a marked increase between 10th Grade and Adults.

The next analysis considered modification of the nouns in the sentences constructed with them. Figure 49 describes the overall distribution of responses.

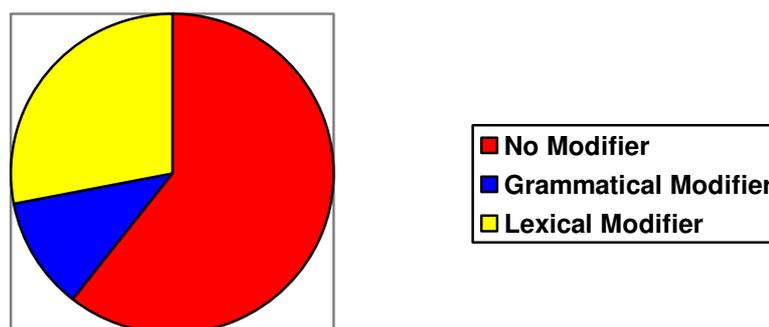


Figure 49: Overall Distribution of Modifiers in Sentence Construction across the Population [N= 1,378]

Figure 49 shows that in almost two-thirds (60.4%) of the sentences, the input noun was used without any Modifiers, over one-quarter (28%) had a Lexical Modifier, and approximately one tenth had a Grammatical Modifier (11.4%).

Examination of the effect of the independent variables on modifiers revealed significant effects for the independent variables of Root, Concreteness, and Age, as detailed in Figures 50 to 52 respectively, with response-types labeled as follows: No=No Modifier; Grammatical=Grammatical Modifier; Lexical=lexical Modifier.

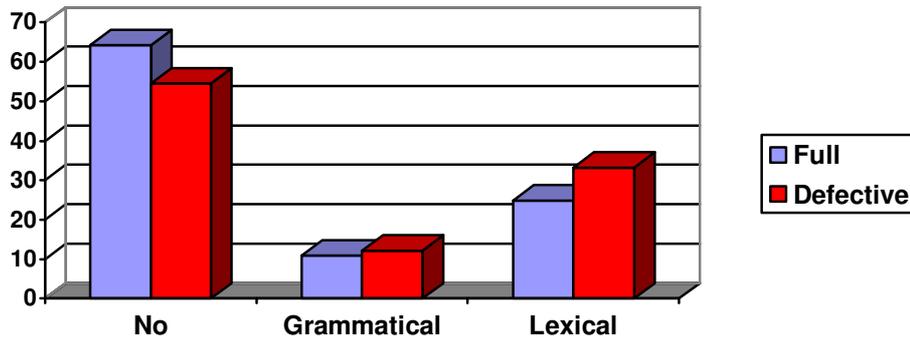


Figure 50: Effects of Root Transparency on Type of Modifiers on Sentence Construction

A chi-square test for independent samples revealed significant effects for Root ($\chi^2(1, N= 1,599)= 13.624, p<.05$) as follows: Nouns derived from Full Roots had fewer modifiers, while nouns derived from Defective Roots had more.

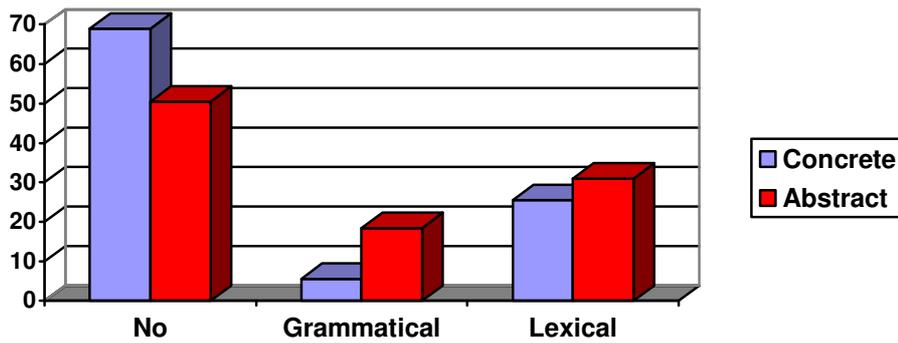


Figure 51: Effects of Concreteness on Type of Modifiers on Sentence Construction

A chi-square test for independent samples revealed significant effects for Concreteness ($\chi^2(1, N= 1,599)= 74.291, p<.001$) as follows: Concrete nouns had fewer modifiers and Abstract nouns had more Grammatical and Lexical modifiers.

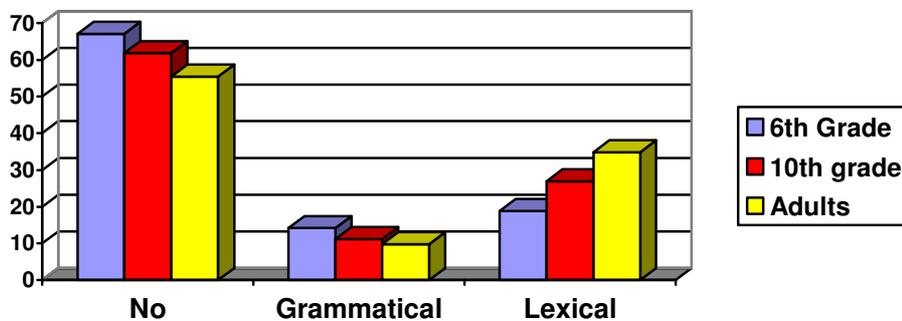


Figure 52: Effects of Age on Type of Modifiers on Sentence Construction

A chi-square test for independent samples revealed significant effects for Age ($\chi^2(4, N= 1,599)= 28.364, p<.001$) as follows: There was an increase in the amount of Lexical Modifiers with Age and a concomitant decrease in the amount of unmodified and grammatically modified nouns.

As for interactions between Age and the other independent variables, chi-square tests revealed an interaction between Age and Root and Age and Concreteness. The interactions are shown in Tables 30 and 31 with response-types labeled as follows: No=No Modifier; Grammatical=Grammatical Modifier; Lexical=Lexical Modifier.

Table 30 shows the interaction in percentage of responses between Age and Root (6th Grade, $\chi^2(2, N= 1,599)= 13.549, p<.05$, 10th Grade, no significance, Adults, $\chi^2(2, N= 1,599)= 6.907, p<.05$).

Modifier	Full Roots			Defective Roots		
	No	Grammatical	Lexical	No	Grammatical	Lexical
6 th Grade	74.0	12.6	13.5	55.7	16.8	27.5
10 th Grade	62.6	11.3	26.2	60.6	11.2	28.2
Adults	59.6	9.6	30.8	48.6	10.1	41.3

Table 30: Interaction Age X Root by Modifiers, Sentence Construction

Table 30 shows an increase in Lexical Modifiers and a concomitant decrease in unmodified nouns with Age for both types of Root. The difference between the Root types lies in distinct developmental trajectories: for Full Roots the marked change takes place between 6th and 10th Grade, while for Defective Roots this change occurs between 10th Grade and Adults.

Table 31 shows the interaction in percentage of responses between Age and Concreteness (6th Grade, $\chi^2(2, N= 1,599)= 31.856, p<.001$, 10th Grade, ($\chi^2(2, N= 1,599)= 25.528, p<.001$, Adults, $\chi^2(2, N= 1,599)= 20.913, p<.001$).

Modifier	Concrete			Abstract		
	No	Grammatical	Lexical	No	Grammatical	Lexical
6 th Grade	75.0	5.4	19.6	55.6	26.8	17.6
10 th Grade	71.1	6.0	22.9	50.9	17.4	31.7
Adults	62.8	5.0	32.3	47.3	15.0	37.7

Table 31: Interaction Age X Concreteness by Modifiers, Sentence Construction

Table 31 shows that (1) for both types of nouns, there is a gradient increase in the Lexical Modifiers with Age, (2) for Concrete nouns, there is a decrease in unmodified nouns with Age, and (3) for Abstract nouns, the Age-related decrease is in proportion of Grammatical Modifiers.

The third part of the results analyses the position of the input nouns in the sentence -- Pre-verbal or Post-verbal. Figure 53 describes the overall positions of the nouns.

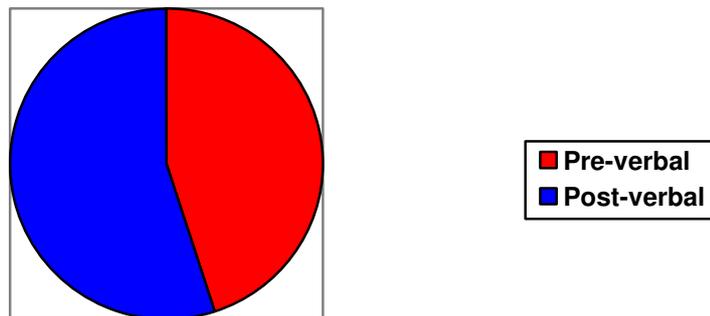


Figure 53: Overall Distribution of Nouns by position in Sentence Construction across the Population [N= 1,378]

Figure 53 shows that over half (55%) of the nouns were in Post-verbal position and the rest (45%) in Pre-verbal position.

Examination of the effect of the independent variables on the position of the noun revealed significant effects for the independent variables of Root, Frequency and Concreteness, as detailed in Figures 54-56.

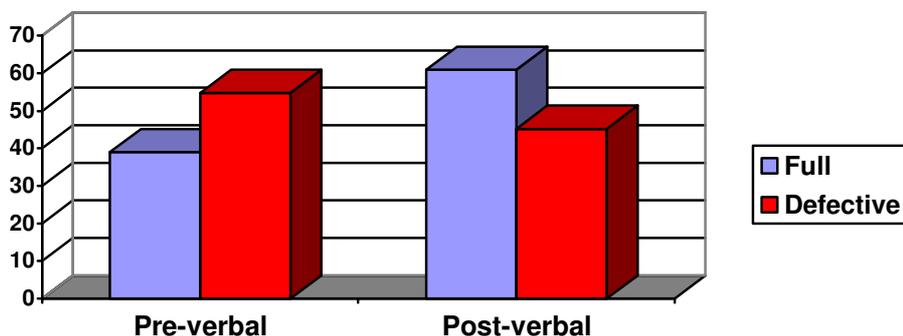


Figure 54: Effects of Root Transparency on Noun Position on Sentence Construction

A chi-square test for independent samples revealed significant effects for Root ($\chi^2(1, N= 1,378)= 32.638, p<.001$) as follows: Nouns derived from Full Roots occurred more often Post-verbally, while nouns derived from Defective Roots were more common in Pre-verbal position.

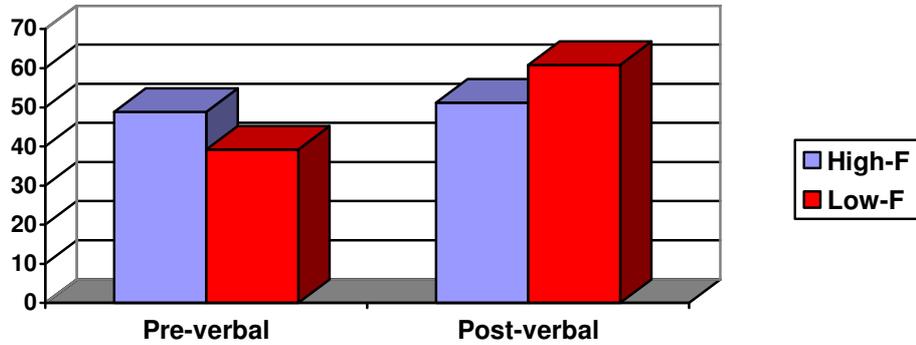


Figure 55: Effects of Familiarity/Frequency on Noun Position on Sentence Construction

A chi-square test for independent samples revealed significant effects for Familiarity/Frequency ($\chi^2(1, N= 1,378)=12.467, p<.001$) as follows: For High-F nouns, the division between pre-verbal and post-verbal position was pretty much the same, whereas Low-F nouns showed a preference for Post-verbal position.

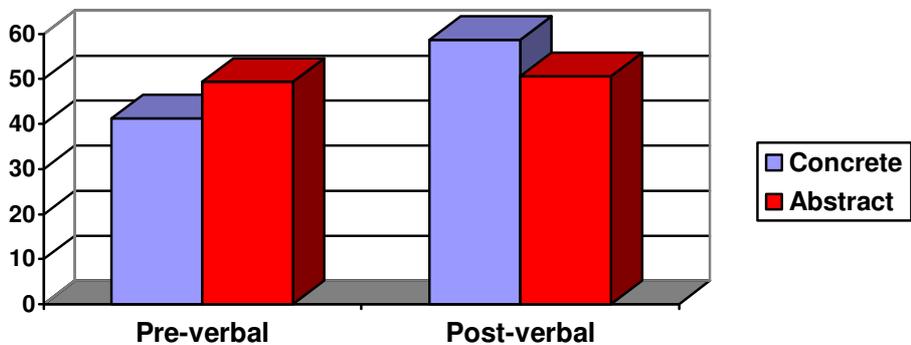


Figure 56: Effects of Concreteness on Noun Position on Sentence Construction

A chi-square test for independent samples revealed significant effects for Concreteness ($\chi^2(1, N= 1,378)= 8.931, p<.01$) as follows: Concrete but not Abstract nouns showed a preference for Post-verbal position.

As for interactions between Age and the other independent variables, χ^2 tests revealed an interaction between Age and Root and Age and Familiarity/Frequency. There

was no interaction of Age and Concreteness. The interactions are shown in Tables 32 and 33.

Table 32 shows the interaction in percentage of responses between Age and Root (6th Grade, $\chi^2(1, N= 1,378)= 18.613$, $p<.001$, 10th Grade, $\chi^2(1, N= 1,378)= 10.859$, $p<.001$, Adults, $\chi^2(1, N= 1,378)= 6.634$, $p<.05$).

Position of Noun	Full Roots		Defective Roots	
	Pre-verbal	Post-verbal	Pre-verbal	Post-verbal
6 th Grade	31.5	68.5	55.0	45.0
10 th Grade	40.9	59.1	56.1	43.9
Adults	42.1	57.9	53.4	46.6

Table 32: Interaction Age X Root by Noun Position, Sentence Construction

Table 32 shows that (1) for Full Roots there is a preference for Post-verbal position which decreases with Age, mainly between 6th and 10th Grade, and (2) for Defective Roots there is a preference for Pre-verbal position which does not change dramatically with Age.

Table 33 shows the interaction in percentage of responses between Age and Familiarity/Frequency (6th Grade, $\chi^2(1, N= 1,378)= 4.248$, $p<.05$, 10th Grade, $\chi^2(1, N= 1,378)= 6.170$, $p<.05$, Adults, $\chi^2(1, N= 1,378)= 5.134$, $p<.05$).

Position of Noun	High-F		Low-F	
	Pre-verbal	Post-verbal	Pre-verbal	Post-verbal
6 th Grade	43.6	56.4	31.0	69.0
10 th Grade	51.4	48.6	40.1	59.9
Adults	50.9	49.1	49.1	58.8

Table 33: Interaction Age X Familiarity/frequency by Noun Position, Sentence Construction

Table 33 shows that (1) High-F nouns reveal a preference for Post-verbal position in the 6th Grade and a roughly equal division in 10th Grade and Adults, while (2) Low-F Nouns reveal a preference for Post-verbal position that decreases with Age, mainly between 6th and 10th Grade.

6.3. Summary and Interim Discussion

The first analysis, of level of understanding, revealed that the overwhelming majority of the sentences written by respondents reflected good knowledge of the input nouns, in interaction with all the independent variables. Higher percentages of understanding were attained by (1) nouns derived from full roots, (2) familiar/frequent nouns, (3) concrete nouns, and (4) the older age groups.

The second analysis, of noun modification, revealed that a lexical modifier was supplied less in case of (1) nouns derived from full roots, (2) concrete nouns, and (3) younger participants. In contrast, a lexical modifier was more often supplied in the case of (1) nouns derived from defective roots, (2) abstract nouns, and (3) older participants.

The third analysis, of syntactic position, revealed that (1) nouns derived from full roots, (2) concrete nouns, and (3) unfamiliar/infrequent nouns were more likely to appear in post-verbal position, while nouns derived from defective roots and abstract nouns were more likely to appear in pre-verbal position.

These three separate, and essentially unrelated analyses yielded converging evidence for a similar impact of the four independent variables of this study, as follows.

The first independent variable, type of root, had a pervasive influence on every analysis applied, including in interaction with age. Nouns derived from full roots were better understood, required fewer modifiers, and were more likely to appear in post-verbal position, whereas nouns with defective roots were less well understood, required more modifiers and were more likely to appear in pre-verbal position. This strong effect of type of root had not been predicted for this particular task, which involved constructing sentences out of words that are relatively known. The factor of root transparency was expected to affect words in isolation and/or less known words, yet it also proved highly relevant to the task of sentence construction, with the distinction between full and defective roots interacting with age in diverse ways.

The second independent variable, of familiarity/frequency, interacted with the level of understanding of the nouns and with age, as predicted. An unexpected result was the interaction of familiarity/frequency with the position of the input noun in the sentence. The preference for post-verbal position for Low-F nouns can be explained in terms of a syntactic hierarchy along the lines proposed by Keenan & Comrie (1979) for

relative clauses, such that lesser known nouns will be assigned to a lower place on the continuum, that is, to some kind of object or other post-verbal position. The results of this task further suggest that highly familiar/frequent nouns have cognitive and not only structural or linguistic precedence. .

The third independent variable, that of concreteness, affected all the analyses performed on the sentence-construction task: Concrete nouns were slightly better understood, less often modified, and occurred more often in post-verbal position than did abstract nouns. Age-related differences were more moderate for concrete nouns, and more dramatic for abstract nouns, yielding two distinct developmental curves, with a sharper rise for abstract nouns.

In general, the variable of age had widespread effects and revealed marked interactions on the sentence-construction task. Younger participants manifested less understanding overall, they used fewer modifiers, and performed better on nouns with full roots, and on nouns that were familiar/frequent or concrete.

In sum, the results of this task reveal an unequivocal interdependence between lexical and syntactic factors. Purely lexical factors such as root transparency, familiarity/frequency, and concreteness had strong effects on the syntactic structure of the sentences – an interface with implications for the mental lexicon that are considered further in the final discussion in Chapter 4 (Section 1.4).

7. Definitions

This task required participants to provide definitions to a set of nouns, as described in Chapter II (Part B, Section 1.5). It consisted of 10 nouns with High-F scores, selected from the concreteness subset, 5 Concrete and 5 Abstract, 6 with Full Roots and 4 with Defective Roots. Coding categories are described in Section 7.1 below, followed by a description of results (Section 7.2), and a summary and interim discussion of findings (Section 7.3).

7.1. Coding Categories

Four independent types of analysis were employed in this task, relating to the following four facets of the responses in (attempting to) provide a definition: Super-ordinate element, Syntactic Structure, Repetition of input item, Basis for definition.

(i) Super-ordinate Category: This analysis focused on the presence or absence of a super-ordinate term in the definition as follows:

- (1) Super-ordinate -- e. g., *rahit* '(piece of) furniture' for the input item *šulxan* 'table'.
- (2) Synonymic/Antonymic expression -- e. g., *ra'ayon* 'idea' for the input item *maxšava* 'thought'; *ha-héflex mi-zilzul* 'the opposite of contempt' for *kavod* 'respect'.
- (3) Near synonym, partial or implied synonym -- e. g., *ka'ašer yeš mašehu ba-roš še-xošvim alav* 'when there is something in your head that (you are) **thinking** about' for the input item *maxšava* 'thought'.
- (4) Approximate Super-ordinate -- e. g., *haf'alat šrirey ha-móax* 'activation of the **brain** muscles' for *maxšava* 'thought'.
- (5) Semantically Empty, use of a general term instead of a super-ordinate noun -- e.g. *šulxan ze mašehu še-samim alav dvarim* '(a) table is **something** that you put things on'.

(ii) Syntactic Structure: This analysis focused on the presence or absence of a Relative Clause, as follows:

- (1) Relative Clause -- e.g., *parit še-nitan lehaníax alav dvarim* 'an item on which things can be placed' for the input item *šulxan* 'table'.
- (2) Complex Noun Phrase, including (a) an infinitival complement -- e.g., *kli ezer le-hagbía xafacim....* 'a means for making objects higher' for the input item *šulxan* 'table'; (b) a nominal complement -- e.g., *yedi'a muššézet ha-ola be-rošo šel ha-prat...* 'abstract knowledge that arises in the head of an individual...'; and (c) other modifying elements such as adjectives.
- (3) No relative clause -- a simple phrase or single word (e.g., *zman* 'time for the input item *pnay* 'leisure').
- (4) Miscellaneous –irrelevant or erroneous responses.

(iii) Repetition: Whether respondents repeated the root of the input item or the input item itself in the definition, thus:

(1) Root Repetition – Use of another word derived from the same root as the input item -- e.g., *ka`ašer yeš mášehu ba-roš še-xošvim alav* ‘when there is something in your head that you **think** about’, containing the plural verb *xošvim* ‘think’ from the same root *x-š-b* as the input item *maxšava* ‘thought’.

(2) Item Repetition -- Repetition of the input item in the definition -- e.g., *dimyon ze mášehu še-lo kayam ba-meci’ut* ‘imagination is something that does not exist in reality’ for the input item *dimyon* ‘imagination’.

(iv) Basis of Explanation (for Concrete nouns only): This analysis took into account the features that respondents included in their definitions – perceptual and/or functional.

(1) Physical properties -- description of the object, its shape, color, size, etc. (See (2) below).

(2) Functional -- description of the function of the input item. The following example illustrates both a physical features and a functional description of the input item: *rahit bá'al árba ragláyim, be-dérex klal alav menixim xafacim* ‘a piece of furniture with four legs, on which people generally place things’ for the input item *šulxan* ‘table’.

7.2. Findings

The first part of the results describes the analysis of the Super-ordinate category, as detailed in (i). Figure 57 describes the overall distribution of the responses.

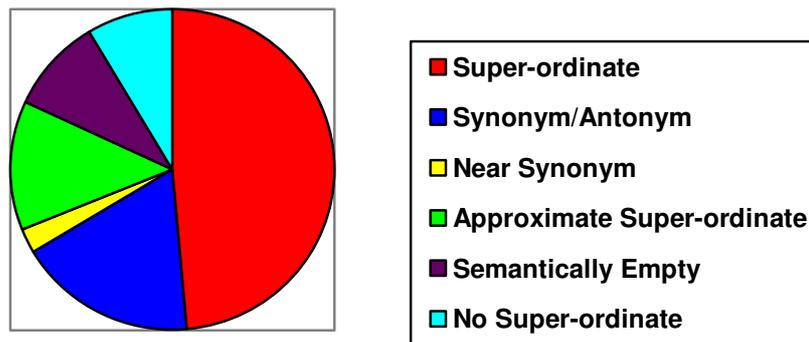


Figure 57: Overall Distribution of Responses in Terms of Super-ordinate Category on Definitions across the Population [N= 815]

Figure 57 shows that almost half of the definitions (48.7%) includes a Super-ordinate term, followed by ones with a Synonym or Antonym (17.5%), with an Approximate Super-ordinate (13.1%), Semantically Empty (9.3%), No Super-ordinate

(8.7%), and a residual category of Near Synonyms (2.6%). Significant effects for the Super-ordinate category in definitions were found for the independent variables of Root, Concreteness, and Age, as detailed in Figures 58 to 60, with response-types labeled as follows: Super=Superordinate; Syn=Synonym/Antonym; Near=Near Synonym; Approx=Approximate Super-ordinate; Empty=Semantically Empty; No=No Super-ordinate.

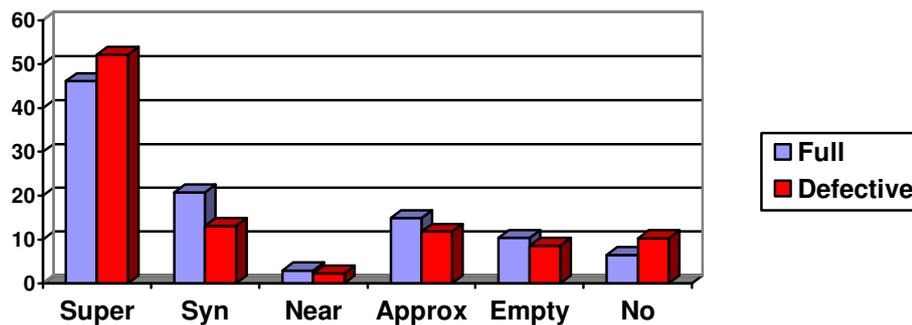


Figure 58: Effects of Root on Super-ordinate on Definitions

A chi-square test for independent samples revealed significant effects for Root ($\chi^2(5, N= 815)= 13.777, p<.05$) as follows: There were more Super-ordinates for nouns derived from Defective Roots and more Synonyms/Antonyms for nouns derived from Full Roots. The other differences were marginal.

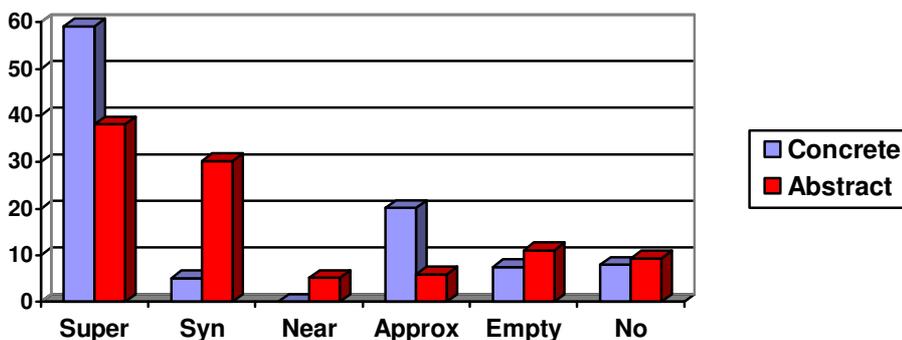


Figure 59: Effects of Concreteness on Super-ordinate on Definitions

A chi-square test for independent samples revealed significant effects for Concreteness ($\chi^2(5, N= 815)= 147.702, p<.001$) as follows: There were markedly more Super-ordinates for Concrete nouns and markedly more Synonyms/Antonyms for Abstract nouns. In the remaining categories, Concrete nouns had more Approximate Super-ordinates while Abstract nouns had more responses in the categories of Near

Synonyms, Semantically Empty, No Super-ordinate.

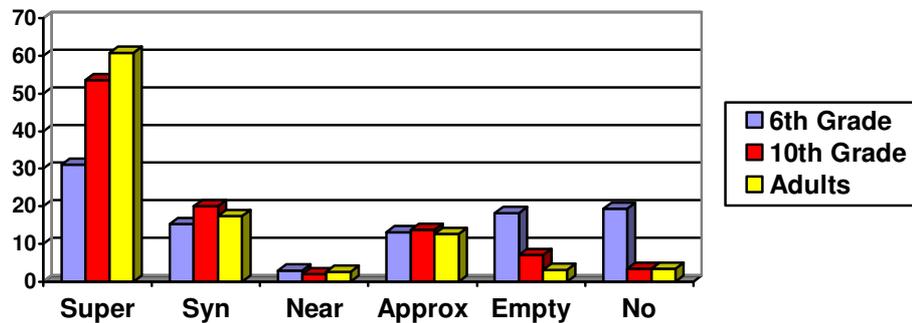


Figure 60: Effects of Age on Super-ordinate Terms in Definitions

A chi-square test for independent samples revealed significant effects for Age ($\chi^2(10, N= 815)= 118.772, p<.001$) as follows: There were two clear shifts between the 6th and 10th Grade: (1) a marked increase in the use of Super-ordinates, and (2) a concomitant marked decrease in the “Semantically Empty” and “No Super-ordinate” responses.

These analyses of the Super-ordinate element in definitions yielded a picture that could be defined as a hierarchical scale, as follows: (0) No response, (1) Semantically Empty, (2-3) Approximate Super-ordinates and Near Synonyms, (4) Synonym/Antonym, and (5) Super-ordinate. A two-way ANOVA, with Age as a between-subjects factor and Concreteness as a within-subjects factor revealed main effects of Age ($F(2, 812)= 60.353, p<.001$) as follows: Adults scored the highest ($M=3.290, SD= 1.053$) followed by 10th Graders ($M=3.129, SD= 1.132$), and 6th graders scored the lowest ($M=2.201, SD= 1.522$). A Scheffe post-hoc test revealed that the 6th Grade group was significantly different from the other two groups. There were also close to significance effects of Concreteness ($F(1, 799)= 3.284, p= .7$).

As for interactions between Age and the other independent variables on the Super-ordinate analysis, chi-square tests revealed an interaction between Age and Concreteness. For technical reasons, the interaction Concreteness X Age is divided into two tables, for Concrete and Abstract items respectively. Tables 34 and 35 show the interaction between Concreteness (Concrete, $\chi^2(8, N= 815)= 48.894, p<.001$, Abstract, $\chi^2(8, N= 815)= 86.779, p<.001$) and Age (6th Grade, 10th Grade, Adults) in percentage of responses as reflected in the Super-ordinate, with response-types labeled as follows:

Super=Superordinate; Syn=Synonym/Antonym; Near=Near Synonym;
 Approx=Approximate; Empty=Semantically Empty; No=No Super-ordinate.

Concrete						
Response	Super	Syn	Near	Approx	Empty	No
6 th Grade	40.6	7.5	0	21.1	17.3	13.5
10 th Grade	63.6	5.4	0	20.9	4.7	5.4
Adults	71.8	2.7	0	18.8	1.3	5.4

Table 34: Interaction Age X Concreteness (Concrete) in Super-ordinate, Definitions,

Abstract						
Response	Super	Syn	Near	Approx	Empty	No
6 th Grade	21.5	23.0	5.9	5.2	19.3	25.2
10 th Grade	43.2	35.2	4.0	6.4	9.6	1.6
Adults	49.3	32.6	5.6	6.3	4.9	1.4

Table 35: Interaction Age X Concreteness (Abstract) in Super-ordinate, Definitions

Tables 34 and 35 show that for Concrete nouns, there is shift between the 6th and the 10th Grade expressed by (1) a dramatic increase in use of Super-ordinates and (2) a marked decrease in the “Semantically Empty” and “No Super-ordinate” response types. These developmental lines are by and large consistent with the Super-ordinate element in definitions of Abstract nouns, with the following differences: (1) smaller absolute percentages for Super-ordinates, (2) a more gradual decrease in the “Semantically Empty” response type, and (3) a more marked decrease in “No Super-ordinate” responses.

The second part of the results describes the Syntactic Structure of responses to the definitions task. Figure 61 describes the overall distribution of the responses.

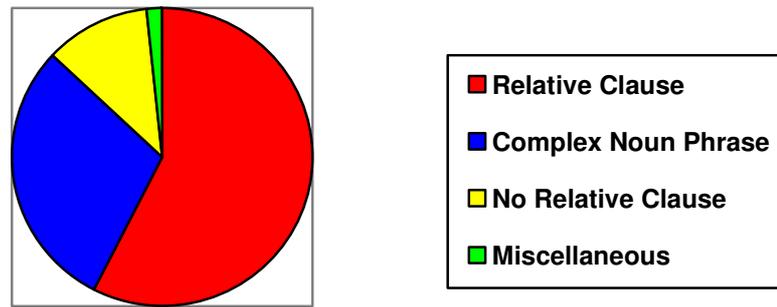


Figure 61: Overall Distribution of Responses in Terms of Syntactic Structure on Definitions across the Population [N= 815 responses]

Figure 61 shows that Relative Clauses accounted for more than a half (57.5%) of the total responses, followed by Complex Noun Phrases (29.4%), followed by No Relative Clause (11.4%) and the residual category of Miscellaneous (1.7%).

The Variables of Concreteness and Age had significant effects on the results as detailed in Figures 62 and 63 respectively with response-types labeled as follows; RC=Relative Clause; NP=Complex NP; No RC=No Relative Clause, excluding the residual category of Miscellaneous.

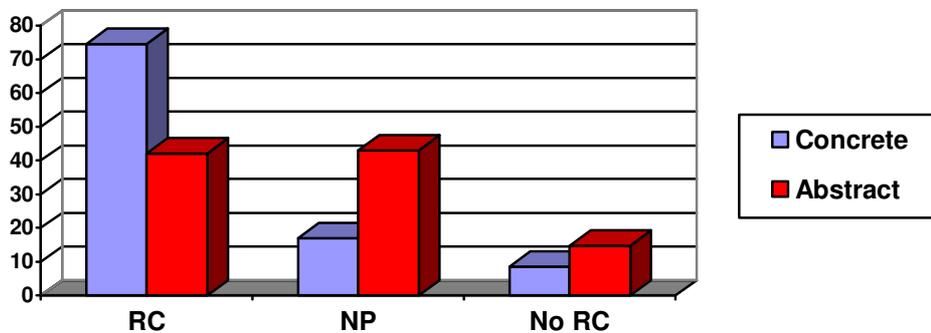


Figure 62: Effects of Concreteness on Syntactic Structure on Definitions

A chi-square test for independent samples revealed significant effects for Concreteness ($\chi^2(2, N= 815)= 89.075, p<.001$) as follows: Concrete nouns received more Relative Clauses while Abstract nouns received more Complex Noun Phrases and fewer Relative Clauses.

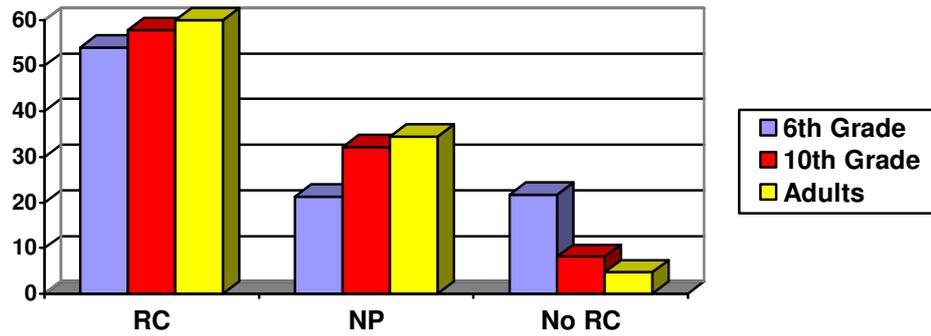


Figure 63: Effects of Age on Syntactic Structure on Definitions

A chi-square test for independent samples revealed significant effects for Age ($\chi^2(6, N= 815)= 58.388, p<.001$) as follows: There was an Age-related increase in proportion of Relative Clauses and Complex Noun Phrases with a concomitant Age-related decrease in the proportion of the “No Relative Clause” type of response.

As for interactions between Age and the other independent variables in Syntactic Structure, chi-square tests revealed interactions between Age and Root and Age and Concreteness, as detailed in Tables 36 and 37, with response-types labeled as follows: RC=Relative Clause; NP=Complex Noun Phrase; No RC=No Relative Clause. Table 38 shows the interaction between Root (Full, Defective) and Age (6th Grade, $\chi^2(2, N= 815)= 8.894, p<.05$, 10th Grade, no significance, Adults, no significance).

Syntactic Structure	Full Roots			Defective Roots		
	RC	NP	No RC	RC	NP	No RC
6 th Grade	52.2	19.1	28.7	60.4	26.1	13.5
10 th Grade	63.1	31.2	5.7	51.9	36.1	12.0
Adults	60.2	34.7	5.1	61.3	34.5	4.2

Table 36: Interaction Age X Root in Syntactic Structure, Definitions

Table 36 shows that 6th Graders, in contrast to the two older groups, constructed fewer definitions with Relative Clauses in response to nouns derived from Full Roots and they constructed fewer Complex Noun Phrases in the definitions they gave to both types of nouns.

Table 37 shows the interaction reflected in the Syntactic Structure of definitions between the variables of Concreteness (Concrete, Abstract) and Age (6th Grade, $\chi^2(2, N=$

815)= 24.693, $p < .001$, 10th Grade, $\chi^2(2, N = 815) = 24.926$, $p < .001$, Adults, $\chi^2(2, N = 815) = 44.920$, $p < .001$).

Syntactic Structure	Concrete			Abstract		
	RC	NP	No RC	RC	NP	No RC
6 th Grade	70.7	15.8	13.5	40.7	28.1	31.1
10 th Grade	72.9	18.6	8.5	44.4	47.6	8.1
Adults	79.2	16.8	4.0	41.8	52.7	5.5

Table 37: Interaction Age X Concreteness in Syntactic Structure, Definitions

Table 37 reveals a differentiation between Concrete and abstract nouns that consolidates with Age: An Age-related decrease in proportion of “No Relative Clause”, and a concomitant gradual increase in the proportion of Relative Clause for Concrete nouns and in the proportion of Complex NounPhrases for Abstract nouns.

The third part of the results analyses the Repetitions. Figure 64 describes the overall distribution of the responses.

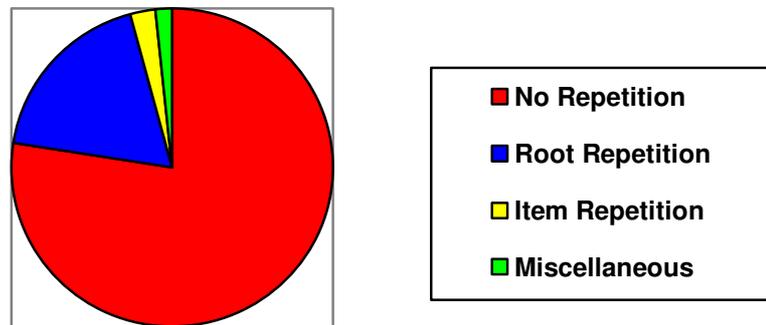


Figure 64: Overall Distribution of Repetitions in Definitions across the Population [N=815]

Figure 64 shows that over three-quarters (77.5%) of the definitions contained No Repetitions of the input item, while almost one-fifth (18.3%) repeated the Root, with the other, residual categories accounting for less than 10% of the responses.

The independent variables of Root, Concreteness, and Age revealed significant effects for Repetition, as detailed in Figures 65, 66 and 67 respectively with response-types labeled as follows; No=No Repetition; Root=Root Repetition; Item=Item Repetition.

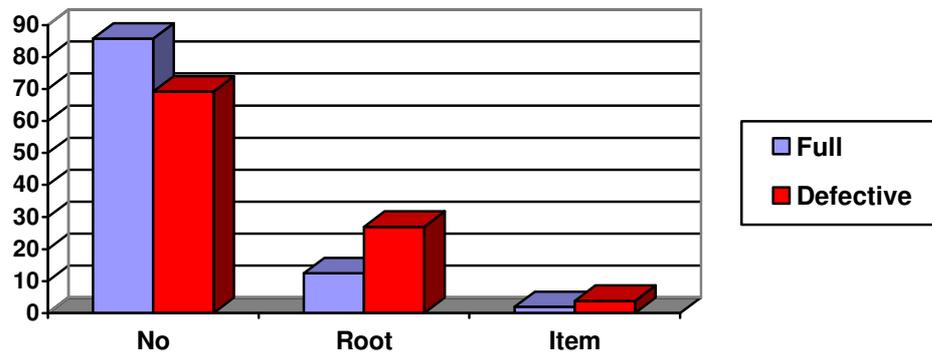


Figure 65: Effects of Root on Repetitions in the Definitions

A chi-square test for independent samples revealed significant effects for Root ($\chi^2(2, N= 815)= 60.820, p<.001$) as follows: There were fewer Repetitions to items with Full Roots and more to items with Defective Roots.

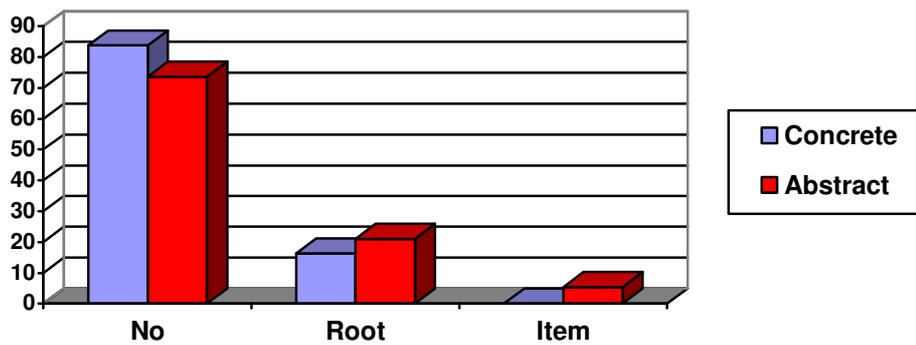


Figure 66: Effects of Concreteness on Repetitions in the Definitions

A chi-square test for independent samples revealed significant effects for Concreteness ($\chi^2(2, N= 815)= 27.375, p<.001$) as follows: Abstract nouns were more prone to Repetitions than Concrete nouns.

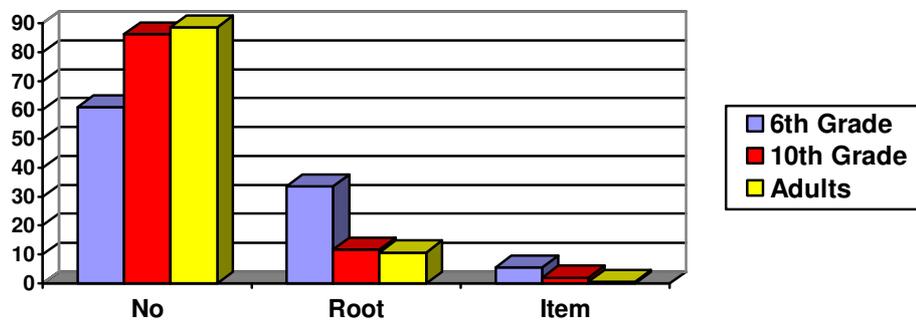


Figure 67: Effects of Age on Repetitions in the Definitions

A chi-square test for independent samples revealed significant effects for Age

($\chi^2(4, N= 815)= 77.210, p<.001$) as follows: There was an Age-related increase in definitions with No Repetition and a concomitant Age-related decrease in the proportion of Repetitions.

The fourth and final set of results on the definitions tasks relates to the type of explanations given to Concrete nouns, the vast bulk of which (411 = 87.3%) related to Functional properties. In contrast, only 17% of the definitions described Physical or Perceptual properties of the input item, while fewer than 4% mentioned both Physical and Functional properties. There were no interactions with Age for either of these two factors.

7.3. Summary and Interim Discussion

Two independent analyses were conducted of super-ordinate elements and syntactic structure, with results of both factors indicating strikingly similar trends, along the following lines. They both revealed (1) a strong interdependency with concreteness, (2) a strong interdependency with age, (3) an unexpected effect of type of root, and (4) interactions between age and the other independent variables which, taken together, demonstrate a marked distinction between the 6th graders and the two older age groups.

Analysis of repetitions showed a similar effect of all the independent variables: There were fewer repetitions in definitions of concrete nouns, of nouns derived from full roots, and those constructed by older participants. An age-related decrease in the amount of repetitions was predictable, but the effects of root and concreteness on repetitions were less expected, suggesting that these (psycho)linguistic factors play a pervasive role in the construction of coherent, non-redundant definitions.

The fourth analysis, of reference to functional as against physical properties in relating to concrete nouns, showed clearly that functional properties constitute more of a defining feature than physical properties, as earlier suggested in developmental perspective by Keil (1989). Another possible explanation for this finding is item-dependent: Nouns like *misparáyim* 'scissors' or *šulxan* 'table' yielded more definitions with physical properties than nouns that were judged as concrete but which have less clearly specified or more heterogeneous physical composition, such as *mazgan* 'air conditioner' or *ma'alit* 'elevator'.

Taken together, results on the definitions task show (1) effects of all the independent variables on almost every analysis applied to this task, and (2) a strong lexico-syntactic interdependency, realized in the effects of (psycho)linguistic factors on the syntactic structure of defining sentences and on avoidance of repetitions.

8. Priming Experiments

In addition to the written test batteries, two priming experiments were conducted, with a short Stimulus Onset Asynchrony (SOA) of 50 ms and a long SOA of 100ms, as described in Chapter II (Part B, Section 2). Results of the two experiments are described below. Recall that for reasons outlined in describing the design of the study (Chapter II, Part B, Section 2) and as further discussed in the conclusion to the study in Chapter IV (Section 1.5), it was decided that – largely for methodological and procedural rather than conceptual reasons -- the priming experiments conducted in the framework of the project documented here be considered as extensive pilot studies rather than as fully-blown pieces of research. Nonetheless, despite the reservations noted earlier, results of the priming experiments referred to in this section suggest food for thought, and yielded several findings that warrant being reported.

8.1. Findings

First, an analysis of the overall accuracy rates in the two experiments across SOA and priming conditions was conducted. A mean accuracy rate was calculated for each participant for each condition of word type (High-F words, Low-F words, and Non-Words), followed by a mixed-model General Linear Model (henceforth GLM). A significant main effect of Familiarity/Frequency on accuracy rate was revealed [$F(2, 216) = 758.61, p < 0.001$] as follows: Accuracy rates for High-F words were the highest ($M = 99.07\%$, $SE = 1.54$), followed by those for Non-words ($M = 97.07\%$, $SE = 4.46$), with the lowest scores yielded by Low-F words ($M = 49.48\%$, $SE = 16.60$). A Bonferroni post-hoc test revealed that the mean accuracy rate of the High-F targets was significantly higher than that of the Non-words, and the mean accuracy rate of the Non-words was significantly higher than that of the Low-F Targets.

A second analysis examined overall reaction time (RT) in the two experiments across SOA and priming conditions. Only RTs for words were included in this analysis. A mean RT was calculated for each participant for each condition of word type, followed by a mixed-model GLM. A significant main effect of Familiarity/Frequency on RT [$F(2, 216) = 124.5, p < 0.001$] as revealed as follows: RT for High-F words was the shortest ($M = 664.88\text{ms}, SE = 103.89\text{ms}$), followed by the RT for Non-words ($M = 799.05\text{ms}, SE = 204.44$), with the longest RT for Low-F words ($M = 899.36\text{ms}, SE = 219.64$). A Bonferroni post-hoc test revealed that the mean RT of the High-F Targets was significantly shorter than that of the Non-words and that the mean RT of the Non-words was significantly higher than that of the Low-F Targets.

In order to test the priming effects, mean RTs were calculated for each subject in each of the following conditions: Familiarity/Frequency (High-F, Low-F), Root (Full, Defective), Prime Type (Morphological, Semantic, Morpho-Semantic, Unrelated). Each participant was exposed to one of the SOAs (50ms, 100ms). Non-words were not included in this analysis. Trials in which response errors occurred were removed from this sample and trials in which the Z-score of the RT was lower than -2.5 or higher than +2.5 were likewise discarded.

In order to calculate the priming effects for each of the prime types (Morphological, Morpho-Semantic, Semantic), the average response time for each of these conditions was subtracted from the average response time in the unrelated condition for each participant, thus creating three new variables, each of which represents a single priming effect. These three priming effects were calculated separately for each level of Root and Familiarity/Frequency per participant. A mixed-model GLM was used to examine the effect of Familiarity/Frequency (High-F, Low-F), Root (Full, Defective), Prime Type (Morphological, Semantic, Morpho-Semantic, Unrelated) and SOA (50ms, 100ms). A significant main effect of Root [$F(1,48) = 5.12, p < 0.05$] was found, so that the priming effect for Targets derived from Full Roots ($M = 63.24, SE = 22.42$) was significantly higher / greater than for Targets derived from Defective Roots ($M = -5.66, SE = 19.89$). In addition, a four-way interaction of Familiarity/Frequency, Root, Prime Type and SOA [$F(2, 96) = 3.78, p < 0.05$] was revealed. In order to examine this interaction, the data were / observation was split by Familiarity/Frequency.

A General Linear Model of the Low-F Targets revealed a marginally significant effect of the Root [$F(1,48)= 3.681$, $p= 0.061$] so that the priming effect for Targets derived from Full Roots ($M=96.49$, $SE= 41.29$) was significantly higher / greater than the priming effect of Targets derived from Defective Roots ($M= -15.93$, $SE= 37.04$). In addition, a three-way interaction was found between the Root, the Prime Type and the SOA [$F(2,96)= 3.39$, $p<0.05$]. In order to examine this interaction, the observations were [is this the accepted formulation – or “the data were split”?] split by SOA. This further analysis yielded a marginal interaction between the Root and the Prime type in the longer SOA of 100 ms [$F(2,40)= 2.71$, $P= 0.78$]. Further, inspection of the effects of the Prime Types in the longer SOA revealed a marginal effect of the Morphological Prime [$F(1,26)= 3.68$, $p=0.66$], such that the priming effect of Targets derived from Full Roots ($M= 113.32$, $SE= 74.06$) was greater than that of the Targets derived from Defective Roots ($M= -52.79$, $SE= 63.5$). The Morpho-Semantic Prime also revealed a significant effect of the Root [$F(1,29)= 8.66$, $p<0.01$] , such that the priming effect for Targets derived from Full Roots ($M= 125.59$, $SE= 55.79$) was greater than for Targets derived from Defective Roots ($M= -114.65$, $SD= 67.73$).

A General Linear Model of the High-F Targets revealed a marginally significant two-way interaction [$F(2,212) = 2.54$, $p= 0.081$] between the Prime Type and the SOA. Further analysis of this interaction yielded no significant results. Another significant three-way interaction appeared between the Root, the Prime Type and the SOA [$F(2, 2121) =4.57$, $p<0.05$]. In order to examine this interaction, the observations were split by Root. For Targets derived from Full Roots there were no significant results. For Targets derived from Defective Roots, however, there was a significant effect of the Morphological Prime on the SOA [$F(1, 106)= 10.24$, $p< 0.005$], such that the effect of the Morphological Prime in the short SOA (50 ms) ($M= 48.46$, $SE= 16.6$) was greater / larger than that of the Morphological Prime in the long SOA (100 ms) ($M= -29.73$, $SE=17.63$).

The main results of the priming experiments are summarized in Table 38.

Familiarity/Frequency	Significant effects of Familiarity/Frequency across the board Shorter Reaction times for High-F Targets Higher Accuracy Rates for High-F Targets
Root	Overall larger priming effects for Targets derived from Full Roots than for Targets derived from Defective Roots
Root X Prime X SOA X Familiarity/Frequency	1. Larger effects of Morphological and Morpho-Semantic Primes in the long SOA for Unfamiliar/Infrequent Targets derived from Full Roots than for Targets derived from Defective Roots 2. Larger effects of Morphological Primes for Familiar/Frequent Targets derived from Defective Roots in the short SOA than in the long SOA.

Table 38: Summary of Significant Results on (Pilot) Priming Experiments

8.2. Summary and Interim Discussion

Both analyses of accuracy and reaction times across prime types revealed significant differences between the unfamiliar/infrequent words as against familiar/frequent words and non-words. Unfamiliar/infrequent targets required longer latencies and their accuracy levels indicated that the participants performed their lexical decision at chance levels. These very clear and consistent results provide evidence for the difficulty experienced by Hebrew speakers when morphology and semantics are at odds with one another. Being faced with well-formed Hebrew words constructed out of existing roots and prosodic templates but lacking in an established semantic interpretation evidently causes them considerable uncertainty, as reflected in these results. The high agreement of the accuracy and reaction time measures suggests, further, that the participants in the experiments were reliable, not manifesting a speed-accuracy trade-off phenomenon. The role of frequency in priming experiments is not straightforward; in some studies, it did not have an effect on results (e.g., Fortser & Davis, 1984), while in others it did (e.g., Rajaram & Neely, 1992). The present study did show a clear effect of familiarity/frequency.

Analysis of the priming experiments in terms of reaction times yielded both expected and unexpected results. An effect of familiarity/frequency was expected, but it

was not predicted to play such a prominent role, to the extent that it, in fact, overshadowed the effect of the root. The differential effect of the root and the favoring of full over defective roots was consistent both with the results of the written tasks in the battery and with former priming experiments performed in Hebrew (Frost et al, 2000), highlighting the important role of the full root in lexical processing. Unexpected results were the partial effects of morphological (and morpho-semantic) priming, which appeared (1) for unfamiliar/infrequent targets derived from full roots in the long SOA and (2) for familiar/frequent targets derived from defective rather than full roots in the short SOA. These unexpected results of morphological priming for defective roots are also supported by existing literature on priming effects in Hebrew, which have documented priming effects for full as well as for defective roots (Schiff et al, 2008; Velan et al, 2005)

These results seem *prima facie* not to fully conform to the predictions underlying the design of the priming experiments in this study and with findings of other masked-priming studies – in Hebrew as well as in other languages as described in Chapter II (Part B, Section 2.1). A more robust and consistent priming effect was expected to appear for both types of roots, for high and low familiarity/ frequency targets, with differential effects of morphology/semantics across SOA's. A detailed examination of the figures yields several possible lines of explanation to this lack of consistency of the priming results, along the following lines. First, difference in software may account for certain of the discrepancies, since the vast majority of masked-priming studies to date employed the DMDX program (Forster & Davis, 1984), whereas the Haifa laboratory uses E-Prime software, which to date has been applied mainly for experiments in semantic priming. This suggests that the E-Prime program may be less compatible for a masked-priming design. One possible source for the discrepancy with the studies of Frost et al could, nonetheless, be the diacritical marks. Frost and his colleagues did not use diacritics at all, whereas in my study, 22 of the 72 Targets (29%) and 53 of the 288 Primes (18%) had minimal diacritical marking for purposes of disambiguation given the great homography in Hebrew (see Chapter I, Section 3.1). The criteria I adopted in this connection may have been too stringent, and the diacritical marks could be reduced even more. This question, too, remains open for further research. A third consideration is the fact that the raw figures indicate that the results of the present study do not in fact differ so very much

from those of Frost et al. The latter consistently obtained 11 to 15 ms priming for root-related words as significant, whereas in the present study, only results of higher than 30 ms were counted as having reached significance. This discrepancy may be due to between-subject variance, reflected in the high standard deviations in our study, which may also have played a role here, and which may be due to the relatively small number of observations obtained in each condition, meaning that there might not have been sufficient measures to reach significance. Another possible explanation for the high interpersonal variance in the present study may also derive from the different conditions that it involved, since it presented participants with a large proportion of unfamiliar/infrequent words, to which they in all likelihood responded very variably, employing different strategies to cope with them in each case.

Two other interesting though unpredicted priming effects are worth noting. First, the fact that there was a significant morphosemantic priming effect for low-F words at the 50 ms condition indicates that semantic processes may be active even at this short duration. The existence of semantic priming at 50 ms is subject to debate, with the research literature divided between reports that found priming effects as against others that failed to find effects for priming at this short SOA (Bueno & Frenck-Mestre, 2008; Diependaele et al, 2009; Marslen-Wilson et al, 2008; Perea & Gotor, 1997). Results of the current study support the view that semantic priming may in some cases appear even with a short SOA. Second, the unexpected finding for morphological priming to familiar/frequent defective roots in the short SOA, together with the negative priming to the same roots in the long SOA, yields a complex picture regarding the status of defective roots in the mental lexicon. On the one hand, they are morphologically partial and hence non-transparent, with the result that even educated, but non-expert Hebrew speakers have difficulty in extracting the full or appropriate set of abstract root radicals in each case. On the other hand, the very fact that they deviate from transparently canonic roots may cause speakers to adhere more closely to morphology in processing them. This is a general trend, which appears across the board in the present study, in the off-line written tests as well as in the on-line priming tasks, as further discussed in Chapter IV (Section 2.1).

This concurrent effect of different types of knowledge and the high activation of various types of connections between words provides evidence for the multi-faceted

nature of the mental lexicon. Taken together, the results of the on-line priming experiment combine with those of the off-line tests to reveal the dynamic nature of lexical processing: In the restricted time-span of priming tasks, all types of relations between words are activated simultaneously, whereas the more monitored contexts and the more conscious strategies of off-line written tasks yield a radically different outcome, in which one particular type of relation is favored.

CHAPTER IV -- DISCUSSION

This concluding chapter provides an integrative discussion of the findings from the different tasks described in the preceding chapter, in relation to the independent variables of the study and their implications for the nature of the mental lexicon in general. The chapter starts with discussion of the key results of the off-line and on-line tests in relation to the *a priori* predictions of the study as well as to prior research in relevant domains (Section 1), followed by conclusions regarding the overall effects of the independent variables of the study (Section 2), commentary on insights on the mental lexicon deriving from the study (Section 3), concluding with delineation of its broader implications and directions for future research (Section 4).

1. Discussion of Results on the Test Battery

This section first discusses the results of the written test battery -- Relatedness between Words (Section 1.1), Interpretation in Context (1.2), Free Associations (1.3), and Sentential Use and Definitions (1.4) – followed by discussion of the two priming experiments (1.5), in relation to the predictions guiding the study (as formulated in Chapter II, Part B, Section 1.5) and to prior research in the relevant domains. Each part starts with a brief recapitulation of major trends summarized in the preceding chapter.

1.1. Relatedness-between-Words Tasks

Recall that results on the two tasks of Relatedness yielded both shared trends and also some discrepancies between them. The shared trends were (1) preference for familiar/frequent items over unfamiliar/infrequent items and (2) avoidance of phonological distractors. The two tasks differed in the hierarchies of favored responses and in amount and type of interactions, especially with respect to development, since the Multiple-Choice but not the Ranking task showed a clear developmental curve.

The prediction that participants would select more morphological distractors for words with a low F-score was confirmed for the Multiple-Choice task. The second prediction, that the tendency to provide morphological responses to Low-F words would interact with age, was also confirmed for this task. Neither of these two predictions was

confirmed for the Ranking task. Not as predicted, the Ranking task showed overall reliance on morphological distractors, even for familiar/frequent nouns. The second prediction, of interaction of age and reliance on morphology, was not confirmed on this task, either, since participants across the board preferred the morphological distractors. The overall tendency to favor morphological responses (as noted in Chapter III, Part A, Section 2.2) provides strong support for the quite general tendency of Hebrew speaker-writers to rely on morphology as a consistently powerful structural resource. Prior research on Hebrew reveals a “ceiling effect” in school-age mastery of Hebrew derivational morphology in the form of productive recourse to morphologically appropriate but lexically inappropriate responses in experimental conditions (Avivi Ben-Zvi, 2010; Berman, 2000; Levie & Ben-Zvi, 2008; Ravid & Schiff, 2006; Seroussi, 2002). School-age and adolescent participants, like the adults in my 2002 study, for example, who lacked command of the conventionally established form of Hebrew action nominals, typically gave an alternative action nominal, composed of the same root but in a different morphological pattern, resulting in a non-occurrent but morphologically well-formed action nominal. Closely corresponding findings were yielded by Levie and Ben-Zvi’s (2010) study of derived adjectives. The cognitively demanding task of ranking items for level of Relatedness between them may have driven participants to adopt the same strategy as they employed in production tasks, causing them to adhere to morphology as a reliable “fall-back” source of information.

These two tasks, of Multiple-Choice and Ranking Relatedness are, to the best of my knowledge, the first documented experiments attempting to disclose the nature and internal hierarchies of various relations of meaning and/or form in the mental lexicon. Research on English has focused on the two themes of vocabulary and semantic-pragmatic knowledge. Particularly relevant here are two studies of vocabulary knowledge that employed the multiple-choice method in order to assess word knowledge on an implicit level (Anglin, 1993; Durso & Shore, 1991). Importantly, these were administered after participants had failed at tasks requiring a higher, more explicit level of word knowledge, so that multiple-choice tasks were employed mainly for unfamiliar/infrequent words. Another set of studies dealt with various aspects of semantic-pragmatic knowledge in a forced-choice task (Lucariello & Nelson, 1985; Nelson, 1977; Waxman

& Namy, 1997), with participants typically asked what “goes best with” with the experimental item, hence requiring that they choose between two items. For example, a large body of research has examined development of a thematic versus taxonomic preference, following Inhelder and Piaget’s (1964) notion of the “thematic-taxonomic shift” in conceptual-linguistic development (Hashimoto, McGregor & Graham, 2007; Nguyen, 2007; Nguyen & Murphy, 2003; Whitmore et al, 2004). No other study that I know of incorporates semantic, morphological, and phonological relations concurrently, let alone for high-frequency words.

Rather surprising support for the results of the present study of an overall preference of semantic over phonological distractors in the single-choice task comes from the study of Gonnerman et al (2007). Employing the method of cross-modal priming, they found that their participants, young college students, revealed pure semantic priming, but not pure phonological priming. They concluded that this semantic superiority was due to the richness of the semantic system in terms of modalities, which they explain as deriving from the fact that semantic representations incorporate information from various input modalities, whereas phonological information is based on only one single sensory modality. Implications of the factor of semantics with respect to modality is discussed further below (Section 3.3). Another fresh and unpredicted source of support for the relatively low contribution of phonology in Hebrew derives from Cohen-Mimran’s (2009) investigation of correlations between reading fluency and various linguistic factors among grade-school children. The unexpected finding of the Israeli study was that success on the morphological tests was the best predictor of reading fluency, more so than phonological awareness tests, which have long been considered superior as predictors of reading fluency. This finding provides another, typological, explanation for the relative disregard for phonological cues, at least in written Hebrew.

Results of both tasks of relatedness between words in the current study thus clearly demonstrate the dynamic nature of relations between words in general, as sensitive to various psycholinguistic factors and to different task demands.

Two Hebrew-specific points emerge from these results. The first is the clear preference for morphology over phonology on both tasks. Phonology, which has a crucial effect on development of both oral and written language in Hebrew (Ben-David, 2002;

Frost, 1995) as well as in English (Freyd & Baron, 1982; Reilly, Chrysikou, & Ramey, 2007), is construed by Hebrew speaker-writers as a marginal factor with negligible impact as compared with morphology when assessing relations between words. Further evidence for the weight of morphology in addition to the study of Cohen-Mimran (2009) (in this case, of a consonantal skeleton) is provided by the comparative findings contrasting Spanish- with Hebrew-speaking children, particularly once the latter were familiar with the writing-system of their language (Tolchinsky & Teberosky, 1997). The second interesting observation, one that appears across the board in this study, concerns the dual, and even paradoxical, nature of the Hebrew root. Root transparency (as detailed in Chapter I, Section 3.2, in the description of Hebrew morphology) evidently serves as an anchor for Hebrew speaker-writers for further semantically-driven psycholinguistic processes. The absence of a full three-consonantal root seems to limit the scope of psycholinguistic processing, causing Hebrew speakers to rely even more on structural cues such as are largely lacking in the case of defective roots. In other words, fully established word knowledge appears more readily available for words derived from full roots, whereas the structural deficiency of defective roots narrows down their accessibility to further processing.

1.2. Interpretation-in-Context Task

The presence of a sentential context for unfamiliar/infrequent nouns in this task promoted use of semantic-pragmatic response, unlike in other tasks on the battery, which consisted of words in isolation. All the independent variables interacted with each other and with age in responses to this task showing, once again, that these variables have a strong effect on deriving word meaning from a sentential context. The variable of concreteness had a particularly strong effect, expressed by an advantage for concrete over abstract words in the youngest schoolchildren, and by differential paths for processing concrete and abstract words across the population.

The prediction that the supportive sentential context would motivate participants to rely more on semantic-pragmatic contextual cues in interpreting unknown words was confirmed. So was the second prediction, that this tendency would interact with age. The interactions that emerged for the independent variables of concreteness and root

transparency likewise confirmed the prediction, both interacting with type of response. On the other hand, the complex and manifold properties involved in each of these two factors had an impact beyond what had been expected. Full roots, in line with other tasks on the battery, raised the proportion of semantic responses; defective roots, on the other hand, resulted in a higher proportion of responses that incorporated both structural as well as semantic-pragmatic cues. The same was true for concrete versus abstract nouns: The former elicited a higher proportion of semantic-pragmatic responses, while the latter yielded responses that related morphologically as well as semantically-pragmatically to the input noun.

Considering, next, the results of the Interpretation-in-Context task in relation to relevant prior research, note that the sentential contexts provided in this task were deliberately limited and rather vague, yet nonetheless they were sufficient for the majority of participants to succeed in deriving the meaning of the unfamiliar/infrequent words that they contained. Barsalou (1982), for example, has suggested that words in the mental lexicon encode two types of information, context-independent and context-dependent, with the former a more inherent or core property that emerges in all circumstances, whereas the latter is more sensitive to context. Borrowing Barsalou's terms, the task at issue here provided participants with context-dependent clues, leaving them to infer the correct meaning for themselves. I interpret my results as revealing a strong relation between context-dependent and context-independent features of words, since participants succeeded in finding the correct meaning of the input items a large part of the time. Along rather different lines, Bolger et al (2008) relate the task of deriving word meaning from context to models of reading comprehension. Although they do not explicitly mention the factor of familiarity/frequency, it stands to reason that learning word-meaning from context involves mainly unfamiliar/infrequent words, whether in the objective or subjective sense of these notions. An important insight emerging from their study is the distinction between deriving word meaning from a context as a relatively conscious process, compared with the more passive nature of incidental word learning. For Bolger and associates, learning the decontextualized meaning of a word was affected by how well the context supported the meaning represented by the target word.

Moreover, studies examining the relative weight of global versus local information in text comprehension (Hess, Foss, & Carroll; 1995) and production (Berman & Nir-Sagiv, 2009), reached similar conclusions regarding the dissociation between global and local information in discourse processing, hence further highlighting the importance of context, even minimal, especially in processing unfamiliar/infrequent words.

Further support for this claim is provided by Chaffin et al's (2001) eye-tracking comparison of processing times for high-familiar words, low-familiar words, and non-words in a sentential context: They found that processing of low-frequency words required more time than processing of high-frequency items, and that in the initial stages of reading, low-frequency words were treated the same as non-words, with participants differentiating between words of low-frequency and non-words only at later stages of the reading process. Their findings provide evidence for the difficulties readers have when encountering infrequent or unfamiliar words, which require far more cognitive resources and attentional skills than highly frequent or familiar items. Another result of Chaffin and his associates was the importance of type of context for reading comprehension, such that a neutral context led participants to seek contextual cues elsewhere. Williams and Morris (2004), who extended Chaffin et al's study to more advanced stages in reading comprehension using the same paradigm of eye-tracking, found differences in processing times between infrequent/unfamiliar words and novel words. They further found differential effects for words of equal levels of objective frequency but with different subjective familiarity ratings: Processing of more familiar words of low-frequency (e.g., *dagger*) took less time than of less familiar words (e.g., *lance*) of the same frequency level, indicating that familiarity measures are more reliable as a tool for assessing word knowledge than occurrences in corpora.

Moving to the semantic-syntactic interface, the study of Shore and Kempe (1999) underlines the importance of the semantics of the sentential context, to the effect that the more constrained the context, the more likely it is that participants will be able to identify all potential words related to the domain in question. In such cases, respondents can exploit their knowledge of the contextual domain as an aid in deciding the correct meaning of the unfamiliar word. This line of reasoning provides one possible explanation

for the differential processing of concrete and abstract nouns in the current study. Concrete nouns, by their very nature, involve a more restrictedly delimited or constrained semantic environment than abstract concepts, which are more open-ended entities and so demand different processing mechanisms (Lyons, 1997; Ravid, 2006b). A second finding of Shore et al that is directly relevant to the current study is that knowledge about the derivational morphemes out of which the target words were constructed was apparently not helpful to participants in determining their meaning. This finding for English is in marked contrast to results of the current study, in which derivational morphology (the consonantal root, sometimes even the prosodic template or morphophonological pattern) provided participants with important clues in interpretation of unfamiliar/infrequent derived nouns. These clues were sometimes helpful, as in the case of a semantically transparent derived noun like *xalécet* ‘a rescue boat’ from the root *x-l-c* ‘rescue’, where participants across the board inferred that *xalécet* is some kind of entity that rescues. Morphological clues may, however, be misleading, as in semantically opaque, unfamiliar/infrequent derived nouns; for example, when participants encountered the noun *gamlon* ‘pediment’, which is superficially very similar to the noun *gamal* ‘camel’, some of them mistakenly thought that *gamlon* is somehow related to *gamal*. These examples, together with other findings of the interpretation-in-contexts task in the current study, confirm that derivational morphology plays a crucial role in reading comprehension in general and in deriving the meaning of unfamiliar/infrequent words in particular in the mental lexicon of Hebrew reader-writers. Returning to the developmental factor, Whitmore et al found that young children and adults alike attend to taxonomic information when inferring the meaning of novel words. This facet of semantic knowledge warrants further research in Hebrew, since it was not included in the current task.

This literature review concludes with detailed consideration of the study of Fukkink, Blok, and De Glopper (2001), since this was the most similar to the current task, and the only developmental study on interpretation of words in context that I encountered. The authors conducted a developmental study of Dutch with 2nd, 4th and 6th graders, who were presented with unfamiliar words embedded in short contexts, and asked to define the target items, half of which were concrete and half abstract. Like the

current study, Fukkink et al found an increase with age in deriving word meaning from context. However, the concreteness effect was evident in their study only for the younger age groups, while the 6th graders, the oldest group in their study, did not show a concreteness effect; this contrasts with the current study, which found concreteness effects in all three age groups, from 6th grade up. Closer inspection of the data-base examined by Fukkink et al reveals possible sources of this discrepancy. First, in number, they assigned only five nouns that they defined as concrete and five others as abstract, with only ten participants in each age group. Second, and more importantly, their so-called concrete words covered two verbs, two adjectives, and one noun. Yet lexico-grammatical category is known to affect concreteness so that, for example, verbs as relational terms are considered more abstract than nouns (Colombo & Burani, 2002; Gentner, 1982; Markman, 1989). Moreover, the English translations of the items used in their test -- *tirade*, *to subside*, *to shatter*, *lanky*, *surreptitious* -- are unfamiliar/infrequent but not concrete. In short, Fukkink et al not only relied on a small number of respondents, they failed to control for lexico-grammatical category, nor do they appear to have an adequate characterization of concreteness as a key variable in their study.

In sum, results of the Interpretation-in-Context task in the present study yield both insights that are both novel and consistent with findings from prior research. Earlier studies supporting the current findings were conducted mainly on monomorphemic words in English, whereas the task at hand here was based on morphologically complex items and included the Hebrew-specific facet of root transparency, which turned out to have a significant effect on the results.

1.3. Free Association Tasks

Below follows a brief summary of the main trends of the thousands of responses obtained on these two tasks: (1) The most favored type of association was semantic-pragmatic, taking into account various sub-types of semantic-pragmatic relations; (2) all the independent variables had significant effects on the results; (3) the number of associations was higher to high-F nouns and among mature participants; (4) there were significantly more morphological responses to low-F nouns and among younger participants; (5) concrete nouns manifested a preference for frame-related responses and

co-hyponyms, whereas abstract nouns favored syntagmatic responses and synonyms; and (6) with respect to lexico-grammatical category, there was an increase with age in nominal responses and a concomitant age-related decrease in responses in other lexico-grammatical categories.

The prediction that words with a low F-score would elicit more structural associations and words with a high F-score more semantic-pragmatic associations was confirmed, as was the prediction that this trend would interact with age. The prediction that the multiple-associations task would yield more associations to words with a high F-score than to words with a low F-score and that number of associations would increase as a function of age were also confirmed. The enormous pool of responses turned out to be the source of numerous other, unanticipated insights as well. For example, I had not *a priori* predicted the active role played by type of consonantal root in structural associations and the interplay of root transparency with meaning and form – in the shape of adherence of full roots to semantics and defective roots to morphology-phonology. Nor were the differential paths of concrete and abstract nouns predicted in full. These unexpected and hence novel finding concerning type of root and the factor of concreteness are discussed in further detail (in Section 2 below) in relation to the overall impact of the independent variables of the study.

Three more specific findings that shed novel light on the developing mental lexicon of Hebrew emerged uniquely in the free-association tasks: Two concern the role of Hebrew morphology in structural and in mediated associations, and the third relates to the unexpected developmental increase in paradigmatic associations. “Clang” or sound associations are defined in the literature as ones that share phonological features with the input noun, to which they are related only by sound, even in the case of written materials. This phenomenon has been discussed in the research literature mainly in relation to young children (Cronin, 2002; Entwisle, 1966; Ervin, 1961; Hoar, 1978), second language learners (Crawley & Johnson, 1976; Greindaus & Nienhuis, 2001; Meara, 1978), and mental health patients (Baskak et al, 2008; Bleuler, 1911; Kent & Rosanoff, 1910; Kiang, 2010). For example, young English-speaking children in Cronin’s study gave the associations *old* and *giver* to the input nouns *cold* and *river* respectively. Hoar gives examples of clang associations of mentally ill adults such as *bite* to the input noun *light*

and *goat* to the input noun *go*. In the two studies that investigated associations for low-F words in English, of Chaffin (1997) and Durso and Shore (1991), this phenomenon was labeled “same-sound” by Chaffin (e.g., *armor* to the input noun *paramour*) and “sound-alike” by Durso and Shore (e.g., *orangutan* to the input noun *harangue*). The latter failed to perform a separate analysis of this type of association, but Chaffin found that 14% of associations to unfamiliar words were “same sound”, which he included in the category of non-semantic associations. As for the current study, if only what were defined as morphophonological associations (i.e., either same pattern, rhymes, or partially similar phonology – as specified in Chapter III, Section 4.1) are treated as sound associations, the percentage of such responses to high-F words is less than 1%, very much in line with what Chaffin found, and to low-F words around 6.5%, less than in Chaffin’s study.

It should be noted in this connection that morphology clearly has a strong phonological component, interfacing powerfully with phonology, with the two domains so closely intertwined that it is sometimes difficult to distinguish between them, not only but also in Hebrew. In fact, a prominent school of Hebrew researchers even claims that the source of morphological alternations lies in the domain of phonology and that purely phonological parameters control Hebrew morphology (Bat-El, 1989; McCarthy, 1981; Ussishkin, 2005). This phonological approach to morphology has weak and strong versions: The latter argues for lack of a consonantal root, viewing phonological templates as the single organizing principle of the Hebrew lexicon, whereas a weaker version argues that phonological processes determine the traditional root-pattern interface in Hebrew word-formation (Berent, Everett & Shimron, 2001; Berent & Shimron, 1997). I adopt a relatively conservative approach suggesting that at least part of Hebrew morphological structure can be attributed to a phonological component. If the morphological associations are added to the sound association responses in the present study, the total number of sound / clang associations would come to nearly 10% (9.1%) to high-F words and well over 40% (44.2%) to low-F words! Even if not all of the latter can be attributed purely to phonology, these figures are impressive, revealing the powerful impact of Hebrew morphology in speakers’ responses to unfamiliar/infrequent words.

A second unexpected finding on the Hebrew associations tasks involve those termed “semantically mediated” in our study and “sound-mediated” by both Chaffin and

Durso and Shore. These include Chaffin's example of *spice* in response to *persimmon* (via the mediation of *cinnamon*) and Durso and Shore's *fancy dress* to *eloquent* (via the mediation of *elegant*). About 10% of all associations on both tasks in the current study were of this type, nearly all to low-F words, for which they came to around 21% altogether, compared to 16% in Chaffin's study. Comparison of Chaffin's findings with those of this study reveals discrepancies, for "same-sound" associations and for sound-mediated associations, both of which are relatively lower in the English than in my Hebrew-based study. Two possible explanations can be suggested for this incompatibility. The first relates to respondents' age: Chaffin's participants were all adults, whereas in the developmental design of my study, younger participants were found to rely far more on morphological-phonological cues than the adults. A second line of explanation for the discrepancy between the two studies lies in the relative frequency of the input nouns used in each. The first five unfamiliar nouns in Chaffin's study are: *ocelot*, *organdy*, *henna*, *armoire*, and *persimmon*. The first five unknown items in Durso and Shore's study were *aesthetic*, *ambiance*, *ambivalent*, *anathema*, and *ancillary*. These words are relatively more familiar even to me, a non-native speaker of English, than the unfamiliar/infrequent nouns used in the current study in Hebrew. First, the nouns defined as low-F for present purposes were quite generally declared as unknown to around ten native-speaking Hebrew graduate school linguistics majors affiliated with the present research study; second, they were derived by carefully, specially designed procedures for identifying nouns as unfamiliar/infrequent, whereas Chaffin was able, like other researchers on English, to base his selection of words on existing category norms, such as are not available in Hebrew. The implications of this lacuna and how I attempted to cope with it in the present study are discussed in further detail in relation to the independent variables of the study (Section 3.2 below).

The third unexpected result of the association tasks concerns the well-known "syntagmatic-paradigmatic shift" (Inhelder & Piaget, 1958, 1964) concerning differences in the ratio of lexico-grammatical classes between young children and adults in free association tasks. Whereas Inhelder and Piaget found that children under the age of seven years tended to provide syntagmatic associations, from a different lexico-grammatical class (for example, an association in the form of the verb *eat* to the input noun *table*),

respondents beyond age seven tended to provide associations in the same lexico-grammatical class (e.g., the noun *chair* in response to the input noun *table*). Note here that the category of “paradigmatic” is a cover-term for most of the common types of semantic relations, including co-hyponymy, super-ordination, and synonymy (Aitchison, 2003; Greindaus & Nienhuis, 2001). Following Piaget’s theory of stages in cognitive development, Nelson (1977) hypothesized that the shift from syntagmatic to paradigmatic associations represents a conceptual change that takes place during the early school years. Other studies relate this phenomenon to the “thematic-taxonomic shift”, as another well-established developmental phenomenon analogous to the “syntagmatic-paradigmatic shift”, documented by the preference of younger children to select a thematically rather than a taxonomically related item in forced-choice or matched-to-sample tasks (Brown & Berko, 1960; Cronin, 2002; Waxman & Namy, 1997). Thus, presented with an experimental item such as *carrot* and two other items related to it (say *rabbit* and *tomato*), young children are said to prefer the thematically related item (*rabbit*) whereas older children prefer the taxonomically related item (*tomato*). The preference for a thematic relation is considered immature, while a taxonomic relation is taken to indicate mature conceptual knowledge (Emerson & Gekosky, 1976; Ervin, 1961; Inhelder & Piaget, 1958, 1964; Luciareello & Nelson, 1985).

This equating of thematic = immature, taxonomic = mature has, however, been challenged in recent times (Bauer & Mandler, 1989; Blaye & Jacues, 2009; Hashimoto et al, 2007; Liu, Golinkoff & Sak, 2001; Markman & Hutchinson, 1984; Nguyen, 2003; 2007; Waxman & Namy, 1997). Studies found that, in suitable experimental conditions, toddlers as young as 2 to 3 years old were able to attend to taxonomic relations. Moreover, adults could successfully adopt both types of relations, reflecting the “cross-classificational” ability to navigate flexibly across various types of relations between words as a hallmark of mature linguistic-conceptual proficiency – a topic I return to in discussing meaning relations in the mental lexicon (Section 3.3). Coming back to the syntagmatic-paradigmatic issue in the present study, not only were almost three-quarters of the associations given by 6th graders paradigmatic, but this proportion in fact increased to 85% in 10th grade, going up to 87% in the adult group. Importantly, all participants in the current study were well beyond the age of seven years old, defined as the “critical

period” for the syntagmatic-paradigmatic shift. By this reasoning, all respondents across my population should have shown a similar favoring of paradigmatic, nominal associations to the input nouns. The finding for a gradual increase in associations of nouns to nouns with age challenges the notion of a dramatic shift away from syntagmatic responses, suggesting a less radical, more gradual developmental pattern. This finding, in line with other results on the test battery, is strong evidence that linguistic (and conceptual) development is by no means completed by age seven, and that the best way to describe this development is as a continuum rather than a shift.

Returning now to the issue of the kind of knowledge revealed by association tasks in general, the vast literature on the topic of associations describes both free-association as well as forced-choice tasks as reflecting associative strength in the mental lexicon. From this point of view, the tasks of relatedness between nouns in the present study can also be viewed as forced-choice tasks. Associations can be investigated both in isolation and in a sentential context (as done by Prior, 2004; Prior & Bentin, 2008). In the present context, relevant research is reviewed mainly for free-associations in isolation, as the task targeted in this study, with more general discussion of the notion of association and how it is reflected across the entire test battery left for the final concluding part of this chapter.

Research on free associations in isolation can be divided into four major areas, as follows: (1) as reflecting of language-cognitive development, as discussed in the preceding section on so-called developmental shifts; (2) as a diagnostic tool of pathologies, a topic lying outside the concerns of the current study, except for the fact that sound or “clang” associations are provided by mentally ill populations to familiar/frequent nouns as well as by normal speakers in the absence of sufficient lexico-semantic knowledge; (3) to establish norms for psycholinguistic research; and (4) as a mirror on semantic-associative connections in the mental lexicon. In what follows, I briefly describe studies of the third type -- norming data – before proceeding to selected research directly concerned with free associations that have important implications for the present study. Studies that deal with associations as reflecting various types of semantic-associative knowledge are deferred till later, in the context of a general discussion focusing on meaning and semantic-conceptual facets of the mental lexicon (Section 3.3 below).

Free association norms have been available for several decades, serving a valuable tool for various research purposes since Galton (1880), the first to use the free association paradigm as a psychometric measure. Free association norms have been established for English (Nelson et al, 2004), Spanish (Fernandez, Diez, Alonso & Beato, 2004), Dutch (De Groot, 1984), as well as other languages, in single / discrete tasks and in multiple / continuous tasks (De Deyne & Storms, 2008a). Following De Groot, Israeli researchers from Ben-Gurion University published free association norms for 800 words in Hebrew (Rubinstein, Anaki, Drori, & Faran, 2005), collected by both single / discrete and multiple / continuous procedures. In their replication of De Groot's on-line design, reaction times were measured for participants required to provide an oral free association to a target word appearing on the computer screen. The target words in the Israeli study were in part Hebrew translations of De Groot's original stimuli, with nearly three-quarters of their target words (588 out of 800) consisting of relatively familiar nouns and the rest made up of verbs and adjectives. The present study differs fundamentally from that of Rubinstein et al, since its goal was not to establish norms but, rather, to better understand the mental lexicon of Hebrew speaker-writers by means of the associations they provide. That is, in the present study, associations were a means rather than an end in themselves, as in the earlier Hebrew study. Besides, half of the input items in the current study – all carefully selected from the large pool of derived nouns in the language – were independently specified as unfamiliar/infrequent, whereas association norms are usually established for familiar/frequent words.

Discussion of the task-internal distributions of associations yielded by the current study, starts with De Groot's (1989) important study, the major source of reference for the 2005 Hebrew norming design. De Groot's investigation of meaning relations in the mental lexicon through free associations led her to draw a critical distinction between imageability and frequency. She proposes that imageability represents the strength of the links of associative networks in the mental lexicon, whereas frequency represents the number of links an item has in the mental lexicon. Consequently, according to De Groot, concrete nouns have an advantage over abstract nouns due to their stronger network links, while high-frequency words have an advantage over infrequent words due to their multiple nodes and links in the mental lexicon. As noted earlier (in Chapter I, Section

2.2), the advantage of concrete over abstract nouns can be explained either visually (Clark & Paivio, 2004; Goetz et al, 2007; Paivio, 1991) or contextually (Schwanenflugel et al, 1988). De Groot found that associations given in a continuous task (multiple associations) were more heterogeneous than associations in a discrete (single) task, in line with the findings of the present study, and that the associations to low-imageability words in the continuous study were more diverse than to words of high-imageability. She further found that synonym and near-synonym responses were given more to low-imageable than to high-imageable words, again consistently with the results of the present study. However, the difference between concrete and abstract nouns turned out to be far much more complex and variegated in the current study, involving, moreover, a preference for morphological, syntagmatic, and categorically-related responses in the case of abstract nouns. In sum, while not all the differences between concrete and abstract nouns revealed by the current study were found by de Groot, the two studies showed certain lines of correspondence.

In contrast, De Groot's findings in relation to the factor of frequency differ markedly from those of this study, since frequency had little impact on the associations in her study as compared with the considerable effect revealed by the current study. Closer examination of De Groot's data-base shed light on the source of these contradictory results. The English translations provided by De Groot for the first five high-imageable low-frequency words in her study are: *altar, strawberry, bath, executioner, pouch*; and the first five low-imageable low-frequency words are given as: *far, jealousy, benefit, regret, to know*. This mini-sample of De Groot's input data leads to the following observations: (1) There was no control for lexico-grammatical categories, which have a clear effect on degree of imageability (Gentner, 1982; Colombo & Burani, 2002); (2) there was no control for animacy, which has also been shown to have an effect on imageability (Langacker, 1991; Lyons, 1977); and (3) more importantly, the bulk of De Groot's stimuli, taken from a Dutch frequency corpus, are highly familiar relative to the stimuli used in the present Hebrew-based study. This can be explained in terms of the discrepancy between the often confounded variables of familiarity and frequency: The English-translated words given earlier are analogous to Gernsbacher's (1984) famous examples of words like *pizza*, which have low frequency of occurrence in a corpus but

high ratings for subjective familiarity. This familiarity/frequency discrepancy was taken into careful account in designing the present study (Chapter II, Part A, Section 2.3), with implications discussed in greater detail in Section 2.1 below. Further support for the suggestion that de Groot's frequency measures were biased comes from De Deyne et al (2008b). Their check of the frequencies of association norms in the far larger and more updated corpus of the CELEX database (Baayen et al, 1993) revealed significant effects for frequency as well as for imageability, in line with the findings of the present study.

Prior's (2004) examination of the 1730 associations in the Rubinstein et al (2005) Hebrew-based study revealed that the vast majority of the associations exhibited established semantic relations (Cruse, 1986), as follows: synonymy, antonymy, meronymy (part-whole and whole-part), hierarchical relations (category-exemplar, exemplar-category, and category coordinates), idiomatic, functional relations, and not otherwise specified. Only slightly over 6% (112 of the 1730) associations were classified as "not otherwise specified". In order to compare Prior's results with those of my study, I refer only to association responses obtained for familiar/frequent nouns provided by the adult population. An attempt to adopt the categories listed by Prior in analyzing associations provided in the present study shows that they are all compatible with what I defined as the semantic-pragmatic category, except for idiomatic associations, which accounted for nearly 7% of the total associations obtained by Prior. Taking into account that the syntagmatic category in my study, which accounted for slightly over 12% of the adults' associations to the familiar/frequent nouns, contained idiomatic expressions along with several other types of associations such as adjectives, the figures seem quite compatible. Moreover, the semantic-pragmatic associations to familiar/frequent words in my study (Prior's synonymy, antonymy, and hierarchic relations) correspond closely to the associations defined as categorially and hierarchically related in my study: These accounted for more than a third (37%) of the responses in Prior's study, compared with slightly over half (around 50%) in my study. Meronyms and functional relations in Prior's categorization combined yielded roughly half (49%) of the associations, in close correspondence to what were termed "Frame" relations in the current study: Here, they accounted for almost 49% of the associations – again, of the adult population, and to familiar/frequent nouns. Taking into account that the Rubinstein et al data that formed the

basis for Prior's analysis (1) included associations not only to nouns but to verbs and adjectives as well and (2) did not control carefully for concreteness as in the current study, while (3) Prior's categories of analysis were not exactly the same as those specified here, the distribution of associations in the different studies seems largely compatible with one another.

Moving away from Hebrew-based research on associations, Chaffin (1997) tested free associations given by adult participants to familiar words, unfamiliar words, and novel words. Direct comparison of Chaffin's findings with those in my study is not all that feasible due to the very different criteria for selection of low-familiarity items noted earlier, as well as the considerable impact of the different typologies of the lexicon in Hebrew and English. Accordingly, only general lines of comparison are drawn between my findings and those of Chaffin's important study. Chaffin distinguishes two types of associations: (1) event-based -- associations that illustrate semantic relations between words linked by an event, corresponding to the frame-related category in my study; and (2) definitional -- associations that answer the question "what kind of thing is it?", corresponding to what I classed as hierarchically related associations. On the basis of this distinction, Chaffin proposes event-relatedness and definitionality as two alternative hypotheses for dealing with unfamiliar words. He conducted a series of experiments that supported the definitional hypothesis, such that low-familiarity words elicited a higher proportion of definitional responses than high-familiarity words. That is, associations to low-familiarity words in Chaffin's study tended to be definitional whereas associations to high-familiar words favored the event-related type. This line of reasoning is well suited to the results of the current study, in which low-F words yielded more hierarchical associations and the ratio of frame-based associations dropped markedly to low-F words as against high-F words. Note, moreover, that responses classed in my study as categorially related -- including both "categorical" (for example, *robin:bird*) and "coordinate"/cohyponymous (e.g. *armoire:dresser*) are considered "definitional" in Chaffin's study. It follows that if I were to code responses in my study to fit the criteria applied by Chaffin, number of definitional relations would increase to be even closer to his. Further, the category termed "completion and morphological" by Chaffin referred mainly to idiomatic expressions (e.g. *honey:dew*), accounting for 7% of the associations

to high-familiar words (in close accord with Prior's analysis for Hebrew) and for none of the responses for low-familiar words. This finding, too, is highly compatible with the current study, in which High-F words received slightly over 10% of syntagmatic responses whereas Low-F words received practically none.

Other of the experiments reported by Chaffin investigated the use of synonyms as associations, associations to verbs, and associations in sentential context to high-familiar, low-familiar, and novel words (e.g. *The tourists rode in a taxi / rickshaw / kaptim through the city streets.*) An interesting finding from this sentential experiment is that novel words resembled low-familiarity words in many ways: Compared with their high-familiarity counterparts, both types of stimuli received (1) a large amount of non-semantic-related responses like sound and sound-mediated associations, (2) no completion (syntagmatic) responses, (3) fewer semantically related responses, and (4) fewer thematically related responses. This finding has an important implication in relation to the current study. Recall that low-F words in my study were in many respects virtually nonce words, or novel words in Chaffin's terms, that is, they constitute possible but not actual items (Aronoff, 1976) in the mental lexicon of Hebrew speaker-writers. Chaffin's results for novel words can thus be taken as additional support for the class of low-F words in the present study. Further, from a developmental point of view, in discussing the origins of the "definitional" effect that emerged for low-familiar words, Chaffin cites as evidence findings from research on early language-conceptual development with regard to toddlers' adoption of a taxonomic, hence more definitional, strategy, when encountering novel stimuli (e.g., Markman, 1989; Markman & Hutchinson, 1994). Further developmental support for Chaffin's observations is provided by Keil's (1989) distinction between characteristic (i.e., more thematic) and defining (i.e., more definitional) attributes and their role in the consolidation of conceptual knowledge. Moreover, reading comprehension studies in adults further support the importance of definition when encountering a novel item in the course of reading (Bolger et al., 2008).

The study of Durso and Shore (1991) also included a free association task, but only to unknown words and to items classified as "frontier words", in which participants revealed partial word knowledge. The associations to these words ranged from meaningfully to non-meaningfully related to the target word, with marked differences

between frontier words and unknown words, such that the former yielded more meaningful associations with more relevant information than the latter. Durso and Shore employed the same pool of words as in their association task for a different, sentence-decision task, where participants had to select one of a pair of sentences, only one of which made correct use of the target words. Participants performed above chance even for words to which they had given non-meaningfully related associations, supporting the researchers' claim that even in the absence of a declared meaningful knowledge reflected in associations, implicit word knowledge aids participants in selecting the sentence that gives the correct meaning of the unknown/frontier word.

To conclude this section on the associations tasks, the rich and variegated responses yielded by my study revealed numerous interesting trends, both developmental and shared across the population, both Hebrew-specific and shared with findings from research on other languages, with results in general going far beyond what had originally been predicted.

1.4. Sentential Use and Definition Tasks

The study involved two types of sentence-production tasks: constructing sentences with nouns that were both high-F and low-F and both concrete and abstract and defining concrete and abstract words high on familiarity/frequency. Results of the Sentence Construction task revealed that all the independent variables it involved (root transparency, familiarity/frequency, concreteness, and age) affected the results in terms of both overall success and of more specific semantic-syntactic factors such as of types of modifiers and nominal position.

The predictions for increase with age in overall understanding of the input nouns in interaction with the word-internal independent variables were confirmed, as was, by and large, the prediction for an impact of the independent variables of familiarity/frequency, concreteness, and root transparency. On the other hand, the prediction that root transparency would interact mainly with unfamiliar/infrequent words was not fully confirmed since root transparency was found to play a role in relation to all the nouns on this task, irrespective of their relative familiarity/frequency; but the prediction that relatively unfamiliar/infrequent nouns would elicit fewer sentences overall and that the

sentences constructed with low-F items would be more general and less appropriate was confirmed, as was the prediction that concreteness would affect the syntactic position of the stimulus items. Several findings that had not been anticipated included (1) the affect of type of root on even familiar/frequent words and the interaction of root transparency with modifier lexicality and syntactic position; (2) the favoring of post-verbal position for unfamiliar/infrequent nouns; and (3) the strong effect of familiarity/frequency and its interaction with the other independent variables, especially with age. Recall that the nouns selected for this task were taken from the concreteness subset, so that the relative familiarity/frequency of the low-F nouns in this specific task was higher than that of low-F nouns selected for the other tasks (as explained in Chapter II, Part A, Section 2.4). Nevertheless, these relative differences in familiarity/frequency, although not so dramatic as on the other tasks, proved to be sensitive to age differences and to affect all the other variables in the process of constructing sentences with the given target nouns.

A review of the literature on sentence production or construction reveals that the status of this task as a research tool is unclear. It is employed in many variegated disciplines and domains. For example, there is vast literature on generation of sentences in general and on relative clauses specifically as a hallmark of early syntactic development (e.g. Brandt, Diessel & Tomasello, 2008), other research has queried the pertinence of this task outside of the written modality (Myhill, 2008), while from a pedagogical perspective, studies have been conducted on the efficiency of sentence-construction as a part of the school language-arts curriculum (e.g. Andrews, Torgerson, Beverton, Freeman, Locke, Low, Robinson & Zhu, 2006), and as a diagnostic tool for reading achievements (e.g. Frost, Madsbjerg, Niedersøe, Olofsson & Sørensen, 2005). Despite, or perhaps because of these richly diverse approaches, there are no accepted or established criteria for evaluating sentence construction as a basis for lexical knowledge. Another controversy relates to the psycholinguistic status of sentences, which since the advent of generative grammar have served as a fertile ground for both linguistic analysis and psycholinguistic experimentation in topics such as embedding (e.g., Karlsson, 2007; Shetreet, Friedmann, & Hadar, 2009), garden path sentences (e.g., Ferreira, Christianson & Hollingworth, 2001), relative clauses (e.g., Brant et al, 2008; Güenzberg-Kerbel, Shvimer & Friedmann, 2008) and other various syntactic phenomena, but the very

validity as a unit of spoken language has been queried from different perspectives by functional linguists and in oral discourse analysis (Chafe, 1994; Halliday, 1989; and see, too, Myhill, 2008). One line of research that appears particularly relevant in the present context is Jaeger and Norcliffe's (2009) study providing cross-linguistic evidence for the lack of universals in sentence processing, hence challenging the universality of the sentence as an element in a grammatical hierarchy. One point of theirs that is particularly relevant to the present study is the argument that conceptual accessibility affects word order in the sentence (Bock, Eberhard, Cutting, Meyer & Schriefers, 2001; Bock & Levelt, 1994). The concrete-abstract opposition as applied in the present study is a conceptual distinction, so that the fact that respondents quite generally assigned abstract nouns to pre-verbal and concrete nouns to post-verbal positions in the sentences they constructed constitutes clear evidence that conceptual differences shaped the surface order of elements in sentential contexts.

Further support for the ideas emerging from the present study is provided by results of a largely similar sentence-construction task included in a previous developmental study of mine (Seroussi, 2004) as well as by findings of a large-scale cross-linguistic project on text construction in different languages, including Hebrew (Berman, 2008). Thus Ravid and Cahana-Amitay's (2005) analysis of verbal and nominal expressions in personal-experience narratives produced by Hebrew-speaking gradeschoolers, pre-adolescents, and adolescents (aged 9-10, 12-13, 16-17 respectively) compared with adults revealed that, with age, derived nominals were more widely used, they were more abstract, more likely to appear in complex noun phrases, and to occur in post-verbal positions. Ravid and Berman's (2010) study of noun-phrase complexity in narrative and expository texts produced by the same Hebrew-speaking participants compared with parallel groups of English speaker-writers employed two criteria of particular relevance to the present study -- semantic complexity of the noun phrase head ranging from 1 (concrete) to 4 (abstract), and the quality and number of modifiers, ranging from 1 (grammatical items) to 4 (lexical and phrasal modifiers). They found a similar age-related increase in both languages in the degree of abstractness of the head nouns, accompanied by an age-related increase in lexical compared with grammatical modifiers. In expository texts written in Hebrew in the Ravid and Berman study, the

average degree of semantic abstractness increased from 2.34 in the youngest age group (9-year-olds) to 3.03 among adults, while quality and number of modifiers increased from 1.3 in the youngest group to 2.03 in the adult group. Although scores were assigned by ranking, not in percentages, these results are highly compatible to the findings of the present study. Besides, Ravid and Berman note that similar criteria should be applied in relation to the variables of syntactic site (pre-verbal or post-verbal position), similarly to the analysis employed in the present study and in Seroussi (2004). The close compatibility between the discourse-based results with those of isolated sentence-construction tasks indicates that, from the point of view of word usage and syntactic positioning at least, sentences may be considered as “small-scale pieces of discourse”. Finally in this connection, note that the qualitative analyses I applied in my earlier (2004) study yielded highly similar conclusions to the present study, which provides quantitatively measured empirical support for the quite general preference for abstract nouns in more complex noun phrases and in pre-verbal position and for concrete nouns in simple noun phrases and in post-verbal position.

As noted earlier, the present study used the task of sentence construction as a means of assessing lexico-semantic knowledge, as was done, too, by Anglin (1993) and Durso and Shore (1991). The present analysis went beyond these two important studies by requiring participants to generate sentences with words established *a priori* and independently as representing different degrees of familiarity/frequency, independently of participants' subjective word knowledge; the English-based studies, in contrast, had participants generate sentences only to familiar/frequent words, based on individual measures of vocabulary level. A second difference is that the present study took into account the additional lexico-semantic and syntactic factors of noun concreteness, type of modification, and sentence-position.

The second “sentential” task included in the study elicited definitions for words independently ranked as having high familiarity/frequency. The distinction between a sentence and a definition is not explicitly considered in the Durso and Shore study, whereas Anglin assigned definitions a higher level of lexico-semantic and lexico-syntactic knowledge than sentence-production. Bolger et al (2008) claim that the difference between definitions and sentences lies in their different roles in the acquisition

of lexical knowledge, in the sense that sentences provide referentially specified predication for a new word, whereas definitions add pointers to meaning boundaries – an observation of critical importance in evaluating the nature and role of definitions as a window on the mental lexicon of Hebrew speaker-writers. The results on the definitions’ task in the present study (as detailed in Chapter III, section 7) revealed an increase with age in semantic content, in syntactic complexity, and in the quality of the definitions, measured by avoidance of repetitions. Further, a strong interdependency of the results with concreteness and an unexpected effect of type of consonantal root also emerged.

The prediction that concrete nouns would be easier to define than abstract nouns, so that definitions given to concrete nouns would be better-structured and would observe the Aristotelian stipulated form of conventional definitions was confirmed, as was the prediction that the quality of the definitions would increase with age. Yet this task, too, like all the others on the battery, yielded certain unexpected results, the most salient of which was the effect of type of root, which had not been predicted to play a role in this task. The strong interdependency of semantics and syntax in defining nouns, as in the sentence-construction task, was predicted in the context of the “conspiracy” of different factors combining together in linguistic knowledge and language use in general and in later language development in particular (Berman, 2004, 2005), but the high degree of interrelatedness between these different factors had not been *a priori* anticipated. It had also been predicted that concrete and abstract terms might pursue rather different paths in definitions, but it came as a surprise to find that providing definition of abstract concepts that met the Aristotelian conventions of “perfect” was beyond the command of even proficient, educated native-speaking adults.

Research on definitions relevant to the present study is reviewed below first in relation to adult populations, then in developmental perspective, subsequently in Hebrew-specific terms. From a theoretical point of view, Bolger et al’s (2008) model of learning the meaning of words refers mainly to definitions of words that are unfamiliar/infrequent to readers, but their notion of definitions as a clue for decontextualized meaning is important for the present study, too. Application of the criteria used in the present study for high quality definitions, that is, ones that are characterized as semantically, syntactically, and structurally well-formed, leads to the conclusion that high quality

definitions are more decontextualized, hence more helpful in learning word meanings. This observation of decontextualization relates to the pragmatic value of definitions as described by Watson (1995) in the framework of relevance theory, arguing that provision of a superordinate term helps the addressee by limiting the potentially endless range of possibilities to a single domain. Watson's work is relatively unique in the connection she makes between semantics and pragmatics, since the bulk of studies on definitions concern mainly their cognitive, linguistic, and/or metalinguistic rather than their pragmatic value. This pragmatic facet of definitions, again, fits well into the idea that language, even the most highly scholarly and apparently decontextualized language, does not evolve in a vacuum, but that it emerges and is consolidated and used in particular communicative contexts (Chafe, 1994; Halliday, 1989).

Sadosky, Goetz, and their associates conducted experiments on adult populations to check the effect of imageability/concreteness on the quality of definitions and the effects of visual/verbal strategies on performance in the tasks in the framework of the dual-coding theory (Goetz et al, 2007; Sadosky et al, 2000; Sadosky et al, 2003; Sadoski et al, 1997). This review will focus on the differences between concrete/imageable and abstract/non-imageable words, disregarding the issue of strategies employed by the participants as lying outside the scope of the present study. Sadosky et al (1997) had participants write on-line definitions for five concrete and five abstract nouns on microcomputers with a time limit of 90 seconds. Definitions of concrete nouns were shorter in latencies, longer in number of words, and rated higher in quality. The quality scales employed by Sadosky et al referred to "content" (equivalent to semantic analysis) and "style" (equivalent to syntactic/structural analysis), ranging from zero ("No response or uninterpretable response") to 4 ("More than three independent, substantial, defining classes or characteristics" for content and "Complete, grammatical, well-written sentences that are organized into a cohesive and non-redundant text" for style). On this scale, for example, the mean quality score of concrete words in Sadoski et al (1997) was 3.26 and the mean quality score of abstract words was 2.62. These results are very much in line with the results of the present study in which, for concrete nouns, nearly three-quarters (71.8%) of the definitions included a superordinate term and as high as 80% (79.2%) included a relative clause as against less than half (49.3% and 41.8%

respectively) in the definitions given to abstract nouns respectively. Broadening the scope of imageability/concreteness effects to discourse, Sadoski et al (2000) found that concreteness was the most effective predictor of comprehensibility, interestingness, and recall of texts in four distinct genres of discourse. This advantage of concrete/imageable words over abstract/non-imageable words in definitions was replicated in Sadoski et al (2003) as well as in Goetz et al (2007), where degree of concreteness/imageability was manipulated on a continuum rather than dichotomously. Another replication of the results and supporting evidence for the dual-coding theory is provided by the study of Kellogg et al, (2007), all of which are discussed later in this chapter in the section dealing with concreteness (2.3).

The developmental review starts with Snow (1990), who requires 2nd to 5th graders to define English familiar nouns, most of them concrete, employing a combined evaluative scale for semantics and syntax of a formal definition. Quality of the definitions increased with age and was predicted by the level of English schooling level. 76% of the definitions of 5th graders were evaluated as “high-quality” in the combined measure. Snow did not provide data on the separate components of her qualitative measure, so this figure cannot be compared to any of the analyses employed in the present study. Watson (1995), who required children aged 5, 7, and 10 years to define concrete nouns of two types -- natural kinds and artifacts -- in the framework of relevance theory, predicting that super-ordinates would be provided more for natural kinds than for artifacts and they would increase with age. About 30% of the definitions given by the 10-year-olds Watson’s study included a super-ordinate term, as against as high as 40.6% super-ordinates given to concrete nouns by youngest participants in the present study (aged 11 to 12), suggesting quite consistent findings for the two studies, especially considering the age difference. Johnson and Anglin (1995) asked children in grades 1, 3, and 5 to provide definitions of words representing various parts of speech with a methodology very similar to the one described earlier for Anglin (1993). Children’s responses were coded on a qualitative scale ranging from 1 (minimal contextualized knowledge) to 4 (precise content, conventional form), showing an increase with age in the quality of the definitions, in both content and form and, most importantly, definitions of nouns, as against verbs and adjectives, were the highest in quality. The ratio of high-quality

definitions at 5th grade was around 40%. Calculating a mean of the percentage of 6th grade definitions in the present study that could be rated as high-quality (that is, they make use of a super-ordinate term and a relative clause) would yield a figure of somewhat over 40% (42.5%). Given that this figure includes definitions of abstract nouns, which are typically rated lower in quality, the percentages correspond closely to those of Johnson and Anglin. Marinellie and colleagues (Marinellie & Chan, 2006; Marinellie & Johnson, 2003; 2004) expanded the scope of definitions by comparing nouns, verbs, and high-frequent and low-frequent adjectives and nouns. The 2003 study on adjectives included the same age groups as the present study, supporting the rationale for selecting these specific age groups as the object of study (see Chapter II, Part B, section 1.2 above, and discussion of developmental trends below). Other interesting findings of the 2003 study were: (1) definitions of adjectives typically do not include a super-ordinate, rather a synonym, in parallel to the results of the present study for abstract nouns; and (2) there was a significant age-related increase in the quality of definitions between the age groups, closely corresponding to the present study. Marinellie et al's (2006) study of 4th, 7th, 10th graders, and young adults revealed a significant increase with age in the quality of the definitions, robust frequency effects on quality, and strong interactions of age and frequency, very much in line with the overall results of the present study.

Another set of developmentally motivated studies address the issue of concreteness (Benelli, Belacchi, Gini, & Lucangeli, 2006; McGhee-Bidlack, 1991; Nippold, 1999; Nippold, Hegel, Sohlberg & Schwartz, 1999). Benelli et al probed definitions of concrete and abstract nouns, verbs, and adjectives in various age groups, ranging from preschool to adults on a qualitative scale ranging from 1 (non-definitional) to 5 (definitional both in form and content). The relevant findings for comparison with the present study are the results for definitions of nouns given by 6th graders and adults. Their coding system, which was qualitatively evaluative and combining semantics and syntax, differed radically from that of the present study, so that direct numerical comparisons cannot be drawn between the two studies. Nonetheless, it is worth noting that the relative differences between the 6th graders and adults were significant in both studies, with an increase from 20% highest quality definitions in the 6th grade to 30% in

adults in Benelli et al compared with an increase from 30% to 60% respectively in the proportion of super-ordinates and from 54% to 60% in relative clauses in the present study. Further, Benelli et al found a concreteness effect and an interaction of age and concreteness, just as in the present study; for example, 6th graders' mean score for concrete nouns was 3.39 as against only 2.90 for abstract nouns. Importantly, these researchers found a significant positive correlation between performance on the definitional tasks and on a battery of metalinguistic tasks.

Further evidence for the difficulty of defining abstract nouns derives from Nippold et al (1999) who examined definitions given to abstract nouns by 6th graders, 9th graders, 12th graders, and young adults, assessed by a qualitative score from zero to 2. A score of 2 for the highest quality definitions was given to half the definitions of the young adults (51%) as against only 6% of the 6th grade definitions. In the present study the ratio of super-ordinates for abstract nouns in the 6th grade was 21.5%, going up to around half (49.3%) in the adults; however, the proportion of relative clauses for abstract nouns, the second criterion of definitional quality, did not increase with age, as found by Nippold et al.

As for Hebrew-based studies, two of these are not detailed here since they concern only nouns as defined by young, largely pre-school age children, both normally developing and with specific language impairment (Biran, 2003; Neumann, 1995). Of interest here is the study of Friedmann, Aram, and Novogrodsky (in press), who probed the production of different types of relative clauses by definitions to a set of nouns, the most of which were inanimate imageables (e.g., *kóva* 'hat', *sakin* 'knife', *masmer* 'nail') presented to children in the age range 3;5 to 5;6 years – with some of the kindergarten children being further retested two and a half years later, when they were 8 years of age. One of the main conclusions of Friedmann et al, was that “the ability to produce relative clauses of the types examined in this task already stabilizes by age 5;6-6;0, and does not change when retested 2;6 years later. This finding might indicate that at the age of 5;6-6;0 children already master the syntactic abilities required for the definition of words”(p. 21). Results of the present study, showing an increase in the ratio of relative clauses with age to concrete nouns (from 70.7% in the 6th grade, through 72.9% in the 10th grade to 79.2% in the adult population), are at odds with this statement on two grounds. First, there is a

slight difference even between 6th graders and 10th graders, and between them and adults, so manifesting the gradual and protracted nature of later language development beyond the age of 8. Second, there is ample evidence to the effect that children are able to produce relative clauses in Hebrew as in other languages as early as 3;5 year old. Yet the locus of age-related differences in later language development lies not in the command of forms manifested in structured elicitation, but rather in the efficient and skillful deployment of these abilities in various communicational circumstances (Berman, 2004, 2005; Berman & Slobin, 1994; Ravid, 2004).

The only study, to the best of my knowledge, conducted in Hebrew on definitions of abstract nouns in adolescence was Rachel Wool's (1988) bilingual (Hebrew-English) study on relative clauses occurring in definitions to various types of nouns given by 9th and 11th graders. One typical finding of Wool was that in definitions of instrument nouns, as many as two-thirds of the responses (62%) included a relative clause as against only 40% of the definitions given to abstract nouns. In the present study, if I combine the "complex noun phrase" and "no relative clause" types of responses, in the 10th grade, the mean age between the 9th and 11th graders of Wool's study, the percentage of definitions without a relative clause to concrete nouns reaches 27% whereas the percentage of those to abstract nouns reaches 57%, in close correspondence to Wool's findings.

The present study differs fundamentally from most of the developmental studies cited above in some respects. First, it avoided applying an evaluative scale specifying the quality of definitions, in order to examine distinct components each of which contributes individually or at least separately to the quality of a definition. In this sense, the current study can be viewed as "bottom-up" as against the "top-down" type of research cited above. A second, related difference between the current study and other developmental studies lies in the convergence of their scales, which typically include reference to both the form (syntax, structure) and content of the definitions, whereas the present study deliberately isolated out each domain in and of itself. The third difference lies in the less directed nature of the present study as against the more didactic or pedagogical motivation of the other studies, in which participants were instructed as to what constitutes a good definition and even given examples of high-quality definitions. In the present study, the instructions were deliberately open-ended, and participants were not

given any examples, to ensure as spontaneously undirected responses as possible. Nonetheless, the “bottom-up” analyses undertaken here in a more open-ended and non-judgmental setting than in previous research, yield findings that are largely consistent with those of prior, qualitatively scaled, evaluative, and often pedagogically motivated studies, hence providing strong independent support both for the current analyses and those of other developmentally oriented studies of definitions.

1.5. Pilot Priming Experiments

Recall that results of the priming experiments of this study are regarded here largely as being by way of an extensive pilot project, based on relatively few observations per experimental cell and subject to high levels of standard deviation. Nonetheless, irrespective of prime type, analysis of lexical decision revealed highly significant differences, in both reaction time and accuracy rates, between low-F words and the other two groups -- of high-F words and non-words. This robust finding provides on-line evidence for the difficulty faced by Hebrew speakers when encountering possible but totally unfamiliar/infrequent words. The second main finding was the occurrence of significant across-the-board priming effects for targets derived from full roots over targets derived from defective roots. As for the types of primes, only partial morphological and morpho-semantic priming appeared.

The prediction that there would be morphological priming in the short SOA was confirmed but not across the board, since significant levels of priming emerged only for words with defective roots. The prediction that there would be semantic priming in the long SOA was partially confirmed because morpho-semantic priming appeared only for unfamiliar/infrequent targets derived from full roots. The prediction that there would be no priming effect for unfamiliar/infrequent words was partially confirmed, since words derived from full roots did revealed significant effects of morphological and morpho-semantic priming.

Unexpected results emerging from the priming tasks included (1) the marked difficulty presented by unfamiliar/infrequent words; (2) the lack of morphological priming for full roots in the short SOA; (3) the lack of pure semantic priming in the long SOA; and (4) the existence of morphological priming in the long SOA.

In reviewing relevant prior research in this domain, it must be noted that the results of the priming tasks in the present study call for caution in comparing them with findings of other studies due to a possible lack of statistical validity. First of all, in cross-linguistic perspective, account needs to be taken of the factor of familiarity/frequency. This had two major effects on the results, one more and the other less predicted. Results in terms of lower reaction times and higher accuracy rates for high-F targets were predicted, and correspond well with what is reported in the vast research literature on the frequency advantage in lexical-decision tasks (Baayen et al, 2006; Baayen et al, 1997; Baayen et al, 2007; Balota et al, & Yap, 2004; Bates et al, 2001; Bertram et al, 2000; Cole, Beauvillain & Segui, 1989; Colombo & Burani, 2002, Cordier & Le Ny, 2005; De Jong et al, 2000; Forster, 1981; 2004; Gernsbacher, 1984; Hay & Baayen, 2001; Juhasz & Rayner, 2003; Malvern, Richards, Chipere & Durán, 2004; McDonald & Shillcock, 2001; Nelson & McEvoy, 2000; O'Malley et al, 2007; Yap, Tse, & Balota, 2009). The interaction of familiarity/frequency with root type and SOA was less anticipated. And in fact, the literature concerning frequency effects in masked priming studies yields inconsistent results. In one influential study, Forster and Davis (1984) found an equal priming effect for low-F and high-F words, a result in contradiction to the findings of the present study. This finding as reported in Forster and Davis is cited by numerous other researchers (e.g. Frost et al, 1997; Segui & Grainger, 1990) and taken as evidence for the absence of frequency effects in masked priming. There is, however, some counter-evidence for the differential effect of frequency in masked priming (Rajaram & Neely, 1992) and other priming methods (Tse & Neely, 2007). Further, careful inspection of the materials used by Forster and Davis reveals the source of the discrepancies between their study and the one reported here: They based their selection of stimuli on the 1967 Kučera and Francis database -- a relatively small corpus in contemporary terms whose reliability as a source for selection of stimuli was subsequently challenged by Gernsbacher (1984). Other researchers, too, have pointed to the problematic nature of selecting low-F words from corpora as being potentially biased by a range of different factors (Balota et al., 2004; to Le Ny, 2005; Gordon, 1985; Malvern et al., 2004; McDonald & Shillcock, 2001; Peerman et al, 1998). Besides, Forster and Davis made sure that the low-F words they selected (e.g., *adore*, *heave*, *arid*) were all ones that they

judged to be “within the working vocabulary of the typical subject”; in contrast, the low-F words in the present study, which were to all intents and purposes nonce words with virtually no semantic representation in the mental lexicon of the average, even well-educated speaker-writer of Hebrew.

Support for the findings for the present study is provided by two studies. The first is Forster (1985) which, along similar lines to Schwarzwald’s (1981) off-line study in Hebrew, checked priming effects in the masked-repetition priming paradigm for morphologically complex semantically transparent obsolete English words (e.g., *holimonth*) and found that error rates and reaction times for obsolete words were significantly different from both familiar/frequent words and non-words. Even more interesting is the fact that significant priming for the obsolete words appeared only after their meaning was explained to the participants. A second study, by Rajaram and Neely (1992), found differential priming effects for studied words, unstudied words, and non-words, as follows: Frequent words revealed priming effects for both studied and unstudied words, whereas non-words showed priming effects only for studied, but not for unstudied non-words. These results might explain the lexical decision results for low-F targets in the present study, since these can be viewed as largely equivalent to the unstudied non-words of Rajaram and Neely or to the unexplained obsolete words of Forster. One future line of research that emerges from this comparison is to extend the priming pilots of the present study by checking the effect of providing an additional component by explanation of the meaning of the low-F words.

Another possible explanation for the lack of priming in part of the conditions employing low-F targets in the present study relates to frequency discrepancies between primes and targets. This high discrepancy in frequency (target of low-F and prime of high-F) may cause reverse priming or inhibition (Forster & Davis, 1984; Frost, Kugler, Deutsch & Forster, 2005; Segui & Granger, 1990). Seven out of the 12 conditions in the present study yielded negative priming effects for low-F words as against only one for high-F words.

With respect to the morphology-semantics interface, results of the present study revealed partial morphological priming for high-F words derived from defective roots in the short SOA and partial morphological and morpho-semantic priming for low-f targets

derived of full roots in the long SOA. The research literature on this topic is divided into three major views (see Chapter I, Sections 1.2 and 1.4). The bulk of studies found differential priming effects dependent on the semantic transparency of prime-target pairs, with semantic relatedness a prerequisite for morphological priming (Diependaele et al, 2009; Marslen-Wilson et al, 1994; Meunier & Longtin, 2007; Schirmeier et al, 2004) -- corresponding to the morpho-semantic priming condition in the present study. Other studies found graded priming effects, modulated by the degree of semantic transparency of prime-target relations (Feldman et al, 2009; Feldman & Prostko, 2002; Feldman & Soltano, 1999; Feldman et al, 2004; Frost et al, 2000; Plaut & Gonnerman, 2000; Raveh, 2002). A third group of studies found a similar level of morphological priming irrespective of semantic transparency, at least in the initial stages of lexical processing, which is taken to be automatic and insensitive to semantic processing (Dohmes et al, 2004; Frost et al, 1997; Longtin & Meunier, 2005; Longtin et al, 2003; Marslen-Wilson et al, 2008; Rastle & Davis, 2008; Sánchez-Casas et al, 2003; Solomyak & Marantz, 2010). Results of the present study correspond largely to this third line of research, with morphological priming emerging for both semantically transparent (morpho-semantic) and opaque (morphological) pairs. The surprising fact is that this morphological priming appeared at the longer SOA of 100 ms only for unfamiliar/infrequent words. Such priming effects at an SOA of 50 ms would have been more in line with the “morphology by itself” account (Aronoff, 1994) in the initial stages of lexical processing.

The next issue addressed here is the definition and status of non-words, another controversial topic. Studies employ mainly two types of non-words: “lexically illegal”, non-words legally structured with no semantic representation and “structurally illegal” non-words, structured from an illegal root/stem/affix. Researchers agree that the rejection of “lexically illegal” non-words is slower and much more effortful than rejection of “structurally illegal” non-words (Forster, 1985; Kempe & MacWhinney, 1996; Meunier and Longtin, 2007). The present study may shed novel light on this issue, since the difference between non-words and unfamiliar/infrequent words straddles this “structurally illegal”/ “lexically illegal” distinction. Whereas the non-words used in the present study were constructed out of non-existing roots interwoven into existing patterns, its unfamiliar/infrequent words were constructed out of existing roots and

existing patterns, but lacking in an established semantic representation. This issue has also been addressed by other Hebrew-based studies. For example, Feldman and Bentin (1994), in a repetition priming experiment, employed two types of “pseudowords”, one with meaningless roots and the other with meaningful roots, and found delayed reaction times to the latter type of “pseudowords” compared with the former. Other researchers found similar evidence for the root as an active unit of processing even of “nonce” words (Deutsch et al, 1998; Feldman, Frost & Pnini, 1995; Goral & Obler, 2003). Novel findings concerning the neural correlates of morphology come from fMRI studies in English (e.g. Vannest, Polk & Lewis, 2005) and in Hebrew, such as Bick et al (2010), who found that areas involved in morphological processing were more strongly activated when non-words were composed of legal roots – leading them to conclude that “information regarding the root of a non-word supplies false and misleading information, creating an increase in activation and making it harder to reject the non-word” (p. 1966). The difference between these studies and the present one is that their “non-words with roots” served as primes, whereas here they served as targets. Examination of the data of Feldman and Bentin reveals that the latency for unrelated primes and pseudowords with meaningful roots was almost the same, whereas accuracy rates did not vary markedly and were very low (about 2%) for all types of primes. In Bick et al’s study, latencies and error rates were higher for non-words with roots, although overall error rate was low, ranging from 5.5% to 6.5%. Goral and Obler’s study, a lexical decision task with no priming involved, revealed significantly longer latencies and higher error rates (18.6%) for what they term “real-root non-words” over “pseudo-root non-words” (5.8% error rates). Results of the present study, in terms of lexical decision latencies and error rates, are more similar to Goral and Obler’s study; nonetheless, error rates for low-F words in this study are much higher, reaching almost 50%. This can be explained by the fact that the present study, unlike Goral and Obler’s, included dictionary-listed low-F words: These seem to have posed a particular challenge to participants due to their elusive status as “real” words. Unfortunately, these studies do not provide full lists of their stimuli items, making it difficult to fully judge the differences between what they include in the category of “lexically illegal” non-words compared with the “virtually lexically-illegal” low-F words of the present study. One conclusion that can be drawn from the foregoing

analysis is the notion of lexicality as a continuum, ranging from “high lexicality” (high-F words) at the one end, via the “moderate/low lexicality” of unfamiliar/infrequent or non-existing but possible words (Aronoff, 1976) – in the case of Hebrew, root plus pattern combinations, to the “non-lexicality” of non-words derived from non-existing roots.

As for Hebrew-based priming studies relevant to the morphology-semantics interface, the study of Bentin and Feldman (1990), employing the method of repetition priming, found differential effects for semantic and morphosemantic priming, while Frost et al’s (2000) cross-modal design found semantic transparency effects. The remaining studies, which employed explicit morphological manipulations (Bick et al., 2008) or masked-priming (Bick et al., 2010; Deutsch et al., 1998; Frost et al., 1997), found morphological priming irrespective of semantic transparency. Results of the present study are compatible with most of the latter studies although its durations diverge from typical masked-priming effects, which are generally reported as appearing at shorter time-spans. The topic of root transparency was also examined in previous Hebrew-language priming studies. One such study, by Frost et al (2000) found no priming effects for defective roots, whereas other studies, both with children (Schiff et al, 2008) and adults (Velan et al, 2005), found differential priming effects for defective roots when divided between what they term “mute” and “defective” types of roots. While targets derived from full roots revealed significant morphological (as well as semantic and morphosemantic) priming at the long SOA in my study, targets derived from defective roots as defined in the present context, showed reverse priming effects: positive priming at the short SOA and negative priming at the long SOA. Such negative priming or inhibition at a long SOA in masked priming is, in fact, reported in the literature (Forster & Davis, 1984; Frost, et al, 2005). The unusual result in the present instance is that it appeared only for defective roots. Again, these results should be interpreted with caution, since their data-size may not suffice for substantial statistical conclusions. Nonetheless, they clearly indicate that the representation of nouns constructed out of full roots is far more solid and stable than is the case for defective roots -- in close accord both with the off-line tasks administered in the test-battery as well as with findings from the on-line Hebrew-language experiments cited above.

2. Discussion of the Independent Variables

This section considers the implications of results across the different tasks in relation to the three word-based independent variables, in the order in which they are presented in the chapter describing the overall research design: the structural word-internal factor of root transparency (Section 2.1 below), the lexical-usage based factor of familiarity/frequency (2.2), the semantic factor of concreteness versus abstractness (2.3), and the developmental variable of age-schooling level (2.4).

2.1. Root Transparency

Discussion in this section is confined to the status of the consonantal root in psycholinguistic processing of Hebrew speaker-writers as reflected in the study. Implications of findings in this domain for more general issues such as models of morphological processing and typological comparisons are dealt with later in the chapter (Section 3 below).

The design of the root transparency variable for the study specified a ratio of two-thirds to one-third full to defective roots, in order to meet the following *a priori* methodological constraints: For a root to be eligible for inclusion in the database, it had to (1) be productive, (2) occur in at least four derived nouns, and (3) display a range of both semantically transparent and opaque derivations (see Chapter II, Part A, Section 1 for details on selection of stimuli). The ratio of two-thirds to one-third types of roots differs from Velan et al.'s (2005) estimation of defective roots as accounting for around only 10% of Hebrew roots, where there is no further specification as to whether reference is to root types or tokens, nor to the source of this figure. On the other hand, the ratio of full to defective roots in the present study (based on criteria detailed in the previous chapter), corresponds well with the division of roots documented in Bolozky's (2006) corpus of 5.3 million Hebrew word-tokens derived from the *Maariv* daily newspaper: Interestingly, the ratio of verb-types specified there as based on full to defective verbs is also around 2/3 to 1/3 respectively, with an even higher ratio of around half each in the case of verb-tokens.

The prediction that words based on full roots would be easier to identify and manipulate than defective roots was confirmed across the board, including on the tasks of

relatedness between words, in which the four possible response options were explicitly presented to participants, hence not requiring them to actively extract their root elements. The higher proportion of defective roots in responses classified as “unrelated” or “miscellaneous” was likewise salient across the test battery. Also fully confirmed was the prediction that root transparency/opacity would interact with age such that younger participants would across the board find it harder than the older groups to cope with defective roots. (Developmental implications of these findings are discussed further in Section 2.4 below). The level and strength of our findings for the interaction of root transparency with age, the effect of root type on almost every single analysis performed, and the close similarity between analyses of the root variable to those of the other independent variables in the study went far beyond what had been anticipated. Particularly surprising was the role of root transparency in the two sentential production tasks – sentence-construction and definitions – where it turned out to be a significant factor in noun phrase complexity, pre-verbal versus post-verbal position of the noun in the sentence, and amount of repetitions in definitions.

These robust findings in relation to type of consonantal root offer several fresh directions of interpretation concerning the status of the Semitic root from a (psycho)linguistic point of view. On the one hand, the status of roots as an abstract construct is a matter of debate in relation to root-based versus word-based linguistic analyses (Aronoff, 2007; Bat-El, 1989; Berman, 2003; Prunet, 2006; Ravid, 2003; Ussishkin, 2005) Yet, on the other hand, from a psycholinguistic point of view, researchers typically view the root as having an unequivocal status as an organizing element in the mental lexicon of Hebrew speaker-writers. Psycholinguistic evidence for the status of the root is provided by a range of studies on language acquisition and development, showing that even young Hebrew-acquiring children are sensitive to at least some kind of consonantal skeleton, very often to the canonic root of words in their language (e.g., Berman, 1988, 2000, 2003; Clark & Berman, 1984; Ravid & Bar-On, 2005; Ravid & Malenky, 2001; Seroussi, 2002; Shiff et al, 2008), while awareness of the consonantal root has been demonstrated experimentally for Hebrew-speaking adults as well (Bick et al., 2008, 2010; Deutsch et al., 1998; Frost et al, 1997, 2000). The novelty of the present study in this respect lies in its exposure of the role of the root “beyond

awareness”, that is, beyond the initial stages of lexical processing. In the off-line written tasks, root transparency contributed to speaker-writers’ processing of derived nouns in Hebrew on a par with the other independent variables of the study -- familiarity/frequency and concreteness – factors that are assumed to operate at more advanced stages of lexical processing. And the priming experiments provided further support for the important status of root transparency, by the robust effects that they revealed for full roots.

A second implication of the present study concerns the status of the root morpheme as a minimal structural unit bearing a core meaning (Berman, 1987, 1993; Ravid, 1990, 2003), in contrast to Aronoff’s (1976) views against meaning in morphology. The present study argues that full roots do incorporate a core meaning, to which Hebrew speaker-writers are sensitive and of which they are very often fully aware. The tendency of Hebrew speaker-writers to rely on core meaning can operate in two opposite directions: It may be helpful when encountering unknown words, but it may also be misleading, pointing users to incorrect interpretations in the case of semantically opaque words (Nir, 1982; Seroussi, 2002). And indeed, this kind of reliance on root elements, without lexically specific knowledge of the item itself, was evident in the high rankings attributed to clearly unfamiliar items on the questionnaire in this study that aimed at evaluating lexical familiarity but in fact turned out to be measuring form familiarity (Cordier & Le Ny, 2005). This discrepancy is captured well by the explicit distinction drawn by Cordier and Le Ny (2005) between “form familiarity” and “meaning familiarity”, as both determining the degree of word familiarity (Chapter II, Part A; and see, further, Sections 2 and 2.2 below).

The relative strength of the canonic triconsonantal root allows Hebrew speaker-writers / hearer-readers to exploit it as a structural foundation on the basis of which they can apply further lexical operations and convey form-meaning relations to their optimal realization. The picture is rather different in the case of defective roots. Whereas full roots embody a clear and unequivocal intersection of morphology and semantics, a case *par-excellence* of the form-meaning interface, defective roots reflect more strictly structural aspects of the lexicon, in terms of form-sound relations embodying the morphology-phonology interface. Across the board, participants in my study proved

unable to differentiate maximally between morphology and phonology when dealing with items based on defective roots, leading them to give higher proportions of phonological and morphophonological responses to words derived from defective roots than in the case of words with full roots. This applied in the case of both the open-ended as well as closed tasks in the battery, for example, both when choosing out of a set of given responses in relatedness tasks and when producing their own responses on free association tasks. This full/defective root differentiation is clearly illustrated by responses defined by the category of “mediation” in the association tasks. Whereas almost all of the mediated associations to unfamiliar/infrequent nouns derived from full roots were based on the root (e.g. *pil* ‘elephant’ to the input noun *gdil* ‘tassel’ through the mediation of the root *g-d-l* ‘grow’), a large number of the mediated associations to unfamiliar/infrequent nouns with defective roots were based on phonological resemblance rather than on root structure (e.g. *šeker* ‘a lie = falsehood’ to the input noun *blaya* ‘weathering’ through the mediation of the rhyming *bdaya* ‘a (literary) lie = fabrication’). The study thus provides clear evidence for the multi-faceted nature of the Hebrew consonantal root and the differential status of words based on canonically triconsonantal roots compared with ones constructed from less transparent roots, involving a shift from morphology-semantics for full roots to morphology-phonology for defective roots. Implications of these outcomes for models of morphological processing are considered further later in this chapter (in Section 3 below).

2.2. Familiarity/Frequency

Recall that the variable of familiarity/frequency was specified on the basis of an independently derived “F-score” (high-F/low-F) integrating results of responses to two large-scale questionnaires ranking levels of (subjective) familiarity and frequency (Chapter II, Part A, Section 2). This variable of lexical usage proved to be a very powerful factor across the study, revealing strong effects and interactions on all five written tasks in which it was employed, as well as in the priming experiments.

The prediction that words with a low F-Score would elicit more morphologically-based responses in terms of consonantal root than words with a high F-score was confirmed. Also confirmed was the prediction that participants would rely more on factors of content, relating more to the meaning of words with high F-scores, for which

they have an established semantic representation, in contrast to words with low F-scores, where such knowledge is lacking. The prediction that this variable would interact with age was also confirmed, as further discussed below in relation to the variable of development (Section 2.4). The various strategies adopted by participants in order to cope with unfamiliar/infrequent nouns such as mediation (in free-associations tasks) or the preference for post-verbal position (in the sentence-construction task) were not fully anticipated. Nor was the striking difference between unfamiliar/infrequent input nouns when presented in isolation and in a sentential context.

Findings of this study shed light on several controversial issues regarding the notion of frequency, as addressed in the introduction (Chapter I, Section 2.1). In the first place, the materials used in other studies that take frequency into account turn out to differ markedly from the present study with respect to just about every aspect of the notion (Nelson & McEvoy, 2000a). For example, a radically different conception of frequency is implied by Foster and Davis (1984), for whom a low-frequency word is one belonging to the vocabulary of the typical subject. There is also little uniformity in deciding the cut-off point between high- and low-frequency items or in stipulating criteria for selection of infrequent items, hence making it difficult to compare across different studies. As for the issue of subjective/objective measures of frequency, reliance on corpora and on objective frequency-of-occurrences measures, especially for low-frequency words, has been widely challenged in the literature for English and French (Balota et al., 2001, 2004; Gernsbacher, 1984; Gordon, 1985; Peerman et al, 1998; Williams & Morris, 2004; Yap et al, 2009). In view of the lack of accepted frequency corpora for Hebrew, the present study relied on subjective measures, known to be more sensitive to individual word knowledge (Yap et al., 2009). Accordingly, I suggest that frequency effects revealed in the present study, which both appeared across the board and also proved sensitive to development and to other, word-based independent variables, are a genuine reflection of the impact of frequency in a rich range of lexical domains.

It should be borne in mind, however, that the variable employed in this study was a combined measure of mean subjective familiarity/frequency (the F-score) (see Chapter II, Part A, Section 2). Some researchers claim that subjective familiarity and subjective frequency are the same (Gernsbacher, 1984), others propose that subjective familiarity is

more sensitive to meaning than subjective frequency (Balota et al., 2001; 2004; Cordier & Le Ny, 2005; Williams & Morris, 2004).

The present study in fact demonstrates something rather different: Subjective familiarity judgments showed sensitivity mainly to structural factors of Hebrew word-formation rather than to semantics or meaning. The observation of McDonald and Shillcock (2001) that subjective familiarity is more intuition-based than subjective frequency accords well with what emerged from the present study, where participants seemed to rate level of subjective familiarity of the items on their questionnaires by intuition rather than by declared solid knowledge. The F-score adopted in the present study can also be viewed as an integrated variable combining both form and meaning, along the lines proposed by Cordier and Le Ny (2005).

The lexico-semantic facet of frequency, or what stage of processing involves frequency, is also under current debate. Balota and associates (2001, 2004) refer to frequency as a lexical factor that operates in the initial stages of processing, before semantic, post-lexical, factors start to apply. However, researchers in this group (Yap et al, 2009) also find evidence for frequency-semantics dependency in relation to individual vocabulary knowledge. Other researchers, in line with Yap et al, suggest that the locus of frequency is post-lexical (Baayen et al, 2006; Forster, 1981, 2004), as evidenced by frequency-semantics interdependency. Results of the present study, although not confined to lexical access, conform to the lexical-semantic interface, in two ways. First, familiarity/frequency interacted with semantics across the board in the written tasks; for example, familiar/frequent words were given more semantic distractors in the relatedness tasks and more semantic-pragmatic associations on the associations tasks. Second, the most stable priming effects appeared to familiar/frequent words. Other researchers, too, point to the fact that that morphological complexity also plays a role in frequency measures, most notably Baayen and associates (Baayen et al, 1997, 2006, 2007; De Jong et al, 2000; Hay & Baayen, 2001; Moscoso del Prado Marti'n, et al, 2005; Moscoso del Prado, Marti'n, Kostič & Baayen, 2004; and, see, too, in this connection, Nagy & Anderson, 1984; Raveh, 2002; Reichle & Perfetti, 2007). The relation between morphological complexity and the F-score applied in the present study is further discussed in Section 3.2 below.

Other frequency-related issues relevant to the results of the present study include the correlation of frequency with other psycholinguistic factors, the dynamic nature of frequency, and frequency in isolation as against frequency in context. Recall that frequency in general is correlated with various psycholinguistic variables (see Chapter I, Section 2.1 for a detailed description). Of interest here is the variable of concreteness as applied in the present study, taking into account that the literature is divided on the interdependency of these two variables (Bates et al, 2001; Colombo & Burani, 2002; De Groot, 1989; Gernsbacher, 1984; Juhasz & Rayner, 2003). Direct correlations of familiarity/frequency and concreteness were not performed in the present study, yet its findings are indicative of a strong interdependency between the two. This interdependency emerged in Phase II (the “questionnaire” phase) of this study, when even educated adults were unable to provide imageability and/or concreteness ratings to unfamiliar/infrequent words (see Chapter II, Part A, Section 2.4), as well as in the subsequent test-based Phase III part of the study. In the two tasks of associations in the latter phase, for example, familiarity/frequency and concreteness, which were manipulated independently of each other, yielded similar results, such as more semantic-pragmatic associations to familiar/frequent as well as to concrete nouns and more morphological associations to unfamiliar/infrequent as well as to abstract nouns. Age of acquisition was not included in the present study, since Age-of Acquisition norms are lacking in Hebrew, yet this constitutes another variable considered highly related to frequency (Barry & Gerhand, 2003; Bird et al, 2001; Bonin, Barry, Méot & Chalard, 2004; Caza & Moscovitch, 2005; Colombo & Burani, 2002; Gilhooly & Logie, 1980; Morrison et al, 1997; Zevin & Seidenberg, 2004). In this connection, the strong interdependencies which emerged in the present study between familiarity/frequency and developmental level of age-schooling indicate that this high correlation is psychologically valid for Hebrew as well.

The dynamic nature of frequency is discussed in much of the literature in diachronic perspective, in terms of changes over time in preferences in productivity of devices for word-formation (Anshen & Aronoff, 1999; Baayen & Lieber, 1991; Baayen & Renouf, 1996; Balota et al, 2004; Berman, 1987, 2000; Clark, 1993; Clark & Berman, 1984). Another, more local (and synchronic) perspective related to stimulus quality is

presented in O'Malley et al (2007), who found that degradation of the stimuli in lexical-decision experiments affected low-frequency items more strongly than high-frequency words. Findings of the present study indicate that frequency is indeed a very dynamic entity in various respects, broad and narrow, synchronic and diachronic. This was particularly marked in the initial phase (Phase I) of the study, of consultation of dictionaries and databases of the Academy of the Hebrew Language for purposes of data selection. During these searches, I noted a very considerable number of items whose frequency of use had changed radically over a period of several decades. Many of the entries listed in the major five-volume Even-Shoshan (1993) dictionary, for example, appeared to me as most likely unknown to the average speaker-writer of Hebrew. Findings yielded by the familiarity and frequency questionnaires (Phase II) confirmed these intuitions about the high rate of “gain” and “loss” of lexical items in the dynamic mental lexicon of Hebrew. For example, a high proportion of the nouns taken from the Even-Shoshan dictionary were rated by educated native-speaking adults as unfamiliar/infrequent (see Section 3 below for further discussion of this issue).

Other, more locally focused, types of evidence for the heterogeneity of the term frequency as accounting for exposure even to inflected forms were provided by informal analyses I conducted of responses to the frequency questionnaires. Several items drew my attention as having received low frequency scores that could be attributed to the way they were presented to respondents. Recall that all of the 2,400 nouns on the questionnaires were presented with vowel values represented by normative diacritic pointing, as accepted in conventional Hebrew-language dictionaries. This might have had an effect on frequency rankings, since the normative vocalizations often conflict with more colloquial everyday pronunciations, hence with more familiar versions of the “same” words. (See Section 3 below for further discussion of Hebrew orthography). Other low-frequency values that drew my attention were given to words that seemed to me more frequent in their plural form or as a part of a noun compound, whereas all items in the questionnaires were presented in the singular. To test this hypothesis, I changed the mode of presentation of 50 such items to a more “user-friendly” version, either by transforming diacritical marks to more familiar ones, or by changing the stimulus items to plural in cases of nouns which seemed to me more familiar in the plural (e.g. *mešotim* ‘oars’

instead of *mašot* ‘oar’), or to a compound in cases of nouns that seemed to more familiar in a compound. This mini-questionnaire consisting of 50 modified nouns was administered to another group of 30 adult native speakers of Hebrew. The result confirmed my hypothesis: Frequency rates for the items in the modified questionnaire were significantly higher than those given in the original, unmodified version, providing nice proof of the variegated nature of frequency, as a variable that is to a large extent item-dependent. These results also indicated the strong adherence of frequency judgments to the visual mode of presentation, at least in the case of written questionnaires in Hebrew. This evidence for visual dependency of frequency rankings given in the written modality in my study thus sheds fresh light on the ongoing debate concerning the dependence-independence of frequency and modality (Bates, et al, 2001; Gaygen, & Luce, 1998)

The last issue addressed under this heading concerns frequency of isolated words as against frequency in context. This distinction relates to the subjective-objective measures of frequency, since subjective frequency ratings are typically obtained through questionnaires containing lists of isolated words, whereas objective frequency measures are obtained by counting occurrences in a corpus. As background to their examination of various psycholinguistic variables by eye-tracking, Juhasz and Rayner (2003), for example, argue that single words in isolation do not reflect a natural reading situation, while McDonald and Shillcock (2001) extend frequency measures to co-occurrences in texts. The present study constitutes a good source for investigating interrelations between familiarity/frequency and supportive context. Thus, low-F words in isolation yielded mainly morphological/phonological associations, both in comprehension (in the relatedness tasks) and in production (in the association tasks). In contrast, even the limited context of a single sentence was enough to radically change this tendency in favor of a semantic-pragmatic preference, additional evidence for the dynamic nature of frequency as well as for the important role of context in genuine reading situations. Taking into account findings on the Context-Dependent versus Context-Independent differentiation (Barsalou, 1982; Bolger et al, 2008; Hess et al, 2005), and the claim for context as a means of improving understanding of unfamiliar/infrequent words, the

equation that emerges can be generalized as follows: The more frequent an item, the less context is necessary, and conversely, the less frequent it is, the more context helps.

2.3. Concreteness

This study, as far as I know, is the first to establish *a-priori* values for the concreteness/abstractness contrast in the Hebrew lexicon, established in relation to a carefully selected subset of Hebrew derived nouns, and subsequently employed as a variable in a range of structured elicitations and in developmental perspective. The complicated process for obtaining values for concreteness/abstractness used in this study is described in detail in Chapter II, Part A, Section 2.4. Earlier intuitions on the major role of concreteness as a psycholinguistic factor were confirmed, providing further support for the impact of this variable as shown by a vast pool of research data from other languages. In the present context, concreteness proved to be an important variable with strong overall effects and interactions in the tasks in which it was involved.

The concrete/abstract variable was applied to five of the seven written tasks in the present study – the three sentential tasks and the two association tasks -- yielding across-the-board robust syntactic as well as semantic effects. Semantically, concrete nouns evoked (1) more semantically-related interpretations than abstract nouns, while the latter received more morphologically/phonologically as well as semantically related interpretations, (2) more adherence to semantically related interpretations than their abstract counterparts, and (3) more co-hyponyms and super-ordinates, whereas abstract nouns yielded more synonyms and definitional associations. In syntactic terms, concrete nouns were less modified, occurred more in post-verbal position, were more likely to be embedded in relative clauses, and less prone to repetitions in comparison with their abstract counterparts. This variable also revealed strong interactions with developmental implications further discussed below (in Section 2.4).

The prediction that concreteness would have differential effects on different tasks on the test-battery was confirmed. Each and every task revealed distinct effects of concreteness, none of which could be defined as a simple superiority for concrete over abstract nouns, but rather as defining differential trajectories for each. This differential route went beyond what had been predicted *a-priori* for this factor. Not only was the

prediction concerning the syntactic effect of the concrete/abstract opposition in the sentence-construction task clearly confirmed, this variable turned out to have other, varied syntactic effects in this and other tasks, such as on amount of repetitions of stimulus items in giving definitions. So, too, was the prediction for an interaction of concreteness with age (see, further, Section 2.4 below). In sum, the variable of concreteness, like the other independent variables of this study, yielded throughout both predicted and unpredicted effects.

The notions of concreteness and imageability are typically dealt with together in the research literature, even though they are not exactly the same, each relating to rather different types of representations (see Chapter I, Section 2.2 for detailed analysis of these two variables). Recall that attempts to elicit rankings for both imageability and concreteness across the full database that served to establish values for the variable of familiarity/frequency were not successful. Moreover, while from the point of view of respondents' subjective reactions to the task, this inaccessibility was shared by both the notions of imageability and concreteness, they turned out to differ, as follows. Participants complained more and commented more on their difficulties when asked to rank items for imageability, particularly so in the case of nouns that cannot be clearly identified with one of the two extremes of concreteness/abstractness. A second circumstance that emerged mainly in the imageability ratings was the large extent of non-agreement and discrepancies in individual responses, often accompanied by comments such as (in free translation from the Hebrew): "perhaps I am not a typical respondent, because I have a very visual mind", "I'm an architect, so I am visually-oriented", etc. Support for the high degree of interpersonal variability in imageability ratings comes from Flieller and Tournois (1994), who reported that 75% of their imageability ranks ranged from 1 (very high) to 7 (very low). These different observations can be taken as evidence for the genuine psycholinguistic differentiation between imageability and concreteness, attributable to the more specific, modal-dependent nature of the former, compared with concreteness, which has a relatively non-specific and amodal representation.

In what follows, I consider research that involves either imageability or concreteness or both with no differentiation between the the two, in relation to five topics

of current relevance: concreteness effects revealed by the present study, neural mechanisms underlying the concrete/abstract differentiation, correlations between concreteness and other psycholinguistic variables, interfaces in later language development, and theories accounting for the concreteness effect in light of the results of the present study. Reference to what is termed the “concreteness effect” in the literature occurs mainly in the context of lexical access, in the initial stages of lexical processing. The bulk of such research describes this in terms of the superiority of concrete over abstract words in early as well as later language acquisition, in reading comprehension and production, and in various psycholinguistic measures such as lexical decision and naming. A small number of studies, further noted below, found converse results for superiority of abstract over concrete words. The present study adopted a rather broader approach to the topic, by examining concreteness/abstractness effects across a range of tasks with differing demands, in various semantic-syntactic domains, as well as in different age groups from schoolchildren across adolescence. This perspective made it possible to relate to the notion in terms of a **task-sensitive** concreteness/abstractness differentiation that consolidates during the period of later language development and matures in adulthood, illuminating a rich variety of interesting patterns not revealed by studies conducted from the point of view of the “concreteness effect” in the accepted sense of the term.

As for the neural mechanisms underlying the concreteness effect, of particular relevance here are two studies showing that **context effects** modulate and interact with concreteness/abstractness (Giesbrecht et al, 2004; Tolentino & Tokowicz, 2009). In Tolentino and Tokowicz’s ERP study, responses to concrete words were different than those of abstract words when a block of abstract words preceded a block of concrete words as well as when the two types of words were mixed in a single block, whereas when concrete words preceded abstract words, ERPs to abstract and concrete words did not differ. The finding that context has an effect even at the neuro-physiological level provides general support for results of the current study, in which the variable of concreteness in words presented in isolation (e.g., in the association task) had a fundamentally different impact than when they were presented in context (e.g., in the sentence-construction task).

A range of studies demonstrate the strong interdependencies between concreteness and familiarity/frequency, as discussed early in this chapter -- in Section 2.1 above (Barry & Gerhand, 2003; Bates et al, 2001; Clark & Paivio, 2004; Colombo & Burani, 2002; De Groot, 1989; Flieller & Tournois, 1994; Gernsbacher, 1984; Gilhooly & Logie, 1980; Juhasz & Rayner, 2003; Paivio et al, 1968; Rinaldi et al, 2004). This topic is thus not considered further in the present context.

The study by Reilly and Keah's (2007) sheds light on the relation between imageability and concreteness from the rather novel perspective of linguistic analyses of imageability ratings, indicating that most theories of concreteness address only semantic properties, hence assuming arbitrary relations between form and meaning, whereas their analyses indicated the opposite. One important result that they report is the relatively high measures of objective frequency that were obtained by the words they examined, a finding that provides additional support for the interdependency of concreteness/imageability and familiarity/frequency in objective measures. Their findings for objective frequency can thus be taken as support for the findings of the present study, which was based on subjective measures. Reilly and Keah also report that English low-imageable words were mainly of Latinate origin and tended to be longer and morphologically more complex than those of Germanic origin. Similar interdependencies between imageability/concreteness and historical factors were revealed by the English-language, discourse-based studies of Bar-Ilan and Berman (2007), Corson (1982, 1984), and Malvern et al (2004), indicating that some aspects of form-meaning relationships are to a certain extent predictable. These analyses have twofold implications in the present context. On the one hand, they are confined to the Latinate-Germanic distinction as specific to the typology of Modern English. For example, the word-stock of Modern Hebrew is based on (at least) two distinct historical layers, Biblical and Mishnaic, with many synonymous words deriving from either one or the other, most typically differing in register (Ravid, 2005; Ravid & Berman, 2009; Schwarzwald, 2001). Yet current Hebrew manifests virtually no structural distinction between lexical items of different historical origins, in terms of word-length, syllable structure, or morphological patterning. On the other hand, findings such as those reported above for English go beyond language-specific factors in the evidence they provide for the existence of

“interfaces” between different variables – where the term “interface” is used here in the sense of mutual, two-way interdependencies between two or more factors -- even at the level of word-internal structure and use.

Moving now from interfaces within words, the sentential tasks -- of interpreting (largely unfamiliar) target words in context, constructing sentences with both familiar and unfamiliar target words, and providing definitions of familiar words -- provided evidence for the existence of interconnections at the level of the sentence, too. The present study did not set out to encompass the rich array of syntactic issues relevant to lexical meaning and structure, yet nonetheless its findings have implications relevant to the typically syntactically-motivated debate on linguistic universals (Evans & Levinson, 2009; Jaeger & Norcliffe, 2009). Thus, by demonstrating a strong semantic-syntactic interdependency as discussed in Section 1.2 above, the results of my study argue against modularity in language processing (Fodor, 1983). These findings further indicate that word order in sentences is not pre-determined or governed by set syntactic hierarchies (Pinker & Bloom, 1990), but rather that it is sensitive to conceptual constraints (as argued by Bock et al, 2001; Bock & Levelt, 1994).

With respect to various approaches to concreteness effects, accepted accounts fail to fully accommodate the findings of the present study. Pavio’s ((1991; 2006) “dual-coding” proposal predicts an advantage of concrete over abstract nouns due to the additional visual properties of the former. My study, however, did not reveal a robust advantage for concrete nouns as predicted by dual-coding, possibly because the latter is assumed to operate mainly in lexical access, whereas the present study went beyond issues of access in relation to the mental lexicon. The “context-availability” theory is more ambiguous and prone to various interpretations. First, the vagueness with which the term “context” is used means that it is often unclear what context is being referred to -- of words, sentences, or even entire pieces of discourse. Thus, researchers refer alternatively to word-associations (Schwanenflugel & Harnishfeger, 1988) as well as to sentences (Schwanenflugel & Noyes, 1996), without taking into account difference between the two types of context. Second, I suggest that these approaches are based on a confounding between context-availability and frequency/familiarity. For example, Schwanenflugel and Harnishfeger (1988) gave the following instructions to participants in performing the task

of ranking context-availability: “It is easy to think of a context for the word ‘baseball’ and ‘emotion’, but it is much harder to think of a context for the word ‘inversion’ and ‘sloop’ ” (p. 502). This suggests that context-availability as measured in these and other studies of Schwanenflugel and associates in fact is equated with the ease of producing a sentence for a given target word. Yet level of understanding of (unfamiliar) target words as analyzed in responses to the sentence-construction task in my study was not found to differ for concrete versus abstract nouns respectively, even though this task in question also tapped into the same psycholinguistic factor of context-availability. On the contrary, the differences that emerged between the two types of words was revealed by **morpho-syntactic** analysis, with sentences constructed with abstract words more likely to include other words from the same root as the target word and/or to embed it in complex syntactic contexts, in the form of heavily modified NPs (Ravid & Berman, 2010), whereas concrete words typically occurred alone, or with minimal modification. In other words, **different strategies** were adopted in constructing sentences with concrete versus abstract nouns, with sentences using concrete nouns not necessarily “better” than those with abstract nouns.

Of particular relevance in the present context are sensory-verbal accounts of the “concreteness effect” that focus on shared features and embodiment of experience (Desai et al, 2010; Grondin et al, 2009; Vigliocco et al, 2009; Vinson et al, 2003). Such models seem to best account for the differential processing of concrete versus abstract nouns revealed by my study, in terms of a differential activation of distinct semantic features. Also of relevance in this connection is Vinson et al’s observation that the concreteness effect differs between animate and non-animate entities, in view of the fact that the present study was deliberately confined to nouns standing for non-animate referents. Tolentino and Tokowicz’s (2009) account, which relates concreteness to a high degree of specificity and abstractness to generality, seems to best explain the tendency revealed in this and other studies, of concrete words to be more autonomous and unmodified and of abstract words to require some type of modification.

In sum, a concreteness/abstractness differentiation emerged throughout my study, in semantic and in syntactic analyses, to nouns lying at the two extremes of the concreteness/abstractness scale. It would be interesting to further examine when and how

this differentiation consolidates in relation to other nouns with varying degrees of concreteness, imageability, and/or specificity on a more detailed evaluative scale (Ravid, 2002, 2006b).

2.4. Developmental Findings

This section concerns the main age-related trends emerging from the study, starting with general developmental findings and proceeding to comparisons of my findings with those of prior research in English and in Hebrew, focusing on derivational morphology.

Age-related changes were revealed across the board in almost every facet of the study covered in the battery of written tests, typically in the form of a preference for one type of response and a concomitant decrease with age in other, less favored types of responses. The developmental curves that emerged were in some cases linear, indicating a gradual shift with age, in others they were step-wise, indicating a more marked change, with 10th graders and adults typically clustered together as against 6th graders. In general, there was an overall increase with age in preference for semantically-related responses, with a concomitant decrease in non-semantic responses as well as in the proportion of unrelated, inappropriate, or miscellaneous responses.

Specific analyses demonstrated a strong inter-dependency between age-schooling level and all the other independent variables of the study: root transparency, familiarity/frequency, and concreteness. With respect to root transparency, younger participants relied markedly more on full roots than did the older ones, not only for unknown words that they encountered, but also in responses they gave to familiar words both in isolation (on the associations tasks) as well in sentential contexts (in sentence-construction and definitions). Further, full roots served as a platform for further processes of analysis, whereas defective roots turned out to restrict the scope of younger children's responses, with a shift in favor of more structurally-related or else unrelated responses and more moderate developmental curves.

Degree of familiarity/frequency of target words can be defined in terms of an intersection of factors combined from two types of exposure to linguistic input, one age-dependent, as reflected in developmental trends, and the other text-dependent, as reflected in frequency of encounters with particular lexical items. Effects on results were

precisely as predicted by this intersection: a familiarity/frequency effect with respect to frequency of encounter, an age-based effect with respect to development, and an interaction of familiarity/frequency and age with respect to the combined effect of both. Results of the sentence-construction task illustrate this constellation clearly: High-F words achieved a rate of nearly 100% success as reflecting full understanding of the target words as early as 6th grade; on the other hand, the low-F words, which reflected full understanding in nearly 80% of the cases in the adult population, did so only 50% of the time among the youngest group of 6th graders and close to 70% in the 10th grade. This finding is remarkable, given that the low-F words selected for this task were ones that had received relatively higher scores on the F-scale than items defined as low-F on the other tasks in the battery. On the other hand, the overall tendency for preference of semantic and far more diverse responses to high-F words and more limited, structure-based responses to low-F words was consistent across the entire test battery. Further, similarly to what was found for age-root interdependencies, two distinct developmental patterns emerged with respect to familiarity/frequency, as follows: a steeper and more clearly demarcated curve in the case of familiar/frequent items and a more moderate and fuzzier curve for unfamiliar/infrequent items.

As for the developmental effect of concreteness, it was manifested in two ways: On the one hand, concrete items proved easier to cope with, especially in the younger age groups but, on the other, there emerged an age-dependent pattern of distinct trajectories for concrete as compared with abstract items. Use of superordinate versus synonymous terms in definitions given to abstract nouns provides clearly illustrates these complementary trends: There was a significant increase in proportion of superordinates and a concomitant age-dependent differentiation between superordinates and synonyms in defining abstract nouns, one that did not occur in 6th grade, but emerged only from 10th grade up.

The predictions that there would be age-related changes across the board, on all tasks, and that age would interact with the other independent variables were thus fully confirmed. The prediction that high school students would reflect an intermediate stage between younger children and adult participants with respect to the developing mental lexicon was partially confirmed, because in many cases 10th graders were closer to the

adult population in their responses, whereas in other cases, the adolescents did in fact reflect an intermediate stage between the younger children and adults.

In reviewing relevant research, discussion starts with “later language development” as the domain of concern to the present study via the prism of lexical development. Psycholinguistic research on later, school-age lexical development is growing, but it is still relatively sparse compared with the rich body of studies concerned with the lexicon in early, largely preschool-age acquisition. Studies dealing with the developing lexicon at age-schooling levels similar to those in the present study can be divided into several different areas of concern, including: (1) lexical usage as one aspect of text-embedded, discourse-based linguistic expression in different languages, including Hebrew (e.g., Bar-Ilan & Berman, 2007; Berman, 2005, 2006, 2009; Berman & Nir-Sagiv, 2009; Berman, Ragnarsdóttir & Strömqvist, 2002; Nir-Sagiv et al, 2008; Ravid & Berman, 2010; Ravid & Cahana-Amitay, 2005; Ravid, van Hell, Rosado & Zamora, 2002); (2) the development of definitional skills (e.g. Benelli et al, 2006; Johnson & Anglin, 1995; Marinelle et al, 2003, 2004, 2006; Nippold, 1999, 2000); (3) estimates of vocabulary growth during adolescence (e.g. Anglin, 1993; Auer & Bernstein, 2008; Nagy & Anderson, 1984; Nagy & Herman, 1987); (4) work relating vocabulary to literacy and school-based academic achievements in the domains of reading and writing (e.g. Bolger et al, 2008; Ouellette, 2006; Perfetti, 2007); and (5) of particular relevance to the present study, a quite considerable body of research on school-age acquisition of derivational morphology (e.g., Anglin, 1993; Burani, Marcolini, De Luca & Zoccolotti, 2008; Carlisle, 1995, 2000; Deacon & Bryant, 2005; Feldman et al, 2002; Freyd & Baron, 1982; Larsen & Nippold, 2007; Leong, 2000; Lewis & Windsor, 1996; Mahony et al, 2000; Rabin & Deacon, 2008) including in Hebrew (e.g., Ben-Dror, Bentin & Frost, 1995; Ravid, 2004; Ravid & Avidor, 1998; Ravid & Bar-On, 2005; Ravid & Levie, 2010; Ravid & Malenky, 2001; Ravid & Schiff, 2006). Despite this rich and varied range of research, relatively few studies have conducted thorough-going, qualitative investigations aimed at in-depth analysis of the internal composition of the mental lexicon in later, school-age development (as for example, for Hebrew: Avivi Ben-Zvi, 2010; Ravid, 2002, 2006b; Seroussi, 2004).

Thus, as noted, psycholinguistically motivated developmental studies examining acquisition of the lexicon, as the focus of the present study, quite generally fail to consider schoolchildren and adolescents. The research population most commonly used in investigating the “syntagmatic to paradigmatic shift”, for example, consists of two- to four-year-olds, as in the studies of Luciarello and Nelson (1985) and Waxman and Namy (1997). The few studies that involve school-age children typically deal with the early school years, hence still in the period of “emergent literacy”; for example, Brown and Berko’s (1960) well-known work included 1st, 2nd, and 3rd graders as compared with adults, while the studies of Cronin (2002), Hashimoto et al (2007), and Nguyen and Murphy (2003) likewise concerned children in the same range of the early school years.

Studies on English employing participants at the same or similar age-schooling levels and dealing with issues directly related to the present study are, as noted earlier, few and far between. Most such studies take 6th-graders as their oldest group, without proceeding to adolescents (e.g., Benelli et al, 2006; Burani et al, 2008; Emerson & Gekoski, 1976; Ervin, 1961; Larsen & Nippold, 2007; Leong, 2000; Lewis & Windsor, 1996; Mahony et al, 2000; Nippold et al, 1999; Tyler & Nagy, 1989). The study reported here, in contrast, deliberately selected 6th-graders as the youngest group for its investigation. First, from a Piagetian perspective on cognitive development (Inhelder & Piaget, 1958, 1964; Piaget, 1972), pre-adolescents aged 11 to 12 years represent a cut-off point between concrete operations and the final stage of formal operations. This age-group also represents crucial developmental trajectories in physiological, sociological, and educational terms as well as psychologically, so that, for example, 6th grade often represents the end of the elementary or grade-school phase of formal education in Israel as in other countries (Segal, 2001, 2008). Larsen and Nippold’s work on English (2007) provides further, morphologically-based rationale for investigating this age group, as half-way between 4th and 8th grade, representing a period of rapid growth in derivational morphology skills. Again, as noted repeatedly, few studies employ young adolescents, I know of only two that, as in the present study, included 10th graders in their designs (Marinellie & Chan, 2006; Marinellie & Johnson, 2003).

In comparing findings of my study with those of research on school-age lexical development (mainly in English and Hebrew, as two languages for which relatively many

relevant studies are available), focus is on derivational morphology as a key component of this study, closely identified with the domain of later language development. Research in English points to increased mastery of derivational morphology with age, interacting powerfully with factors of semantic transparency and phonological regularity, such that semantically opaque and phonologically irregular derived forms consolidate later than their semantically and phonologically more transparent counterparts. (Anglin, 1993; Carlisle, 1995; 2000; Deacon & Bryant, 2005; Feldman et al, 2002; Freyd & Baron, 1982; Larsen & Nippold, 2007; Leong, 2000; Lewis & Windsor, 1996; Mahony et al, 2000; Rabin & Deacon, 2008). Further, comprehension is generally found to precede production, with command of vocabulary correlating highly with literacy development, reflected in increased attention to morphological cues in both writing-spelling and reading, accompanied by a decrease in reliance on phonological cues with age. Of particular interest in terms of the age range of participants in the present study is Mahoney's (1994) finding for significant differences between the morphological skills of 9th graders compared with young adults. While my study does not include direct comparison between morphological abilities and other school-based language and literacy skills, the overall trends it reveals are largely consistent with findings from such research: An across-the-board increase with age in overall performance, together with an age-related differentiation between full and defective roots and increasing preference for morphological over phonological responses.

Another topic in this connection is the relationship between development of derivational morphology and metalinguistic abilities. This is typically examined by means of explicit tasks, such as explaining why two derived words are related (e.g. Baron, 2001), constructing a derived word with a given stem/root (e.g., Avivi Ben-Zvi, 2010; Levie et al, 2008), drawing analogies between derivationally complex words based on roots, stems, and/or affixes (e.g. Ravid & Schiff, 2006), or the exact interpretation of a morphologically complex word, based on an analysis of stem/root and affix (e.g., Anglin, 1993) -- abilities considered as the hallmark of mature metalinguistic knowledge. In contrast, **priming tasks**, conducted most generally with adults, uncover implicit facets of morphological knowledge in the organization of the mental lexicon (see Chapter II, Part B, Section 2 for details). In recent years, priming studies have also been conducted with

schoolchildren in both English (Feldman et al, 2002; Rabin & Deacon, 2008) and Hebrew (Raveh & Yamin, 2005; Schiff et al, 2008), with the latter revealing robust priming effects in schoolchildren for full compared with defective roots. Findings of the present study, which included derivational morphology as an important research variable, provide strong evidence for the involvement of the consonantal root in almost every aspect of analysis, from the most implicit tasks, such as those examining relatedness between words, to the most explicit, such as definitions.

There is relatively rich research on acquisition of word-formation processes in Hebrew, as a language in which derivational morphology plays a particularly important role, and one to which Hebrew-speaking children show relatively early sensitivity (Berman, 1987, 2000, 2003; Clark & Berman, 1984; Ravid, 2003, 2006a; Ravid & Malenky, 2001). Comparison of findings of the current study with prior research is confined here mainly to the issue of the consonantal root, as the only strictly morphological independent variable in the present context. The issues of derivational patterns and linear affixation are further considered below, as playing an indirect role in my study in the context of typological facets of the mental lexicon of Hebrew (Section 3 below). Here, I consider first studies examining morphological awareness and other types of Hebrew-based morphological experiments in school-age population (Bar-On, 2009; Ben-Dror, Bentin & Frost, 1995; Cohen-Mimran, 2009; Ravid & Bar-on, 2005; Ravid & Malenky, 2001), and then proceed to more detailed discussion of three particularly relevant studies, using derived nouns with school-age populations (Avivi Ben-Zvi, 2010; Ravid & Avidor, 1998, Seroussi, 2002).

In the written modality, Ravid and Bar-On (2005) examination of 3rd, 4th, 5th, 6th and 10th graders' spelling of root letters after previous exposure to primes that contained the same root letters found an age-related increase in reliance on root elements, expressed by a general decrease in spelling errors with age and, more specifically, a decrease in primed-root spelling errors with age. Even stronger support for the importance of morphological cues comes from two recent studies of reading. Cohen-Mimran (2009) examined correlations between reading fluency and various linguistic measures among 5th graders, finding that the strongest predictor of reading fluency was their performance on a morphological task. Bar-On (2009), who gave grade-school children and adolescents a

series of reading tasks, likewise found evidence for the reliance of skilled Hebrew readers on morphological cues, an ability that consolidates with age. Another two studies were performed in the oral modality. Ben-Dror et al's (1995) comparison of reading-disabled 5th graders with their non-reading disabled peers -- in an on-line study measuring reaction times to tasks in various linguistic domains and of various degrees of difficulty -- revealed correlations between morphological skills and reading comprehension, in line with a range of other studies. Ravid and Malenky (2001), who investigated kindergarteners, 3rd, 6th, 9th graders and adults on various root-pattern tasks with various degrees of explicitness, found a gradual increase with age in all the tasks with respect to the root. On the other hand, success on root extraction in the Ravid and Malenky study was directly related to the lexicality of the research items, since root extraction of non-words was more challenging for participants than root-extraction from real words, in interaction with age, such that the distinction between words and non-words was more prominent in the younger age groups; for example, 3rd graders were already at ceiling of 100% success in extracting the root of real words, but only 72% success on the same task with nonce words. These findings support the idea of the dual-nature of the root as emerged from the present study as well. On the one hand, (full) root awareness is evident from early on and its identification very soon reaches a ceiling effect; yet on the other hand, this awareness is not only lexically dependent -- as revealed by Ravid and Malenky -- but also semantically dependent, as shown by the present study's finding for the correspondence between words with full roots and mainly semantic responses. The present study adds a further, (morpho)phonological factor to this pattern, revealed by responses to words with defective roots. None of the studies cited so far, except for Schiff et al's (2008) on-line task, investigated full against defective roots in developmental perspective, carefully controlling for other independent variables, as was done in the present study. The major conclusion from adding the phonological factor to this equation is that what can best be termed "root strength" -- in the sense of "cue strength" -- depends on both semantic and phonological/orthographic consistencies (Berman, 1993; Gonnerman et al, 2007; Ravid, 1990, 2003).

Studies cited so far provide evidence for the dual-faceted nature of root awareness, as an ability that emerges early, but that has a protracted developmental route

until it is consolidated, in interdependence with lexical, semantic, and phonological factors combined. Another three studies, in the specific domain of Hebrew derived nouns, are in quite general agreement with this line of thought. Ravid and Avidor (1998) investigated oral command of Hebrew-speakers (5-year-old preschoolers and children in 3rd, 6th, and 9th grade compared with adults) on comprehension and production of Hebrew action nominals, both morphologically regular and irregular (as described in Chapter I, Section 3). In keeping with findings from English, comprehension preceded production; regular derived nouns were easier to process than irregular ones, and consolidation of this type of morpho-lexical knowledge turned out to be a long and protracted process that continued well into adolescence and adulthood. Seroussi's study (2002), conducted in writing with students in 6th, 8th, and 11th compared with younger (19- to 20-year-olds) and more mature adults, extended the study of Ravid and Avidor to a broader set of Hebrew derived nouns with varying degrees of specificity and irregularity, on a range of tasks varying in requirements of explicit metalinguistic knowledge (e.g., identification versus correction, sentence-completion versus sentence- production). Here, too, comprehension was found to precede production, and acquisition was not completed until adulthood, such that in the Ravid and Avidor study, comprehension versus production scores were respectively 46% / 50% in 6th grade, 79% / 68% in 9th grade, and 84 % / 76% in the adults. Two tests in Seroussi's study aimed specifically at the comprehension/production distinction were those requiring respectively identification and correction of the wrong derived noun in a sentential context: Scores increased respectively from 55% / 24% in 6th grade, to 60% / 36 % in 8th grade, 82% / 70 % in 11th grade, 76 % / 70 % in young adults, up to 92% / 87 % among the older adults – showing a decreasing discrepancy with age in comprehension versus production abilities. The present study differs from the earlier two studies of Hebrew derived nouns in development in the following important ways. First, derivational morphology was not referred to explicitly in the present contexts, since participants were not required to perform direct morphological manipulations as in Ravid and Avidor (1998) and Seroussi (2002). Second, all items in the two earlier studies were confined to full roots only, whereas the present study deliberately included nouns derived from defective roots as well. Nonetheless, despite these marked differences, the present study, too, revealed a comprehension / production discrepancy, as follows. Comparison

of results on two tasks of associations between words -- comprehension (in the single-choice relatedness task) and production (in the unique-associations task) -- yielded the following patterns: for production -- 40% in 6th grade, 44% in 10th grade, and 53% in adults; for comprehension (in terms of proportion of semantic responses) 56% , 65%, and 72% in the adults – patterns that correspond well to the results of prior studies.

Another important trend that emerged from the studies noted above was the split between two types of knowledge -- morphological, in terms of command of rules for Hebrew word-formation, and morpho-lexical, reflecting command of the established lexicon of Hebrew with all its idiosyncracies and irregularities. Whereas awareness of morphology and command of conventional morphological means for creating new words are apparent from early on in development, even from preschool age (Berman, 2000, 2003; Berman & Sagi, 1981; Clark & Berman, 1984), full command of the morphology-meaning interface is shown, time and again, to be a lengthy and protracted process that continues into adolescence and beyond, even in adulthood. This discrepancy between knowledge of morphological structure versus lexical convention is consistent with findings of the study of Avivi Ben-Zvi (2010), which involved sentence completion with derived nouns performed by participants ranging from 1st graders to young and mature adults. Rate of success in providing a well-formed Hebrew derived noun was relatively high, from almost 50% in 1st grade to over 90% in the adult population. In contrast, success at providing a lexically-specific and morphologically accurate derived noun was significantly lower and showed a much steeper curve, from 5% in 1st grade to over 80% in adults. Of relevance here are the results of three age groups corresponding to those of the present study -- 6th graders, 11th graders and adults. Whereas the ratio of morphologically well-formed derived nouns was over 90% as early as in the 6th grade, the ratio of lexically-correct derived nouns was slightly over 40% in the 6th grade, around two-thirds in 11th grade, and nearly 85% in the adult population, revealing a developmental trajectory that is highly consistent with this study. Similar patterns of results were found in Seroussi's (2002) study, in which correct morphological action nominals accounted for 89% among 6th graders, 90% in 8th graders, up to 95% in 11th graders and among young adults, reaching a ceiling of 98% among the older adults, as compared with far lower success rates in supplying the conventional, lexically correct

action nominals: 42% in 6th grade, 55% in 8th grade, 86% in 11th grades, and up to 90% and 83% among the younger and more mature adults respectively.

This age-dependent morphology-semantics interface can be inferred from the present study as well, although it did not score responses in terms of either right/wrong or evaluative rankings of success. With respect to morphology, the impact of root transparency in almost every analysis employed here and its interaction with age offer clear and resounding proof of the status of the root as a fundamental factor in the mental lexicon of Hebrew speaker-writers in general, and as an important basis for lexical development in the language in particular. With respect to semantics, the qualitative and quantitative changes with age that emerged in the semantics-pragmatics domain of my study indicate that the developmental trajectory on the way to full command of a complete array of word-specific meanings and a full range of semantic nuances and connotations are established only in adulthood, if ever.

To conclude, the rich and variegated developmentally motivated information provided by the present study suggest reconsideration of a range of issues in the domain of later language development, going beyond rather than ending with grade-school pre-adolescents. The study has implications for issues of gradual developmental trajectories as against one-time shifts, the importance of qualitative analyses in relation to the developing lexicon, and the gap between early structural mastery compared with later lexical proficiency.

3. Discussion of the Mental Lexicon

This section of the discussion concerns the nature of the “mental lexicon” in light of the findings of the present study, starting from more general consideration of the properties of the mental lexicon in general (3.1), moving to Hebrew-specific features that emerged from the study (3.2), and concluding with the morphology-meaning interface in the mental lexicon as reflected in my study (3.3).

3.1. Properties of the Mental Lexicon

Definition and demarcation of the boundaries of the mental lexicon are by no means unequivocal, as surveyed in the introduction (see Chapter I, Section 1.1). Findings of the present study shed light on some of the controversies regarding the nature of the mental lexicon, including in terms of the distinction between the mental lexicon and conventional published dictionaries, the internal composition of the mental lexicon, the size of its units, and models of lexical access. In-depth investigation of the mental lexicon, typically couched in terms of the metaphor describing it as an “inner dictionary”, yields both shared and distinct properties when compared with conventional dictionaries. As background to this question, it should be borne in mind that conventional dictionaries are by no means uniform, since they are written by lexicographers motivated by different considerations and applying distinct linguistic criteria (Anshen & Aronoff, 1999; Zechmeister et al, 1993). Of the three dictionaries employed in the present study (see Chapter II, Part A, Section 1.1), *Even-Shoshan* (1993) took upon himself the monumental task of documenting every single word that ever appeared in print in Hebrew, regardless of actual usage, while the compilers of the condensed one-volume dictionary of *Sapir* (1997) were motivated by primarily commercial considerations. As opposed to common folk beliefs, the very fact that a word occurs in a dictionary is not proof that it in fact exists in actual usage nor, conversely, does the fact that a word is not listed in any conventional dictionary mean that it is not occurrent in the language. Discrepancies in both directions are legion. Of the many lines of comparison that can be drawn between conventional dictionaries and the mental lexicon, three are detailed here are: the root as a lexical entry, distinction between possible and actual words (Aronoff, 1976), and what is considered a lexical entry.

With respect to the status of the consonantal root, right from the start of my study, numerous discrepancies emerged between the three Hebrew dictionaries I consulted both in what was listed and how. Taking the root *š-m-r* ‘keep, guard’ for example, *Sapir*’s (1997) very lenient criteria include under the same root-entry all the words that share this sequence of letters regardless of their morphological composition (e.g., *šomer* ‘guard’, *šmura* ‘nature reserve’, *šamranut* ‘conservatism’, *šmarim* ‘yeast’, and even the morphologically non-derived and semantically unrelated words that happen to contain the

same three letters, such as *šumar* ‘fennel’ and *šamir* ‘dill’). More stringent criteria of semantic relatedness are applied by Even-Shoshan (1993), which distinguishes between one sense, as in *šomer* ‘guard’, *šmura* ‘nature reserve’, *šamranut* ‘conservatism’, and another, as in *šmarim* ‘yeast’. The computerized *Rav-Milim*, in its earlier (1997) floppy-disk version, likewise attempted to differentiate semantic relatedness between senses or “word families” made up of words from shared roots. The current on-line version of this highly sophisticated dictionary (Choueka & Freidkin, 2001) unfortunately does not allow for searching for a given root as a lexical entry. As for the existence of roots in the mental lexicon of Hebrew speaker-writers, a rich range of psycholinguistic studies, both explicit and implicit (priming), have demonstrated that roots exist as an organizational principle of the mental lexicon of Hebrew. Hebrew speaker-writers have also been shown to be sensitive to the degree of semantic (Frost et al, 2000b; Moscoso del Prado Martí n et al, 2005) and phonological transparency of roots (Frost et al, 2000a; Schiff et al, 2008; Velan et al, 2005), so that they tend to perceive as more clearly root-related words that share clear semantic and phonological connections. For example, it is safe to assume that most Hebrew speakers, if asked, would say that the words *šomer* ‘guard’ and *šumar* ‘fennel’ are not related by root, so reflecting the impact of semantic unrelatedness. On the other hand, it is hard to specify what exactly is involved in the notion “semantically related”, as is evident from the disparate findings yielded by different dictionaries as well as by the subjective judgments of individual speakers. The picture is different, however, in the phonological domain, which reveals a clear and marked discrepancy between conventional dictionaries and speaker judgments. Dictionaries, not concerned with psychological processes or speaker perceptions, typically treat defective and full roots exactly the same, whereas the morphophonological opacity of defective roots leads speakers to differentiate significantly and across the board between the two types of roots.

Another discrepancy lies in the boundary between actual and potential words. Even-Shoshan (1993) favors potential words, listing numerous unfamiliar, almost completely unknown words, including, for example, regularly derived, but non-occurrent action nominals (e.g., *hitxalcut* as the hypothetical rule-based action nominal for the non-occurrent verb-form *hitxalec* – cf. the root *x-l-c* occurring in a range of actual words

including verbs meaning ‘to remove (shoes)’, ‘to rescue’ and nouns meaning *rescue-boat*, *pioneer*, *pioneering*’); and his dictionary also lists numerous arcane literary innovations from published works, coinages stipulated by the Academy of the Hebrew language that have never been absorbed into current usage, as well as archaic or obsolete words from earlier historical stages of the language. Such items are deliberately excluded from *Rav-Milim*, in the interests of adhering to contemporary usage. For example, the following totally unknown nouns *xelcon*, *xalaca*, and *hitxalcut* from the root *x-l-c* ‘rescue’ appear in Even-Shoshan, and the word *xalécet* ‘rescue boat’ is listed on the internet site of the Academy of the Hebrew Language, yet none of these are given in *Rav-Milim*. As for the mental lexicon, proof of the actual/potential discrepancy emerged very clearly from the findings of the questionnaires (Chapter II, Part A, Section 2). Familiarity questionnaires tended to reflect **potential** words by relatively high ratings given to even clearly unknown words, since they represented possible well-formed Hebrew words. In contrast, frequency questionnaires turned out to better reflect **actual** words such as in fact occur in speaker usage. For example, the highly specific coinage of the Academy of the Hebrew Language *mavzek*, a translation of the word ‘(camera) flash’ scored 4.14 on familiarity but only 1.93 on frequency, while the abstract literary term *sguliyut* ‘uniqueness’ scored 4.17 on familiarity but only 1.93 on frequency.

The issue of what is considered as a lexical entry is also controversial, as was earlier apparent in relation to the debate on the lexical status of roots. A typical lexical entry in conventional dictionaries is a single word, usually in the singular form in the case of Hebrew nouns. With respect to the mental lexicon, scholars disagree on such topics as: what constitutes a lexical entry in the mental lexicon, whether units smaller than words (morphemes) or larger than words (compounds, collocations) exist in the mental lexicon and to what extent (Aitchison, 2003; Arnon & Snider, 2010; Bannard & Matthews, 2008; Berman & Ravid, 1986; DiSciullo & Williams, 1984; Jackendoff, 2002; Lyons, 1977; Nemo, 2003). Findings of the present study shed light on these issues as follows. As detailed earlier in this chapter (Section 2.2), in the mini-experiment that I performed on selected nouns from the frequency questionnaires, their frequency scores rose significantly after I modified the way they were presented to a more “user-friendly” format, one more familiar to the average speaker-writer of Hebrew (by addition of more

familiar diacritical marks instead of the unfamiliar, normative ones, changing nouns from singular to plural, and embeddings nouns in a noun compound construction). There was a significant increase in the frequency scores for all such modified forms, a finding that supports a non-symbolic, highly specific characterization of entries in the mental lexicon. Further, the significant increase in the frequency scores assigned to nouns that appear more often in the plural form (e.g. *kišur* ‘skill, talent’ – which scored 3.14 in the singular form and 4.54 in the plural form of *kišurim* ‘skills, talents’) can be taken as evidence for the role of inflectional morphology in the mental lexicon (Baayen, Dijkstra & Schreuder, 1997; Baayen, Levelt, Schreuder & Ernestus, 2008; Baayen, McQueen, Dijkstra & Schreuder, 2003; Caramazza, Laudana & Romani, 1988; Clahsen, 1999; Katz, Rexer & Lukatela, 1991; Laaha, Ravid, Korecky-Kröll, Laaha & Dressler, 2006; Nakisa, Plunkett & Hahn, 2000; Prasasa & Pinker, 1993; Ramscar, 2002). And there is also evidence for the role of familiarity of nouns in the plural rather than the structurally unmarked singular form in Hebrew language acquisition (Berman, 1981; Dromi & Berman, 1982).

Inflectional morphology is not further considered here, as lying outside the scope of the present study, but these findings support the idea that inflectional morphology is not confined to grammar or (morpho)syntax, and that it plays a role in the lexicon as well.

A further example of lexical specificity is provided by the third type of modification, applied to is the noun *xaróšet* ‘industry’: Initially, in its “bare” form, it scored 3.54 on frequency, but when inserted as the modifying element in the context of the lexicalized compound *beit xaróšet* ‘house-GEN industry = ‘factory, plant’, it scored 4.59, indicating that this noun is far better known and more commonly used in the compound construction, hence evidence for the existence of units larger than single words in the mental lexicon. Further support for the psychological reality of multiword expressions as lexical entries is provided by the syntagmatic responses given in the association tasks, for example, for the noun *tahalix* ‘process’, *tahalix lešoni* ‘linguistic process’, *tahalix murkav* ‘complex process’ -- with adjectival modifiers – and *tahalix ha-šalom* ‘the peace process’ and *tahalix lemida* ‘learning process’ -- in compound head-noun plus adjunct noun constructions. Such eventualities are not taken into account by conventional dictionaries, which typically do not list (morphologically regular) plural forms or (not fully lexicalized) compounds as major lexical entries.

Overall, findings of the present study clearly demonstrate the multi-dimensionality and dynamic organization of the mental lexicon, way ahead of any conventional dictionary, even more sophisticated ones like the Hebrew *Rav-Milim*. The results documented here prove that Hebrew speaker-writers are constantly constructing flexible task- and age-dependent networks of connections between words, which are sensitive to the numerous variables involved in the study – including factors of usage, morphological structure, and semantic content.

3.2. The Mental Lexicon: Hebrew-Specific Properties

This section details Hebrew-specific findings that emerged in the course of the investigation that had not been anticipated *a priori*, and so can be considered as by-products of the study. The first topic discussed in this connection is the impact of typological factors on familiarity/frequency scores, followed by factors of Hebrew morphology not dealt with in the preceding chapters, such as Hebrew *mishkal* patterns and diacritical vowel-marking.

Results of the familiarity questionnaires, the first administered in the study, drew my attention as seeming to reflect typological preferences more than familiarity *per se*. Consider, for example, the regular action nominals of the five non-passive Hebrew *binyan* patterns: *CCiCa* for P1 (Qal, Pa'al), *CiCuC* for P2 (Pi'el), *haCCaCa* for P3 (Hif'il), *hitCaCCut* for P4 (Hitpa'el) and *hiCaCCut* for P5 (Nif'al). It was immediately evident to me that the action nominals derived from P5 (Nif'al) verbs were consistently given low scores for familiarity, leading me to conduct more detailed statistical analyses, to examine the effects of these and two other typological factors (historical origin, and type of derivation) on the distributions in the familiarity questionnaire by means of a three-way ANOVA performed on the entire database of 2,400 derived nouns. In the first domain, the regular **action nominals**, which constituted over one-third (867) of the nouns were divided as follows: 28% were in the pattern *CiCuC* of P2 (Pi'el), 26% in the pattern *haCCaCa* of P3 (Hif'il), 19% in the pattern *CCiCa* of P1 (Qal, Pa'al), 17% in the pattern of *hitCaCCut* of P4 (Hitpa'el) while less than 10% were in the pattern *hiCaCCut* of P5 (Nif'al)– a distribution which, while not taken directly from a representative sample of nouns in Modern Hebrew, nicely reflects current trends in

Modern Hebrew (Bolozky, 1999; Schwarzwald, 2001, 2002), with P2 a highly frequent *binyan* with the highest rate of productivity (Berman, 1993, 2003), and P5 as the least frequent. Significant differences emerged between the familiarity scores ($F(8, 2353)=14.546, p<.001$) as follows: P4 (Hitpa'el) scored the highest ($M=4.72, SD=0.42$), P3 (Hif'il) was the second ($M=4.59, SD=0.62$), followed by P1 (Qal, Pa'al) ($M=4.58, SD=0.6$), P2 (Pi'el) ($M=4.5, SD=0.75$) and the last was P5 (Nif'al) ($M=4.29, SD=0.57$). A post-hoc analysis revealed significant differences between the action nominals derived from P2 and P4, and between the action nominals from P5 and almost all the other *binyan* patterns (P1, P3 and P4), such that P5 scored significantly lower than the others. The most interesting result here was the inferior status assigned to P5-derived nominals, in both quantitative and in qualitative terms. This provides further support from the nominal domain for the nonfavored status of *binyan nif'al*, as earlier established for verbs (Berman, 1993; Raz-Salszberg, 2006; Schwarzwald, 1981).

The second analysis, of the effects of the **historical source** of the derived noun ($F(1, 2353)=227.827, p<.001$) revealed that derived nouns from Biblical, Mishnaic, and Medieval Hebrew scored significantly higher ($M=4.54, SD=0.04$) than their more contemporary counterparts, nouns coined in Modern Hebrew, starting with the late 19th century ($M=4.051, SD=0.03$). The rationale for the third analysis, type of **derivational process**, was the fact that, even though the study adopted non-linear, non-concatenative root-based derivation as its point of departure, in order to establish large enough families of words from the same morphological basis, a substantial proportion (411 =17.1%) of the derived nouns in the database were in fact ones constructed by linear derivation – for example, *maxševon* ‘pocket calculator’, linearly derived from the derived noun *maxšev* ‘computer and the suffix *-on*, in contrast to the noun *maxšev*, itself derived from the root *x-š-b*. These cases of “double derivations” – in the sense of two layers of derivation via the root to one noun, and via this noun by affixation to another noun, are evidence for the increasing prevalence of linear derivation in Modern Hebrew, as opposed to earlier stages of the language, which were more canonically root-based (Ravid, 2006a; Schwarzwald, 2001). The analysis revealed significant differences between them ($F(1, 2353)=10.815, p<.005$), the root-derived nouns ($M=4.4, SD=0.03$) scored significantly higher than the linear-derived nouns ($M=4.19, SD=0.06$). These findings clearly reflect the following

trends in contemporary Modern Hebrew morphology: On the one hand, interdigitated, non-linear morphology remains dominant in Modern Hebrew, both in amount and in linguistic and psycholinguistic reality, but on the other hand, concatenative, linear morphology is becoming more and more prevalent in Modern Hebrew.

The presence of linear morphology in this study further relates to the on-going debate concerning the source of derivation, whether a root or a whole word (Aronoff, 1994; 2007; Bat-El, 1989; Berman, 2000; Berent & Shimron, 1997; McCarthy, 1981; Prunet, 2006; Ravid, 2006a; Shimron, 2003; Ussishkin, 2005). The findings of this investigation point to a “hybrid “ account as the most adequate, taking both roots and whole words as two complementary sources of derivation – certainly in the case of Hebrew derived nouns.

The results of the free-associations, the only open-ended tasks in the battery that required single words as a response, proved to be a remarkable window on many variegated facets of the mental lexicon of Hebrew speakers. For example, the category termed “morphophonological” included both associations with shared *mishkal* patterns, suffixes, and rhymes (see Chapter III, section 4.1) since it was in many cases impossible to distinguish between them. Pattern-related associations typically rhyme and rhyming words are often related by a shared suffix and/or pattern, while shared endings most typically are a sign of a common pattern. Associations such as *mexiron* ‘price list’ to the input noun *mešivon* ‘answering machine’ or *te’avon* ‘appetite’ and *bitaxon* ‘security’ to the input noun *bita’on* ‘magazine’ or *bdil* ‘tin’ to *gdil* ‘tassel’, *zadon* ‘wickedness’ to *madon* ‘(literary) dispute’, further highlighted, in different perspective, the existence of interrelations between patterns and suffixes in the mental lexicon of Hebrew speaker-writers. The present study did not directly address the category of pattern, which research has shown to be less psycholinguistically salient and as consolidating later in development than the root (Avivi Ben-Zvi, 2010; Clark & Berman, 1984; Levie et al, 2008; Ravid & Malenky, 2001; Ravid & Schiff, 2006). However, results of my investigation, particularly on the association tasks, reveal that patterns, too, have some psychological reality and hence play a role in the mental lexicon of Hebrew.

As for vowel-marking by diacritics, the last issue discussed under this heading, the bulk of the stimuli in the study were presented to participants marked by conventional

diacritical marks, as accepted in dictionaries and in formal written Hebrew (see Chapter I, Section 3.1). This was the only way for the study to avoid homography, as a prevalent phenomenon in Hebrew (Bar-On, 2010), since the stimuli in this study were isolated words. Differences between more and less familiar diacritic marks, not formerly anticipated, emerged in the early phases of the usage questionnaires, as discussed above. The bulk of studies on use of diacritic markings with adult population in Hebrew (Bar-On, 2010; Bentin, 1989; Bentin & Frost, 1987; Frost, 1995; Rahamim & Friedmann, 2009; Ravid, 1995, in press; Schiff & Ravid, 2004; Schwarzwald, 2003) fail to address the internal distribution of various diacritical marks and the relative frequency of each. An exception is the study of Shany, Bar-On, and Katzir (submitted), who found differential developmental paths in the acquisition of diacritical marks in gradeschool children in relation to their relative frequency of occurrence, yet they, too, failed to take into account the precise contribution of each separate diacritical mark.

In order to further clarify this complex issue, the following needs be noted with regard to use of diacritical marks in contemporary Hebrew. Hebrew speaker-writers are introduced to the full range of diacritic marks in the first years of elementary school, which are included in all the materials presented to them, as part of learning to read. From the 4th grade on, however, most school texts are written without diacritics, so leading to a considerable amount of homography, which is solved mainly by reliance on context as well as, in some cases, partial supportive diacritic marking (termed *nikud ezer* ‘ancillary pointing’) aimed at disambiguation of the potential homographs by employing only the five most frequent and prototypical diacritical marks for the five vowels in Hebrew script – standing roughly for the cardinal vowel values of *a, e, i, o, u*. This very common method of disambiguation has the effect of strengthening the weight of these prototypical types of diacritics, which have relatively consistent phoneme-grapheme mappings, so undermining the status of the other, less canonic diacritics, which are generally completely disregarded by readers of Hebrew. Today, for Hebrew reader-writers, the full range of normative diacritics is confined largely to children’s literature, to poetry, and to the scriptures (Bar-On, 2010; Ravid, 1996, in press). For example, the most common way of representing the vowel *o* is the *xolam* (indicated by the letter for the historical glide *w* and a dot on the top-left side), but in fact it can also be represented by

the less familiar *xolam xaser* (the dot alone) and the less common *qamats katan* (a mark shaped like a small capital T below the consonant, with the same shape as one used for *a*, but read like *o*). An examination of the surprising results of the questionnaires with respect to diacritical marks revealed that the most problematic were ones other than the five prototypical signs representing the basic vowel sounds. For example, in the present study, words with the very rare *qamats katan* were often misread by participants. Moreover, this phenomenon of ignoring the normative diacritic marks was so apparent in relation to items on the test battery, that it was identified as a special category termed “misreading”. This appeared mainly, but not only, in case of unfamiliar/infrequent words, such as the novel coinage *ma’aróxet*, stipulated by of the Academy of the Hebrew Language, as equivalent to the term ‘(inner) constitution’ in psychology: No fewer than 23 of the 120 associations given to this noun were based on misreading and interpreting it as *ma’aréxet* ‘system’, a more familiar/frequent noun both in form and meaning, hence in the relative frequency of the non-normative, misleading diacritical mark. Other evidence for this phenomenon, even in the case of familiar/frequent nouns, is provided by the noun *nófeš* ‘vacation, respite’: Several (15 of the 196) associations given to this noun took it for the word *néfeš* ‘soul’, demonstrating exactly the same confusion and misinterpretation of less common diacritical marks, of the kind rarely encountered from 4th grade on. The priming experiments in this study also yielded striking results with respect to diacritic markings. Whereas prior studies performed in Hebrew reported priming effects to targets with diacritics (Bentin & Feldman, 1990; Feldman & Raveh, 2003), the initial piloting experiments in the present study revealed no priming effects for targets with normatively stipulated diacritics. Priming effects appeared only after the vowel-marking diacritics were reduced to the minimum required for accurate reading of the target words.

The next issue addressed here is the relevance of transferring to Hebrew research tools such as frequency corpora that have been devised primarily for European languages like English and Dutch (e.g., Baayen, Piepenbrock & van Rijn, 1993). The typological effects of the “morphological bias” and the phenomenon of “pseudo familiarity” of unknown words on the initial familiarity questionnaires (Chapter II, Part A, Section 2) combine with the complexity of homography disambiguation in Hebrew noted earlier to challenge the reliability of Hebrew frequency corpora based on criteria borrowed

wholesale from English. For example, English manifests a large overlap between words and strings of letters occurring between spaces in writing (including computerized materials), so that almost every item that occurs between spaces can be defined as a “word” – with the possible quite marginal exception of verb-particle combinations and lexicalized compounds (Berman, 2002; Berman & Ravid, 1986; Lyons, 1977). In contrast, incompatibility between a single word and a string of letters occurring between spaces are numerous in Hebrew; for example, the string of letters הסברה can be read as the derived noun *hasbara* ‘information’, the definite-marked noun *ha-svara* ‘the-assumption’ and the possessive noun *hesbera* ‘explanation-her = her explanation’. One important source of such ambiguity is the fact that seven very high-frequency closed class items that constitute words in English and other European languages (the so-called *moshe ve-kalev* ‘Moses and Caleb’ series standing for the prepositions meaning ‘in, to, as, from’, the definite article ‘the’, and the conjunctions ‘and’, ‘that’) are written as part of the next word. Thus, a frequency corpus in Hebrew actually reflects string-of-letter frequencies rather than word frequencies. It thus seems to me that the best way to achieve psycholinguistically valid norms for Hebrew would be either by subjective ranking, as done in the present study, or by meticulously taking into account homograph disambiguation by at least minimal diacritical marking, and/or by providing relevant context.

Three conclusions can be drawn from this discussion of Hebrew orthography in light of the present study. The first is that the diacritical marks have a two-fold impact on the average writer-reader of Hebrew (Bar-on, 2010; Rahamim & Friedmann, 2009): In some cases they may aid in disambiguation, while in others they may interfere, depending on their relative frequency in conjunction with other factors. Second, the traditional division of Hebrew orthography into two systems – pointed (with diacritic markings) and unpointed (without diacritics) – may need to be revised, at least for psycholinguistic purposes, by addition of a third, intermediate system of partially supportive diacritics, highlighting the role of a few canonic vowel signs and disregarding others, which stand for morphophonological distinctions that in many senses no longer apply in current Hebrew. A third conclusion relates to models of reading Hebrew in light of the problems faced by Hebrew readers in processing words in isolation. The bulk of reading models in

English are based on words in isolation (e.g., Balota et al, 2006; Besner & Humphreys, 1991), which is understandable, since readers of isolated English words do not encounter homography to nearly the same extent as their Hebrew counterparts, nor do they need to cope with a complex system of diacritical marks. For all these reasons, psycholinguistic models based primarily on English, as the most widely researched language in the world, are not automatically compatible to other, typologically distinct, languages (see, further, Share, 2008).

3. 3. Conclusions: The Morphology-Meaning Interface in the Mental Lexicon

This concluding part of the discussion of the mental lexicon aims at a renewed look at the morphology-meaning interface in light of the findings of the present study, beginning with morphology, followed by meaning, and ending with the interface between the two.

Before going any further, as an oft repeated motif of this discussion, it should be borne in mind that the bulk of theories and models apply to English morphology, which differs markedly from Hebrew. One such difference is the observation that derivational morphology in English is regarded by numerous researchers principally as a clue for word-class distinctions (e.g. Shore & Kempe, 1999), which operates mainly when speakers encounter unknown words. Further, complex words in English tend to be longer, more abstract, and relatively lower in frequency (Bar-Ilan & Berman, 2007; Curson, 1982; 1984; Reily & Keah, 2007). In contrast, the rich morphology of Hebrew provides far more than lexico-syntactic information, it applies across the board, and is by no means confined to longer, more abstract, or less frequent lexical items.

The first debate re-evaluated on the basis of the findings of this study concerns the existence of morphology as an independent domain in the mental lexicon (see Chapter I, Section 1.1). In this respect, results of my study provide strong and consistent proof that morphology in general and the Semitic root specifically have a robust, across-the-board reality in the mental lexicon, even in the case of familiar/frequent words and at more advanced stages of lexical processing. Further, not only is morphology not secondary to other linguistic domains, the study shows it to have a preferred status compared to phonology in the mental lexicon of speaker-writers of Hebrew.

The second debate re-evaluated here concerns the source of derivation -- the whole-word versus root controversy – for which evidence is provided from two sources in this study. The first is the fact that no fewer than 17% of the nouns selected for the initial data-base of this study, taken from the root supplement of the Even-Shoshan dictionary, turned out to be derived linearly – reflecting the increasing use of linear, word-based derivation in Modern Hebrew. The second comes from examination of the mediated associations to low-F words, which proved to be an unexpected source of insight into the mental lexicon of Hebrew (see Chapter III, section IV). Qualitative analysis of these responses revealed that the associations coded as mediated represented a very mixed group of items, motivated by different considerations. In some cases, such as the association *délet* ‘door’ or *cilcul* ‘ringing’ to the input noun *pa’aman* (a Hebrew equivalent stipulated by the Academy of the Hebrew Language for the noun *metronome*), it is clear that the source of the association was the very similar familiar/frequent word *pa’amom* ‘bell’, whereas in other cases, such as the associations *maxala* ‘illness’ and *pérax* ‘flower’ to the input noun *gdil* ‘tassel’, it was clear that the mediation was through the root *g-d-l* ‘grow’. These mediated associations thus point to the presence of both words **and** roots in the associative lexical networks of Hebrew speaker-writers, who rely on both elements, whether mixed together or separately, as clues in interpreting novel words. These varied possibilities as sources of information in assessing new words in the language suggest a type of processing that is highly compatible with connectionist-type architecture.

Moving to meaning relations, the basic controversies in this respect can be summed up as follows: (1) the line between semantic and pragmatics criteria in the organization of the mental lexicon, (2) the line between semantic and associative relations, and (3) the question of whether semantic representation is modality-dependent or not. With respect to the first debate, the tasks of free association, mainly to familiar/frequent input words, provided supportive evidence for the difficulty of drawing a clearcut boundary between semantics and pragmatics, due to the complex word-world relations that they involve. These difficulties in drawing the line, often expressed by disagreements between the coders that needed to be resolved by a third party, lead to the following conclusion: It is practically impossible to tease apart semantics from

pragmatics, since they are so closely related in the mental lexicon. Further, the rationale for teasing them apart is artificial, not related to reality but to semantic theories. The best way, in my opinion, to view word-world relations is as complementary, mutually affecting and bootstrapping each other. The approach adopted in this study as a theoretical framework that best accounts for this inter-dependency is Frame-Semantics (Barsalou, 1992; Fillmore, 1974, 1975, 1985; Fillmore & Atkins, 1992), which considers both word and world knowledge in determining meaning relations in the mental lexicon.

The second and third debates noted here are closely related to the concrete-abstract distinction. So-called semantic and so-called associative relations are both manifestations of meaning relations in the mental lexicon, the main differences between them being largely related to concreteness, as reflected, for example, in the finding for more synonymic relations to abstract nouns and more co-hyponymic relations to concrete nouns. The third issue, concerning the modality (in)dependency of semantics was also shown to be strongly affected by the concrete-abstract distinction. Taken together, the results of my study lead to the conclusion that any account of meaning relations in the mental lexicon which refers solely to semantic-associative distinctions or to any other types of relations and/or dependencies without considering the factor of concreteness-abstractness, will fail to reflect the psycholinguistic reality of meaning in the mental lexicon in its multifaceted totality

As for morphology-meaning interface, the root indeed has an unequivocal psycholinguistic reality in the mental lexicon, yet the dominant status of the root is by no means a representation of a single, intact independent module. Fine-grained analyses demonstrated that the robustness of the root depends heavily on semantic and phonological/orthographic transparency. The best account for these findings, in my understanding, is in a form of a Parallel Distributed Processing (PDP) network (Gonnerman et al, 2007; Plaut & Gonnerman, 2000; McClelland & Rumelhart, 1985; Monsell, 1991) with a hidden layer, which constitutes the locus of morphology. This hidden layer, which mediates between the input and the output by detecting consistencies and co-occurrence in form and meaning, in fact performs morphological operations. By this account, morphology thus evolves from the regularities and sub-regularities detected by the hidden layer. One of the prevalent claims against PDP accounts (e.g. Aronoff,

1994; Dohmes et al, 2004) is that morphology loses its independent status under such accounts because it merely reflects correspondence between phonology/orthography and semantics. The answer to this claim would be first, that the “classical” division into linguistic domains is not *a priori* a part of the network’s architecture and second, that by this account, the status of morphology as a mediator between input and output data would be even higher in the hierarchy than in most accepted approaches to linguistic analysis.

4. Implications and Future Directions

This final part of the discussion summarizes first the major theoretical, pedagogical and clinical implications of the study (4.1) and concludes with comments on directions for further research (4.2).

4.1. Further Implications and Possible Applications

Several quite general implications emerge from the complex three-phased study documented here, which employed four independent variables in a variety of tasks. Methodologically, the study spotlights a number of key themes in both its design and outcomes. First of these was the value ensuing from meticulous and explicitly motivated selection of the target items in the form of a coherent yet adequately large and varied set of stimuli. Second, administration of specially constructed questionnaires, although tedious and lengthy, enabled the researcher to re-evaluate the criteria adopted for characterizing such well-known notions as frequency or concreteness and the inter-relations between them; this novel specification of the research variables meant that it was possible to control carefully for each both independently and in relation to one another, ensuring unbiased analysis of results which turned out to yield many unexpected insights and breakdowns. Third, the study underscores the importance of a research strategy that combines quantitative and qualitative lines of analysis, providing complementary perspectives on lexical structure and development, hence a more rounded picture of “the mental lexicon”. Relatedly, application of both off-line and on-line tasks provided complementary evidence for processing of the same materials at different levels of consciousness, while querying the extent to which the “mental lexicon” can be

adequately represented by research focusing on initial stages of lexical access. Another point highlighted by the study is the need for caution in transferring theoretical models no less than methodological procedures from one target language to another, particularly in moving from English to a language like Hebrew, which differs markedly in morphological structure as well as in its orthographic systems and conventions; this was demonstrated, for example, by how Hebrew speaker-writers construe the notion of “familiarity” of words presented in isolation and how they interpret words written with normative vowel-marking diacritics. Finally, developmental findings on the nature of the mental lexicon call into question claims made in prior research based largely on younger pre-school or early-school aged children – including the lack of a clear-cut “syntagmatic-paradigmatic” shift on associations tasks and the complex lexico-syntactic differences rather than a merely linear developmental curve in processing concrete compared with abstract terms.

Pedagogical implications of the present study include, first, the need for more careful and in-depth consideration of the abilities it reveals among 6th grade pre-adolescents. On the one hand, they are regarded by the school system as mature enough to cope with the abstract and sophisticated learning materials to which they are exposed, yet, on the other hand, they still have a long way ahead en route to maturely proficient mastery of both linguistic structure and use – a state of affairs that constitutes a challenge for teachers acting as mediators in mastering the linguistic and literacy-based challenges facing their students. By balancing for task difficulty, the study underscores the high level of metalinguistic resources required by tasks such as constructing sentences and providing definitions that are in routine use in schools -- suggesting that 6th graders not be assigned tasks that they are not as yet capable of performing, such as definitions of unfamiliar, infrequent, or abstract nouns of the kind common in school curricula (Nagy & Anderson, 1984). A third, Hebrew-specific pedagogical implication would be to give more weight to defective roots, considering both the processing complexity they entail and how common they are in everyday usage, so as to provide students with strategies for coping with them on a par with items and paradigms of words constructed out of full roots. Another Hebrew-specific pedagogical implication would be to re-introduce and review the normative diacritical marks at schooling levels higher than 3rd grade, in tasks

such as reading aloud, so as to ensure that they continue to form part of students' receptive reading knowledge.

Clinical implications of the study would be to try and administer similar, suitably adapted tasks to other populations such as children with Specific Language Impairment (SLI), who are known to have difficulty with the acquisition of Hebrew derivational morphology (Leong, 1995; Ravid, Avivi-Ben Zvi & Levie, 1999; Schiff & Ravid, 2007). The study has demonstrated that the full root serves as a kind of "automatized" anchor that is readily accessible for further lexical processing in normally developing children; but such "automatization" in the sense used in connectionist accounts (e.g., Plaut & Booth, 2000) may be less available, less well established, and less efficient in the case of children with language and learning disabilities. The clinical implication here is twofold: Diagnostic measures should examine the ability of such children to manipulate words and word families constructed, at least initially, out of both shared roots and shared meanings. And carefully focused instructional programs need to be devised on the assumption that their morphological decoding skills are impaired in varied ways – so that controlling for variables of root transparency, familiarity/frequency, and concreteness seems particularly critical in such populations.

4.2 Directions for Future Research

The first such course would be to extend the priming pilot to full-scale priming experiments, containing enough observations to ensure statistical significance beyond what was feasible in the time-scale of the present study. This could be achieved by increasing the time course of the experiment and/or by recruiting additional participants. A further recommendation in this connection would be to add more time intervals between the prime and the targets (for example, 75 ms, 150 ms) to the design of the experiments, so as to give a better chance at detecting gradedness effects, as predicted by connectionist accounts. It would also be interesting to perform these experiments in other priming paradigms such as cross-modal priming and to compare naming latencies to lexical decision latencies.

The second direction is to elaborate the age range of participants in order to achieve a more fine-grained picture of the developing mental lexicon in adolescents and

adults. This could be done by adding (1) an interim age group such as 8th graders, lying half-way between the two groups of schoolchildren in the present study, in order to fine-tune developmental curves for differentiating between grade-school and middle-school students (Berman, 2008); and (2) a group of young adults, who proved to be significantly different from adults in their late 20s and beyond in other Hebrew-based studies (Avivi Ben-Zvi, 2010; Seroussi, 2002, 2004) – particularly since the Israeli population of college and university students is typically several years older on average than their American or European counterparts.

A third direction concerns the impact of instructions given to participants on what tasks to perform and how, since this has been found to have an effect even in priming experiments, which are supposed to access directly the mental lexicon in the most implicit way (Rajaram & Neely, 1992). It would be interesting, for example, to ascertain what kind of effect, if any, would be obtained by providing more explicitly directive instructions, such as requiring participants to focus on semantic relations in the relatedness task, or requiring them to provide a super-ordinate in the task of definitions, would change the results.

A fourth direction would be to extend the scope of this study to atypical populations of the kind noted above, using the results of this study as a kind of baseline for both diagnosis and treatment of adults as well as children with various kinds of language and learning disabilities, reading difficulties, and other types of impairments.

A fifth recommendation would be to extend the scope of familiarity/frequency norms for Hebrew in both size and make-up, and to establish Hebrew-language norms for imageability/concreteness, as well as for age-of-acquisition of the lexicon. Regarding the first of these requirements, the norms set for familiarity and frequency in the present study filled a lacuna in Hebrew lexical research, but they were confined to the specific domain of derived nouns and so need to be extended to other types of nouns (for example non-derived and borrowed nouns) and to other lexico-grammatical categories such as verbs and adjectives. Providing more widely-based Hebrew norms for imageability/concreteness is also necessary, so as to go beyond the two extremes of plus or minus concrete terms, to account for words that manifest an intermediate degree of imageability/concreteness, inter alia so as to examine whether the concrete-abstract

contrasts revealed by this study would also apply to words with an intermediate status in this respect. A further recommendation would be to confine these norms to familiar/frequent words, taking into account the high level of dependency found in this study between the factors of imageability/concreteness and familiarity/frequency respectively. It is also important to establish Hebrew norms for Age-of-Acquisition, as a variable of growing prevalence world-wide and one that manifests significant correlations with other dimensions of linguistic structure and use (Barry & Gerhand, 2003; Bonin et al, 2004; Bird et al, 2001; Colombo & Burani, 2002; Morrison et al, 1997; Reily et al, 2007, Zevin & Seidenberg, 2004).

A sixth direction would be to assess the factors of familiarity/frequency and concreteness/imageability on other classes of typologically distinct nouns in the lexicon of Hebrew such as, for example, foreign terms (Fisherman, 1986). An attempt was made in the initial stages of the present study to construct questionnaires that also included borrowed nouns, but this was abandoned due to the complex and time-consuming design that it involved. However, preliminary impressions from this attempt indicate that foreign or loan words -- which are generally longer than native Hebrew words and often do not conform to Hebrew phonological constraints on stress-assignment and syllable structure -- are, in fact, processed differently in the mental lexicon of Hebrew speaker-writers. For example, participants in this part of the study seemed to show far less of a tendency to disambiguations in interpreting loan words (which do not demonstrate the same homography as do native items) nor did they rely on diacritical markings in the same way as in processing root-derived items. Supporting evidence for this differentiation in the Hebrew mental lexicon between root-derived and foreign words is provided by studies conducted on typical (Velan & Frost, 2007, 2009) and atypical populations (Friedmann & Gvion, 2001, 2005; Gvion & Friedmann, in press) showing that the letter transposition effect, well-known in English, does not exist in Hebrew due to the different principles in the morpho-orthographic organization of the two languages. Further, Hebrew-English bilinguals in Velan and Frost's (2007) study revealed priming effects when primes were combined from transposed letters of the targets in reading English but not in reading Hebrew. Moreover, not only does letter transposition in Hebrew often lead to another meaningful word owing to the morpho-orthographic density

of the Hebrew writing system, Friedmann and Gvion also report a Hebrew-specific type of letter-transposition dyslexia. In light of these findings it would be interesting to further investigate form-meaning mappings in the mental lexicon of Hebrew in relation to foreign/borrowed words as against derived words, as representing two distinct types of lexical architecture.

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Appendix 1: Written Test Battery, Version A



הקרון הלאומית למדע

שאלון מחקרי

שלום רב,

במסגרת לימודי באוניברסיטת תל אביב, אני עורכת מחקר העוסק בהתפתחות השפה העברית בקרב ילדים, בני נוער ואנשים מבוגרים. המחקר בודק את הידע של תלמידים בכיתות שונות ואנשים מבוגרים על השפה שבה הם משתמשים. מחקר זה אינו בא כלל לבחון אותך או את הישגיך האקדמיים, אלא לבדוק כיצד מתפתח ידע לשוני באופן טבעי.

אין בשאלות אלה תשובות נכונות או לא נכונות. נסה/נסי לתת את התשובה המתאימה ביותר, לדעתך. בשאלון יש מילים רבות לא מוכרות. אבקש את התייחסותך גם למילים אלה, אף אם אינך מכיר/ה אותן.

המידע שייאסף במסגרת השאלון ישמש לצורכי מחקר בלבד ולא יועבר לאף גורם מחוץ לצוות המחקר.

אני מודה לך מקרב לב על השתתפותך ועל תרומתך לחקר השפה העברית, בתיה סרוסי

פרטי רקע

תאריך: _____

מין: זכר / נקבה

תאריך לידה: _____

האם את/ה ילידת ישראל? _____ אם לא, באיזה גיל הגעת לישראל? _____

מהי שפת האם שלך? _____

מהי ההשכלה (מס' שנות לימוד) שלך? _____

קוד: _____

מס' סידורי: _____

קריית האוניברסיטה, ת.ד. 39040, רמת-אביב, תל-אביב 69978. טל'. 6409685 - 03 פקס' 6405109-03
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גרסה A**קטע מס' 1 - אסוציאציה**

לפניכם רשימת מילים, חלקן מופרות וחלקן לא מופרות. פתבו ליד כל מילה את המילה הראשונה שעולה בדעתכם בעקבותיה. השתדלו למצוא אסוציאציות כלשהן לכל המילים ברשימה, גם למילים לא מוכרות.

_____	הַקְרוּת
_____	דִּיכָה
_____	עֲגָלָה
_____	אָמֶן
_____	קְדִימוֹן
_____	בְּלִיָּה
_____	מְכֻסָּה
_____	מִנַּח
_____	יִצְרִיּוֹת
_____	חֲמֵץ
_____	חֶמֶר
_____	מְדוֹן
_____	תְּמֻזָּגֶת
_____	מַעֲרָכָת
_____	בְּטָאוֹן
_____	מִשְׁטָחִית
_____	תִּיכּוֹן
_____	מִצְאֵי
_____	הַמְּלָכוֹת
_____	תְּבוּנָה

קטע מס' 2 – הגדרה בהקשר

לפניכם חמישה משפטים. בכל משפט יש מילה מודגשת. מהו, לדעתכם, הפירוש המתאים למילה המודגשת? כתבו אותו מתחת לקטע.

1. הוועדה פנתה לאנשי מדע לקבל **תמחית** על ההצעות שהוגשו לה. מהי תמחית?

2. בכל נמל צריכה להיות לפחות **חלצת** אחת למקרה חירום. מהי חלצת?

3. צילי הנגינה ששמעתי ממרחק רב העלו בי **תסמיך** של ערב קר וגשום. מהו תסמיך?

4. בתוך מדבר צחיח קשה אך נעים למצוא **מבוע**. מהו מבוע?

5. ה**לקטנות** של האופנה בת ימינו מאפשרת לכל אדם להתלבש לפי טעמו. מהי לקטנות?

קטע מס' 3 – חיבור משפטים

לפניכם רשימת מילים, חלקן מופרות וחלקן לא מופרות. עבור כל מילה, חֲבְרוּ משפט הכולל מילה זו.

מְקַטְרוֹן _____

פְּרֻטְיוֹת _____

פְּקֻחוֹן _____

רְצֻפָּה _____

הֶקֶשׁ _____

מִפְתָּח _____

הֶסְבֵּר _____

רְצוּי _____

מְשֻׁאֵית _____

בְּעָרוֹת _____

קטע מס' 4 – קשר בין מילים

לפניכם רשימת מילים, חלקן מופְּרָוֹת וחלקן לא מופְּרָוֹת. מתחת לכל מילה מודגשת כתובות ארבע מילים שקשורות אליה בקשרים שונים. **כתבו מספר** מ-0 עד 4 ליד כל אחת מארבע המילים האלה. המספר צריך לציין את חוזק הקשר בין המילה בשורה התחתונה לבין המילה המודגשת בשורה מעל, כשסימון 0 מציין שאין, לדעתך, קשר בין המילים, ואילו סימון 4 מציין קשר חזק מאוד. מותר לכתוב אותו המספר יותר מפעם אחת באותה שורה.

חִזְרָה

הִחְזֵר _____ חִזּוֹר _____ שִׁיבָה _____ כְּפָרָה _____

תְּחִזִּית

חִזְזִית _____ חִזּוּי _____ מְחִזָּה _____ נְבוּי _____

הֶקְשׁוּ

הִקְשִׁיף _____ גִּדְּלָה _____ הִתְקַדְּף _____ מִקְשָׁף _____

יְבִילוּת

הִבְבִּילָה _____ נִידוּת _____ יוֹבֵל _____ אֲוִילוּת _____

נְגוּעַ

זְהוּם _____ נָגַע _____ שְׁגוּעַ _____ הִנְעָה _____

מְחוּשׁ

הִחְשָׂה _____ רָכַשׁ _____ תְּחוּשָׁה _____ כָּאֵב _____

מְכוּנִית

מְכוּן _____ רָכַב _____ מְכוּנָה _____ מְלוּנִית _____

יְצִירָה

בְּרִיאָה _____ יְצוּר _____ יְצִירָה _____ יֵצֵר _____

מְמַחֶה

מְחִיתָ _____ מְחַאֵה _____ מְנַחֵה _____ מְעַרְבֵּל _____

אֲבוּק

אֲבָקָה _____ נְקוּי _____ מְאָבָק _____ חֲבוּקָה _____

קטע מס' 5 - אסוציאציה

כמו בקטע מס' 1, גם כאן מוצגת רשימת מילים, חלקן מופרות וחלקן לא מופרות. כתבו ליד כל מילה את המילה הראשונה שעולה בדעתכם בעקבותיה. השתדלו למצוא אסוציאציות כלשהן לכל המילים ברשימה, גם למילים לא מוכרות.

_____	פֶּעֶמוֹן
_____	מַגֵּבָה
_____	פְּסִיק
_____	מִסְקָנָה
_____	תְּכוּנָה
_____	תְּשֻׁקָּפֶת
_____	מְנוּחָה
_____	צְבוּר
_____	הַקְדָּמָה
_____	מַחְשָׁב
_____	פְּסִיקָת
_____	תְּהַלִּיךְ
_____	צָבִיר
_____	מְקַלְפָּה
_____	מְבִנָּה
_____	מְכַנְסִים
_____	סְמִכוּתָנוּת
_____	הַשְׁקָפָה
_____	נְפִישָׁה
_____	תְּשׁוּבוֹן

קטע מס' 6 – הגדרה בהקשר

כמו בקטע מס' 2, לפניכם חמישה משפטים. בכל משפט יש מילה מודגשת. מהו, לדעתכם, הפירוש המתאים למילה המודגשת? כתבו אותו מתחת לקטע.

1. הַגְמָלוֹן היה נפוץ בבנייה של ימי קדם, ומשמש לבנאים גם כיום. מהו גמלון?

2. החברה החליטה להוציא תְּקוּפּוֹן כדי לעדכן את הלקוחות באופן סדיר. מהו תקופון?

3. חקר הַמְסוּכָה תרם ללימודי היהדות כמה חיבורים חשובים מאוד. מהי מסורה?

4. החוקר בחר את הפריטים בקפדנות, כדי להימנע מִיִּתְירוֹת במאמרו. מהי יתירות?

5. למרות השימוש במחשב, הַסוֹדְרָן עדיין נמצא בשימוש במשרדים רבים. מהו סודרן?

קטע מס' 7 – חיבור משפטים

כמו בקטע מס' 3, גם כאן מוצגת רשימת מילים, חלקן מופְּרוֹת וחלקן לא מופְּרוֹת. תְּבַרוּ משפטים למילים אלו.

_____ מְקוּשׁ

_____ מְסָד

_____ מְצַפּוּנִיּוֹת

_____ הֶבְנָה

_____ אֶמוּנָה

_____ הַפְּבֵת

_____ אֶמְצָה

_____ נְטִיף

_____ יִצִּירְתִּיּוֹת

_____ מְקַטְרוֹן

קטע מס' 8 – קשר בין מילים

כמו בקטע מס' 3, גם כאן מוצגת רשימת מילים, חלקן מופרות וחלקן לא מופרות. מתחת לכל מילה מודגשת כתובות ארבע מילים שקשורות אליה בקשרים שונים. **כתבו מספר** מ-0 עד 4 ליד כל אחת מארבע המילים האלה. המספר צריך לציין את חוזק הקשר בין המילה בשורה התחתונה לבין המילה המודגשת בשורה מעל, כש-0 מציין שאין קשר בין המילים ו-4 מציין קשר חזק מאוד ביניהן. מותר לכתוב את אותו המספר יותר מפעם אחת.

חֲדִיכָה

הַחֲדָרָה _____ חֲגִיכָה _____ חֲדָר _____ פְּרִיכָה _____

חֲנֻכָּה

חֲנִיכִים _____ חֲנוּךְ _____ דְּלָקָה _____ שְׁלָכָה _____

מְסִיכָה

הַעֲבָרָה _____ מוֹסֵר _____ מְכִיכָה _____ מָסָר _____

פְּרָשׁ

הַפְּרָשָׁה _____ קָרָשׁ _____ צוֹאָה _____ פְּרוֹשׁ _____

צָבַע

צְבִיעָה _____ צְבִיעוֹת _____ גָּוָן _____ טָבַע _____

צִלְמִית

פְּסוּלוֹן _____ תְּרַמִּית _____ צָלַם _____ מְצַלְמָה _____

קִלְטָה

שִׁטָּה _____ הַקִּלְטָה _____ קִסְטָה _____ מְקַלֵּט _____

רְשָׁמָה

רְשִׁמָה _____ רֶשֶׁם _____ פְּרִסְמָה _____ שְׂרִטוּט _____

שְׂמִיעָה

מְשַׁמְעוֹת _____ שְׂמוּעָה _____ הַאֲזָנָה _____ דְּמִיעָה _____

תְּקוּף

שְׂקוּף _____ אֲשׁוּר _____ תְּקִיפָה _____ תְּקוּף _____

קטע מס' 9 - אסוציאציה

כמו בקטעים מס' 1 ו-5, גם כאן מוצגת רשימת מילים, חלקן מופרות וחלקן לא מופרות. כתבו ליד כל מילה את המילה הראשונה שעולה בדעתכם בעקבותיה. השתדלו למצוא אסוציאציות כלשהן לכל המילים ברשימה, גם למילים לא מוכרות.

_____	מְצִיָּאָה
_____	מְקָרָה
_____	מְשַׁמְעוֹת
_____	הֶסֶק
_____	מוֹנִית
_____	גְּבַה
_____	גְּדִיל
_____	בְּצוּעַ
_____	מְשַׁחֲתָת
_____	אֶצְבְּעוֹן
_____	שְׁטִיחַ
_____	בְּטָחָה
_____	מְאַקְלָת
_____	פְּעָמָן
_____	מְטָבַע
_____	מְאַזְנֵת
_____	יִלְקוּט
_____	חֲבִילָה
_____	חֲבוּר
_____	כְּשָׂרוֹן

Appendix 2: Written Test Battery, Version B



הקרו הלאומית למדע

שאלון מחקרי

שלום רב,

במסגרת לימודי באוניברסיטת תל אביב, אני עורכת מחקר העוסק בהתפתחות השפה העברית בקרב ילדים, בני נוער ואנשים מבוגרים. המחקר בודק את הידע של תלמידים בכיתות שונות ואנשים מבוגרים על השפה שבה הם משתמשים. מחקר זה אינו בא כלל לבחון אותך או את הישגיך האקדמיים, אלא לבדוק כיצד מתפתח ידע לשוני באופן טבעי.

אין בשאלות אלה תשובות נכונות או לא נכונות. נסה/נסי לתת את התשובה המתאימה ביותר, לדעתך. בשאלון יש מילים רבות לא מוכרות. אבקש את התייחסותך גם למילים אלה, אף אם אינך מכיר/ה אותן.

המידע שייאסף במסגרת השאלון ישמש לצורכי מחקר בלבד ולא יועבר לאף גורם מחוץ לצוות המחקר.

אני מודה לך מקרב לב על השתתפותך ועל תרומתך לחקר השפה העברית, בתיה סרוסי

פרטי רקע

תאריך: _____

מין: זכר / נקבה

תאריך לידה: _____

האם את/ה ילידת/ת ישראל? _____ אם לא, באיזה גיל הגעת לישראל? _____

מהי שפת האם שלך? _____

מהי ההשכלה (מס' שנות לימוד) שלך? _____

קוד: _____

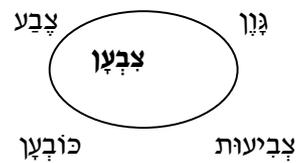
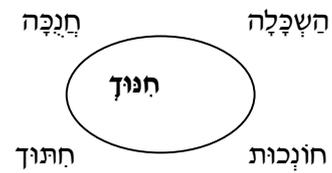
מס' סידורי: _____

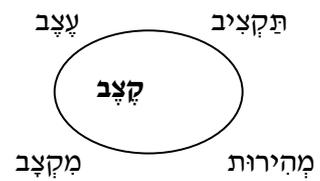
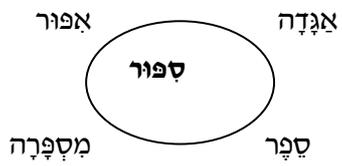
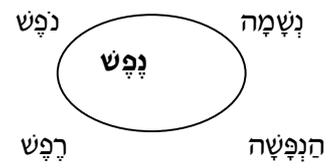
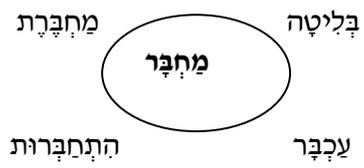
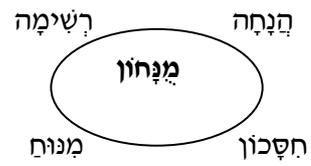
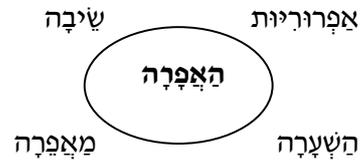
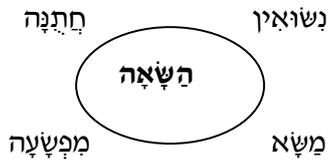
קריית האוניברסיטה, ת.ד. 39040, רמת-אביב, תל-אביב 69978. טל'. 6409685 - 03 פקס' 6405109-03
 TEL-AVIV UNIVERSITY, P.O.B 39040, RAMAT AVIV, TEL- AVIV 69978, ISRAEL TEL.972-3-6409685 FAX 972-3-6405109

גרסה B

קטע מס' 1 – קשר בין מילים

לפניכם קבוצות של מילים, שחלקן מופרות וחלקן לא מופרות. מסביב לכל מילה שבמרכז העיגול (המילה המודגשת) כתובות ארבע מילים שקשורות אליה בקשרים שונים. בחרו את המלה הקשורה ביותר, לדעתכם, למילה המודגשת והקיפו אותה בעיגול.





קטע מס' 2 - אסוציאציות

עבור כל מילה ברשימה הבאה, פתבו בשורה שלידה את כל המילים שלדעתכם קשורות אליה.

_____	תזכית
_____	מבנן
_____	בלוי
_____	מסזק
_____	מצב
_____	השפלה
_____	שיטה
_____	חזקת
_____	חמצת
_____	מזג
_____	מערכת
_____	נפש
_____	בוננות
_____	דיון
_____	סקרנות

קטע מס' 3 – הגדרה בהקשר

לפניכם חמישה משפטים. בכל משפט יש מילה מודגשת. מהו, לדעתכם, הפירוש המתאים למילה המודגשת? כתבו אותו מתחת לקטע.

1. כדאי שתהיה **מְלַקַּחַת** בכל ארגון כלי עבודה בבית ובבתי מלאכה שונים. מהי מלקחת?

2. רמת ה**דְּמִיּוֹת** בין אחים שונה ממשפחה למשפחה. מהי דמיות?

3. ה**דְּרָשׁ** של אימרה עממית לפעמים שונה מהפְּשֵׁט שלה. מהו דרש?

4. התלמידים נעזרו ב**תְּכִסִּית** כדי לאתר את בירות ארצות אירופה. מהי תכסית?

5. אנשים הנוהגים ב**פְּרָצְנוֹת** לעתים מצטערים על כך. מהי פרצנות?

קטע מס' 4 – הגדרות

כתבו הגדרה לכל אחת מן המילים הבאות. השתדלו להסביר מה המשמעות של כל מילה במדויק, בדומה להגדרות הניתנות במילונים.

_____ **דְּמִיּוֹן**

_____ **בְּחִיכָה**

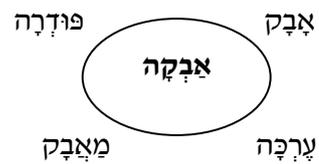
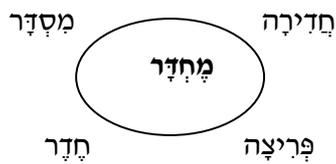
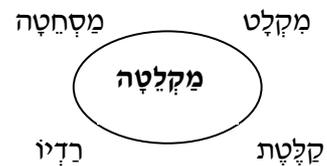
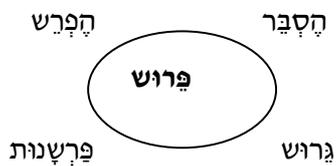
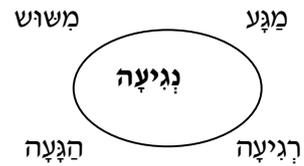
_____ **תְּקָרָה**

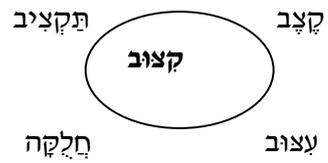
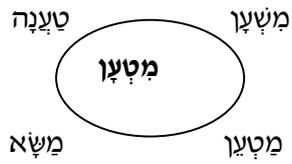
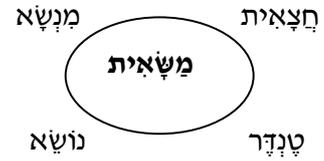
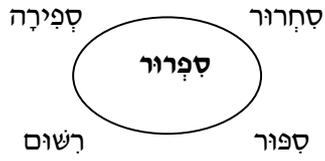
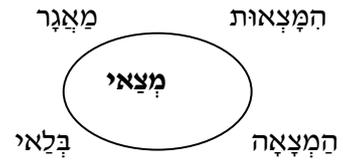
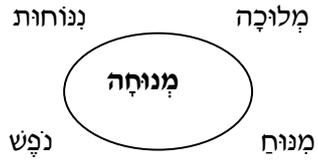
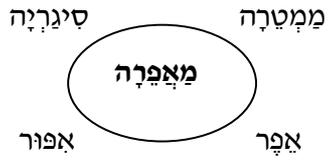
_____ **שְׁלָחַן**

_____ **כְּבוֹד**

קטע מס' 5 – קשר בין מילים

כמו בקטע מס' 1, גם כאן מוצגות קבוצות של מילים, שחלקן מופרות וחלקן לא מופרות. מסביב לכל מילה שבמרכז העיגול (המילה המודגשת) כתובות ארבע מילים שקשורות אליה בקשרים שונים. בחרו את המלה הקשורה ביותר, לדעתכם, למילה המודגשת והקיפו אותה בעיגול.





קטע מס' 6 - הגדרות

כמו בקטע מס' 4, כתבו הגדרה לכל אחת מן המילים הבאות. השתדלו להסביר מה המשמעות של כל מילה במדויק, בדומה להגדרות הניתנות במילונים.

מַעֲלִית

מְחַשְׁבָּה

מִסְפָּרִים

מִזְגָן

פְּנָאי

קטע מס' 7 – הגדרה בהקשר

כמו בקטע מס' 3, לפניכם חמישה משפטים. בכל משפט יש מילה מודגשת. מהו, לדעתכם, הפירוש המתאים למילה המודגשת? כתבו אותו מתחת לקטע.

1. הרקדנית לא יכלה להשתתף במופע כי נקרעה לה ה**מַצְרָפֶת**. מהי מצרפת?

2. אין בהכרח ה**לִימָה** בין מה שלומדים בכיתה לבין מה שנבחנים עליו בסוף השנה. מהי הלימה?

3. החקלאי השקיע מאמצים רבים כל מנת להיפטר מן ה**יַבְלִית** בגינה שלו. מהי יבלית?

4. עד לזמן האחרון לא היה קיים אָגְרוֹן לשפה העברית. מהו אגרון?

5. בעל המפעל רכש מכונות חדשות בעלות נְצִילוֹת גבוהה יחסית. מהי נצילות?

קטע מס' 8 - אסוציאציות

כמו בקטע מס' 2, עבור כל מילה ברשימה הבאה, כתבו בשורה שלידה את כל המילים שלדעתכם קשורות אליה.

_____	מְשַׁקְפִים
_____	מְטַבְּעַת
_____	עֶצֶב
_____	חֲצֵאִית
_____	כְּסִיָּה
_____	שָׁקֶל
_____	בְּצִיעָה
_____	מְגִדֵּל
_____	חֲשֻׁבוּנִית
_____	חֶמֶר
_____	מְלַקְטָת
_____	מְשִׁיבוֹן
_____	אֲמִינּוֹת
_____	חֶבְלוֹל
_____	מְאֻזְנִים

Appendix 3: List of Overall Stimuli, Written Test Battery

Task 1=Degree of Relatedness -- Multiple; Task 2=Degree of Relatedness -- Ranking;

Task 3=Interpretation in Context; Task 4=Free Associations -- Single; Task 5=Free

Associations -- Multiple; Task 6=Sentence Construction; Task 7=Definitions

Task	Familiarity/Frequency Database				
	Full		Defective		
	High-F	Low-F	High-F	Low-F	
1		אבקה	מחזר	הובלה	מיצור
		חניך	מחזרת	נגיעה	מקור
		פרוש	מסרון	תחושה	מכונה
		מצלמה	צבען	התמחות	החזיה
		התקף	שמיעות	משאית	השאה
		התרשמות	מקלטה	מנוחה	מנחון
		מאפיה	האפיה	מציאה	מצאי
		חלוץ	מחלץ	נפש	נפישא
		ספור	ספורר		
		קצב	קצוב		
		מטען	מטענית		
		חוברת	מחבר		

Task	Familiarity/Frequency Database				
	Full		Defective		
	High-F	Low-F	High-F	Low-F	
2		חדירה	אבוק	נצירה	יבילות
		חזרה	חנכת	הקף	נגוע
		מסירה	פרש	מכוננית	מחוש
		צבע	צלמית	תחזית	ממחה
		קלטת	רשמת		
		שמיעה	תקוף		

5

Familiarity/Frequency Database

Full		Defective	
High-F	Low-F	High-F	Low-F
אַמִּינוֹת	בְּצִיעָה	נֶפֶשׁ	בוֹנִנוֹת
מִגְדָּל	חֶבְלוֹל	דִּיוֹן	תּוֹכִית
חוֹבֶרֶת	חִמְצָת	מְשִׁיבוֹן	מִבְּנֵן
חֹמֶר	מִטְבַּעַת	בְּלוּי	בְּסָיָה
מֵאֲזֻנִּים	מִלְקָטָת		
מְזֻג	מְעֻרְכָת		

Concreteness database

Concrete				Abstract			
Full		Defective		Full		Defective	
High-F	Low-F	High-F	Low-F	High-F	Low-F	High-F	Low-F
מִשְׁקָפִים		חֲצֵאִית		עֶצֶב		מִצָּב	
שָׁקֶל		מִסּוֹק		הַשְּׂכָלָה		שִׁטָּה	
חֲשׁוֹבוֹנִית				סִקְרֵנוֹת			

6

Concreteness database

Concrete				Abstract			
Full		Defective		Full		Defective	
High-F	Low-F	High-F	Low-F	High-F	Low-F	High-F	Low-F
רֶכֶּבֶת	פְּעֻמוֹנִית	מִסָּךְ	נְטִיף	פְּרֻטִיוֹת	מִצְפוֹנִיוֹת	יְצִירָתִיוֹת	הַקֶּשׁ
רִצְפָה	מִקְטָרֶן	מִשְׁאִית	מִקּוּשׁ	הַסָּבֵר	פְּקֻחוֹן	הַבְּנָה	רְצוּי
מִפְתַּח	אַמְצָה			אַמוֹנָה	בְּעֻרוֹת		

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Concreteness database

Concrete				Abstract			
Full		Defective		Full		Defective	
High-F	Low-F	High-F	Low-F	High-F	Low-F	High-F	Low-F
מִזְגָּן		תִּקְרָה		כְּבוֹד		פְּנָאִי	
שְׁלָחוֹ		מְעֻלִית		בְּחִיכָה		דְּמִיוֹן	
מִסְפָּרִים				מְחֻשָּׁבָה			

Appendix 4: Stimuli for Priming Experiments

M=Morphological; MS=Morpho-semantic; S=Semantic; U=Unrelated;

Words					Non-Words				
Target	Prime M	Prime MS	Prime S	Prime U	Target	Prime	Prime	Prime	Prime
Full Roots, Familiar/Frequent									
חינוך	חנוכה	חונכות	השכלה	מזלג	חיסוט	ניגוד	בלוט	חידה	פונדק
מצלמה	צלם	צילום	סרט	אפרסק	מזלרה	מדרגה	מסתירה	מזלג	כישלון
התרשמות	מרשם	רושם	דיעה	חשבונית	התלדמות	התרגשות	אלימות	התעלמה	ברזיה
חילוץ	חולצה	חליצה	הצלה	כרית	חינום	דיבור	לנום	חילזון	משקל
סיפור	מספרה	ספר	אגדה	ביצה	סיטוג	פיסול	לדוג	סירה	מדף
קצב	תקציב	מקצב	מהירות	בית	כזד	ברך	עודד	קיסם	ציפור
פירוש	הפרש	פרשנות	הסבר	גולן	פיעון	סירוב	טעון	פיאה	דרגש
אבקה	מאבק	אבק	פודרה	מזלף	אלשה	עמדה	פגישה	אלוהי	תנור
התקף	תוקף	התקפה	התפרצות	ספסל	הפצם	התאם	פיטם	הפקרות	רטוב
מאפרה	איפור	אפר	סיגריה	תעשין	מעקטה	מאפרה	שעטה	מערוך	הארכה
מטען	טענה	מטען	משא	ברכה	מרוץ	מדגם	נוף	מרפסת	בלון
חוברת	חברות	מחברת	פנקס	אומגה	חולצת	מולדת	פוחזת	חולני	אמפיבי
חזרה	חיזור	החזר	שיבה	מתנה	חגמה	עדשה	אדמה	חרוב	תיאבון
צבע	צביעות	צביעה	גוון	אמא	צען	פחם	כובען	צפע	מפית
חדירה	חדר	החדרה	פריצה	לביבה	חקישה	אמירה	התפלשה	חברות	משאית
מסירה	מוסר	מסר	העברה	חללית	מדיקה	תפירה	צדקה	מדינה	ארונית
קלטת	מקלט	הקלטה	קסטת	מפתח	קרכת	אדמות	הולכת	קרון	בשלנו
שמיעה	משמעות	שמועה	האזנה	כרטיס	שדינה	שמיכה	עדינה	שדיפות	חתול
Full Roots, Unfamiliar/Infrequent									
מסרון	מוסר	מסר	הודעה	שבלול	מפדון	מזנון	אדון	מפתן	גיבור
צבען	צביעות	צבע	גוון	משפך	צלון	מבחן	רגזן	צילמה	מבחר
שמיעות	משמעות	שמיעה	קוליות	פונפון	שדיגות	סבילות	מנהיגות	שדיפות	קיום
האפרה	מאפרה	אפרוריות	שיבה	חמניה	החפקה	השבתה	מציקה	החמרה	אינטליגנט
מחבר	מחברת	התחברות	בליטה	סכין	מצחף	דרדס	נדחף	מצנח	פינה
מטענית	טענה	הטענה	משאית	סביבון	מסבגית	מפרשית	דילגית	מסבאה	חנוכה
מקלטה	מקלט	קלטת	רדיו	הפתעה	מדשחה	מקהלה	פתיחה	מדביר	קרפיון
מחדר	חדר	חדירה	פריצה	גלגל	מחנץ	מרכז	שבץ	מחילה	כיסא
מחזורת	חיזור	מחזור	פיסקה	נעליים	מעדולת	מחפורת	סולת	מערוך	אבוקדו
מחלץ	חולצה	חילוץ	פוחחן	שקית	מסטך	מגבר	ריתך	מסלול	עכבר

Words					Non-Words				
Target	Prime M	Prime MS	Prime S	Prime U	Target	Prime	Prime	Prime	Prime
ספרור	סיפור	ספירה	רישום	בולען	סילגוג	שלטוט	זיגוג	סילאן	רקדן
קיצוב	קצב	תקציב	חלוקה	פטיש	קינוף	דיבור	מינוף	קיר	חריץ
צלמית	מצלמה	צלם	פסלון	חשבון	צנטית	אבנית	תחתית	צנרן	שכפול
חנכת	חינוך	חניכים	דלקת	בלטה	חבמת	שלכת	רושמת	חבר	גיטרה
פרש	פירוש	הפרשה	צואה	סבא	פכץ	מתג	פרץ	פירוש	קרקר
רשומת	רושם	רשימה	שרטוט	בלדה	רזובת	נחושת	נושבת	רחוב	פילגש
תיקוף	תקיפה	תוקף	אישור	חמור	תיגוס	שימור	נגוס	תיק	שרביט
איבוק	מאבק	אבק	ניקוי	ריצה	איתוז	קילוף	גנוז	איתורית	חולצה

Defective Roots, Familiar/Frequent

הובלה	יובל	תובלה	הולכה	זיכרון	הוגצה	הוצאה	פירצה	הודו	מרפסת
תחושה	מוחשיות	חוש	הרגשה	מדרון	תפומה	גנובה	בלימה	תפוקה	מדבר
נפש	נופש	הנפשה	נשמה	אבא	נלץ	מרד	מכץ	זם	זעם
מציאה	מציאות	ממצא	גילוי	עבודה	מזיטה	גלימה	מיטה	מזיגה	אורון
נגיעה	הגעה	מגע	מישוש	הפסקה	נריפה	מריבה	שאיפה	נזילה	מפוחית
התמחות	מחאה	מומחיות	מיומנות	מכשירן	התכזות	התפרעות	חזות	התמרד	מדשאה
מנוחה	מינוח	נינוחות	נופש	ספריה	מגושה	מתונה	אישה	מנופח	כלנית
משאית	נושא	מנשא	טנדר	קרפדה	מכחית	במאית	הנחית	מתנה	עיפרון
תחזית	מחזה	חיזוי	ניבוי	הפקדה	תפצית	שדרית	מצית	תלמיד	מסדרון
מכונית	מכון	מכונה	רכב	קפושון	מזולית	קרונית	אדריכלית	מגודל	עיריה
יצירה	יצר	ייצור	בריאה	מלגזה	יחגה	מתיחה	עוגה	ילדים	ארונית
היקף	מקף	הקפה	גודל	אגס	הימב	טרם	עשב	האח	שידה
תקרית	תקרה	מקרה	ארוע	עיתון	תפטית	תלכיד	אלונטית	תפציר	אסיר
גובה	גיבוי	הגבהה	מפלס	רצף	גושל	אומר	נשל	גורן	מלך
ניצול	התנצלות	נצלנות	שימוש	מפגש	נילור	ריצוף	ניעור	נקנס	מחסן
יציבות	מצבה	יציבה	עמידות	מסעדה	יטיזות	חביבות	עליזות	ינשוף	הליכה
רצון	הרצאה	ריצוי	שאיפה	ממתק	חבון	אסון	דביבון	חתן	מסמר
בילוי	בליה	בלגנות	בידור	סרגל	ביגוי	גירוי	עיסוי	בקתה	משתה

Defective Roots, Unfamiliar/Infrequent

מיצור	יצר	יצירה	סימפונייה	גרעין	מיזוף	מכשול	חלוף	מישהו	עבר
מכונה	מכון	כיוון	דרך	הלבשה	מרלה	מכבסה	עגלה	מרמור	חצאית
השאה	משא	נישואין	חתונה	רעלה	הפיה	הכרה	נטייה	הלום	אוטומט
מונחון	הנחה	מינוח	רשימה	כבאית	מוטשון	ניסיון	קילשון	מוטציה	גחלילית
מקוף	מקף	הקפה	שכונה	נסיך	מגוך	מסור	נבוך	מגן	ספק
התזיה	חווה	חיזיון	ראיה	מעצמה	העסנה	החטאה	אמנה	העלם	חשוביות

Target	Words				Target	Non-Words			
	Prime M	Prime MS	Prime S	Prime U		Prime	Prime	Prime	Prime
מצב	יציבות	מצב	סטטוס	שולחן	מיסט	מפרץ	נסת	מיקרוב	כלה
רציה	הרצאה	רצון	שאיפה	פשטידה	רהיכה	רכיבה	חנינה	רשות	הצלבה
בליה	בילוי	בלאי	התפוררות	מוצץ	בצנה	כפפה	תאנה	בגדים	קלפים
מצאי	המצאה	המצאות	מאגר	סרטן	מדאי	גנאי	שי	מדינה	חלון
נפשה	נפש	נופש	מרגוע	הרדמה	נהיבה	יציאה	שיבה	נהמה	מלומד
ניגוע	הגעה	נגע	זיהום	רכבת	נילוח	קיטוע	תפוח	נלכד	עגבת
מיחוש	הקשה	תחושה	כאב	קצין	מיסון	מירוץ	חיסון	מסיבה	כפית
ממחה	מחאה	מחית	מערבל	שוטר	מבשה	מרצה	קשה	מבחין	ענף
יבילות	יובל	הובלה	ניידות	רקדנית	יפישות	רצינות	אנושות	יפנה	קבלה
קרוי	מקרה	תקרה	גג	שעון	קתוי	איחוי	שתוי	קירצוף	סינר
מגבה	גיבוי	הגבהה	גיק	שעלת	מספע	מקלע	מפעפע	מגעיל	חרוסת
נצולת	התנצלות	ניצול	אשפה	ברקת	נטוקת	פסולת	ירוקת	נפילה	תשלובת

יחסי צורה-משמעות במילון המנטלי של דוברי עברית

תקציר מורחב של עבודת הדוקטור -- בתיה סרוסי

* הערה – כל מראי המקום, גם אלו שנכתבו במקור בעברית, נכתבו באנגלית בסקירה זאת, כדי שיתאימו לרשימה הביבליוגרפית של המחקר המקורי, שנכתבה באנגלית.

במוקד מחקר זה נמצאים שמות גזורים, דהיינו שמות מורכבים משורש ומשקל בגזירה משורגת. השמות הללו, המאוגדים במעין "משפחות מילים" במילון המנטלי של דוברי עברית, שימשו כמסד הנתונים למחקר, בו נבדק כיצד משפיעים גורמים כמו שלמות השורש, דרגת המוכרות/שכיחות ודרגת החזותיות/מוחשיות על ייצוג השמות הללו בהיבט התפתחותי. לשם בדיקת השערות המחקר, תוכנן מערך מחקר תלת-שלבי, שכל שלב בו שימש כפלטפורמה לתכנון השלב הבא. בשלב הראשון נבנה מסד הנתונים למחקר, בשלב השני נקבעו מידת המוכרות/שכיחות והמוחשיות לפריטים מתוך מסד הנתונים ובשלב השלישי נערכו ניסויים, הן כתובים והן ניסויי הטרמה (priming) ממוחשבים, על פריטים נבחרים מתוך מסד הנתונים הכולל. תקציר זה מכיל ארבעה פרקים, המקבילים לכל אחד מארבעת פרקי העבודה המלאה, כדלהלן: הפרק הראשון סוקר את הרקע התיאורטי למחקר (פרק א'), הפרק השני סוקר את מערך המחקר בשלושה שלבים (פרק ב'), הפרק השלישי מתאר בקצרה את התוצאות העיקריות בניסויים (פרק ג') והפרק האחרון (פרק ד') דן בתוצאות שהושגו לאור המידע התיאורטי והמחקרי הקיים.

פרק א' – רקע תיאורטי

הבסיס התיאורטי למחקר עוסק, ראשית, בהגדרה מהו המילון המנטלי ומהם עקרונות הארגון שלו. דימוי מקובל משווה את המילון המנטלי למילון קונבנציונאלי כתוב, אולם שני מאגרים לשוניים אלו אינם זהים כלל וכלל (Aitchison, 2003; Anshen & Aronoff, 1999). אם נשווה, לדוגמה, את המהירות בה אנו שולפים ערך מילוני במילון המנטלי לעומת המהירות בה אנו מוצאים ערך מילוני במילון קונבנציונאלי ולו הממוחשב המתקדם ביותר, ניווכח ביתרוננו העצום של המילון המנטלי, המאפשר לנו לשלוף ביעילות ובמהירות פריטים מילוניים בקצב מסחרר של עשרות מילים בדקה. יתרון נוסף של המילון המנטלי על פני מילונים קונבנציונאליים היא ברב-המימדיות שלו וביכולת ההשתנות המהירה שלו. אנו ממיינים פריטים במילון המנטלי בדרכי מיון מגוונות, לפי קטגוריות משתנות, בהתאם לצרכים התקשורתיים שלנו (לדוגמה, מיון חיות על פי מחלקות בעולם החי, על פי תכונות פיזיות ואחרות, על פי אות פותחת, על פי שילוב בין שני קריטריונים שונים ועוד) (Nguyen, 2007; Nguyen & Murphy, 2003). בעוד שהמילון הקונבנציונאלי הוא חד-מימדי בעיקרו וממיון לפי העיקרון האלפביתי בלבד. האינטואיטיביות והרגישות של המילון המנטלי לגורמים פסיכולינגוויסטיים שונים מבדילה אותו גם כן ממילונים קונבנציונאליים. הרגישות לשכיחותם של הפריטים, לדוגמה, גורמת לכך שפריטים שכיחים יישלפו במהירות מירבית, בעוד שמילונים קונבנציונאליים אינם מראים העדפה לפריטים שכיחים. לסיכום, למילון המנטלי יש דמיון מה למילון קונבנציונאלי, יחד עם זאת שני מאגרי מידע אלה שונים באופן מהותי.

השאלה הבאה המוצגת כאן היא מהו גודלן של היחידות הבסיסיות במילון המנטלי? האם הן מילים, כמקובל להניח (Aitchison, 2003)? ואם כן, איזה סוג של מילים? האם הן יכולות להיות גדולות ממילה (לדוגמה, ביטויים, צירופים כבולים, ניבים)? בעוד שהערכים המילוניים המקובלים במילון קונבנציונאלי הן מילים בודדות, בד"כ לא מוטות, במילון המנטלי יש מקום גם ליחידות גדולות ממילה (DiSciullo & Williams, 1987; Jackendoff, 2002). ואם במילון המנטלי יש זכות קיום גם ליחידות גדולות ממילה, האם יש זכות קיום גם ליחידות קטנות ממילה, קרי מורפמות/צורנים כבולים? סוגיה זו קשורה ישירות לאחת משאלות המחקר העיקריות והיא מהו מעמדה של המורפולוגיה, העוסקת במבנה המילה ובצורנים (מורפמות) שמרכיבים אותה, במילון המנטלי. מחד, מעמדה של המורפולוגיה נחשב משני בעיני בלשנים רבים, הרואים את המורפולוגיה ככפופה לחוקים פונולוגיים או תחביריים (McCarthy, 1982; Selkirk, 1982), ומאידך השאלה אם ומתי תפרוק המילה לצורניה גם היא נתונה לוויכוח בין חוקרים. חלקם טוענים לפירוק עקבי ומלא של כל מילה לכל צורניה (לדוגמה, פירוק המילה מגדל לשורש גד"ל ולמשקל מְקַטֵּל), חלקם טוענים שאין כלל פירוק של מילה לצורניה, וחלקם טוענים שפירוק המילה לצורניה אינו אחיד ומושפע משיקולים שונים כמו שכיחות המילה. כלומר, מילה שכיחה כמו מגדל לא תפרוק בעוד שמילה נדירה כמו גדיל תפרוק (Bybee, 1985; Hay & Baayen, 2001; Prunet, 2006). אחת מהמטרות העיקריות של מחקר זה היא אכן לבדוק את השפעת השכיחות על פירוק המילה לצורניה, כפי שיתואר בהמשך.

הנושא הבא שנסקר בהקדמה הוא ייצוג הסמנטי במילון המנטלי, הקשור לשאלות כמו: האם קשרי משמעות נובעים מקשרים מקובלים בין מילים בתוך שדות סמנטיים (לדוגמה, יחסי ניגוד, מילים נרדפות, מילים מאותה קטגוריה סמנטית)? האם קשרי משמעות מעוגנים בידע עולם או שמא ניתן לשלב בין שניהם (Fillmore, 1982; Lyons, 1977; Nerlich & Clarke, 2000)? ובמילים אחרות, מה הגבול בין סמנטיקה (word knowledge) לבין פרגמטיקה (world knowledge) במילון המנטלי. נושאים נוספים שנסקרו בהקשר זה הם סוגים שונים של קשרים סמנטיים ו/או אסוציאטיביים -- מה הגבול בין קשרים שנחשבים סמנטיים מובהקים ומביעים בד"כ תכונות משותפות (למשל, שמלה וחולצה) לעומת קשרים הנחשבים אסוציאטיביים מובהקים ונבנים על סמך היקרות משותפת בעולם (למשל, שמלה ואישה), עד כמה הסמנטיקה היא תלויה אופנות (modality), כלומר עד כמה הייצוג הסמנטי תלוי בערוץ החושי. כן נסקרו מודלים שונים המתארים קשרים סמנטיים-פרגמטיים ונסקרו מחקרי דימות (imaging) השופכים אור על ייצוג סמנטי-פרגמטי במוח. לאחר הסקירה המורפולוגית והסמנטית נסקר הממשק בין צורה למשמעות במילון המנטלי ונשאלה השאלה עד כמה משפיעה דרגת השקיפות או הקשר הסמנטי על הקשר בין מילים. יש הטוענים שכל המילים מהשורש גד"ל, קרי מגדל, גזל, גידול תגיל קשורות ביניהן במילון המנטלי עקב קשרי השורש (Taft & Forster, 1976), ללא תלות במשמעות, ואילו אחרים, המייחסים לשקיפות הסמנטית או לקשרי משמעות תפקיד מכריע (Gonnerman, Seidenberg & Andersen, 2007), טוענים שהמילה גדיל אינה קשורה למילים האחרות מאותה משפחה משום שהיא אינה מתארת המשמעות הבסיסית של השורש גד"ל.

שכיחות (frequency) ומוכרות (familiarity) הם שני גורמים שנמצאים במתאם גבוה, ואמורים, לפי השערת המחקר להשפיע על תיהלוך מילים במילון המנטלי. בהקדמה נדונו שני הגורמים, שכיחות ומוכרות ונערכה השוואה ביניהם (Gernsbacher, 1984). בעוד ששכיחות ניתנת למדוד הן באופן אובייקטיבי, דרך היקרויות מילים במאגרי מידע שונים, ובאופן סובייקטיבי, ע"י שאלונים שניתנים לדוברים (Balota, Piloti & Cortese, 2001), מוכרות ניתנת למדידה רק באופן סובייקטיבי ויש חוקרים הטוענים שהיא משקפת יותר רגישות פסיכולינגוויסטית מאשר מדידות שכיחות אובייקטיביות. לאחר מכן תוארו הגורמים של המוחשיות (concreteness) ודרגת החזותיות (imageability), שני גורמים נוספים שנמצאים במתאם גבוה ומשפיעים על תיהלוך מילים במילון המנטלי. מילים חזותיות/מוחשיות מתוארות בספרות המחקרית כבעלות יתרון על פני מילים לא חזותיות/מופשטות, וליתרון זה מוצעים הסברים שונים בספרות (Paivio, 2006). היות שלא קיימים מאגרי מידע ממוחשבים בעברית המתאימים לצרכי המחקר הנוכחי, תוכננו שאלונים המיועדים לקבוע נורמות לגורמים אלה למאגר השמות הגזורים ששימש מחקר זה, כפי שיפורט בהמשך.

הסעיף הבא בהקדמה סיפק רקע על השפה העברית בקווים כלליים, על הנסיבות ההיסטוריות שבה התהוותה העברית החדשה ועל האורתוגרפיה שלה, בעיקר על מערכת הניקוד. ידוע כי בעברית הלא מנוקדת ההומוגרפיה היא רבה במיוחד (Bar-On, 2010), משום כך היה שימוש בניקוד קונבנציונלי במחקר זה, היות שהמילים שהוצגו לנבדקים היו בעיקר מילים בודדות ללא הקשר תומך. לאחר מכן נסקרה המורפולוגיה הגזרנית בעברית. תחילה נסקרו שתי דרכי הגזירה העיקריות בעברית, המשורגת, דהיינו שילוב של שורש ומשקל והקווית, דהיינו שילוב של בסיס ומוספית (Berman, 1993, 2000, 2003; Ravid, 2003, 2006a; Schwarzwald, 2001, 2002). המילה *מחשבון*, לדוגמה, מייצגת נאמנה שני סוגי גזירה אלה, משום שהיא גזורה בגזירה קווית מהמילה *מחשב* והמוספית *ון*, ואילו המילה *מחשב* עצמה, שהיא הבסיס למילה *מחשבון*, גזורה בגזירה משורגת. לאחר מכן נסקרו השורשים ה"עלולים" (Schwarzwald, 2002), כלומר, השורשים יוצאי הדופן מהגזרות השונות, שגורמים לעמימות ולקושי בזיהוי שלושת מרכיבי השורש, אפילו ע"י דוברי עברית ילידיים משכילים שאינם מומחי לשון. השמות הגזורים, שנמצאים במוקד עבודה זו, נסקרו בהמשך. קבוצה זו של שמות נמצאה מתאימה לצורכי המחקר הנוכחי משום שמצד אחד היא הומוגנית מבחינת קטגוריה תחבירית ומצד שני היא מגוונת מאוד מבחינה סמנטית ומורפולוגית. הגיוון הסמנטי בא לידי ביטוי בשמות שונים של מכשירים, מקומות, שמות פעולה, שנחשבים מופשטים יותר ופועליים יותר, שמות מופשטים אחרים ועוד שמות אחרים במשקלים שונים שאין להם תוכן סמנטי מובהק (Ravid & Avidor, 1998; Seroussi, 2002). הגיוון המורפולוגי בא לידי ביטוי בנוכחותם של שמות הגזורים משורשים שלמים, הנחשבים שקופים יותר, וכן שמות הגזורים משורשים עלולים, הנחשבים עמומים יותר מבחינה מבנית (לדוגמה, *מבנה*, *בניין*, *תבנית*, *בנייה*, *הבנייה* וכן *מבנה* – המקבילה העברית שנקבעה ע"י האקדמיה ללשון עברית למונח הלועזי building cluster – כולם מהשורש בני"י).

רכישת השפה בגיל ביה"ס ואילך נסקרה בסוף הפרק הראשון של עבודה זו. תקופה זו מתאפיינת ביצירת קשרים הדוקים בין התפתחות קוגניטיבית, חברתית, רגשית ובין התפתחות שפתית. השפה שנרכשת מגיל 6 ואילך נשענת על קשרים הדוקים עם רכישת הקריאה והכתיבה, חשיפה לידע בית-ספרי והתפתחות מטא-לשונית מואצת, המאפשרת בקרה יעילה יותר על המסר הלשוני ושימוש באמצעים לשוניים מפורשים (Berman, 2007; Karmiloff-Smith, 1992; Nippold, 1998). כישורי השיח המורחב משתכללים בתקופה זו ובנוסף מתרחשת עלייה איכותית וכמותית בכל תחומי השפה. מבחינה לקסיקלית, נרכשות עשרות אלפי מילים חדשות ונוספות משמעויות חדשות, בעקר מופשטות ולא-ליטרליות למילים הקיימות בלקסיקון (Berman, 2004; Ravid, 2004). המורפולוגיה הגזרנית, שנמצאת במוקד מחקר זה, גם היא משתכללת ומתפתחת במהלך שנים אלה ומאפשרת לדוברים להתמודד ביתר יעילות עם מילים לא מוכרות על ידי פירוקן לצורנים המרכיבים אותן (Anglin, 1993). בשפה העברית נערכו מספר מחקרים על ההתפתחות המילונית-מורפולוגית המאוחרת (Avivi Ben-Zvi, 2010; Ravid & Avidor, 1998; Seroussi, 2002) ובכולם נמצאו שני קווי התפתחות – האחד מצביע על שליטה מרשימה באמצעי תצורת מילים בעברית, בעיקר עם הפריטים שנגזרים באופן סדיר, כבר מגיל 3-4 (Clark & Berman, 1984), ואילו השני מצביע על עלייה מתונה יותר בהיכרות עם הלקסיקון המתקדם, על שלל אי הסדירויות ויוצאי הדופן שבו, שמסתיימת רק בגיל מבוגר אם בכלל.

פרק ב' – מערך המחקר

כאמור, מחקר זה נערך בשלושה שלבים, כשבשלב הראשון הוכן מאגר המילים הראשוני למחקר. נקודת המוצא למחקר הייתה מוסף השורשים במילון "אבן-שושן" (1993), שנסרק בקפדנות בחיפוש אחר משפחות מילים בעלות שורש משותף. הקריטריונים הראשוניים לסינון הראשוני היו: א. החיפוש היה אחר משפחות מילים פרודוקטיביות, משורש פעלי ברור, שהכילו לפחות ארבעה שמות גזורים. ב. מתוך רצון למצוא גם מילים הקשורות ביניהן בקשרי שורש בלבד, בנוסף למילים הקשורות בקשרי שורש ומשמעות, נבחרו משפחות מילים שהראו שינויי משמעות ומשמעויות בלתי צפויות למיניהן. משפחות כמו *אוסף, איסוף, אסיף, אסיפה, ואסופה* מהשורש *אס"ף* מראש לא נכללו ברשימה הראשונית, משום שנראו למחברת מחקר זה קרובות מדי במשמעותן. לעומת זאת, משפחות כמו *מחשב, חישוב, חשבון, מחשבה, חישוב, חשבונית* מהשורש *חש"ב* נכללו, במאגר הראשוני, משום שנראה היה למחברת שיש בהן פוטנציאל לריחוק משמעיים. לאחר גיבוש מאגר ראשוני זה, הושו תוצאות החיפוש עם שני מילונים אחרים, ספיר (1997) ורב-מילים (1997) ומילים שהיו רשומות רק במילון אבן-שושן, שמחברו נטה לרשום כערך מילוני גם מילים שאין להן כל ממשות פסיכולינגוויסטית ולמעשה אינן קיימות בלקסיקון העברית העכשווית, הוסרו מהרשימה. בשלב זה, לאחר הסינון הראשוני של מחברת מחקר זה ושל המילונים, נותר מאגר המכיל כ-4000 שמות עצם, המאוגדים במשפחות קטנות בנות 4-8 מילים מאותו השורש, חלקם שכיחים וחלקם פחות שכיחים. במקביל ערכה מחברת המחקר חיפוש נוסף אחר מילים לא שכיחות, המהוות נדבך חשוב במחקר זה, וליקטה מאתר האינטרנט של האקדמיה ללשון העברית תחדישים שנטבעו ע"י האקדמיה ללשון והתאימו למאגר השורשים שבידיה. בשלב זה, לאחר ביסוס הרשימה הראשונית, שהכילה בידעין

כמות לא מבוטלת של מילים לא שכיחות, נערך שיפוט משמעותיות של המילים ע"י שלוש שופטות כדלהלן: מחברת המחקר ועוד שתי דוברות ילידיות, בעלות השכלה בלשנית, עברו על רשימת המילים אחת לאחת ואישרו או פסלו קרבה סמנטית בין המילים מאותו שורש. במידה שנראה היה לאחת השופטות שיש איזושהי קרבה סמנטית בין מילים מאותו השורש, הן הוסרו מרשימת המילים. כך הוסרו, למשל, המילים *מפגש, פגישה, פגוש* והיפגשות מהשורש פג"ש, שנראו לאחת השופטות קרובות סמנטית. רק משפחות מילים שלגביהן הייתה הסכמה פה אחד בין שלוש השופטות, שלפחות אחת מהן אינה קשורה סמנטית לאחרות, הושארו ברשימה. כך, למשל, הוסכם שהמילים מהשורש אב"ק ייכללו ברשימה משום שהמילים *מאבק, היאבקות* נשפטו כרחוקות סמנטית מהמילים *אבק, איבוק, אבקן ואבקה*. בסיום שלב זה, לאחר הניפוי הנוסף שנערך ע"י השופטות, גובש מאגר הנתונים לשלב הבא במחקר, שהכיל 2400 שמות גזורים, כשני שלישים מהם משורשים שלמים וכשליש מהם משורשים עלולים.

בשלב הבא תוכננו שאלונים לקביעת מידת המוכרות (familiarity) והחזותיות

(imageability) למילים במאגר נתונים זה. לשם כך חולק מאגר הנתונים באופן אקראי לתשעה שאלונים, שכל אחד מהם הכיל כ-260 מילים. השאלון הראשון שהופץ היה שאלון מוכרות, ובו נתבקשו 30 דוברי עברית בעלי השכלה תיכונית ומעלה לדרג את המילים ברשימה בסולם מ-1 עד 5, כש-1 הצביע על מילה לחלוטין לא מוכרת ואילו 5 הצביע על מילה מאוד מוכרת. 270 אנשים (9X30) השתתפו בקביעת דירוגי המוכרות. להפתעת כל הנוגעים בדבר, דירוגי המוכרות היו גבוהים יחסית וכ-80% מהם נעו בין 4-5 בסולם, אף על פי שהרשימות הכילו אחוז לא מבוטל של מילים לא שכיחות, הן ממקורות עתיקים והן מתוך חידושים רשמיים שלא נתקבלו בשימוש הרווח של העברית בת-זמננו. המסקנה המתבקשת הייתה שדירוגי המוכרות אינם רגישים דיים לידע לקסיקלי על משמעות המילה ומצביעים בעיקר על היכרות עם דרכי תצורת המילים המקובלות בשפה העברית, שהרי כל המילים ברשימה היו גזורות משורשים קיימים וממשקלים קיימים. תופעה זו, שכונתה בשם pseudo-familiarity ע"י מנחת עבודת הדוקטור, פרופ' רות ברמן, היוותה ניגוד מוחלט למקובל בספרות המחקרית לגבי השפה האנגלית, בה מדדי מוכרות משמשים כתחליף תקף למדדי שכיחות. לאור תוצאות אלו, עלה הצורך במדד מהימן יותר שישקף שכיחות. בשלב זה הוכנו שאלוני שכיחות סובייקטיבית על כל 2400 המילים במאגר ברוחם של בלוטה ושותפיו (Balota, Piloti & Cortese, 2001), בהם נתבקשו המשתתפים לדרג את מספר ההיקריות שלהם עם המילה בסולם מ-1 עד 5, כש-1 מצביע על כך שהמשתתף לא נתקל במילה אף פעם ואילו הדירוג 5 מצביע על כך שהמשתתף נתקל במילה לעיתים תכופות. 270 אנשים (9X30) השתתפו בקביעת דירוגי השכיחות, שתוצאתם הייתה שונה לחלוטין מדירוג המוכרות. הציון הממוצע בדירוגי השכיחות היה נמוך באופן מובהק מהציון הממוצע בדירוגי המוכרות, ושיקף נאמנה את הסטאטוס הלקסיקלי של המילים במאגר. לאור התוצאות הבלתי צפיות הללו נערכה התייעצות עם מומחה לסטטיסטיקה, שהציע דרך לשלב בין שני המדדים שנתקבלו ע"י עריכת ממוצע משוקלל שלהם. לאחר התייעצויות עם צוות המחקר במעבדה של הפרופ' ברמן הוחלט אכן להשתמש במדד משוקלל זה בהמשך, שכונה על ידנו "the F-score",

כמדד למוכרות ולשכיחות גם יחד (familiarity/frequency). הרציונל למדד משוקלל זה היה שהוא שילב היטב בין היכרות צורנית עם המילים (שבאה לידי ביטוי בדירוג המוכרות) מחד, ובין היכרות הלקסיקלית עם המילים (שבאה לידי ביטוי במדד השכיחות) מאידך. מדד זה שימש בשלב הבא במחקר כמדד מוכרות/שכיחות מהימן, שהבחירה בו הוכיחה את עצמה בדיעבד כמוצדקת.

במקביל להעברת שאלוני השכיחות, הוכנו גם שאלוני חזותיות, בהם נתבקשו המשתתפים לדרג את המילים ברשימות בסולם מ-1 עד 5, כש-1 הצביע על מילה שאין לה ייצוג חזותי כלל ואילו 5 הצביע על מילה שיש לה ייצוג חזותי ברור. מייד בתחילת העברת השאלונים נתגלו קשיים: אנשים רבים לא סיימו את השאלונים והתלוננו שקשה להם לדרג כל מילה בשאלון בדירוג חזותיות. בעקבות תלונות אלו חולקו השאלונים המקוריים לשניים, כך שכל נבדק נתבקש לדרג רק 130 מילים במקום 260, אולם גם זה לא הועיל. בעקבות תלונות של משתתפים על כך שיש להם קושי אמיתי בקביעת דרגת החזותיות, משתנה שהוא סובייקטיבי ונתון לשונות בין-אישית גבוהה, הוחלט לנסות לבדוק את מידת המוחשיות, משתנה כללי יותר, שקשור בקשר הדוק לחזותיות (Paivio, Yuille & Madigan, 1968). הוכנו שאלוני מוחשיות, שבהם אנשים נתבקשו לקבוע את דרגת המוחשיות של המילים בסולם שנע בין 1 ל-5, כש-1 משמעו לא מוחשי, מופשט ו-5 משמעו מוחשי מאוד. אולם גם במילוי שאלוני המוחשיות עלו קשיים, גם לאחר חלוקתם לשניים. בשלב זה עלו שני גורמים עיקריים לקשיים: א. אנשים התקשו לתת דירוג חזותיות או מוחשיות למילים שאינן מוכרות להן, ובזה הוכיחו, למעשה, שיש תלות בין מוכרות/שכיחות ובין חזותיות/מוחשיות. ב. אנשים התקשו בעיקר לדרג מילים שהיו באמצע סקלת החזותיות/מוחשיות, מילים שאינן מאוד חזותיות/מוחשיות או לא חזותיות/מופשטות (Ravid, 2006b). משום כך הוחלט, בשלב זה, להסתפק בשיפוט מוחשיות למילים שנמצאות בקצוות סקלה, קרי, מוחשיות מאוד או מופשטות מאוד, על ידי צוות שופטים מצומצם. לשם כך, חולק מאגר המילים לשניים והועבר לקבוצה של כ-30 שופטים, רובם קולגות ותלמידי בלשנות, שנתבקשו לעבור על המילים ולסמן את המילים שהן, לדעתם, מוחשיות או מופשטות מאוד. מילים שסומנו על ידי יותר מ-70% מהשופטים נכנסו למאגר המוחשיות. לבסוף גובש מאגר קטן, שהכיל 370 מילים, מחציתן הוערכו כמוחשיות מאוד ומחציתן כמופשטות מאוד. בסיומו של שלב השאלונים, הוכנו, אם כך שני מאגרים: הראשון, מאגר המוכרות/שכיחות ובו היו דירוגים משוקללים למדד זה לכל 2400 המילים, ומאגר נוסף, קטן יותר בהיקפו, של שיפוט מוחשיות, שהכיל 370 מילים, שהוערכו כמוחשיות מאוד או כמופשטות מאוד.

בשלב השלישי תוכננו ונערכו ניסויים כתובים וממוחשבים על פריטים שנבחרו בקפידה מתוך מאגרי המידע. הניסויים הכתובים הכילו סוללה של שבעה מבדקים שונים, שבודקים ידע מילים במילון המנטלי בהיבטים שונים ובדרגות קושי שונות, החל מבחירת מסיחים, שנחשבת למשימה קלה יחסית וכלה במתן הגדרה, שנחשבת למשימה ברמה הגבוהה ביותר של ידע מילים. הבחירה בסוגי המבדקים הכתובים הושפעה במידה מסוימת ממחקרו של אנגלין (Anglin, 1993), שבדק היררכיה של ידע מילים שנדגמו באקראי ממילון של האנגלית בקרב ילדים בכיתות א', ג' וה', כשמתן הגדרה הצביע על ידע מילים מתקדם ביותר, מתן משפט במקרה של קושי לתת הגדרה נחשב נמוך יותר בהיררכיה ואילו בחירה במסיח הנכון מתוך ארבעה מסיחים, במידה שהיה קושי בשילוב המילה

במשפט, הראה על ידע נמוך יותר בהיררכיה. מחקר זה, בשונה מאנגליון, לא בקש לקבוע רמת ידע מילים אינדיבידואלית אצל כל נבדק אלא לתת תמונה רוחבית יותר של המילון המנטלי בגילאים שונים למטלות המייצגות שלבים שונים בהיררכיה, תוך מניפולציה של שלושת המשתנים הבלתי תלויים במחקר זה: שלמות השורש, מוכרות/שכיחות ומוחשיות.

ההשערות לגבי המשתנים הבלתי תלויים היו שמילים משורש מלא, מוכרות/שכיחות יותר או מוחשיות יותר תהיינה קלות יותר לתיחולך וכן שמשתנים אלו יהיו באינטראקציה עם הגיל, כלומר הנבדקים הצעירים ביותר יראו פערים גדולים יותר בין תיחולך מילים משורשים שלמים לעומת שורשים עלולים, מילים מוכרות/שכיחות לעומת מילים לא מוכרות/לא שכיחות, או מילים מוחשיות לעומת מופשטות, והפערים יצטמצמו עם העלייה בגיל.

המבדקים הכתובים התרכזו סביב ארבעה נושאים עיקריים כדלהלן: (1) **קשר בין מילים** – הוכנו שני מבדקי קשר בין מילים, בהם לכל מילת מטרה במחקר הוצמדו ארבעה מסיחים שקשורים אליה בארבעה סוגי קשרים. אדגים זאת באמצעות מילת המטרה *חוכרת*: קשר מורפולוגי (*חבורה*), קשר מורפולוגי וסמנטי (*מחברת*), קשר סמנטי (*פנקס*) וקשר פונולוגי של חריזה (*גברת*). אחד מהמבדקים היה **מבדק בחירה**, ובו נתבקשו הנבדקים לבחור את המסיח הקרוב ביותר למילת המטרה והשני היה **מבדק דירוג**, בו נתבקשו הנבדקים לדרג את כל המסיחים במספרים מ 1-4 לפי חוזק הקשר שלהם למילת המטרה. (2) **מבדק פירוש בהקשר** – במבדק זה ניתנו למבדקים מילים לא מוכרות/לא שכיחות בהקשר של משפט, המספק מידע סמנטי-פרגמטי כללי ביותר, לדוגמה: *כדאי שתהיה מלקחת בכל ארגז כלי עבודה בבית ובבתי מלאכה שונים למילת המטרה מלקחת*. הנבדקים נתבקשו לשער מהי משמעות המילה הלא מוכרת/לא שכיחה. (3) **מבדקי אסוציאציה** – הוכנו שני מבדקי אסוציאציה, האחד מבדק **אסוציאציה יחידה**, בו נתבקשו הנבדקים לכתוב את האסוציאציה הראשונה שעולה בראשם למילת המטרה, והשני מבדק **אסוציאציות מרובות**, בו נתבקשו הנבדקים לכתוב אסוציאציות מרובות ככל האפשר למילות המטרה. (4) שני מבדקים בעלי **אופי תחבירי** – האחד של **חיבור משפטים**, בו נתבקשו הנבדקים לחבר משפט למילת המטרה, והשני של **כתיבת הגדרות**, בו נתבקשו הנבדקים לספק הגדרות של מילות המטרה. מספר הפריטים בכל מבדק נשקל בקפידה והותאם לדרגת הקושי המשוערת של המבדק. במבדק האסוציאציה היחידה, לדוגמה, ניתנו לנבדקים 60 מילות מטרה ואילו במבדק ההגדרות ניתנו 10 מילות מטרה. ההוראות בכל המבדקים היו מינימאליות ככל האפשר וכן לא ניתנו הדגמות או דוגמאות בגוף המבדקים, מתוך מטרה לא להטות את תוצאות המבדקים ולקבל תמונה אמיתית ואינטואיטיבית ככל האפשר של המילון המנטלי של דוברי עברית.

שלב זה של המחקר נערך במבט התפתחותי, תוך השוואה בין שלוש קבוצות גיל, כלהלן. הגילאים שנבחרו למילוי המבדקים הכתובים הם תלמידי כיתה ו', המייצגים את החטיבה העליונה בבני"ס היסודי ונמצאים על "קו התפר" מבחינות רבות, בית ספרית, קוגניטיבית (Piaget, 1970) וחברתית בנוסף לזו הלשונית, תלמידי כיתה י' כמייצגים את גיל תיכון ובשלות לשונית וקוגניטיבית מוגברת (Berman, 2008) וסטודנטים בגילאי 20-30 כמייצגים את הלקסיקון הבשל והבוגר. הזמן שתוכן למילוי המבדקים היה מסגרת של שיעור בבני"ס, כלומר, 40-45 דקות. לאחר מבדקי חלוץ נרחבים התברר שאין אפשרות להשלים את כל המבדקים בפרק זמן זה, לכן חולקו המבדקים לשתי

גרסאות, המקבילות בדרגת הקושי שלהן ובפרק הזמן הדרוש למילוי. חלוקה נוספת של שתי הגרסאות נערכה לתלמידי כיתה ו', שלגביהם עלה החשש שלא יספיקו לסיים במהלך שיעור אחד את המבדקים, בגלל האחוז הגבוה של מילים מופשטות ומילים לא שכיחות במבדקים. בסיכומו של דבר, הועברו המבדקים ל-250 נבדקים ששפת אימם עברית, ללא לקויות למידה ידועות, ממיצב סוציו אקונומי בינוני-גבוה הלומדים בבתי ספר מבוססים במרכז הארץ, לפי הפירוט הבא: 126 תלמידי כיתה ו' מלאו ארבע גרסאות של שאלוני ניסוי, 60 תלמידי כיתה י' ו-64 סטודנטים מלאו שתי גרסאות של שאלוני ניסוי. לאחר שהשאלונים מולאו, הנתונים הוזנו לתוך מסד נתונים מיוחד שהוכן לצרכי מחקר זה, שהכיל כ-18,000 תגובות, מתוכן כ-12,000 באסוציאציות, ובמקביל החלה העבודה על קידוד התוצאות. היות שלא היו סולמות הערכה למבדקים מראש (פרט לשני מבדקי הקשר בין מילים), בגלל אופיו הפתוח והאינטואיטיבי של מחקר זה, הקידוד נבנה בהתאם לתוצאות שנתקבלו. קביעת אופני הקידוד נעשתה באופן "עיוור", בעבודת צוות אינטנסיבית, על פי גיליונות תוצאות שנבחרו באקראי, ללא ציון גיל הנבדקים. לאחר שנקבעו אופני הקידוד, החלה העבודה על הקידוד עצמו, כשכל העבודה התבצעה בצוותים קטנים, של לפחות שני אנשים, שהיו אמורים להגיע להסכמה ביניהם על קידוד התשובות. במקרים רבים, כשהיו חילוקי דעות, צורף אדם נוסף שהכריע את הכף. רוב המחלקות נבעו סביב קידוד האסוציאציות משום שבמקרים רבים היה קשה להכריע את הכף באיזה סוג של יחס מדובר – האם סמנטי/פרגמטי ומאיזה סוג, או שמא ביחס סינטגמטי, כלומר יחסים שיש בהם אלמנט תחבירי. האסוציאציה בניין למילה חומר, לדוגמה, מדגימה דילמה זו היטב, משום שניתן לקודדה הן כקשר סינטגמטי המובע ע"י צירוף סמיכות, הן כקשר סמנטי המתאר פריט מקטגוריה והן כקשר פרגמטי, הנובע מסיטואציה משותפת.

חלקו השני של השלב השלישי במחקר יוחד לניסויי הטרמה (priming) ממחשבים, שנערכו באוניברסיטת חיפה, לאחר ניסיונות חוזרים ונשנים שלא צלחו לערכם במעבדת הבית בתל אביב. המילים ששימשו לניסויים אלה היו לרוב זהות למילים ששימשו למבדקים הכתובים של קשר בין מילים, כשהרציונל מאחורי מערך זה היה לבדוק את המילון המנטלי של דוברי עברית בשני היבטים משלימים, אחד יותר מבוקר ומודע (המבדקים הכתובים) והשני יותר סמוי ופחות מודע (ניסויי הטרמה). מבדקים אלה היו מבדקי Lexical Decision, בהם הנבדקים ראו רצפי אותיות על המסך ונתבקשו להחליט במהירות ככל האפשר האם רצפי אותיות אלה מהווים מילה בעברית. לשם כך נוספו למילות הניסוי מספר זהה של מילות טפל, שאינן קיימות בשפה העברית. במהלך הניסוי, מעט לפני הקרנת מילת המטרה על המסך, נחשפו הנבדקים בזמן חשיפה קצר מאוד, לרוב באופן לא מודע, למילת הטרמה (prime) שקשורה למילת המטרה באחד מן הקשרים הבאים: מורפולוגי, מורפולוגי וסמנטי, סמנטי או אינה קשורה כלל, כשהמסיחים מניסויי הקשר בין מילים שימשו בניסוי זה כמילות הטרמה. הניסויים נערכו בשני תנאי ניסוי: זמן חשיפה קצר יותר (50 מילישניות) וזמן חשיפה ארוך יותר (100 מילישניות). 120 סטודנטים השתתפו בניסויים אלה, שנערכו בפקוח צוות טכני מיומן מאוניברסיטת חיפה.

פרק ג' – תוצאות

חלק זה של התקציר המורחב יסקור בקצרה את התוצאות הבולטות במחקר. נתקבלו אלפי תוצאות, שנותחו בסוגים שונים של ניתוחים (המוצגים בפרק התוצאות בעבודה ב-67 גרפים ו-41 טבלאות), מכאן שתקצר היריעה בתקציר זה לפרט את כולן. בכל זאת אנסה לתמצת את העיקריות בהן לפי ארבעת סוגי המטלות שצוינו לעיל.

במבדק הראשון מבין מבדקי הקשר בין מילים, בו נתבקשו הנבדקים לבחור את המסיח הקשור ביותר למילת המטרה, המסיח הסמנטי הועדף על פני המסיחים האחרים, ואחריו המורפו-סמנטי, המורפולוגי והפונולוגי. נתגלו אינטראקציות בין סוגי התשובות ובין כל המשתתפים הבלתי תלויים במבדק זה -- שלמות השורש, מוכרות/שכיחות וגיל הנבדקים כדלהלן: אחוז המסיחים הסמנטיים היה גבוה יותר למילים עם שורש מלא, למילים מוכרות/שכיחות ואצל נבדקים מבוגרים. כמו כן היו אינטראקציות בין גיל הנבדקים ובין שלמות השורש והשכיחות, שהראו עקומת התפתחות מדורגת ויציבה למילים מוכרות/שכיחות ולמילים משורש מלא לעומת עקומת התפתחות פחות מדורגת וברורה למילים לא מוכרות/לא שכיחות ולמילים משורש עלול. ההיררכיה במבדק השני מבין מבדקי הקשר בין מילים, מבדק הדירוג, הייתה שונה ובלתי צפויה – מסיחים מורפולוגיים קיבלו את הדירוג הגבוה ביותר, אחריהם מורפו-סמנטיים, סמנטיים ולבסוף המסיחים הפונולוגיים, שדורגו כבעלי הקשר החלש ביותר. הייתה אינטראקציה במבדק זה עם מוכרות/שכיחות, שבאה לידי ביטוי בדירוגים גבוהים יותר למילים שכיחות. הקווים המשותפים לשני המבדקים היו: (1) השפעה בולטת של מוכרות/שכיחות, (2) הנחיתות המספרית של המסיחים הפונולוגיים, הן באחוז הבחירה והן בדירוגים, המראה על כן שבמילון המנטלי של דוברי עברית יש העדפה ברורה לקשרים מורפולוגיים ולא פונולוגיים.

התוצאה הבולטת ביותר במבדק פירוש המילים בהקשר, שהיה היחיד בכל סוללת המבדקים הכתובים בו ניתנה לנבדקים מילת מטרה לא מוכרת/לא שכיחה בהקשר של משפט, הייתה ההשפעה הבולטת של ההקשר, שהיה כללי ומינימאלי, על תגובות הנבדקים. במבדקים אחרים בסוללה הכתובה, שהכילו מילים לא מוכרות/לא שכיחות במבודד, נטו הנבדקים לפרק מילים לא שכיחות לרכיביהן ולשימוש מוגבר באמצעים מורפולוגיים. במבדק זה, לעומת זאת, הייתה העדפה גורפת, שעלתה עם העלייה בגיל, לתשובות המבוססות על אינפורמציה סמנטית-פרגמטית שניתנה במשפט. היה אפקט לשלושת המשתתפים הבלתי תלויים במבדק זה, שלמות השורש, מוחשיות וגיל הנבדקים והופיעו אינטראקציות בין כל המשתתפים. בנוגע לשורש, הנבדקים נטו "להעז" יותר באינטרפרטציה שלהם למילים לא מוכרות/לא שכיחות משורשים שלמים, ולהיצמד יותר למשמעות המקובלת של מילים משורשים עלולים – ממצא המצביע על תופעה שעברה כחוט השני במחקר זה – של השימוש בשורש השלם כאל מעין נקודת מוצא מבנית או עוגן להיתלות עליו בחיפושים אחר משמעות. הייתה השפעה גם למוחשיות, כפי שנצפה, אולם ההשפעה הייתה שונה מהמתואר בספרות המחקרית, העוסקת בעיקר ביתרון של מילים מוחשיות על מופשטות (Concreteness Effect). במבדק זה הנבדקים נטו יותר להישען על אינפורמציה סמנטית-פרגמטית למילים מוחשיות ואילו באינטרפרטציה למילים המופשטות נעזרו גם בשורש המילה בנוסף למידע הסמנטי-פרגמטי. יתרון מובהק למילים מוחשיות נמצא רק בכיתה ו', יתרון שהצטמצם עם העלייה בגיל.

שני מבדקי האסוציאציות, שהניבו מעל 10,000 תגובות, סיפקו מידע רב ומגוון על המילון המנטלי של דוברי עברית, הרבה מעבר למשוער. רוב האסוציאציות שניתנו, בערך שני שלישים מהן, היו סמנטיות-פרגמטיות, רבע היו אסוציאציות מבוססות שורש, והשאר אסוציאציות סינטגמטיות (קולוקציות, צירוף שימני מורחב, צירופי סמיכות) ומבוססות משקל משותף או דמיון פונולוגי. בדיקה לעומק של האסוציאציות הסמנטיות-פרגמטיות הניבה יחסים שונים, החל מאסוציאציות המבוססות על ידע עולם והיקרות משותפת (למשל, *דירה – משכנתא*), דרך קשרים הנחשבים סמנטיים מובהקים כמו סינונימים (*דיון – משא ומתן*), מתן קטגוריית-על (*חצאית – לבוש*) ועוד שלל יחסים שונים, שתקצר היריעה לתארם בתקציר זה. הייתה השפעה של כל המשתנים הבלתי תלויים במבדקים אלה: שלמות השורש, מוכרות/שכיחות, מוחשיות וגיל הנבדקים, הן על התפלגות האסוציאציות והן על תתי-הקטגוריות הרבות והמגוונות, שנבנו בהתאם לגיליון הנתונים העשיר של מבדקים אלה. שוב, ניכרה השפעה של שלמות השורש בנטייה לתת יותר אסוציאציות סמנטיות וסינטגמטיות ולהעז יותר באסוציאציות למילים משורש מלא, לעומת יותר אסוציאציות פונולוגיות למילים משורש עלול, שהראו על קושי "דליית" עיצורי השורש (למשל, האסוציאציה *בניין מהשורש בני* למילת המטרה *בוננות* מהשורש *בו*). השפעת המוכרות/שכיחות הייתה חזקה מאוד והובילה למספר גבוה יותר של אסוציאציות למילים מוכרות/שכיחות, לאחוז גבוה של אסוציאציות סמנטיות-פרגמטיות וסינטגמטיות למילים מוכרות/שכיחות לעומת אחוז לא מבוטל של אסוציאציות מבניות, מורפולוגיות או פונולוגיות למילים לא שכיחות. תופעה נוספת, שיוחדה רק למילים לא מוכרות/לא שכיחות, הייתה הופעתן של אסוציאציות "מתווכות" (mediated), בהן מבנה המילה שימש כמתווך למילה מוכרת/שכיחה או לשורש מוכר/שכיח אחר, שהיה המקור לאסוציאציה, לדוגמה, האסוציאציה *צלצל למילת המטרה פעמן* (מטרונום) דרך תיווך של המילה *פעמן*, או האסוציאציה *פיל* למילת המטרה *גדיל*, בתיווך השורש *גדל*. גם למוחשיות הייתה השפעה בולטת על סוג האסוציאציות, כשמילים מוחשיות הניבו יותר אסוציאציות המבוססות על ידע עולם ועל היקרות משותפת ואילו מילים מופשטות הניבו יותר אסוציאציות סינטגמטיות ויותר סינונימים (מילים נרדפות). גיל הנבדקים השפיע גם הוא על כל סוגי הניתוחים, והוא נמצא באינטראקציה עם כל יתר המשתנים הבלתי תלויים האחרים והניב תוצאות רבות -- הבולטות ביותר ביניהן, עלייה בכמות האסוציאציות עם העלייה בגיל, ועלייה באסוציאציות הסמנטיות-פרגמטיות במקביל לירידה באסוציאציות הצורניות עם העלייה בגיל. תוצאה מעניינת נוספת הייתה עלייה עם הגיל באחוז האסוציאציות השמניות, כלומר אסוציאציות שהן באותה קטגוריה לקסיקלית של מילות המטרה, תוצאה שלא עולה בקנה אחד עם המושג Syntagmatic-Paradigmatic Shift, שמתואר בספרות (Inhelder & Piaget, 1964). לפי התיאוריה של אינהלדר ופיאז'ה, ילדים עד גיל 8 נוטים לתת אסוציאציות סינטגמטיות, שאינן באותה קטגוריה תחבירית של מילת המטרה (לדוגמה, *כלב – נבח*) ואילו מעל גיל 8 חלה "קפיצה" (shift) קונספטואלית, שניתן לראותה באסוציאציות פרדיגמטיות, דהיינו, אסוציאציות מאותה קטגוריה לקסיקלית של מילת המטרה (לדוגמה, *כלב – חתול*), המעידה על עליית מדרגה בבשלות קוגניטיבית. התוצאות במבדקי האסוציאציות, שהראו על עלייה הדרגתית באחוז האסוציאציות הפרדיגמטיות, בגילאים שהיו אמורים, לכאורה, להיות כבר אחרי קפיצת המדרגה הזאת, מעידה על כך שההתפתחות

הסמנטית-קונספטואלית אינה מתרחשת ב"קפיצות" אלא בהדרגה, ושהיא נמשכת גם מעבר לגיל 8. בנוסף, במבדקים הללו, כמו במבדקים רבים אחרים בסוללה, ניכרו הבדלים בולטים בין תלמידי כיתה ו' לבין הבוגרים מהם ברוב הניתוחים, דבר המעיד על כך שבמונחים של התפתחות שפה מאוחרת, תלמידי כיתה ו' הם עדיין רחוקים מלהגיע לבשלות.

התוצאות של מבדק חיבור המשפטים, בו נתבקשו הנבדקים לחבר משפטים לשמות גזורים נותח בשלושה סוגי ניתוחים. הניתוח הראשון בדק את רמת ההבנה של השם הגזור, והראה רמת הבנה גבוהה, יחסית, שעלתה עם הגיל, וכן אחוזי הבנה גבוהים יותר למילים משורש שלם, למילים מוכרות/שכיחות ולמילים מוחשיות. הניתוח השני, שבדק את מורכבות הצירוף השימני במשפט גילה שמילים משורשים עלולים וכן מילים מופשטות, נוטות יותר להופיע בצירוף שימני מורכב, וכן, שיש עלייה באחוז הצירופים השימניים המורכבים עם העלייה בגיל. בניתוח השלישי נבדק מיקומו של השם הגזור במשפט ונמצא ששמות משורשים שלמים, שמות מוחשיים נטו להופיע יותר בעמדה פוסט-ורבלית (דהיינו לאחר הנשוא) ואילו שמות משורשים עלולים ושמות מופשטים נטו יותר להופיע בעמדה פרה-ורבלית (דהיינו, לפני הנשוא).

מבדק ההגדרות גם כן נותח בשלושה היבטים שונים: סמנטי, תחבירי ומבני. בניתוח הסמנטי נבדקה נוכחות קטגורית-על, שהיא אחד הרכיבים המובהקים של הגדרה טובה. אחוז קטגוריות העל עלה עם הגיל, וכן היה שונה באופן מובהק בין מילים מוחשיות, שנטו לקבל קטגוריית-על, ובין מילים מופשטות, שההגדרות להן הכילו ברובן סינונימים. בניתוח התחבירי נבדקה נוכחותם של משפטי זיקה, שגם הם מהווים אבן דרך לבניית הגדרה טובה, וגם כאן הייתה עלייה עם הגיל באחוז משפטי הזיקה ואחוז גבוה יותר של משפטי זיקה למילים מוחשיות, שמראה, שוב על ממשק סמנטיקה-תחביר. בניתוח המבני, שבדק האם מבנה ההגדרה היה מהודק או חזרתי -- בכך שהכיל את מילת המטרה או מילה הקרובה לה מורפולוגית -- נמצאה פחות חזרתיות עם העלייה בגיל וכן בהגדרות למילים משורש מלא ולמילים מוחשיות. אם כן, גם במבדק ההגדרות נמצא ממשק בין סמנטיקה לתחביר, כפי שנמצא במבדק המשפטים, ונמצאה השפעה בלתי צפויה של השורש ברוב סוגי הניתוחים. הניבוי היה שהשורש ישמש גורם מרכזי בעיקר בתיהלוך מילים לא מוכרות/לא שכיחות, אולם מבדק ההגדרות הכיל בודיעין מילים מוכרות/שכיחות, לכן התוצאות הפתיעו במיוחד. לסיכום, לכל המשתתפים הבלתי תלויים במחקר זה (שלמות השורש, מוכרות/שכיחות, מוחשיות וגיל הנבדקים) הייתה השפעה כמעט על כל סוגי הניתוחים בכל המטלות במערך, וכן ניכרו אינטראקציות רבות ביניהם. תוצאות מעניינות במיוחד הן השפעה בלתי צפויה של שלמות השורש בכל סוגי הניתוחים וממשק חזק בין הסמנטיקה לתחביר, שמראה על כך שסדר המילים במשפט נקבע במידה רבה ע"י סוג שם העצם המשמש כגרעין לצירופים השמניים המשמשים להרכבתו.

לתוצאות של מבדקי ההטרמה הממוחשבים היו שני סוגי ניתוח. הניתוח הראשון, של משימת ההחלטה הלקסיקלית (Lexical Decision), הראה הבדלים מובהקים בין מילים מוכרות/שכיחות ומילות טפל מצד אחד, לבין מילים לא מוכרות/לא שכיחות מצד שני, הן בפרק הזמן הנדרש להגיע להכרעה (664 מילישניות למילים מוכרות/שכיחות לעומת 899 מילישניות למילים לא מוכרות/לא שכיחות) והן באחוזי הדיוק (כמעט 100% למילים מוכרות/שכיחות לעומת פחות מ-50% למילים לא מוכרות/לא שכיחות). נתונים אלה סיפקו מידע בזמן אמיתי (on-line) על הקושי של דוברי עברית

להתמודד עם המילים הלא מוכרות/הלא שכיחות, שהן, מבחינות רבות קשות יותר לתיחולך אף ממילות הטפל, משום שהכילו שורשים קיימים משורגים לתוך משקלים קיימים, ובכך יצרו מילים פוטנציאליות (Aronoff, 1976) שמעמדן הלקסיקלי מוטל בספק. הנתונים מעידים על כך שהנבדקים אכן התקשו להגיע להחלטה האם מה שהם רואים על המסך הוא מילה קיימת או לא קיימת בלקסיקון העברי, ובמקרים רבים ההחלטה הייתה אקראית. ניתוח שני, של השפעת ההטרמה, היה מוגבל בהיקפו והראה סוגים שונים של הטרמה, חלקם צפויים יותר וחלקם צפויים פחות. ההטרמה העקבית ביותר שתועדה היא של כל סוגי המילים המטרימות (primes), הקשורות למילת המטרה, למילים שכיחות משורשים שלמים בזמן החשיפה הארוך, של 100 מילישניות, דבר המעיד על כך שיש ממשות פסיכולוגית לכל סוגי הקשרים, הן מורפולוגי, הן מורפו-סמנטי והן סמנטי, במילון המנטלי של דוברי עברית.

פרק ד' – דיון בתוצאות המחקר

לדיון היו שלושה חלקים עיקריים, הראשון שבהם דן בתוצאות המבדקים אחד לאחד וניסה להסביר אותן תוך כדי השוואה לספרות המחקרית. החלק השני דן במשתנים הבלתי תלויים במחקר זה תוך כדי השוואה עם הספרות. תחילתו של החלק השלישי יוחדה לממצאים לא צפויים של מחקר רחב-היקף זה, שנתגלו כבעלי חשיבות וסיפקו תובנות על המילון המנטלי של דוברי עברית. וסופו של פרק אחרון זה יוחד למבט מחודש על המילון המנטלי לאור ממצאי העבודה כולה.

בחלקו הראשון של הדיון הושוו תוצאות המבדקים להשערות המחקר ובכולם, כמעט ללא יוצא מן הכלל, התוצאות התאימו לתחזיות הראשונות מצד אחד ומצד שני עלו תוצאות רבות שלא נצפו מראש. אחת הסיבות לשלל התוצאות הבלתי צפויות הייתה שרובם של המבדקים במחקר זה, פרט למבדק חיבור המשפטים ולמבדק ההגדרות, היו חדשנים מבחינה מחקרית ולא תועדו בספרות עד כה, למיטב ידיעתי – לא כל שכן בשפה העברית. הסיבה השנייה לשפע התוצאות המעניינות הייתה שהמחקר לא נשא אופי אבלואטיבי במהותו, לא הוכנו סולמות הערכה וציינון מראש ולא הייתה שאיפה לקבלת תגובות מסוג מסוים. ההיפך הוא הנכון, סולמות הקידוד והציינון נבנו בכוונה כאמור על סמך תגובות הנבדקים עצמם לאחר דיונים ממושכים בצוות המחקר. מבדקי הקשר בין מילים, לדוגמה, הם חדשנים בכך שהקשרים שהוצגו לנבדקים הם גם סמנטיים וגם צורניים (מורפולוגיים ופונולוגיים) לבחירה. מחקרים רבים שעסקו בקשר בין מילים התמקדו בסוגים שונים של קשרים סמנטיים אך לא עסקו בפן התורני והתכני בחפיפה אחת (Luciarello & Nelson, 1985; Waxman & Namy, 1997). ההשערה שהנבדקים יעדיפו קשרים סמנטיים על פני קשרים צורניים אוששה במבדקים אלה, אולם ההעדפה של מסיחים מורפולוגיים על פני מסיחים פונולוגיים היא ממצא חדש ומעניין, שלא נצפה מראש, משום שלפונולוגיה, לפחות בשפה האנגלית, יש מקום מרכזי במודלים שונים לתיחולך לקסיקלי (לדוגמה, Levelt, Roelofs & Meyer, 1999). גם במבדק פירוש המילים הלא מוכרות/לא שכיחות בהקשר של משפט אוששה ההשערה המרכזית שאחוז הפירושים הסמנטיים-פרגמטיים יעלה עם הגיל ויהיה באינטראקציה עם המשתנים הבלתי תלויים האחרים מחד, אולם היו השפעות שלא נצפו מראש של השורש והמוחשיות מאידך; שני משתנים אלה לא השפיעו כמותית, על אחוז התשובות הנכונות, אלא איכותית, על סוגי התשובות. מבדק פירוש המילים

בהקשר גם הוא חדשני בכך שעימת היבטים סמנטיים-פרגמטיים עם היבטים מורפולוגיים של ידע מילים בהקשר של משפט. מחקרים שנערכו על מילים לא מוכרות/לא שכיחות בהקשר בשפה האנגלית עסקו בעיקר בהיבטים הסמנטיים וקונטקסטואליים (לדוגמה, Shore & Kempe, 1999) ונתנו משקל מועט להרכב המורפולוגי של המילה הלא מוכרת, ואילו במבדק זה נמצא שלסוג השורש יש השפעה מובהקת על סוג האינטרפרטציה שניתן. במבדקי האסוציאציות גם כן אוששו ההשערות המרכזיות, שלמילים מוכרות/שכיחות תהיינה יותר אסוציאציות סמנטיות-פרגמטיות ולמילים לא מוכרות/לא שכיחות תהיינה יותר אסוציאציות מורפולוגיות, וכך שתהיינה השפעות של כל המשתנים הבלתי תלויים. הפן החדשני במבדק זה היה שהוא בדק את תכני האסוציאציות עצמם כ"חלון הצצה" אל המילון המנטלי, ולא הסתפק רק במתן נורמות לאסוציאציות, כפי שמקובל בספרות המחקרית (Henik, Rubinstein, & Anaki, 2005; Nelson, McEvoy & Schreiber, 2004). שפע הקווים לדמותו של המילון המנטלי, שבאו לידי ביטוי בולט ביותר במבדקים אלו, שהיו פתוחים באופיים, היו מעניינים ובחלקם הגדול מפתיעים. בנוסף לממצא של העלייה ההדרגתית עם הגיל באסוציאציות שמניות, שהוזכר קודם, ממצא מעניין נוסף היה הגיוון העצום באסוציאציות למילים שכיחות, שהעידו על הקושי להפריד בין יחסים סמנטיים טהורים המבוססים על ידע המילה לבין יחסים פרגמטיים המעוגנים בידע העולם, הפרדה שנראית מלאכותית לאור תוצאות מחקר זה. שני ממצאים נוספים ראויים לציון באסוציאציות למילים לא מוכרות/לא שכיחות היו האסוציאציות ה"מתווכות" (mediated) והאסוציאציות הצורניות, המבוססות על דמיון מורפולוגי ו/או פונולוגי למילת המטרה. באסוציאציות ה"מתווכות" ניכרה השפעתו העצומה של השורש כמתווך בין מילים, בשונה מהמתואר בספרות המחקרית למילים בשפה האנגלית (Chaffin, 1997). האסוציאציות הצורניות היו, למעשה, מקבילות לאסוציאציות לא טיפוסיות המתוארות בתחום בריאות הנפש (Kent & Rosanoff, 1910), ובכך נמצאה השוואה בין אסוציאציות צורניות הניתנות ע"י אוכלוסיה לא טיפוסית ובין אסוציאציות צורניות הניתנות ע"י אוכלוסיה תקינה בהיעדר ידע סמנטי-פרגמטי. התוצאות במבדק המשפטים היו צפויות ברובן הגדול, משום שהתבססו על מחקר דומה קודם של מחברת מחקר זה (Seroussi, 2004) והן על מחקרים רבים על השיח הרצוף בהנחייתה של רות ברמן, כפי שמפורט בביבליוגרפיה. ההשערה שאחוזי ההבנה של מילת המטרה יעלו עם הגיל אוששה, וכך אוששו ההשערות שתהיה אינטראקציה בין הבנת מילת המטרה ובין מוכרות/שכיחות ושתהייה השפעה של מוחשיות על סוג הצירוף השמני ועל מיקומה של מילת המטרה במשפט. כל הממצאים הללו נתנו תוקף כמותי לניתוח האיכותי שבוצע במחקרי מ-2004, וכך נתנו תוקף לממצאים של מחקרי השיח ברמה של משפט בודד (Berman, 2008; Ravid & Berman, 2010). השורש שוב הראה השפעה גורפת, שחלקה שוער מראש וחלקה לא שוער מראש, למשל התלות בין שלמות השורש ובין מורכבות הצירוף השימני ומיקומה של מילת המטרה במשפט. המבדק הכתוב האחרון בסוללה, מבדק ההגדרות הניב תוצאות שרובן נצפו מראש, כמו העלייה עם הגיל במשפטי הזיקה ובקטגוריית העל ואינטראקציה עם מוחשיות. יחד עם זאת, ההשפעה של השורש כמעט בכל ניתוח ובמיוחד על ההידוק המבני של ההגדרה הייתה בלתי צפויה, וכמוה ההכרה שיש שני מסלולים נפרדים במילון המנטלי,

האחד להגדרת מילים מוחשיות והשני להגדרת מילים מופשטות. נקודה מעניינת נוספת בהקשר למבדק זה היא שבמחקר הנוכחי, בניגוד כמעט לכל המחקרים המתוארים בספרות, לא היו כאמור סולמות הערכה שנקבעו מראש, ובכל זאת הייתה קורלציה גבוהה בין שלושת הניתוחים שנערכו במחקר זה, ששלושתם גם יחד מהווים סימן מובהק להגדרה בשלה. כלומר, הניתוחים שנערכו במחקר זה, שגובשו בעקבות הנתונים עצמם, הוכיחו את עצמם כשווי ערך לסולמות הערכה שנקבעו מראש במחקרים אחרים. מבדקי ההטרמה הממוחשבים הניבו גם הם תוצאות צפויות ובלתי צפויות. ההשערה הייתה שבמשימת ההחלטה הלקסיקלית (Lexical Decision) יקשה על הנבדקים להתמודד עם מילים לא מוכרות/לא שכיחות, אולם עצמת הקושי לא נצפתה מראש. כמו כן כל הקשיים בדרך, שאילצו לשנות את מערך המחקר כמה וכמה פעמים ולהעבירו לבסוף אוניברסיטת חיפה לא נצפו מראש.

החלק השני בדיון סיכם את התוצאות לאור המשתנים הבלתי תלויים במחקר זה. ראשית נדון תפקידו של השורש במילון המנטלי של דוברי עברית, שהתברר כחשוב מאוד גם בניתוחים שנראו, לכאורה, לא קשורים לתפקיד השורש כמו ניתוחים תחביריים. שנית, התברר שלהבחנה בין שורשים שלמים ועלולים יש השלכות לתחומים לשוניים אחרים, עד כדי קורלציות בין שורשים שלמים ובין תעוזה סמנטית ובין שורשים עלולים, פחות תעוזה סמנטית והיצמדות לפונולוגיה. המשתנה הבלתי-תלוי השני, מוכרות/שכיחות, נדון בהקשר לבעייתיות המוצגת בספרות המחקרית כשמתבססים על מדדים אובייקטיביים של היקריות במאגרים (corpora). בדיקה אחד לאחד של פריטים לא שכיחים במחקרים אחרים, שנלקחו בעיקר ממחקרים בשפה האנגלית, הראתה הבדלים בולטים עד כדי תהומיים בין המחקרים (Nelson & McEvoy, 2000) ובין המחקר הנוכחי, בו היו מילים מאוד לא מוכרות/לא שכיחות, כאלה שמעמדן הלקסיקלי לא היה ברור לנבדקים. בנוסף, במחקר זה נמצאו קורלציות בין מוכרות/שכיחות ובין סמנטיקה, ממצא התומך בעמדתם של באיין ועמיתיו (Baayen, 2006), הטוענים שהמקור למוכרות/שכיחות הוא סמנטי. עוד ממצא מעניין שהתגלה קודם לכן, בשלב שאלוני המוכרות/שכיחות הוא הרגישות של מדדים אלה למאפיינים טיפולוגיים, למשל, למקור ההיסטורי של השם הגזור, לסוג הגזירה ולמערכת בנייני הפועל. שמות הפעולה הסדירים של בניין נפעל שהיו במאגר השכיחות, לדוגמה, דורגו כמוכרים/שכיחים פחות במובהק משמות פעולה סדירים מבניינים אחרים. בנוגע למשתנה הבלתי-תלוי השלישי במחקר זה, משתנה המוחשיות, לא נתגלה יתרון חד-משמעי של מילים מוחשיות על פני מופשטות, כפי שמתואר במרבית המחקרים, אלא נסתמנו מסלולים שונים לתיהלוך מילים מוחשיות ומופשטות, שמתגבשים במהלך ההתפתחות המאוחרת ומשתנים גם בהתאם להקשר. היתרון הבולט של המוחשיות נתגלה כאמור בעיקר אצל תלמידי כיתה ו', שנשענו על מאפיין זה יותר מהבוגרים מהם. המשתנה הבלתי-תלוי הבא, משתנה הגיל, העלה תובנות מגוונות. ראשית, ההבדלים בין קבוצות הגיל השונות כמעט בכל סוגי הניתוחים, הצביעו כל כך שהתפתחות השפה המאוחרת היא תהליך ממושך, שלא בא אל קיצו עד הבררות. במקרים רבים תלמידי כיתה ו' היו שונים באופן בולט מהנבדקים המבוגרים יותר ובמקרים אחרים עקומת העלייה עם הגיל הייתה הדרגתית יותר. משתנה הגיל נמצא באינטראקציה ברוב הגורף של המקרים עם כל המשתנים האחרים, כך שנבדקים צעירים יותר הצליחו יותר עם

מילים משורש מלא, מילים שכיחות ו/או מילים מוחשיות. חיפוש נרחב אחר מחקרים שעסקו בנושאים דומים ובגילאים דומים בשפה האנגלית, לדוגמה, הניב תוצאות דלות, משום שרוב המחקר בשפה האנגלית מתרכז בגילאים הצעירים. בשפה העברית, לעומת זאת, יש גוף נכבד של מחקרים העוסקים בהתפתחות מילונית-מורפולוגית מאוחרת (Avivi Ben-Zvi, 2010; Ravid & Avidor, 1998; Seroussi, 2002). תוצאות המחקר עלו בקנה אחד ונתנו תוקף נוסף מנקודת ראות שונה למחקרים אלו.

בחלק האחרון בדיון הועלו בתחילה נושאים שהייתה להם ההשפעה בלתי צפויה על תוצאות המחקר, הבולט שבהם היה הניקוד. כדי למנוע קושי בפענוח המילים, שרובן הוצגו לנבדקים במבודד וללא הקשר, נוקדו מילות המחקר בניקוד תקני, כפי שנהוג במילונים. כבר בשלב שאלוני המוכרות/שכיחות נראה היה שלנבדקים יש קושי בפענוח סימני ניקוד לא שכיחים. הקושי הזה נמשך ועלה גם בשלב השלישי של המחקר, הן במבדקים הכתובים, בהם נבדקים נטו להתעלם מסימני ניקוד לא שכיחים או לקרוא אותם לא נכון (לדוגמה, כשקראו את המילה נִפֵּשׁ, מִפְּשׁ). גם בניסויי ההטרמה הממוחשבים, בהם לא היה אפקט הטרמה למילים מנוקדות, חזר אפקט זה והופיע לאחר הסרת הניקוד. בעקבות קשיים בלתי צפויים אלה עם הניקוד יוחד דיון נרחב לנושא זה, בעיקר להשפעת מערכת הניקוד על קוראי העברית מבחינה פסיכולינגוויסטית. בהמשך חלק שני זה של פרק הדיון נידונו מחדש נושאים שהועלו בהקדמה לאור תוצאות מחקר זה. נערכה השוואה חוזרת בין מילונים קונבנציונליים והמילון המנטלי בסוגיית השורש ובסוגיית הממשות הפסיכולוגית של מילים, ונדונה גם השאלה אילו מודלים לייצוג מורפולוגי, לייצוג סמנטי ולייצוג יחסי הגומלין בין מורפולוגיה וסמנטיקה מתאימים לתוצאות מחקר זה. המסקנות העיקריות היו: (1) בעוד מילונים אינם אחידים בגישתם לשורש, דוברי העברית מראים רגישות לשורש ולמשפחות מילים מאותו השורש, אך רגישות זו מותנית בגורמים סמנטיים ופונולוגיים; (2) למילים רבות הרשומות במילונים אין ממשות פסיכולוגית בקרב דוברי העברית (לפחות אלה הלא מומחים); (3) דוברי עברית גוזרים מילים הן משורשים והן ממילים שלמות; (4) קשה להפריד בין יחסים סמנטיים ופרגמטיים במילון המנטלי של דוברי עברית, וההפרדה הזאת תלויה במידה רבה במידת המוחשיות; (5) תוצאות מחקר זה שיקפו את רגישות דוברי העברית לגורמי השכיחות, העקביות והסדירות. היחס לשורש, לדוגמה, ניתן להדגמה בהיררכיה הבאה: השורש המובחן ביותר הוא בעל שקיפות מורפולוגית וסמנטית (דהיינו שורש תלת-עיצורי שלם עם משמעות צפויה), מתחתיו בהיררכיה נמצא שורש פחות מובהק, למשל, שורש בעל שקיפות מורפולוגית ועמימות סמנטית (דהיינו שורש תלת-עיצורי שלם עם משמעות בלתי צפויה), נמוך ביותר בהיררכיה נמצא שורש שהוא עמום הן מורפולוגית והן סמנטית (דהיינו שורש עלול עם משמעות בלתי צפויה). היררכיה זו מתאימה לעקרונות למידה קונקשיוניסטיים (Gonnerman et al., 2007), שבהם הכללות מעין אלה נוצרות מתוך חשיפה והתנסות של המערכת.

אוניברסיטת תל-אביב

הפקולטה למדעי הרוח ע"ש לסטר וסאלי אנטין
בית הספר למדעי התרבות ע"ש שירלי ולסלי פורטר

יחסי צורה-משמעות במילון המנטלי של דוברי עברית

חיבור לשם קבלת התואר "דוקטור לפילוסופיה"

מאת

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הוגש לסנאט של אוניברסיטת תל-אביב
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